Freeman Diversion

Multiple Species Habitat Conservation Plan

United Water
CONSERVATION DISTRICT

"Conserving Water Since 1927"

June 30, 2020

Freeman Diversion

Multiple Species Habitat Conservation Plan

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ACRONYMS AND ABBREVIATIONS

AF	acre feet
afy	acre feet per year
AWRM	alternative water resources management
BFP	Adult Migration Base Flow Protocol
BMP	best management practice
BO	Biological Opinion
ca.	circa (approximately)
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CM	conservation measure
CNDDB	California Natural Diversity Database
CWA	Clean Water Act
cfs	cubic feet per second
CUP	Conditional Use Permit
DPS	Distinct Population Segment
DWR	Department of Water Resources
EIR	Environmental Impact Report (in accordance with CEQA)
EIS	Environmental Impact Statement (in accordance with NEPA)
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
FOM	Freeman Operations Model
g	gallon
GIS	Global Information Systems
GMA	Groundwater Management Association
gpm	gallons per minute
HCP	habitat conservation plan
HOSS	Hydrologic Operations Simulation System

HRMP	Habitat Restoration and Management Plan
IA	Implementing Agreement (first noticed in 9.3.1 w/o definition)
IR	infrared (thermal detection)
ITP	incidental take permit
LADPW	Los Angeles Department of Public Works
LADWP	Los Angeles Department of Water and Power
LSAA	Lake or Streambed Alteration Agreement
Ma	million years ago
MBTA	Migratory Bird Treaty Act
MGD	million gallons per day
mg/L	milligrams per liter
mm	millimeters
MSHCP	multiple species habitat conservation plan
mi	miles
NAP	Noise Abatement Protocol
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
NTUs	nephelometric turbidity units
O-H	Oxnard-Hueneme
O&M	operations and maintenance
PTP	pumping trough pipeline
PV	Pleasant Valley
PVCWD	Pleasant Valley County Water District
RCC	roller-compacted concrete
RM	river miles
RPA	Reasonable and prudent alternative
RPM	Reasonable and prudent measure
RV	recreational vehicles
RWQCB	Regional Water Quality Control Board
SAC	Stakeholder Advisory Committee

SCADA	Supervisory Control and Data Acquisition
SCREMP	Santa Clara River Enhancement and Management Plan
SHPO	State Historic Preservation Officer
SMP	Smolt Migration Plan
SSC	suspended sediment condition
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TMDL	total maximum daily load
TNC	The Nature Conservancy
TRP	Turn-in Rate Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
United	United Water Conservation District
VCWPD	Ventura County Watershed Protection District
VFD	variable frequency drive
VFP	Adult Migration Variable Flow Protocol
YOY	young-of-the-year (juvenile fish less than a year old)
WOTUS	waters of the United States

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GLOSSARY OF TERMS

Aestivate To spend a prolonged hot or dry period (e.g. summer) in a dormant state similar to hibernation.

Affected Reach The reach of the mainstem Santa Clara River from the Freeman Diversion downstream through the estuary (i.e., the reach of the river where United's diversion and instream flow operations affect the river's hydrology).

Ammocoete The larval stage of a lamprey. They burrow in fine sediments within rivers and may remain in this stage for several years.

Anadromous Referring to a life cycle trait of fish in which adults migrate from salt water to reproduce in fresh water and juveniles migrate from fresh water to mature in salt water.

Anthropogenic Originating from human activity.

Aquifer A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells or springs.

Artesian Conditions A confined aquifer under positive pressure causing water level in a well to rise to a point where hydrostatic equilibrium has been reached.

Basin A groundwater basin is defined as an alluvial aquifer or a stacked series of aquifers with reasonably well-defined bottom and lateral boundaries made up of geologic features that significantly impede groundwater flow.

Bypass Channel A component of the Freeman Diversion that includes a concrete lined channel and a roller gate in the river channel immediately adjacent to the diversion intake and trash rack. When the roller gate is opened, water moves through the concrete channel. The roller gate is opened when river flows carry too much sediment and debris to divert or when United needs to sluice sediment that has built up in front of the diversion intake. The bypass channel is also called the "flushing channel" in several supporting documents and public documents.

Carapace The hard upper shell of a turtle, arachnid, or crustacean.

Catholic (Adjective) wide-ranging or broad in tastes, preferences, or interests.

Compliance Point A non-specific location upstream of the Highway 101 bridge at the downstream end of the critical reach where United staff measure instream flow compliance, and therefore the site where United maintains prescribed instream flow criteria (e.g. 120/160 cfs). The specific location of discharge measurement may change based on hydrological conditions at the time of measurement, however the general reach location will remain the same. The specific location is chosen based on an annual assessment of where the most logical, accessible, and safe point for conducting accurate discharge measurements should occur.

Connate	In sedimentology or geology, connate fluids are liquids trapped in the pores of a sedimentary rock during formation of the rock.
Critical Overdraft	A groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.
Critical Reach	Usually a hydrologically losing reach of the mainstem Santa Clara River downstream of the Freeman Diversion, beginning approximately adjacent to United's desilting basin and ending at the Highway 101 bridge. The critical reach can occasionally become a gaining reach under groundwater mounding conditions due to high rates of recharge in the recharge basins.
Critical Riffle	The location of the mainstem Santa Clara River between the Freeman Diversion and the estuary where steelhead would have the greatest difficulty passing during low flows.
Diurnal	Related to daytime; active during daytime; periodic alteration of condition between day and night.
Dorsal	Related to the upper side of the body; situated on the back, or posterior equivalent in humans.
Dry ravel	Transportation of sediment by processes other than water, e.g. rolling or sliding.
Fluvial	Referring to rivers or streams, their processes, and the deposits and landforms created by them.
Freshet	Swelling or overflowing of a stream caused by heavy rains or melted snow.
Fry	Juvenile fish that has absorbed their yolk sac and can feed on their own.
Global Information Systems (GIS)	An integrated computer system of software and data used to store, analyze, capture, manipulate, and visualize spatial information.
Kelt	An adult steelhead that has successfully spawned and is returning to the ocean.
Littoral	Referring to the shore of the sea or a lake and their processes.
Lore	The space between the bill and the eye of a bird.
Macrophyte	A plant (typically aquatic) large enough to be seen by the naked eye.
Macropthalmia	The juvenile stage of a lamprey, in which it migrates downstream to the ocean.
Moribund	Close to death or in a state of dying.
Nocturnal	Related to nighttime; active or occurring at night.
Nuchal	Related to or lying in the back of the neck (nape).

Overdraft (Groundwater) the condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin.

Percolation The process of a liquid slowly passing through a porous substance.

Permit Area The Santa Clara River below the Freeman Diversion; the Santa Clara River estuary; the Freeman Diversion facility; and an area of the Santa Clara River upstream of the Freeman Diversion (see Figure 1-3).

Pharyngeal Related to or located near the tube or cavity that connects the mouth and nasal passages with the esophagus (pharynx).

Plan Area The areas where covered activities will occur and areas affected by covered activities and the conservation program, including areas that will benefit from implementation of the MSHCP due to the migration and range expansion of certain covered species, i.e. the mainstem of the Santa Clara River from the Pacific Ocean to near interstate highway 5, including the tributaries Santa Paula Creek, Sespe Creek, Hopper Creek, Piru Creek, and portions of Castaic Creek and Boquet Creek (see Figure 1-2).

Plastron The ventral (bottom) part of a turtle's shell.

Recharge The downward flow of water from surface water to groundwater.

Redd The spawning location or nest of certain fishes.

Resource Agencies Collectively, the U.S Fish and Wildlife Service, the National Marine Fisheries Service, the California Department of Fish and Wildlife.

Riparian Related to or located adjacent to a watercourse.

Rufous Rusty reddish color.

Scute A thickened individual plate on a turtle's shell.

Senesce Deteriorate with age.

Services Collectively, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

Sespe Creek Trigger Threshold of flow required to trigger the adult steelhead upstream migration protocols. Defined as a running 24-hour average of at least 200 cfs over base flow at the USGS Gage No. 11113000 for Sespe Creek near Fillmore, California.

Smolt A juvenile salmonid that exhibits traits of physiological change in preparation for downstream migration and entering the ocean.

Special-status Species Plants or animals that are legally protected or proposed for listing under the Federal or California Endangered Species Acts. Taxa assigned a special-status

	or otherwise determined to be rare, restricted, sensitive, declining, or threatened by a state, federal, or non-governmental agency. Examples include (but are not limited to): Species of special concern (CDFW), fully protected (CDFW), birds of conservation concern (USFWS), sensitive (USDA-FS), and California Native Plant Society rare plant lists.
Subbasin	Designation of a groundwater subbasin boundary is relatively flexible and typically created for the purpose of managing water resources (i.e. collecting and analyzing data). A subbasin is created by dividing a groundwater basin into smaller units usually defined by political or institutional boundaries (e.g. water agency service area). However, geologic and hydrologic barriers are also used as divides (as in the Oxnard Plain) and a subbasin should never cross over a groundwater basin boundary. Divided subbasins within a single groundwater basin always have some degree of hydrologic connectivity.
Suctorial	Adapted for sucking; having a sucker for feeding or adhering to something.
Thalweg	A line drawn to connect the lowest points of a streambed along its entire course.
Turn out	An operation of the Freeman Diversion which involves closing the canal gates and excluding river flows in the Santa Clara River from entering the diversion facilities.
Turn in	An operation of the Freeman Diversion which involves opening the canal gates and allowing river flows in the Santa Clara River to enter the diversion facilities.
Ventral	Related to the lower side of the body; situated on the belly, or anterior equivalent in humans.
Water Year	The 12-month period beginning October 1, through September 30 and designated by the calendar year in which it ends. (E.g. the water year ending September 30, 2016, is referred to as the "2016 water year").
Young-of-the year	Juvenile fish that are less than a year old.
Zygodactyl	Toe arrangement of a bird with two in front and two behind, loosely resembling the letter "K."

EXECUTIVE SUMMARY

The United Water Conservation District Multiple Species Habitat Conservation Plan (MSHCP) has been prepared by United Water Conservation District (United) as part of its application package for incidental take permits (ITP) under section 10(a)(1)(B) of the federal Endangered Species Act (ESA). United owns, operates, and maintains water facilities in a number of locations in the Santa Clara River watershed and Oxnard Plain, some of which have the potential to result in take of federally protected species. The ITPs would authorize incidental take of 7 "covered species" listed as threatened or endangered under the ESA or species that are likely to become listed during the permit term for which take is reasonably certain to occur. This MSHCP provides documentation to support decisions by U.S. Fish and Wildlife Service and the National Marine Fisheries Service on the issuance of ITPs. In general, ITPs will be issued based on the determination that the effects of incidental take of the covered species authorized by the ITPs will be minimized and mitigated consistent with the standards in ESA.

United is a water conservation district, established in accordance with California Water Code Section 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's focus is long-term water conservation management. United comprises seven geographically determined divisions and is governed by a seven-person board of directors elected by division.

United's boundaries encompass nearly 213,000 acres of central and southern Ventura County. This area includes the downstream (Ventura County) portion of the Santa Clara River Valley, as well as the Oxnard Plain. United serves as the steward for surface water and groundwater resources in all, or portions of, eight interconnected groundwater basins. United currently 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. 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 critical aquifers subject to overdraft.

United seeks to acquire ITPs under ESA that would authorize the incidental take of the 7 covered species as a result of the covered activities within the plan area, as defined in this MSHCP. United also seeks "no surprises" coverage and assurances under ESA and its implementing regulations. Conservation measures that minimize and mitigate the take of the covered species are identified in the MSHCP. Funding, monitoring, and adaptive management actions will also be implemented as part of the MSHCP. The proposed permit duration under the MSHCP is 50 years. The MSHCP also provides for short-term extensions under specified circumstances.

The plan area for this MSHCP encompasses the areas where covered activities will occur and areas affected by covered activities and the conservation program, including areas that will benefit from implementation of the MSHCP due to the migration and range expansion of certain covered species. The plan area covers 10,410 acres in the Santa Clara River watershed in Ventura County including the Santa Clara River estuary, a large portion of the Santa Clara River, and several tributaries (i.e., Santa Paula Creek, Sespe Creek, Hopper Creek, and Piru Creek). It also encompasses operational facilities covered by the MSHCP (i.e., the Freeman Diversion facility).

The permit area for this MSHCP encompasses the geographic area where the ITP applies and comprises two areas known as the operation and maintenance permit area and the conservation permit area. The operations and maintenance permit area covers 2,950 acres and comprises the United-owned area and associated stream bed directly upstream of the Freeman Diversion; the streambed directly upstream of the Freeman Diversion affected by sediment sluicing events; the Freeman Diversion facility and associated diversion canal, desilting basin, and recharge basins; the Santa Clara River riverbed bank-to-bank from the Freeman Diversion to the estuary; and the Santa Clara River estuary. The conservation permit area covers 6,260 acres and comprises the United-owned area of the Santa Clara River riverbed bank-to-bank upstream of the Freeman Diversion to approximately 1.6 miles upstream of the confluence with Piru Creek; the Santa Paula Creek streambed bank-to-bank within United's district boundary; the Sespe Creek streambed bank-to-bank within United's district boundary; and the Hopper Creek streambed bank-to-bank. The existing conditions in the plan and permit areas are discussed in detail in Chapter 2.

The facilities and covered activities (Chapter 3) in this MSHCP are a subset of United's overall facilities and current and future activities. The covered activities encompass renovations and current and future operations and maintenance of the Freeman Diversion facility that could result in take of the covered species. United operates the Freeman Diversion facility to redirect surface water from the Santa Clara River for groundwater recharge and surface water deliveries to reduce groundwater pumping. These deliveries are designed to reduce groundwater pumping in areas where overdraft conditions and related water quality issues exist, where aquifers are most susceptible to saline water intrusion and the upwelling of saline waters. Under the MSHCP, United will continue to operate and maintain the Freeman Diversion facility for these purposes. However, United will make certain physical and operational modifications, as part of the conservation program, to minimize effects of the covered activities on the covered species. Specifically, the activities for which United seeks incidental take of covered species under this MSHCP are the following:

- Renovation of the fish passage facility and the Freeman Diversion headworks
- Resurfacing the downstream face of the Freeman Diversion grade control structure
- Fish passage facility operations
- Water diversion operations
- Capture and relocation of downstream moving steelhead as a result of low flows from the diversion operations
- Expansion of the Freeman Diversion off-channel water conveyance infrastructure
- Maintenance of facilities and property
- Conservation program activities
- Restoring and enhancing habitat
- Other Conservation Activities and Monitoring
- Implementing adaptive management measures

Covered species (Chapter 4) are those for which coverage under the ITPs is requested. United is requesting take authorization of the following 7 "covered species" in the MSHCP:

- Southern California steelhead (*Oncorhynchus mykiss*)
- Pacific lamprey (*Entosphenus tridentat*us)
- Tidewater goby (*Eucyclogobius newberryi*)
- Western pond turtle (*Actinemys marmorata*)
- Least Bell's vireo (*Vireo bellii pusillus*)
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
- Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)

Five of these species are listed as threatened or endangered under the ESA and two have the potential to be listed during the permit term.

Incidental take authorization for covered activities is based on implementation of the conservation program (Chapter 5). The conservation program includes a set of conservation measures intended to minimize and mitigate the effects of take on the covered species to the maximum extent practicable. The conservation measures were developed to achieve the following two biological goals and their respective objectives.

Goal 1 Provide conditions that approximate an unimpeded steelhead and lamprey migratory corridor in the lower Santa Clara River.

Objective 1.1: Provide physical and fluvial conditions at and through the Freeman Diversion to approximate unimpeded migration of adult and juvenile steelhead and lamprey.

Objective 1.2: Minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) to and from the Santa Clara River estuary and the Freeman Diversion, for the permit term.

Goal 2 Maintain or improve habitat for least Bell's vireo, southwestern willow flycatcher, yellow-billed cuckoo, and western pond turtle in the Santa Clara River.

Objective 2.1: Minimize impacts of renovation of the Freeman Diversion to riparian and riverine habitat for the covered species and to individuals of the covered species.

Objective 2.2: Minimize impacts of maintenance of the renovated Freeman Diversion on riparian and riverine habitat for the covered species and to individuals of the covered species.

Objective 2.3: Mitigate the loss of riparian habitat for covered species through on-site riparian restoration at 1:1 ratio within 5 years or purchase of equivalent mitigation credits at an approved mitigation bank.

Conservation measures (CMs) intended to meet the goals and objectives are organized around the following five main actions:

- Construct, operate, and maintain new fish passage facilities for steelhead and lamprey (CM 1.1.1 and CM 1.1.2 respectively)
- Implement instream flow operations (CMs 1.2.1, 1.2.2, 1.2.3, and 1.2.4)
- Trap and relocate downstream migrating steelhead smolts and lamprey juveniles if there is a predicted loss in surface water connectivity from the Freeman Diversion to the estuary (CM 1.2.5)
- Minimize Impacts to steelhead and lamprey through limitations on sediment management (CM 1.2.6)
- Implement actions to avoid and minimize effects of construction and maintenance activities (CMs 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.6, 2.1.7, 2.1.8, 2.2.1, 2.2.2)
- Protect, enhance, and manage habitat (CM 2.3.1 and CM 2.3.2)

Compliance and effectiveness monitoring combined with an adaptive management framework and decision-making process are included in Chapter 6 and form the strategy for United to scientifically address uncertainty in the system and foundational assumptions included in the conservation program and the effects analysis. Given the 50 year permit request and "no surprises" assurances of Section 10 of the ESA, United is committed to working with the Services to optimize the balance between meeting the water resource needs of Ventura County while avoiding, minimizing, and mitigating the impacts of the taking of the covered species to the maximum extent practicable.

Chapter 7 of the MSHCP contains a detailed analysis of the effects of the covered activities. Chapter 7 estimates the total amount of take, describes the impact of the taking, and describes the benefits of the conservation program. Among the conclusions, it has been determined that the water diversions/instream flow operations will not affect habitat in the estuary and any covered species (i.e., steelhead, lamprey, tidewater goby) when they are utilizing the estuary. The assessment also found that the water diversions/instream flow operations do not affect covered riparian bird and reptile species.

The assessment does identify potential effects from Freeman Diversion renovations, water diversions/instream flow operations, trapping and relocation, salvage and relocation, maintenance, monitoring, and habitat restoration/enhancement. The conservation program was designed to minimize and mitigate the impacts of the taking to the maximum extent practicable and meet ITP issuance criteria.

Plan implementation is detailed in Chapter 8. Plan implementation addresses:

- MSHCP administration responsibilities (United is responsible for administration)
- Changed circumstances (Changed circumstances with remedial measures are identified)
- Unforeseen circumstances (Defines how conservation measures may be modified to address unforeseen circumstances)
- Amendments to incidental take permits (Establishes procedures for making minor and major amendments)
- Suspension, revocation, relinquishment, and termination of incidental take permits (Establishes procedures for failure to implement MSHCP or comply with ITPs)
- Renewal of incidental take permits (Establishes procedures for the renewal of ITPs)
- Transfer of incidental take permits (New owner must submit an application to take over ITP and MSHCP implementation)

The costs to implement the MSHCP, including operational costs and capital costs, and the sources of that funding are described in Chapter 9. The anticipated capital cost to implement the MSCHP is $88,296,000. The anticipated operational cost to implement the MSHCP across the 50-year permit term is $95,292,000. Total cost for plan implementation is $183,582,000[1]. United will fund the MSHCP using revenues it currently receives and is authorized to generate in accordance with its principal act in the Water Code. This encompasses a combination of funding sources including United's annual operating budget and debt financing, along with supplementation from other potential sources of funding (e.g., grants, bonds, and outside contributions). United is a public agency and water conservation district established in accordance with Water Code Section 74000 et seq. United's current revenues are principally derived from the following sources:

- Ground water extraction charges (both direct and in-lieu delivery charges), annually levied on multiple zones by the Board of Directors
- Ad valorem property taxes
- Investment earnings

Due to the high cost of MSHCP implementation, outside sources of funding would be sought and maximized to the fullest extent; however, until those opportunities are realized and for the purposes of this MSHCP, United will assume that the MSHCP is fully funded by United, without the support of any outside funding. United anticipates funding the construction of the conservation program's capital improvement projects by the issuance of debt, and repayment over the term of that debt instrument from its authorized sources of revenues. United typically funds the construction of infrastructure projects via the issuance of revenue bonds and other forms of financing, as allowed through United's principal act.

United has considered many alternatives in developing this MSHCP. Take alternatives were developed to include a range of approaches to advance the MSHCP's overall goal to "manage, protect, conserve, and

[1] Estimated operational and capital costs listed do not sum exactly to the estimated total cost to implement the MSHCP due to rounding of values to the nearest $1,000 during cost estimate calculations.

enhance the water resources of the Santa Clara River, its tributaries, and associated aquifers in the most cost-effective and environmentally balanced manner." Chapter 10 lists seven alternatives that include structural alternatives to the proposed fish passage facility and diversion infrastructure renovations, operational alternatives to the proposed water diversion and bypass operations, and alternatives that incorporate both structural and operational changes:

- Alternative A, Wishtoyo Operational Remedies Plus Santa Felicia Project, a structural and operational alternative which would include the existing fish passage facility but with modified water diversion and bypass operations
- Alternative B, Notch Structure, a structural alternative with an alternate fish passage facility which would utilize the Proposed MSHCP's water diversion and bypass operations
- Alternative C, Hardened Ramp Structure, a structural alternative with an alternate fish passage facility which would utilize the Proposed MSHCP's water diversion and bypass operations
- Alternative D, Vertical Slot Plus Water Diversion Consistent with 2008 Biological Opinion, an operational alternative which would include the Proposed MSHCP's fish passage facility (vertical slot structure) and infrastructure renovations but with modified water diversion and bypass operations
- Alternative E, Hardened Ramp Plus Water Diversion Consistent with 2008 Biological Opinion, a structural and operational alternative which would include the hardened ramp structure but with modified water diversion and bypass operations
- Alternative F, Infiltration Gallery, a structural alternative which would replace the diversion infrastructure and fish passage facility with an infiltration gallery and utilize the Proposed MSHCP's water diversion and bypass operations
- Alternative G, Remove Structure and Cease Diversions, a structural and operational alternative which would remove the diversion infrastructure and cease water diversions

These alternatives were eliminated because they were determined to be not practicable, to not reduce take of covered species or provide adequate conservation benefit, and/or to not be consistent with the purpose of the activities for which ITPs are requested. Most alternatives had overlapping reasons for being rejected. Practicability failures included being logistically, technologically, financially, and/or economically impracticable. The primary technological constraint was due to fish passage facility durability concerns and potential inability to conduct timely repairs. Alternatives were rejected if they would be too costly in the short-term and/or if they would have long-term regional impacts from reduced water supplies and increased water rates. At some level, all the alternatives were found to be inconsistent with the MSHCP's goals to achieve United's mission. Alternatives were rejected for their inability to achieve the average annual water diversion yield required by United, to provide a minimum water supply to abate water quality degradation in the Oxnard Plain, and/or to implement actions on land United owns or can feasibly acquire.

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1 INTRODUCTION AND BACKGROUND

The United Water Conservation District (United) has prepared the United Water Conservation District Multiple Species Habitat Conservation Plan (MSHCP) as part of its application for incidental take permits (ITP) under Section 10(a)(1)(B) of the federal Endangered Species Act (ESA). United owns, operates, and maintains water facilities in a number of locations in the Santa Clara River Watershed and Oxnard Plain, including the Freeman Diversion and associated water conveyance and sediment management infrastructure. Renovation of the Freeman Diversion driven by construction of an updated anadromous fish passage facility and modifications to the associated water conveyance and sediment management infrastructure as well as diversion operations at the Freeman Diversion have the potential to result in take of federally protected species. The federal ITP would authorize incidental take of 7 species (or populations characterized as subspecies or life history strategy of a subspecies, e.g., southern California steelhead) listed as threatened or endangered under ESA. This document refers to these 7 species as "covered species." This MSHCP provides documentation and analysis to support decisions by federal resources agencies on the issuance of ITPs. In general, an ITP would be issued based on the determination that the effects of incidental take of the covered species would be minimized and mitigated consistent with the standards in ESA.

1.1 UNITED'S MISSION AND OPERATIONS

United is a water conservation district, established in accordance with California Water Code Section 74000 *et seq*. United comprises seven geographically determined divisions and is governed by a seven-person board of directors elected by division. 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's boundaries encompass nearly 213,000 acres of central and southern Ventura County. This area includes the downstream (Ventura County) portion of the Santa Clara River Valley and the Oxnard Plain (Figure 1-1). United serves as the steward for surface water and groundwater resources in all, or portions of, eight interconnected groundwater basins: Piru basin, Fillmore basin, Santa Paula basin, Mound basin, Oxnard Forebay basin, Oxnard Plain basin, Pleasant Valley basin, and West Las Posas basin.

United's focus is long-term water conservation management. Its statutory powers include the ability to conduct water resource investigations, acquire water rights, build facilities to store and recharge water, construct wells and pipelines for water deliveries, commence actions involving water rights and water use, prevent interference with or diminution of river flows and associated natural subterranean supply of water, and to acquire and operate recreational facilities. United's revenues include groundwater extraction (pump) charges, in-lieu water delivery charges, *ad valorem* property taxes, property tax assessments, and recreation fees.

United operates and maintains a number of water facilities and associated water delivery infrastructure in the Santa Clara River watershed and the Oxnard Plain. These facilities directly and indirectly provide irrigation supplies and potable water to municipal customers in the City of Oxnard, the Port Hueneme Water Agency, and Naval Base Ventura County in lieu of coastal groundwater extractions. United's facilities are vital to groundwater recharge, banking water for use during drought years, and reducing or even reversing seawater intrusion into the aquifers of the Oxnard Plain. United prepares annual reports on groundwater conditions and regularly provides information associated with its operations and facilities. In addition to its physical facilities, United advocates for policy and management changes to manage and mitigate demands on the basins and to preserve groundwater quality.

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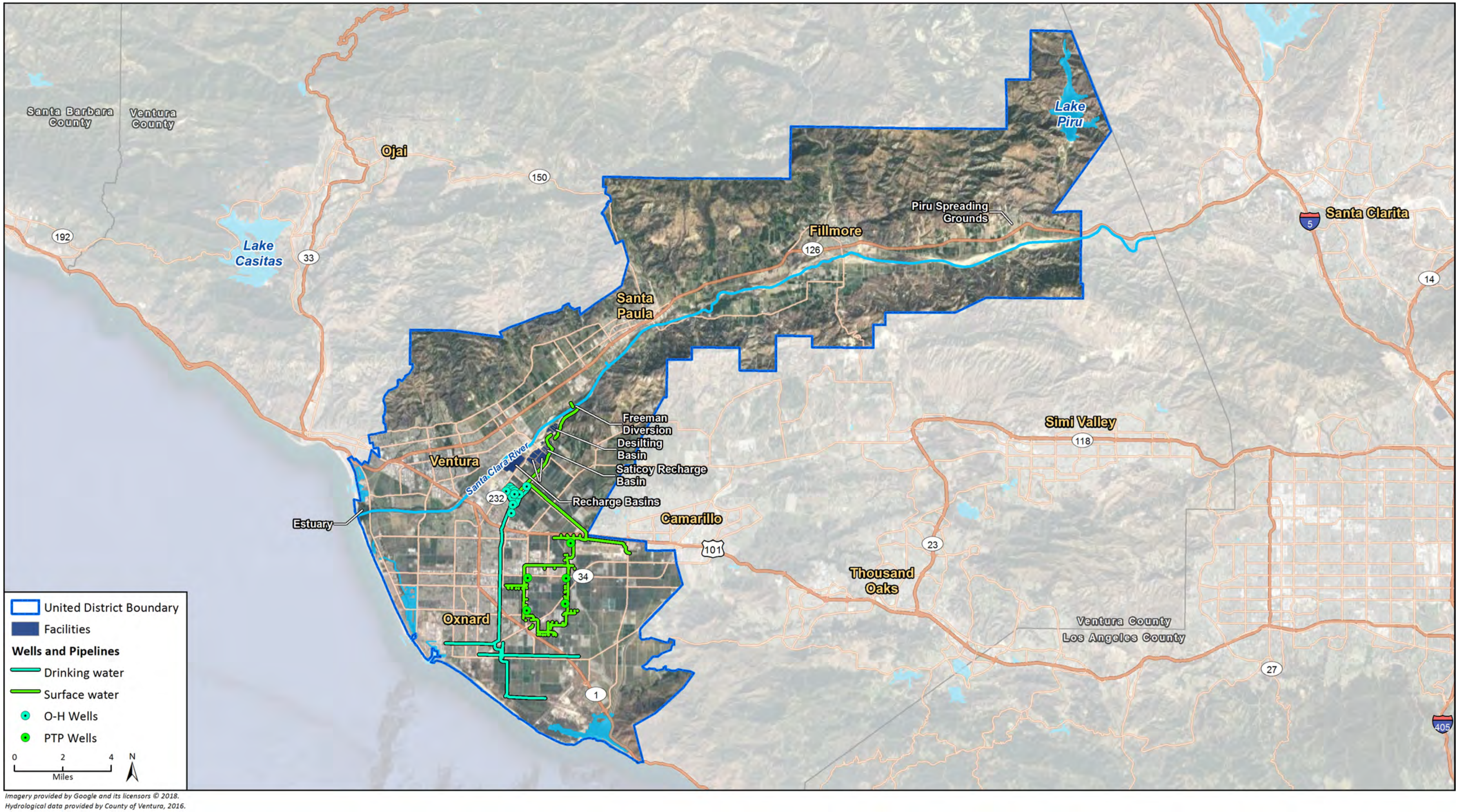
Figure 1-1 District Overview



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1.2 PURPOSE OF FREEMAN DIVERSION

The Freeman Diversion, along with its associated conveyance infrastructure, desilting basin, and recharge basins, is one of United's facilities and is the focus of this MSHCP. The Freeman Diversion facility diverts surface water from the Santa Clara River both for groundwater recharge at United's recharge facilities (the Saticoy and El Rio facilities) and for surface water delivery to reduce groundwater pumping in the over-drafted groundwater basins of the Oxnard Plain, especially where water quality issues exist and where aquifers are most susceptible to seawater intrusion. The operation of the Freeman Diversion facility aids in the maintenance of sustainable groundwater elevations in the coastal basins and in the prevention of groundwater quality degradation that can affect both human health and agriculture.

The renovations proposed for the Freeman Diversion, discussed and analyzed in this MSHCP, will improve the operation of the diversion for future water resource management, while minimizing and mitigating potential take of covered species.

1.3 PURPOSE OF THE MULTIPLE SPECIES HABITAT CONSERVATION PLAN

United seeks ITPs for incidental take of covered species that may result from activities involved in the renovation, maintenance, and operation of the Freeman Diversion. Chapter 3 describes the "covered activities" in detail, which consist generally of the following:

1. Renovation of the fish passage facility and the Freeman Diversion headworks
2. Resurfacing the downstream face of the Freeman Diversion grade control structure
3. Fish passage facility operations
4. Water diversion operations
5. Capture and relocation of downstream moving steelhead as a result of low flows from the diversion operations
6. Expansion of the Freeman Diversion off-channel water conveyance infrastructure
7. Maintenance of facilities and property
8. Conservation program activities
9. Restoring and enhancing habitat
10. Other Conservation Activities and Monitoring
11. Implementing adaptive management measures

These covered activities will aid United in sustaining the long-term and reliable management of water resources based on known and foreseeable demand for agricultural, municipal, and industrial water supplies.

This MSHCP is being submitted to the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). These agencies are collectively referred to as the "Services." The Services have the joint authority to issue an ITP if the MSHCP is determined to meet the issuance criteria. The ITPs would enable United to perform the covered activities, ensuring a continued ability to meet water resource demands in the region while implementing a conservation program that minimizes and mitigates the effects of these activities on covered species to the maximum extent practicable.

1.4 REGULATORY CONTEXT

This section describes the most relevant regulations for accomplishing the MSHCP. United expects that this MSHCP will work in parallel with future regulatory reviews and approvals for this project, helping to make discussions with the regulatory agencies more efficient and facilitate expeditious review and approval of permits. For example, this MSHCP will streamline consultation under ESA Section 7 and Clean Water Act (CWA) Section 404 permit consultations with U.S. Army Corps of Engineers (USACE), USFWS, and NMFS related to activities occurring within the channel that may affect covered species. In addition, this MSHCP addresses all mitigation needs of the covered species that will be outlined in California Environmental Quality Act (CEQA) documents and some of the measures for covered species that will be required for a Lake and Streambed Alteration Agreement (LSAA). Finally, this MSHCP is intended to inform consultation with the California Department of Fish and Wildlife (CDFW) related to state-listed species under the California Endangered Species Act (CESA), in pursuit of a state ITP under section 2081(b) of the Fish & Game Code, as well as consultation with CDFW and Regional Water Quality Control Board (RWQCB) related to potential impacts to Waters of the State and associated species and their habitat. It is United's intention that no additional measures or analysis would be needed for associated federal environmental review or permits other than what is provided in this MSHCP. Further details on all relevant laws and regulations are given below.

1.4.1 FEDERAL LAWS AND REGULATIONS

Federal Endangered Species Act of 1973, as Amended

The stated purpose of ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and to act on specified relevant treaties and conventions" (16 United States Code [U.S.C.] §1531(b)). USFWS, acting on behalf of the Secretary of Interior, and NMFS, acting on behalf of the Secretary of Commerce, oversee administration of ESA. NMFS is the listing and regulatory authority for marine mammals and most anadromous fish species. Section 9 of ESA (16 U.S.C. §1538(a)(1)(B)) prohibits the take of any endangered animal species unless the take has been authorized under other provisions of ESA. Under Section 4 of ESA, the Services may extend this take prohibition to listed threatened animal species (16 U.S.C. §1533(d)). ESA defines take as "to harass, harm, pursue, hunt, shoot, kill, trap, capture, collect, or to attempt to engage in any such conduct" (16 U.S.C. §1532(19)). The Services have further defined "harm" to mean "an act that actually kills or injures fish or wildlife. Such acts may include significant habitat modification or degradation, where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering" (50 Code of Federal Regulations [C.F.R.] §222.102 [NMFS]; 50 C.F.R. §17.3 [USFWS]). USFWS has further defined "harass" to mean "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering" (50 C.F.R. §17.3).

Section 10 and Habitat Conservation Plans

ESA 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 U.S.C. §1539(a)(1)(B)) through the issuance of ITPs by the Services for approved habitat conservation plans (HCPs). An HCP specifies the likely impact that will result from take of the listed species; the steps the permit applicant will take to minimize and mitigate such impacts and the funding that will be available to implement such steps; the alternative actions to the taking the applicant considered and reasons why the alternatives are not utilized; and such other measures the Secretary may require. The Services will issue the ITPs if, after opportunity for public comment, they find the taking will be incidental; the applicant will minimize and mitigate the impacts of taking to the maximum extent practicable; the applicant has ensured adequate funding for the HCP and procedures for addressing unforeseen circumstances have been provided; the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; the applicant has provided such other assurances as may be required by the Services that the HCP will be implemented; and the applicant has taken such other necessary or appropriate measures as may be required by the Services (16 U.S.C. §1539(a)(2)).

HCPs can be long-term, multiple-species plans that cover federally-listed species and unlisted species, as long as those species are treated as if they were federally listed. In addition, HCPs will provide economic and regulatory certainty regarding the overall cost of species mitigation over the life of the permit by making provisions for circumstances and information that could change over time and that might require revisions to the HCP. This regulatory certainty is referred to as "no surprises." In general, under the "no surprises" policy and regulations, an applicant's conservation program provides responses for changed circumstances (defined in 50 C.F.R. §17.3 and 50 C.F.R. §222.102) that may arise in the future. Provided that United is properly implementing the HCP, the Services will not require additional conservation measures, without consent of the applicant, in response to changed circumstances nor will it require additional land, water, or financial commitments in response to unforeseen circumstances (50 C.F.R. §§17.22.(b)(5)(ii),(iii), 17.32(b)(ii),(iii), 1732.b,(ii),(iii); 50 C.F.R. §222.307(g)(2),(3)).

In December 2016, the Services released the Habitat Conservation Planning and Incidental Take Permit Processing Handbook (HCP Handbook) (USFWS and NMFS 2016) that incorporates and updates material from the original 1996 handbook and the Five Point Policy. The purpose of the HCP Handbook is to instruct the Services staff in how to assist applicants with HCP development, and to provide a resource for applicants and the public. United used the most recent HCP Handbook to guide development of this MSHCP.

Section 7 and Consultation

Section 7 (a)(2) of ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of threatened or endangered species or destroy or adversely modify designated critical habitat of listed species (16 U.S.C. §1536(a)(2)). Federal agencies are required to consult with and obtain the opinion of USFWS or NMFS, as applicable, concerning the effects of a contemplated federal action. If the Services determine that the proposed action would jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, they will identify any reasonable and prudent alternatives (RPAs) that would avoid such effects (16 U.S.C. §1536(a)(3)).

Under Section 7(b)(4), a biological opinion (BO) that finds no jeopardy or adverse modification, or that includes reasonable and prudent alternatives that would avoid such effects, must also include an incidental take statement that authorizes incidental take by the federal action agency or applicant. The incidental take statement also includes reasonable and prudent measures (RPMs) to minimize take, and terms and conditions to implement the RPMs (16 U.S.C. §1536(b)(4)). After receipt of a BO, the federal action agency determines how it will proceed, given its obligations under Section 7(a)(2) (40 C.F.R. §402.15).

Although non-federal entities obtain ITPs under Section 10 of ESA, the Services have determined that intra-service Section 7 consultation is still required on the federal action of issuing the Section 10 permit. In the intra-service consultation, the Services evaluate the potential effects that will be added to the environmental baseline to determine if the proposed action (issuance of an ITP) is likely to jeopardize the continued existence of the species, or destroy or adversely modify designated critical habitat for the species, considered for the ITP and evaluated under the consultation. USFWS and NMFS then prepare separate BOs for the covered species under their regulatory authorities. The BOs contain an assessment of the effects on the covered species and critical habitat from the issuance of the Section 10 permits and the implementation of the HCP. If any federal agencies other than the USFWS or NMFS provide authorizations for HCP covered activities, the BOs issued by USFWS and NMFS for the HCP are expected to address the Section 7 consultation needs of those future federal actions.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to prepare an environmental impact statement (EIS) prior to consideration for approval of any major federal action that would have a significant effect on the human environment (42 U.S.C. §4332(c)). The purpose of NEPA is to ensure that federal agencies examine the environmental effects of their actions and utilize public participation in agency decision-making. An EIS analyzes impacts of a proposed action, alternatives to avoid or minimize impacts, and potential impact mitigation measures. NEPA serves as an analytical tool on direct, indirect, and cumulative effects of the proposed project and alternatives. Following completion of an EIS, a federal action agency issues a record of decision documenting its consideration of the EIS and its decision on how it will proceed. This decision may also be incorporated into other records prepared by the agency (40 C.F.R. §1505.2). The issuance of a Section 10 permit by the Services is considered a federal action under NEPA.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) (54 U.S.C. §300101 *et seq*.) requires all federal agencies to examine the impacts of their projects, permitting and licensing activities, and funding approvals on properties of historical or cultural significance, listed or eligible for listing on the National Register of Historic Places. Like NEPA, NHPA is essentially a procedural statute that establishes a review process involving the preparation of documents similar to environmental impact statements and assessments under NEPA. Prior to implementing a project, federal agencies must analyze and consider the effect of a project on historic and cultural properties, and then provide the Advisory Council on Historic Preservation a reasonable opportunity to comment on the project and its anticipated effect. If a project may adversely affect a historic or cultural property, the agency must consult with the Advisory Council on Historic Preservation and the state Historic Preservation Officer to develop a memorandum of agreement with measures the parties agree to implement so the project avoids or mitigates the adverse effects to historic and cultural properties.

Clean Water Act

In 1972, the U.S. Congress passed the Clean Water Act (CWA) (33 U.S.C. §1251 *et seq*.) to provide for the restoration and maintenance of the chemical, physical, and biological integrity of streams, lakes, and coastal waters of the U.S. (WOTUS). The Environmental Protection Agency (USEPA) has general administration, oversight, and approval authorities under the CWA, and distinct activities conducted by other federal agencies or states are subject to USEPA authorities. Section 301 of the CWA generally prohibits the discharge of pollutants to WOTUS without a permit issued under Section 402 or 404. Section 404 authorizes the U.S. Army Corps of Engineers to issue permits for the discharge of dredged or fill material to WOTUS. Under Section 402 and other provisions and under its authority delegated by the USEPA, California issues National Pollutant Discharge Elimination System permits for discharges from municipal, industrial, and other sources. Section 401 of the CWA provides that certain permits including permits under Section 404 of the CWA may not be issued unless the state has issued certification of compliance with state water quality standards. In California, the State Water Resources Control Board and Regional Water Quality Control Boards administer Section 401. Prior to implementing any covered activities that may result in the dredge or fill of jurisdictional WOTUS, CWA authorization would be required from the U.S. Army Corps of Engineers and the Los Angeles Regional Water Quality Control Board. In addition, certain construction activities may be subject to National Pollutant Discharge Elimination System permits governing the discharge of stormwater.

1.4.2 STATE LAWS AND REGULATIONS

California Environmental Quality Act

The California Environmental Quality Act (CEQA) (Public Resources Code [Pub. Res. Code] §21000 *et seq*.) generally parallels NEPA but applies to projects proposed by California governmental agencies and the projects of other parties that require their approval. All projects undertaken by any state or local agency, including any special district (such as United), are subject to CEQA, which requires the preparation of an environmental impact report (EIR) prior to approval of any project that would potentially have a significant adverse environmental impact. The EIR must disclose potentially significant impacts of the proposed project and provide a discussion of alternatives to avoid or minimize significant impacts along with mitigation designed to reduce impacts to less than significant. After consideration of an EIR that includes public comment, the lead agency adopts findings related to its decision on approval of the project, which include any overriding considerations that justify the decision not to adopt alternatives or mitigation that would avoid significant impacts (Pub. Res. Code §21081). CEQA guidelines govern the adoption of ITPs and the actions of United or any other state or local agency that approves the MSHCP or activities undertaken in the MSHCP.

California Endangered Species Act

Generally, CESA parallels the main provisions of ESA and is administered by CDFW. CESA establishes a petitioning process for the listing of threatened and endangered species. The California Fish and Game Commission (Commission) determines whether a species is endangered or threatened. Section 2080 of the California Fish and Game Code (CFGC) prohibits take of any species the Commission determines to be endangered or threatened. In Section 86 of the CFGC, take is defined as "to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" (CFGC §2080). CESA also applies the take prohibitions to species that have not been listed if the Commission has determined that a petitioned listing may be warranted (CFGC §§2074.2, 2074.4 and 14 C.C.R. §783.1(b)).

Section 2081(b) of the CFGC allows CDFW to issue an ITP for a state-listed threatened, endangered, or candidate species if specific criteria are met. 14 C.C.R. § 783.4(a) and (b) provides these criteria, which are as follows:

- Authorized take is incidental to an otherwise lawful activity.
- Impacts of the authorized take are minimized and fully mitigated.
- Measures required to minimize and fully mitigate the impacts of the authorized take adhere to the following:
  - Mitigation is roughly proportional in extent to the impact of the taking on the species.
  - Measures maintain the applicant's objectives to the greatest extent possible.
  - Applicant is capable of successfully implementing measures.
  - Adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with and the effectiveness of the measures.
  - Permits as issued will not jeopardize the continued existence of a state-listed species.

Section 2080.1 of the CFGC provides a mechanism by which federal authorization of take may make it unnecessary to obtain separate authorization for state-listed or candidate species, referred to as a "consistency determination." CESA does not authorize "no surprises" assurances and does not allow incidental take authorization for species other than those listed or for those for which it has been determined listing may be warranted.

Except under limited circumstances, CDFW cannot authorize take of animal species the legislature has designated as "Fully Protected" under CFGC §§3511, 4700, 5050, and 5515. CDFW can authorize collection of these species for necessary scientific research and relocation for the protection of livestock. CDFW can authorize take of Fully Protected Species, however, under the Natural Community Conservation Planning Act.

California Fish and Game Code Section 1600

Under CFGC §§1602 – 1605, CDFW is directed to enter into a lake or streambed alteration (LSA) agreements for activities that will affect streams or lakes. Specifically, CFGC §1602 requires an entity to notify CDFW prior to commencing any activity that may do one or more of the following:

- Substantially divert or obstruct the natural flow of any river, stream, or lake
- Substantially change or use any material from the bed, channel, or bank of any river, stream, or lake
- Deposit debris, waste, or other materials that could pass into any river, stream, or lake

CDFW requires an LSA agreement when it determines that the activity, as described in a complete LSA notification, may have substantial, adverse effect on existing fish or wildlife resources. An LSA agreement includes measures necessary to protect existing fish and wildlife resources. CDFW must comply with CEQA before issuing an LSA agreement.

1.5 OVERVIEW OF THE MULTIPLE SPECIES HABITAT CONSERVATION PLAN

United seeks to acquire ITPs under ESA and CESA that would authorize the incidental take of covered species as a result of the covered activities in the plan area, as defined in this MSHCP. United also seeks "no surprises" coverage and assurances under ESA and its implementing regulations. The MSHCP identifies conservation measures that minimize and mitigate the take of the covered species to the maximum extent practicable, defines monitoring and adaptive management actions that will be implemented, and outlines funding mechanisms.

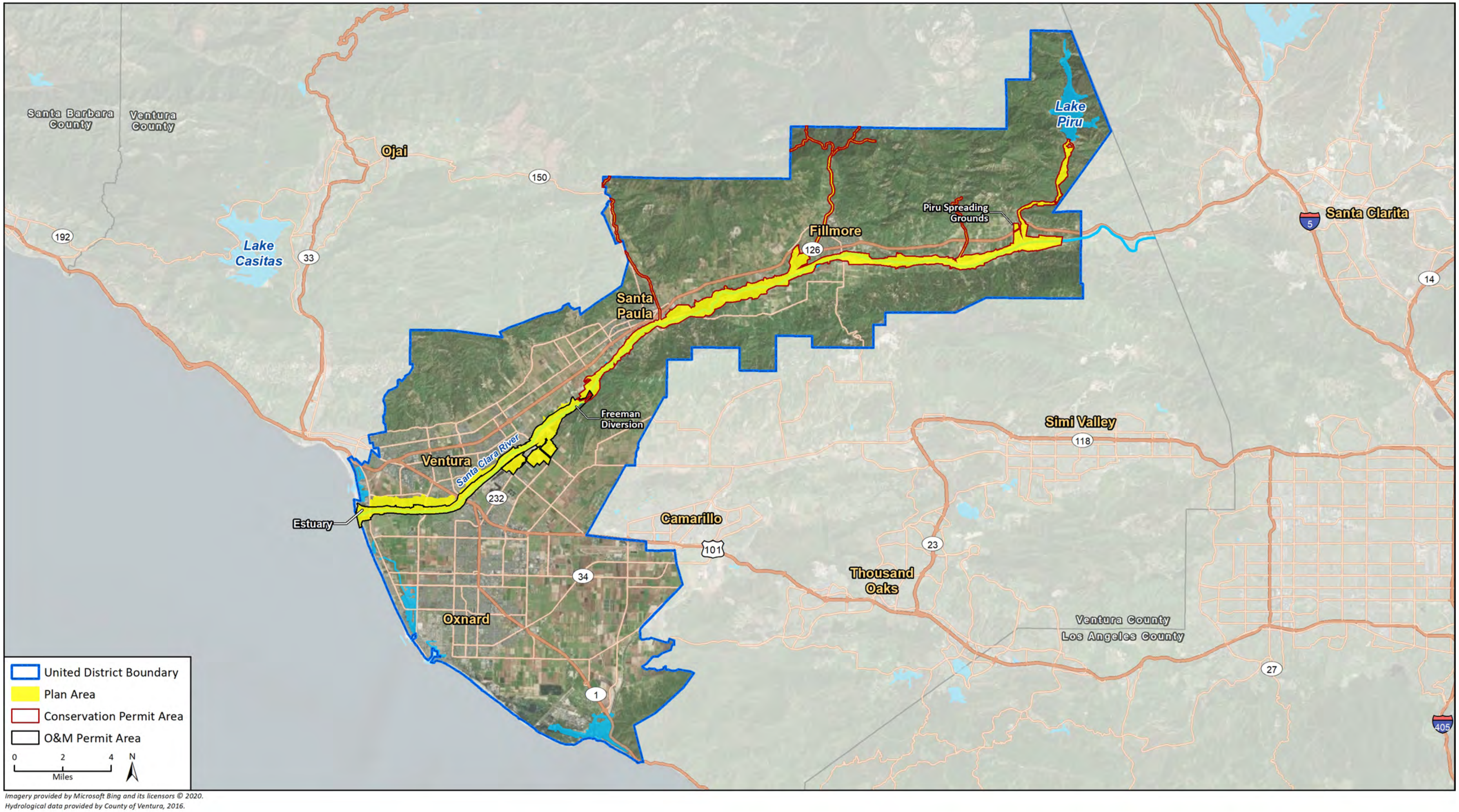
1.5.1 PERMIT TERM

The proposed permit duration under the MSHCP is 50 years. A shorter permit term would not satisfy the need for coverage, as United's mission and the operations intended to fulfill that mission are ongoing and long-term. United will also invest significant funds for the capital construction of the primary conservation measures under the MSHCP (e.g., the new fish passage facility and facility modifications for high-flow diversion). To fund such construction at an estimated cost of $86 million in addition to all the other costs under the MSHCP (mitigation, monitoring, adaptive management, etc.) outlined in Chapter 9, United expects that it will be necessary to undertake long-term debt. To provide certainty and make United's borrowing power feasible in the public finance market, the ITPs must have a minimum duration that corresponds to the debt repayment schedule.

1.5.2 PLAN AND PERMIT AREAS

The HCP Handbook specifies that HCPs must identify a plan area and a permit area. The handbook defines the plan area as "all areas that will be used for any activities described in the HCP, including covered activities and the conservation program." The plan area for this MSHCP encompasses the areas where covered activities will occur, and areas affected by covered activities and the conservation program. The plan area (Figure 1-2) covers 10,410 acres along the Santa Clara River in Ventura County: the Santa Clara River estuary, the 100-year floodplain of the Santa Clara River, and portions of the major

Figure 1-2 Plan and Permit Areas



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lower watershed tributaries, which occur in United's boundaries. These major tributaries are Santa Paula, Sespe, Hopper, and Piru creeks. The plan area also encompasses operational facilities covered by the MSHCP (e.g., the Freeman Diversion, conveyance infrastructure, the desilting basin, and recharge basins).

The HCP Handbook defines the permit area as "the geographic area where the impacts of the activity(ies) occur for which incidental take permit coverage is requested (i.e., the covered activities)" and states that "it must be within the plan area and under the control of the permittee or holder of a certificate of inclusion." The permit area (Figure 1-3) is divided into two sub-areas defined according to what type of covered activities will occur.

The Operations and Maintenance (O&M) permit area covers 2,950 acres and comprises the following:

- Streambed directly upstream of the Freeman Diversion affected by flushing events
- Freeman Diversion facility and associated diversion canal, desilting basin, and recharge basins
- Santa Clara River riverbed bank-to-bank from the Freeman Diversion to the estuary
- Santa Clara River estuary

The conservation permit area covers 6,260 acres and comprises the following:

- The Santa Clara River riverbed bank-to-bank upstream of the Freeman Diversion to approximately 1.6 miles upstream of the confluence with Piru Creek
- The Santa Paula Creek streambed bank-to-bank within United's district boundary
- The Sespe Creek streambed bank-to-bank within United's district boundary
- The Hopper Creek streambed bank-to-bank

Chapter 2 provides details on the existing environment in the plan and permit areas.

1.5.3 COVERED ACTIVITIES AND COVERED SPECIES

The covered activities in this MSHCP encompass the proposed initial diversion/instream flow operations that would be implemented upon permit issuance and proposed future diversion/instream flow operations that would take effect when United acquires a water right change to increase the maximum instantaneous diversion rate and total maximum diversion. This would allow the diversion of more turbid water during or following storm peaks to allow United to achieve a total diversion yield that meets its mission and purpose, while avoiding and minimizing potential for take of southern California steelhead, Pacific lamprey, and western pond turtle. The covered activities also include the construction of a new fish passage system, maintenance of the Freeman Diversion facility, habitat restoration and enhancement, and adaptive management measures including monitoring. Chapter 3 describes covered activities in more detail. Covered species are those for which coverage under the ITPs is requested. Table 1-1 lists covered species included in the MSHCP. Chapter 4 provides additional details on the covered species.

Table 1-1 Covered Species

Species	Federal Status	State Status	Critical Habitat in MSHCP Plan Area	United Applying for ITP
Fish				
Southern California steelhead *(Oncorhynchus mykiss)*	E	None	Yes	Federal
Pacific lamprey *(Entosphenus tridentatus)*	None	None	No	Federal
Tidewater goby *(Eucyclogobius newberryi)*	E	None	Yes	Federal
Reptiles				
Western pond turtle *(Actinemys marmorata)*	None	SSC	No	Federal
Birds				
Least Bell's vireo *(Vireo bellii pusillus)*	E	E	No	Federal & State
Southwestern willow flycatcher *(Empidonax traillii extimus)*	E	E	Yes	Federal & State
Yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	T	E	No	Federal & State

E = endangered, T = threatened, SSC = California Species of Special Concern

1.6 MULTIPLE SPECES HABITAT CONSERVATION PLAN DOCUMENT OVERVIEW

The following is an outline of the MSHCP chapters and a brief discussion of the contents of each chapter.

Chapter 1 is an introduction and general background overview of United's mission, the purpose of the MSHCP, and the regulatory framework for the MSHCP. Chapter one provides a detailed discussion of the plan and permit areas and the permit term and introduces the covered activities and covered species.

Chapter 2 provides a detailed review of the existing conditions of the plan area and provides the historical context of the current structure and operations of the Freeman Diversion.

Chapter 3 includes the detailed project description and defines the covered activities for which take authorization is sought.

Chapter 4 addresses the covered species for which incidental take may occur while carrying out covered activities. Chapter 4 provides a review of the covered species selection process and a brief discussion of the population status as well as natural and life histories of each covered species.

Chapter 5 presents the conservation program designed to avoid, minimize, and mitigate, to the maximum extent practicable, the effects of covered activities on covered species.

Chapter 6 also provides the adaptive management framework for the MSHCP and a detailed description of the monitoring program, including compliance monitoring and effectiveness monitoring measures to address key uncertainties in the MSHCP.

Chapter 7 provides the analysis of effects of the covered activities on the covered species and associated potential take of covered species; the impact of the taking; and benefits of the conservation program to the covered species.

Chapter 8 describes plan implementation, including how changed circumstances and unforeseen circumstances are addressed, and outlines the process for minor modifications and major amendments should the need arise. General changes to the terms of the permit are also addressed.

Chapter 9 provides the detail of plan funding along with the source of funding and assurances.

Chapter 10 presents an analysis of alternatives to take of the covered species that were considered for adoption in the MSHCP.

1.7 LITERATURE CITED

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS). 2016. *Habitat Conservation Planning and Incidental Take Permit Processing Handbook*. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Washington, DC. December 21, 2016. https://www.fws.gov/endangered/what-we-do/hcp_handbook-chapters.html. (accessed August 2018).

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2 EXISTING ENVIRONMENT

This chapter describes the current environment in the MSHCP plan and permit areas.

2.1 THE SANTA CLARA RIVER WATERSHED

2.1.1 GENERAL OVERVIEW

The Santa Clara River Watershed is one of the largest watersheds on the southern California coast. Flowing approximately 83 miles (134 kilometers), the Santa Clara River drains approximately 1623 square miles (4204 square kilometers) (Figure 2–1) (Stillwater Sciences 2011). The river system spans two counties, with the upper watershed in Los Angeles County and the lower watershed in Ventura County. About 40 percent of the watershed is in Los Angeles County and 60 percent is in Ventura County. The headwaters of the Santa Clara River originate at Pacifico Mountain in the San Gabriel Mountains in Los Angeles County. Elevations in the watershed range from sea level to 8800 feet (2682 meters) above mean sea level.

The Santa Clara River system is one of the few remaining relatively free–flowing rivers in southern California. It is prone to drought, flood events, fire, landslides, and seismic activity that serve to increase the sediment load in the river system. Along with other geologic and climatic conditions of the region, these conditions result in the watershed having very high sediment–production rates. River channel morphology and connectivity is strongly influenced by the variable sediment–production rates experienced in the river and this in turn affects the biotic community along the river course. The connectivity of the Santa Clara River is also influenced by groundwater recharge (natural and artificial) as well as groundwater pumping in some reaches. The following sections provide more detail about the interconnected components of the Santa Clara River watershed, which provides the physical and biological context for this MSHCP.

2.1.2 GEOLOGY

The Santa Clara River watershed is in the geomorphic province of California known as the Transverse Ranges, which are oriented east–west unlike most other mountain ranges in California that trend north–south. The Santa Clara River flows between the east–west trending mountains of this province. About 90 percent of the Santa Clara River watershed is north of the mainstem of the river and in mountainous terrain. Surrounding mountains include the San Gabriel, the Sierra Pelona, and the Topatopa Mountains. The remaining 10 percent of the watershed is in relatively flat terrain that includes the Santa Clara River Valley and portions of the Oxnard Plain.

Throughout the watershed, there are several fault lines. Seismic fracturing and folding have caused the bedrock to be highly erodible (Scott and Williams 1978, Wells et al. 1987) (Figure 2–2). The sedimentary bedrock along valley flanks is typically poorly consolidated and steeply inclined, making it susceptible to landslides, particularly during earthquakes. Sediment generated by landslides in the watershed is eventually deposited in waterways and carried downstream, often resulting in a very high suspended sediment load and bedload in the Santa Clara River during storm events. The high sediment yield of the watershed significantly influences the geomorphic processes common to the lower river corridor.

2.1.3 CLIMATE

The Santa Clara River watershed has a semi–arid, Mediterranean–type climate with warm, dry summers and cool, wet winters. Humidity is highest at the estuary and decreases to near–desert conditions at the eastern watershed boundary.

Most precipitation falls between November and March. Complex topographic features result in varying rainfall intensities throughout the watershed. Average annual rainfall ranges from 34 inches (86 centimeters) in the mountainous headwaters of Sespe Creek to about 8 inches (20 centimeters) in the drier, eastern portions of the watershed near the Mojave Desert (Stillwater Sciences 2007a). Average annual rainfall for the Santa Paula station #245 in the lower watershed is 17.2 inches (43 centimeters) (Figure 2–3). Proximity to the Pacific Ocean moderates both seasonal and diurnal temperatures, particularly in the Oxnard Plain area. Based on the weather station #245 for Santa Paula, California (047957), the average maximum temperature is 74.8 °F (23.7 °C) and average low is 47.9 °F (8.8 °C) (Western Regional Climate Center 2018).

Climate models project about 10 percent loss of precipitation throughout California by 2100 under low emissions scenarios (Cayan et al. 2009). However, depending on the global climate model used and the emissions scenario considered, variability exists in the projection that indicates drier or wetter futures are possible in southern California. For example, one study found that between the years 2005 and 2064, modeled precipitation changes range from –13 percent to +16 percent change in precipitation per year, depending on which global climate model and emissions scenario is used for the calculations (Cayan et al. 2008). A range of changes in precipitation from –63 percent to +39 percent precipitation per year in the summer and –8 percent to +26 percent in the winter are also modeled across different global climate models and emissions scenarios at the state level.

The Santa Clara River watershed already experiences considerable variability in rainfall in seasons and across years from other factors, such as the El Niño Southern Oscillation and the Pacific Decadal Oscillation (Killam et al. 2014). This variance makes it difficult to project rainfall in the Santa Clara River watershed even before considering climate change. All the climate change models project increased variability in precipitation (i.e., longer dry periods and shorter, more intense rain storms), increased likelihood of flooding for any given rain event, and increased suspended sediment in runoff due to more wild–fire events (Cayan et al. 2008, Stillwater Sciences 2008, Karl et al. 2009, Killam et al. 2014, Swain et al. 2018).

Despite the uncertainty in precipitation projections for the southern California region, increased resolution of climate models in recent years has made them more reliable and locally specific. Regional projected changes in the 24–hour, 50–year storm for Ventura County range from 3 percent increase under low–emissions scenarios to 10 percent increase under high–emissions scenarios (AghaKouchak et al. 2018). The current 50–year storm (6.5 inches [16.5 centimeters] over a 24–hour period) for Ventura County is expected to occur more frequently, potentially recurring every 15 to 35 years by 2050 (AghaKouchak et al. 2018). While the frequency and intensity of rainfall is expected to increase, stretches between storms are expected to be hotter and drier and overall decreases in snowpack are predicted (California Energy Commission 2018). Drought is expected to intensify on the regional level, causing higher occurrences of extremely wet and extremely dry years (California Energy Commission 2018). Taken together, these changes will likely result in lower surface and groundwater resources, leaving the Los Angeles region to face a combination of decreased water supply and increased water demand. Increased and improved management of water resources in the Los Angeles region will be necessary to effectively respond to these changes.

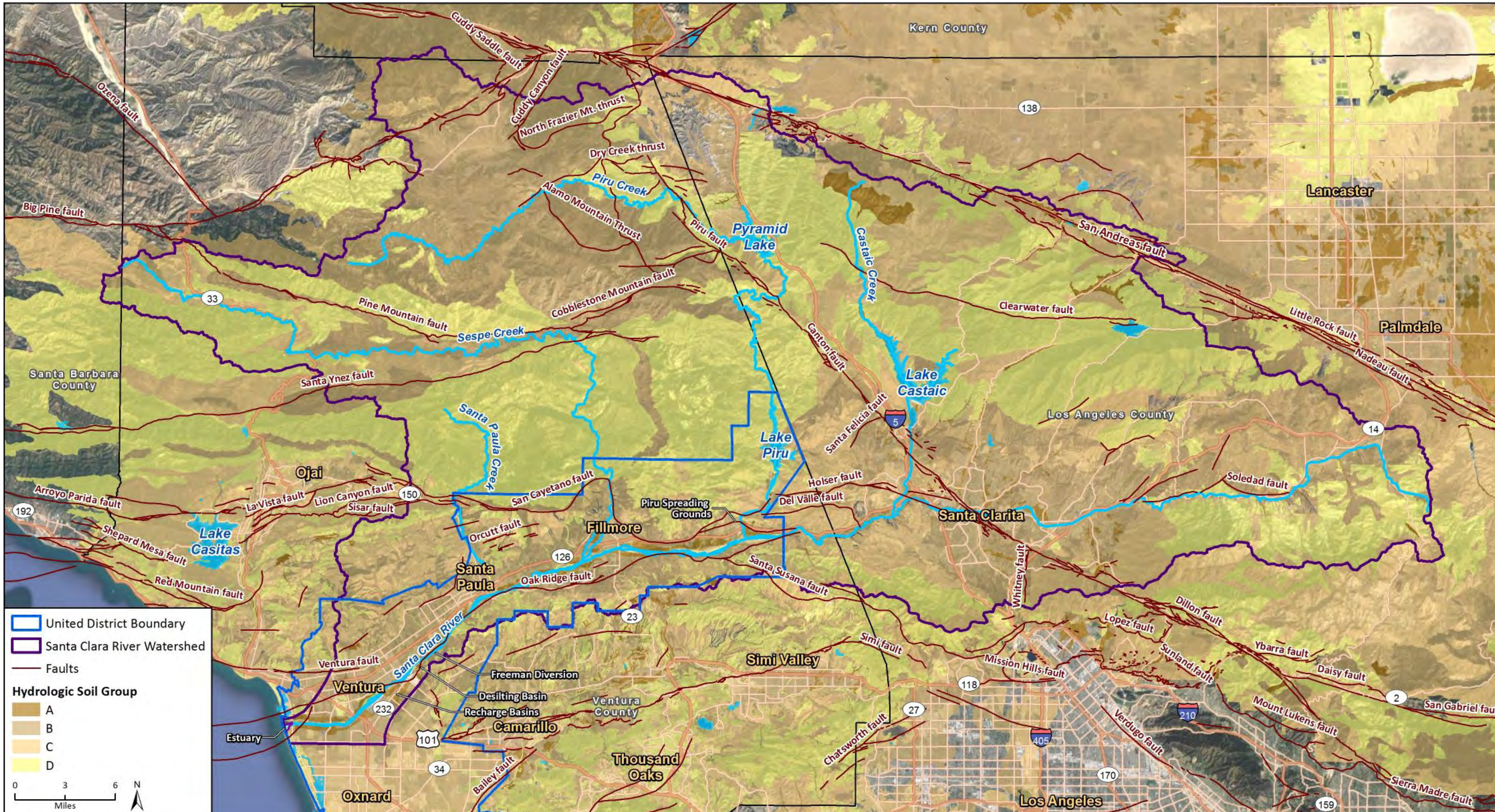
2.1.4 HYDROLOGY

Overview

The Santa Clara River Watershed has a complex system of interconnected groundwater aquifers and an extremely dynamic river (Figure 2–4). The watershed can experience extreme drought when there are

Figure 2–1 Santa Clara River Watershed

Figure 2–2 Seismic Faults



Imagery provided by Google and its licensors © 2018.
Hydrological data provided by County of Ventura, 2016; Soil data provided by United Stated Department of Agriculture, 2016; Fault data provided by Department of Conservation, California Geological Survey, 2010.

Figure 2–3 Historical Precipitation (1890 – 2017) for Santa Paula Station #245

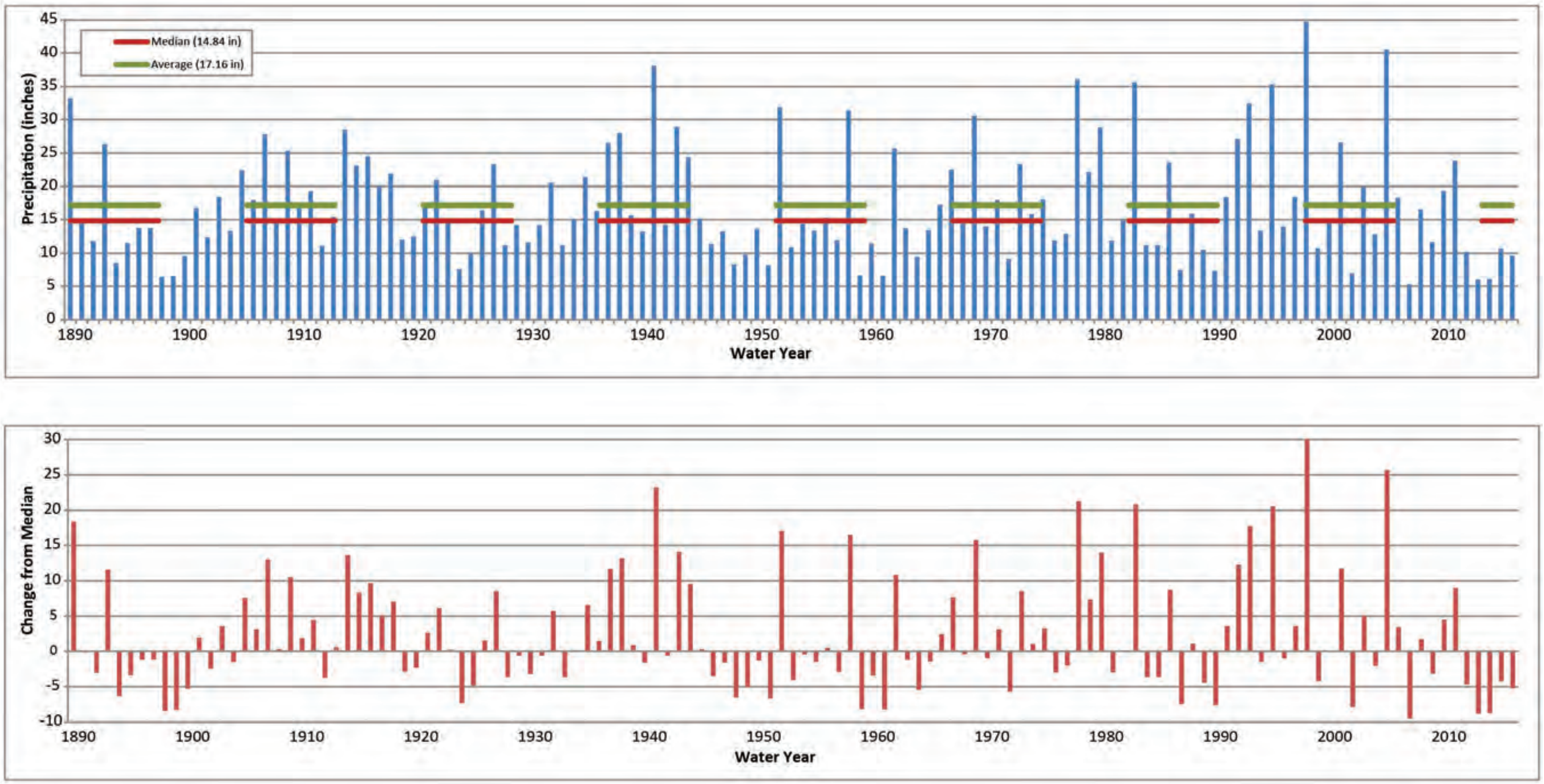


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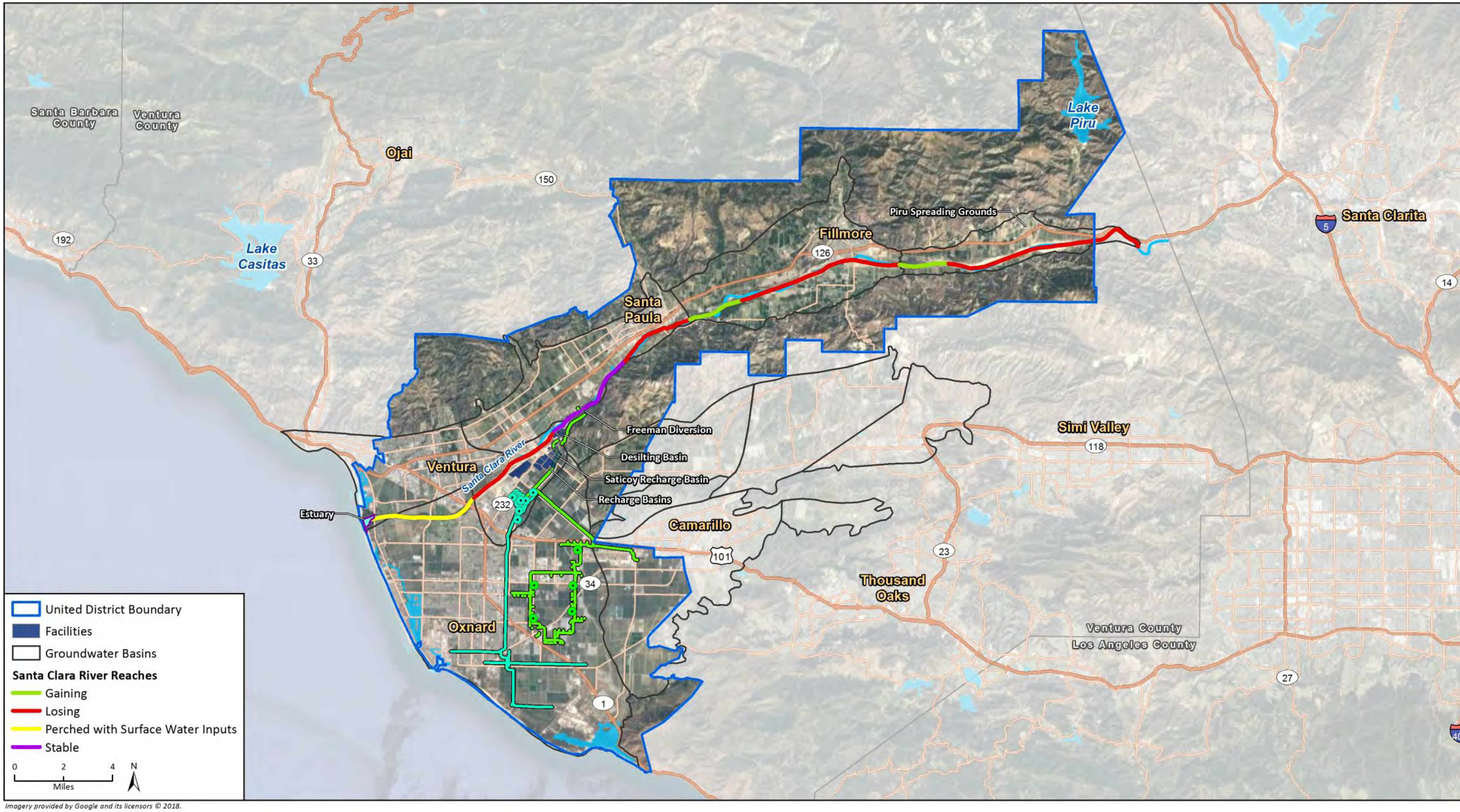
Figure 2–4 Surface Water–Groundwater Interactions



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multiple dry years in close succession and the watershed can experience extreme flood, particularly in saturated or near–saturated watershed conditions (Figure 2–3). The river is often divided into “upper” and “lower” sections, with the Los Angeles County–Ventura County line dividing the two sections. The river forms a coastal lagoon at its mouth near the Ventura Harbor and McGrath State Beach. The coastal lagoon is commonly referred to as the Santa Clara River Estuary and the terms are used interchangeably in this MSHCP.

Complex surface water and groundwater interactions drive an intermittent flow regime in the Santa Clara River watershed. Along the length of the Santa Clara River and along the tributaries, several losing reaches occur where surface flow percolates entirely and results in dry sections of riverbed. Surface flow resumes in gaining reaches some distance downstream, sourcing from rising groundwater that usually occurs near one of the groundwater basin boundaries where groundwater flow is constricted.

Given adequate combinations of saturation and precipitation, surface flow will bridge the losing reaches resulting in continuous surface flow to the ocean. During these events, surface flow typically increases, peaks, subsides, and then either percolates completely or continues as some level of baseflow until another precipitation event occurs. In the wettest years, baseflow can be sustained through the dry season. However, in most (average to dry) years, the mainstem displays interrupted perennial flow where most reaches have minimal flow or are completely dry (losing reaches) and a few reaches maintain surface flow from rising groundwater conditions (gaining reaches) (Beller et al. 2011) (Figure 2–4).

Intermittent flow is more pronounced in the upper reaches of the Santa Clara River with perennial surface flow occurring in Soledad Canyon, the reaches downstream of Santa Clarita, and the reach upstream of the Ventura County line. Treated wastewater discharges from the Saugus and Valencia Water Reclamation plants are major sources of perennial flow in the reaches near Santa Clarita and rising groundwater commonly contributes flow to the river in the reach upstream of the Ventura County line. The upper river has a single channel most of the time, when it flows through areas of high topography and a braided morphology along the relatively flat valley floor areas.

Braided channels, a wide floodplain, and coarse alluvial deposits (coarse sand to gravel and cobble) characterize the lower Santa Clara River. The lower river displays losing and gaining reaches, a stable reach across the Santa Paula basin (losses or gains in streamflow are generally low compared to other losing and gaining reaches), and the most downstream reach, characterized by perched groundwater with surface water inputs (Figure 2–4).

From the Los Angeles County–Ventura County line to the river confluence with Piru Creek, the river floodplain is about 1000 feet (305 meters) wide. This section of the river is a losing reach that results in a dry gap in the central part of the Piru basin in the dry season of most years (dry to average years). This section can also display a dry gap in the wet season, depending on levels of saturation and precipitation each year.

Downstream of the Piru Creek confluence, geologic structures cause the underlying groundwater basin to constrict at the Piru narrows (near the Filmore Fish Hatchery). At this location, groundwater flow converges below the surface and rises up to the riverbed, producing an area of rising groundwater where the river gains surface flow and forms a gaining reach year–round, except for the driest years when low groundwater levels do not intersect the streambed.

Moving downstream of this location, the valley widens (over the Fillmore groundwater basin) and the river’s largest tributary, Sespe Creek, joins the mainstem. However, this area is a losing reach and flows gained at the Piru narrows often percolate entirely in the upstream areas of the Fillmore groundwater basin in the dry season and sometimes in the wet season, depending on levels of saturation and precipitation in a given year.

The floodplain then narrows again to about 1000 feet (305 meters) just east of Santa Paula, and just upstream from where Santa Paula Creek joins the river. Rising groundwater from the Fillmore basin in the areas upstream of the Santa Paula Creek confluence often significantly contribute to surface water flow upstream of the Freeman Diversion.

The river then meanders to the south side of the valley near Peck Road and runs along the southern portion of the valley floor to the Freeman Diversion (located near the western boundary of the Santa Paula groundwater basin). In areas downstream of the Santa Paula basin, the floodplain varies in width from approximately 1000 to 4000 feet (305 to 1219 meters).

Approximately 1 mile (1.6 kilometers) downstream of the Freeman Diversion, the unconfined Oxnard Forebay groundwater basin underlies the channel of the Santa Clara River. The water table of the forebay slopes away from the Santa Clara River to the south. The sand and gravel substrate of the Forebay effectively percolates large volumes of water in the river channel. This losing reach extends approximately to the Highway 101 bridge and is the furthest downstream losing reach of the Santa Clara River that is often dry. In this MSHCP, this reach is referred to as the "critical reach" because this losing reach contains the "critical riffles," areas where steelhead and lamprey would have the greatest difficulty passing during low flows between the Freeman Diversion and the estuary. This reach is described in more detail below because of its ecological importance to this MSHCP.

Finally, between the Highway 101 bridge and the estuary, the river overlies a perched aquifer where water cannot penetrate an impermeable clay layer. Near the Highway 101 bridge, the character of the geologic deposits in the shallow subsurface change as the unconfined conditions of the Oxnard Forebay transition to the confined aquifer conditions of the Oxnard Plain (Mann 1959). The transition to confined conditions is affected by the increasing thickness and continuity of the shallow silt and clay beds that extend over the Oxnard Plain (i.e., the clay cap). The presence of perched water in the area extending from the southern Forebay (Montalvo area) to the estuary changes the character of the flow in the Santa Clara River from that observed over the Forebay. Consequently, the reach between the Highway 101 bridge and the estuary usually has perennial flow supported mostly by discharges of perched water to the river channel.

Historic Hydrology Near the Freeman Diversion

A comprehensive study of the historical ecology in the region characterized pre–development flow in the Santa Clara River as "interrupted perennial stream… [with] intermittent (summer dry) reaches…clearly documented" for areas near Piru and Saticoy (Beller et al. 2011). J. G. Cooper was an ornithologist who spent 14 months along the Santa Clara River between 1872 and 1873 cataloging bird species and collecting specimens. In 1887, Cooper described the dry gap in the Santa Clara River downstream of the present–day location of the Freeman Diversion (the critical reach) as follows:

> *The Santa Clara River runs half a mile distant, but is dry in summer for seven or eight miles along that part of its course, leaving a wide, sandy and gravelly bed, destitute of vegetation except on a few higher patches where small poplar and willow trees grow, with low shrubbery, and which become islands in the high water of winter. Some sand hills along this portion also sustain thickets of low shrubbery, much like that of the desert regions east of the county…. The Saticoy springs furnished the only water in summer, and the only tree shelter for a circuit of three or four miles, the brooks running from the hills drying up nearly to their sources. About three miles east of Saticoy the Santa Clara River runs permanently and a grove of poplars and willows lines its marshy shores for several miles* (Cooper 1887).

The groves of trees to which Cooper refers are just upstream of the present–day location of the Freeman Diversion, in a perennial portion of the river; they are still observable today.

Figure 2–5 presents a composite image of several aerial photographs taken in 1927 along with an overlay of modern Google Earth imagery showing part of the critical reach downstream of where the Freeman Diversion exists today. This aerial image predates diversions conducted by United's predecessor district and the failure of the Saint Francis Dam in the upper watershed. The dry gap is clear in the historic image and can be compared to its condition today. Cooper's description of the Forebay in the 1870s and the 1927 aerial photos document a dry riverbed in the Oxnard Forebay under pre–development and early development nearly a century ago. Thus, the dry gap below the Freeman Diversion is considered a relatively "natural" feature of the Santa Clara River driven mostly by hydrogeology.

Surface Water Hydrology at Freeman Diversion

Stream flow in the Santa Clara River at the Freeman Diversion is highly variable, and most directly influenced by rainfall events occurring in the watershed during the winter rainy season (December to March). Stream flow can increase by tens of thousands of cfs in a day following a significant rainfall event. The duration of the hydrograph recession limb varies from days to months, depending on rainfall amount and duration, saturation of soils in the watershed, and, groundwater storage in the basins of the Santa Clara River valley upstream. The time difference between the peak storm activity in the watershed and the peak of discharge at the Freeman Diversion is often between 12 and 24 hours, mostly dependent on travel time for runoff from the upper Sespe Creek watershed, the largest tributary to the Santa Clara River. Figure 2–6 shows two example hydrographs for the Santa Clara River at Freeman Diversion for the years in 2008 and 2018, and Figure 2–7 shows a flow duration curve for the Santa Clara River at Freeman Diversion for the years 1944–2017. The 25 percent and 75 percent exceedance in daily average flows are 142 cfs and 15 cfs, respectively. Over the 74–year period of record shown, flows less than 10 cfs (0.3 cms) occurred 18 percent of the time and flows exceeding 1,000 cfs (28 cms) were recorded 4 percent of the time.

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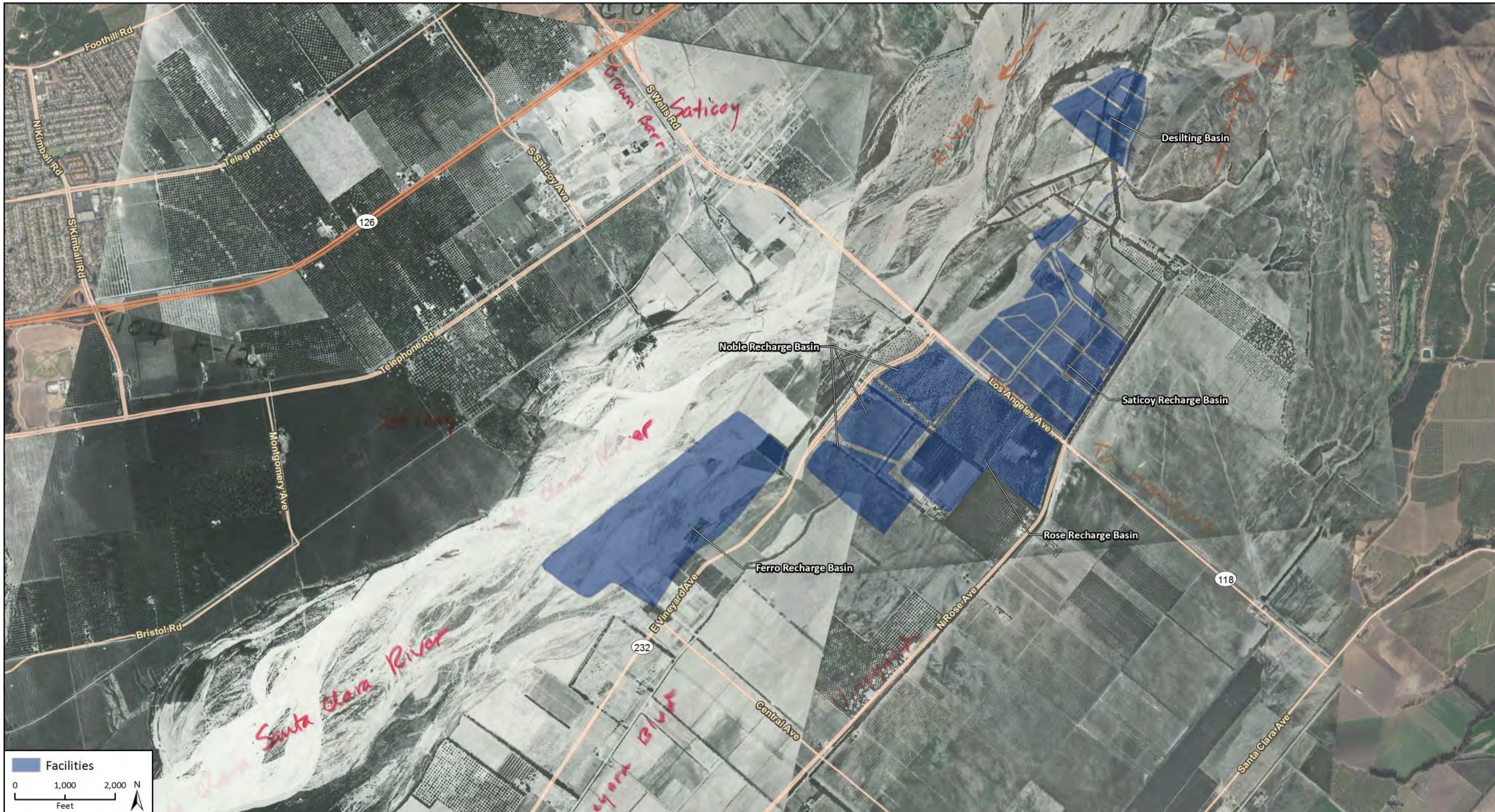
Figure 2–5 Santa Clara River at the Forebay in 1927



Imagery provided by Google and its licensors © 2018.

Aerial imagery Fairchild 1927

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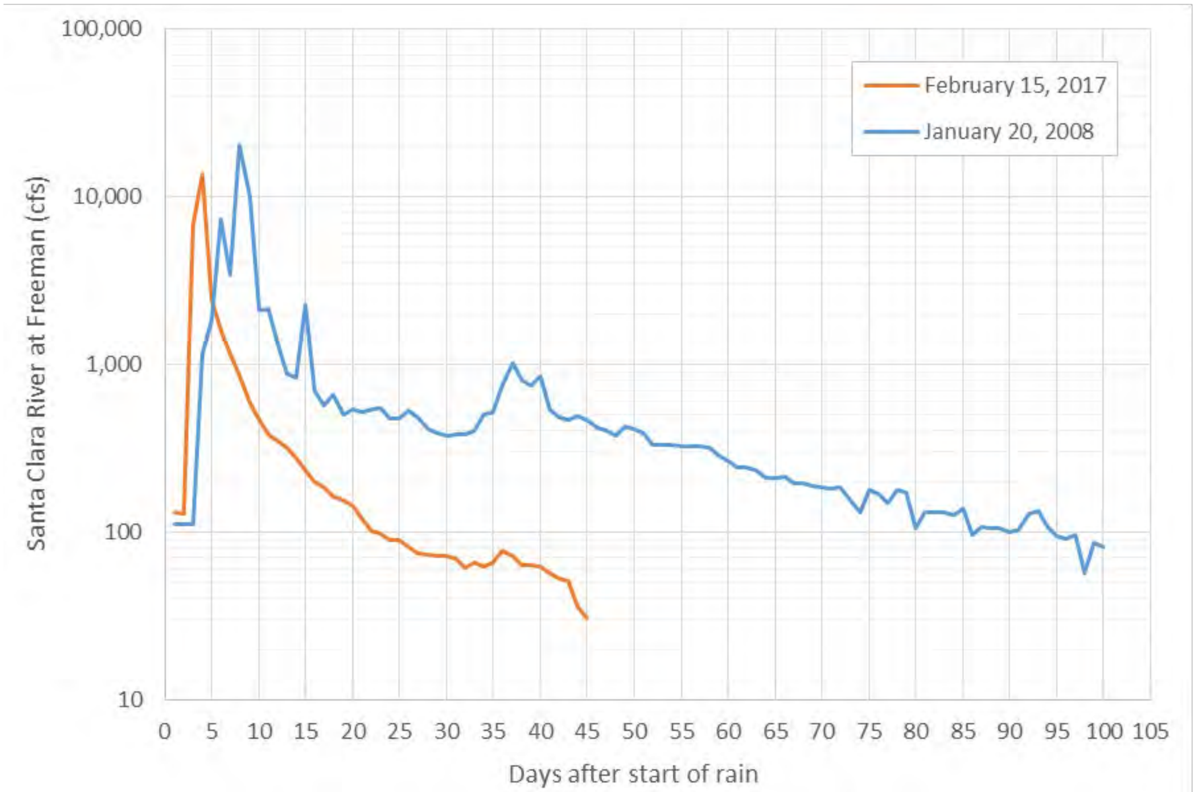
Figure 2–6 Example Hydrographs for Santa Clara River at Freeman Diversion



Note: The February 15, 2017 storm event included 4.6 inches of rainfall during a six–day period, the January 20, 2008 storm event included 7.0 inches of rainfall during a seven–day period.

Figure 2–7 Flow Duration Curve for Santa Clara River at Freeman Diversion (Water Years 1944 – 2017)

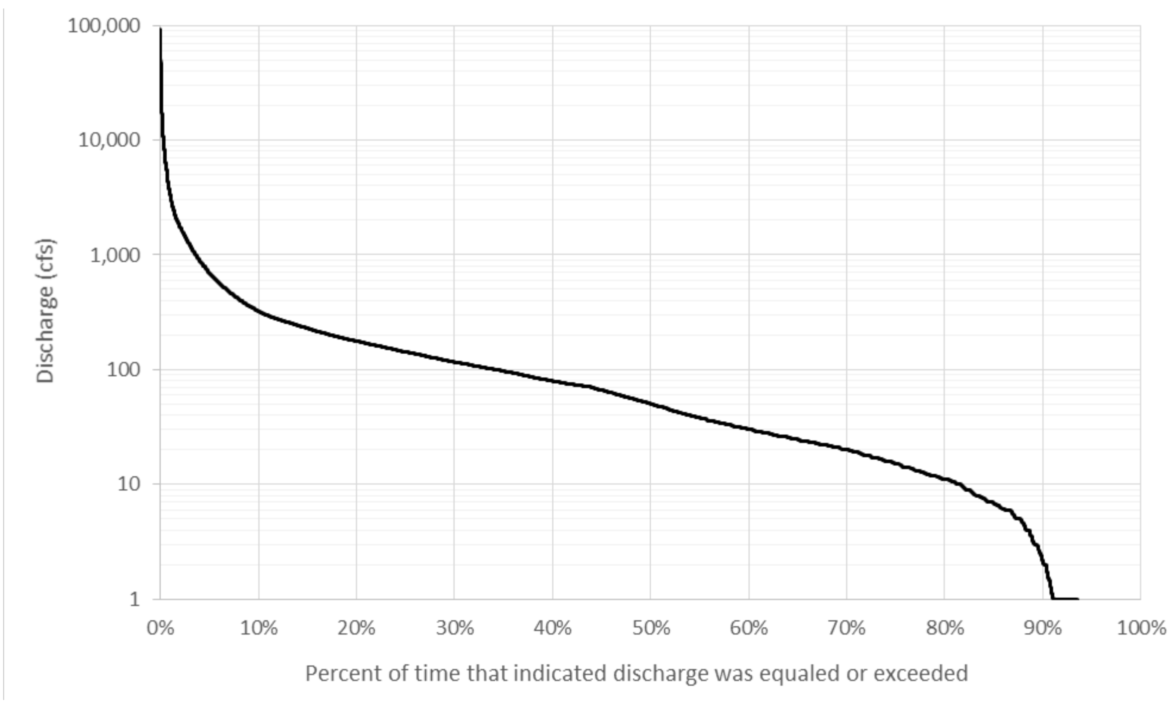


Table 2–1 shows the magnitude of monthly water conditions of total river flow at the Freeman Diversion (minimum, maximum, and median for each month) based on water years 1944–2014. Monthly water conditions were calculated based on the daily flow record included in the HOSS, updated to include measured flows up to 2017 (reference). Daily river flows in any given month are highly variable, with minima as low as 0 cfs and maxima up to 92,300 cfs. The months between January and April generally see the most runoff, but significant flows can occur on the shoulder season (November to December and May).

Table 2–1 Magnitude of Monthly Water Conditions in Santa Clara River Total River Flow (CFS) at Freeman Diversion (1944 – 2017)

Month	Median	Minimum	Maximum
October	26	0	2,710
November	32	0	14,500
December	55	0	22,454
January	86	0	84,900
February	128	0	92,300
March	156	2	30,700
April	108	0	24,300
May	58	0	4,912
June	30	0	578
July	22	0	392
August	18	0	312
September	19	0	1,017

2.1.5 SEDIMENT TRANSPORT AND DEPOSITION

Sediment transport is the movement of organic and inorganic particles by water. Sediment transport influences the morphology of Santa Clara River because the watershed has extremely high sediment–production rates (Farnsworth and Warrick 2007, Stillwater Sciences 2011). The episodic and intertwined effects of tectonic uplift, rainstorms, wildfires, earthquakes, and human and other disturbances drive production and delivery of sediment to the river. The watershed is in a tectonically active region, and with the San Andreas Fault nearby, it experiences episodic earthquakes and tectonic uplift at some of the highest rates in the western United States (Scott and Williams 1978; Inman and Jenkins 1999). The rapid uplifting triggers landslides, causing the input of sediment into tributary creeks and eventually the mainstem Santa Clara River. Furthermore, the area is highly affected by wildfires, which makes it more susceptible to sediment runoff when vegetation mass is diminished, and soil permeability altered. This decreases slope stability, which causes high rates of dry ravel on hillslopes (Florsheim et al. 1991). Sediment produced by these conditions is delivered by streamflow from the tributaries to the mainstem Santa Clara River, which flows downstream past the Freeman Diversion to the estuary and the Pacific Ocean. Overall, the watershed's sediment–production rate has been calculated at approximately 9.0 million tons per year, or 5600 tons per square mile per year, averaged across the entire watershed area (Stillwater Sciences 2011). Considering that the dams on Piru, Castaic, and Bouquet creeks intercept water and sediment from nearly one–third of the total watershed, the predicted sediment–production rate for the watershed is approximately 5.6 million tons per year, or 5400 tons per square mile per year.

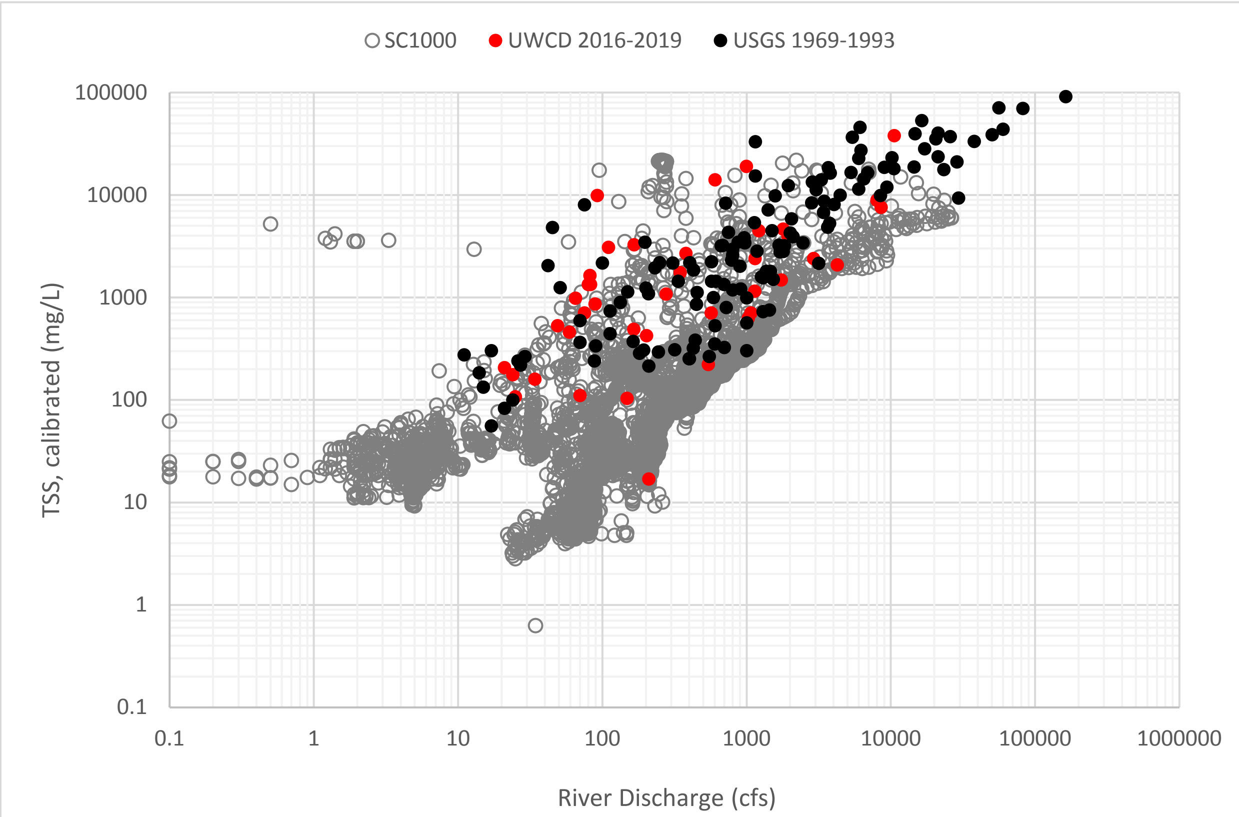
Seasonally intense rainfall and the resulting runoff are the primary mechanisms for sediment transport through the drainage network. Rainfall events can change the morphology of the Santa Clara River, which does not change progressively in response to small floods, but instead experiences significant episodic changes associated with much larger floods (Stillwater Sciences 2007). The amount of sediment available to be transported during storms depends on the grain size of sediment delivered to the river, and the amount of sediment already in the stream channel. This is reflected in the grain size distributions of suspended sediment and bedload in tributary streams. Sediment transported in the river includes silts and clays (Stillwater Sciences 2011). Prediction of sediment loading is complicated by the fact that sediment delivery is episodic, depending on the frequency, magnitude, and relative timing of stochastic events such as storms, fires, landslides, and earthquakes (Stillwater Sciences 2011, Downs et al. 2013).

In addition to sediment contributed by natural events, human activities affect sediment transport, particularly in the lower Santa Clara River. Past activities such as aggregate mining, the construction of dams on tributaries, urban growth, and levee development have interrupted the downstream sediment transport process to the estuary. Aggregate mining was the single largest anthropogenic impact that changed the channel form of the lower Santa Clara River (Stillwater Sciences 2011). Prior to the construction of the Freeman Diversion in 1990, aggregate mining and levee development downstream of the Freeman Diversion contributed to narrowing and deepening of the channel. The construction of the Freeman Diversion stabilized the river's bed elevation on the upstream side of the diversion and eliminated historic downcutting that resulted from the mining operations.

Samples of suspended sediment collected from the Santa Clara River near the Freeman Diversion indicate that sediment concentration typically increases with flow magnitude (Warrick and Mertes 2009, Stillwater Sciences 2011, NHC 2015). Sediment concentrations in the river near the Freeman Diversion increase exponentially with discharge, and for a given discharge are higher earlier in the water year than later (i.e., the early storms carry more wash load) (Stillwater Sciences 2011, NHC 2015). Based upon empirical evidence obtained in recent decades, the lower river conveyed approximately 2 million tons of total sediment load annually, with most sediment transport occurring during the largest flood events of 1969, 1978, 1993 and 2005 (Stillwater Sciences 2011). Sediment transport models indicate the river has the potential to transport a total sediment load of approximately 400,000 tons per day, during a 100–year discharge event near the Freeman Diversion, with most of the sediment made up of very fine to coarse sand (AECOM 2016).

The total sediment load of any given river comprises bedload (coarse sands and gravels), suspended load (fine sands, silts, and clays), and dissolved load (chemical constituents). Studies conducted on the lower Santa Clara River by the U.S. Geological Survey in the 1960s and 1970s observed the total sediment load comprised approximately 10 percent bedload (coarse sands and gravels) and the remainder being suspended and dissolved load (fine sands, silts, and clays) (Williams 1979). Most of the total sediment load was transported during only a few days of flood flow each year. During the 1968–1975 water years, approximately 55 percent of the total sediment was transported in two days, and 92 percent was transported in 53 days. Suspended sediment measured as suspended sediment concentration (SSC) in the river at the former Montalvo gaging station between 1969 and 1993 ranged from concentrations of 253 to 91,400 milligrams per liter (mg/L). The sample data showed a general trend of increasing SSCs with increasing discharge. More recent samples of total suspended solids (TSS), taken by United Water at the Freeman Diversion headworks and fish bay, confirmed these general trends and magnitudes of suspended sediment in the river under varied flow conditions. Figure 2–8 presents measured TSS concentrations at various flows at sample stations along the lower Santa Clara River.

Figure 2–8 Relationship Between Measured TSS and Santa Clara River Discharge[1, 2]



1 SC1000 values include data available from December 2018 – December 2019
2 SC1000,UWCD and USGS values are instantaneous readings.

Sediment transport to the Santa Clara River estuary occurs through both fluvial and littoral processes (Stillwater Sciences 2016). The estuary aggrades and migrates landward during low flows and smaller flood events but can scour and migrate ocean–ward during large flood events. The mouth of the Santa Clara River is often closed with a sand barrier but is breached periodically by high flows during storm events, tidal activity, and anthropogenic breaching. In addition to increased urban developments in the upper watershed, climate change–associated changes in precipitation and fire regimes will likely result in changes to sediment transport in the watershed. The overall sediment transport down the Santa Clara River is expected to decrease because of longer dry periods, but increase during flood events (ESA PWA 2013), especially with increased wildfire frequency and intensity.

2.1.6 WATER QUALITY

Multiple agencies, including United, monitor water quality extensively in the Santa Clara River watershed. The Ventura County Watershed Protection District monitors surface water quality as part of a storm water quality program. Under the Countywide Stormwater Permit, the County of Ventura maintains several auto–samplers that collect surface water samples for assessment of a wide range of parameters multiple times each year, under both wet and dry weather conditions. One of the auto–samplers is located at the Freeman Diversion. In addition to these ongoing monitoring programs, several regulatory programs exist to improve water quality conditions in the watershed. These include development of total maximum daily loads (TMDL) for chloride and nutrients in the upper Santa Clara River and on–going compliance activities related to National Pollutant Discharge Elimination System (NPDES) permits. The Los Angeles Regional Water Quality Control Board (RWQCB) administers the NPDES and TMDL programs as part of its Basin Plan for the preservation and enhancement of water quality, but TMDLs can be adopted by the State Water Quality Control Board or by the USEPA.

United monitors water quality conditions for surface water and groundwater at various locations within United's boundaries (see Section 2.2). This water quality monitoring program includes sample collection from several wells and surface water bodies, seasonally, monthly, or every two weeks, and analysis of samples for a general suite of inorganic constituents. Surface water sampling sites are located generally near groundwater basin boundaries or on major tributaries near their confluence with the Santa Clara River. Sampling tributaries and specific reaches of the Santa Clara River assures that water quality is acceptable for natural groundwater recharge. Sampling is conducted with greatest frequency along the Santa Clara River near the Ventura–Los Angeles County line and at the Freeman Diversion. United's groundwater quality monitoring program relies on area production wells and dedicated monitoring wells for sample collection. Groundwater samples are collected either quarterly or semi–annually. United's public water supply wells surround the El Rio recharge basins and are sampled as often as weekly for problem constituents such as nitrates.

Surface Water Quality

Currently, United regularly collects surface water quality data for the lower Santa Clara River in Ventura County at four locations along the river: near the Blue Cut station below the Los Angeles County line (monthly), near the Fillmore Fish Hatchery (quarterly), near Willard Road at the Fillmore–Santa Paula basin boundary (quarterly), and at the Freeman Diversion Facility (every two weeks). Perennial flow commonly exists at these locations. United also conducts quarterly sampling of major tributaries to the Santa Clara River including Piru, Hopper, Pole, Sespe, and Santa Paula creeks, and at Todd Barranca, which joins the Santa Clara River immediately below the Freeman Diversion. Piru Creek is sampled above and below Lake Piru. The lake is also sampled. Table 2–2 summarizes the surface water quality data.

Rapid growth in the Santa Clarita area followed the import of State water, and by the late 1990s water quality problems were recognized in the Santa Clara River near the Ventura/Los Angeles County line, largely due to increased discharge from upstream water reclamation plants. Treatment for nitrogen removal was completed at the Valencia plant in 2003. Elevated chloride concentrations in the discharge have been a concern for agricultural interests since the late 1990s, and a prolonged TMDL process is underway to reduce chloride loading to the Piru basin where river flow from the upper watershed is a major source of groundwater recharge.

In the lower Santa Clara River watershed, the City of Ventura Water Reclamation Facility (VWRF) is the only municipal wastewater treatment plant releasing effluent to the river, discharging to the estuary south of Ventura Harbor. The VWRF has a design capacity of 14 million gallons (53 million liters) per day and is a tertiary treatment facility. The treatment plants serving the communities of Piru, Fillmore, and Santa Paula discharge to percolation basins near the Santa Clara River. Although water quality in the Santa Clara River is regarded as generally good (The Nature Conservancy 2006), 13 river segments in the lower watershed are on the Clean Water Act Section 303(d) list for impaired water bodies. All the impaired segments are to be assigned TMDLs by 2019.

The watersheds of the large tributary creeks north of the mainstem of the Santa Clara River are largely in the undeveloped lands of the Los Padres National Forest. Surface water flows from these areas are mostly unimpaired by human activities. Sespe Creek enters the Fillmore basin from the north, drains a large, mountainous watershed, and contributes significant flow to the lower reaches of the river. The extensive water quality records from the Santa Clara River at Freeman Diversion show a strong inverse relationship between total dissolved solids (TDS) and flow. Under low–flow conditions, groundwater discharge from the Fillmore basin provides a large percentage of river flow in the Santa Paula basin reach, upstream of the Freeman Diversion. Rising groundwater that contributes flow to the river tends to have a higher mineral content than winter and spring runoff from the watershed; so mineral content generally increases as flow from tributary creeks wane through the summer months.

Groundwater Quality

The quality of groundwater in the basins below the Santa Clara River is acceptable for most municipal, industrial, and agricultural uses, but secondary standards for TDS and sulfate are commonly not met. The area is generally free of large contaminant sites with organic contaminants such as solvents and hydrocarbons (Burton et al. 2011). The communities of Piru, Fillmore, and Santa Paula depend entirely on groundwater for water supply, as do the farmers in the Santa Clara River Valley. United provides regular groundwater conditions reports to the public on its website.

United regularly collects water quality samples from approximately 150 monitoring wells located throughout the District. Nearly all these wells are constructed of 2–inch (5–centimeter) diameter polyvinyl chloride. Most of the monitoring wells have a short screen interval that allows the collection of water from a specific depth in the aquifer. Many monitoring wells were installed as a nest or cluster in a single borehole, allowing the collection of piezometric head and water quality samples from multiple depths at the same location. Monitoring at these locations allows for a determination of head (pressure) in various aquifer units and vertical gradients between aquifer zones at these locations. United measures field parameters during sampling, but a commercial laboratory conducts all water quality analyses. United and the County of Ventura also monitor several private domestic and irrigation wells throughout United's district boundaries as part of their regional monitoring programs. The long screen intervals common to most production wells often draw water from multiple water–bearing zones, which can mask poor–quality water that may source from specific aquifer zones.

Decreasing groundwater levels often cause or contribute to undesirable changes in groundwater quality. The various forms of saline intrusion in the confined aquifers of the Oxnard Plain and Pleasant Valley are all directly related to groundwater overdraft conditions. Direct seawater intrusion occurs when pressure in the aquifer falls below sea level. Prolonged periods of low pressure in the aquifers promote the compaction of clays that may expel connate waters with high chloride concentrations. The upwelling of brines from deeper formations is promoted by low pressure in overlying aquifers, which is caused by groundwater extraction. In the coastal area between Port Hueneme and Point Mugu, more than 10 square–miles (26 square kilometers) of the upper aquifer system (UAS) are impaired by saline waters. In the aquifers of the lower aquifer system (LAS), the impacted coastal area is slightly less extensive. Elevated chloride concentrations are also common in the Pleasant Valley basin and are believed to be associated with upwelling brines (United Water 2016).

Other water quality problems are related to land use practices and can include nitrate from agricultural fertilizer or septic systems, and chloride and TDS from wastewater disposal practices. Nitrate problems are intermittent in many areas, but often worsen when less surface water is available for groundwater recharge. The challenges associated with the abatement of saline intrusion are ongoing. On the Oxnard Plain and in Pleasant Valley, groundwater production on the productive and highly utilized coastal plain commonly exceeds recharge to these basins. Regardless of source or type of pollutant, it is difficult to rehabilitate aquifers once they are contaminated and groundwater recharge on the Oxnard Plain as well as in lieu surface water deliveries play a crucial role in diluting groundwater contaminants.

Table 2–2 Surface Water Quality

	Calendar Quarter	Electrical Conductivity (µS/cm)			TDS (TFR 180C)			pH			Nitrate (mg/L)			Sulfate (mg/L)			Chloride (mg/L)		
		Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Piru Creek at Blue Point CG (1997–2015)	Jan–Mar	834	609	1040	545	370	730	8.3	8.0	8.8	0.3	0.0	2.0	177	110	291	63	34	98
	Apr–Jun	764	533	1150	479	324	744	8.3	7.6	8.8	0.4	0.0	1.8	162	85	258	54	17	96
	Jul–Sep	831	566	1300	542	320	942	8.4	7.3	9.4	0.1	0.0	1.5	205	67	791	62	28	101
	Oct–Dec	834	630	1200	518	370	804	8.3	8.0	8.9	0.1	0.0	1.2	158	62	253	76	35	135
Piru Creek below Santa Felicia Dam (1997–2015)	Jan–Mar	957	809	1150	654	510	828	8.3	8.1	8.5	0.3	0.0	1.5	279	180	379	53	32	82
	Apr–Jun	933	779	1190	617	470	842	8.1	7.6	8.6	1.0	0.0	5.5	264	196	320	47	27	81
	Jul–Sep	940	757	1250	647	490	908	8.2	7.8	9.2	1.0	0.0	5.1	269	182	379	50	27	80
	Oct–Dec	967	676	1310	654	492	968	8.1	7.8	8.5	0.3	0.0	1.8	275	170	482	53	28	98
Piru Creek near Piru (2000–2015)	Jan–Mar	1336	868	1680	957	600	1250	8.2	7.9	8.5	0.8	0.0	2.7	449	242	670	62	38	89
	Apr–Jun	1362	871	2070	984	610	1530	8.3	8.0	8.8	1.0	0.0	10.0	468	267	830	62	27	90
	Jul–Sep	1317	826	1690	943	570	1290	8.3	7.9	9.1	0.3	0.0	1.0	443	274	650	64	29	86
	Oct–Dec	1179	717	1560	825	506	1230	8.3	8.1	9.0	0.3	0.0	1.1	387	180	667	63	36	105
Sespe Creek at U.S. Geological Survey Gauging Station (1997–2015)	Jan–Mar	994	214	1200	695	150	866	8.3	7.8	8.8	0.5	0.0	3.0	284	46	400	52	4	185
	Apr–Jun	915	715	1160	634	480	811	8.4	7.9	9.2	0.1	0.0	0.9	259	204	321	40	8	114
	Jul–Sep	905	748	1370	579	460	957	8.6	8.2	9.3	0.1	0.0	0.9	204	167	296	86	31	207
	Oct–Dec	1109	785	1380	728	540	912	8.4	8.1	8.9	0.1	0.0	0.7	257	168	346	110	30	203
Santa Paula Creek at Harvard (1997–2015)	Jan–Mar	1036	597	1960	723	360	1440	8.2	7.8	8.7	4.7	0.0	20.8	303	140	715	33	10	82
	Apr–Jun	962	574	1640	692	367	1210	8.1	6.7	8.6	4.8	0.0	16.0	289	142	590	32	9	96
	Jul–Sep	1385	750	2240	1014	490	1750	8.7	8.7	8.7	12.9	1.8	31.3	478	220	786	55	14	92
	Oct–Dec	1291	772	1910	937	530	1540	8.2	7.6	8.6	11.8	0.0	23.4	413	200	634	55	18	126
Santa Clara River at Freeman Diversion (1997–2015)	Jan–Mar	1423	558	2790	1020	340	1650	8.1	7.5	8.5	6.4	0.0	11.0	481	158	876	53	8	140
	Apr–Jun	1481	682	2410	1098	460	1880	8.1	7.0	9.1	5.6	0.0	9.5	516	196	956	60	14	150
	Jul–Sep	1670	1170	2670	1249	790	2070	7.9	7.1	8.9	4.3	0.0	13.3	592	336	1160	79	38	180
	Oct–Dec	1485	700	2200	1091	460	1570	8.1	6.9	8.8	6.5	0.0	16.4	513	218	870	66	30	140

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Estuary Water Quality

Physical and chemical water quality conditions in the Santa Clara River estuary are highly variable, due to the combination of meteorological variations, seasonal and inter–annual variations in river flow, the position and closure status of the berm at the mouth of the Santa Clara River, and other variables. Direct discharges to the estuary from the VWRF are accompanied by Santa Clara River flows, agricultural drainage, storm water runoff, tidal exchanges with the Pacific Ocean during open mouth conditions, and/or periodic wave overwash events during closed mouth conditions, as well as stage dependent groundwater exchanges with the shallow aquifer underlying the estuary. In addition to monthly receiving water monitoring carried out by the City of Ventura as a requirement of its NPDES permit, available contemporary data sources were recently reviewed as part of studies carried out by the City (Stillwater Sciences 2011, 2018). A brief overview of water quality conditions affecting aquatic species in the estuary follows.

303(d) List of Water Quality Limited Segments of the Santa Clara River

Historically Santa Clara River estuary waters have exceeded Basin Plan objectives for several parameters including ammonia, nitrate, toxicity, bacteria, dissolved oxygen (DO), and pH (RWQCB 2014). While the VWRF discharge currently meets NPDES discharge effluent limitations, there are several historical water quality impairments for indicator bacteria[1], nitrate, Toxaphane, and ChemA being addressed by a completed TMDL. The Final California 2016 Integrated Report for the 303(d) List/305(b) Report recommended that pH and nitrate should not be included in the current 303(d) list in the Santa Clara River Estuary, but recommended including the estuary for apparent exceedances of water quality objectives for ammonia and maintaining the impaired status for toxicity in the estuary and in "Reach 1," which extends 6.1 miles upstream to the Highway 101 bridge crossing (RWQCB 2017). DO and pH listings in Reach 1 were included along with a requirement to develop a TMDL in the future.

Water Temperature

Estuary water temperatures recorded as part of routine grab sampling events during daylight hours from 2012–2016 exhibit expected seasonal variability from winter to summer. Depending upon sampling location, wintertime water temperatures averaged 57–61 ºF (14–16 ºC) with a range of 52–68 ºF (11–20 ºC) during open mouth conditions, and averaged 59–63 ºF (15–17 ºC) with a range of 46–70 ºF (8–21 ºC) during closed mouth conditions. During summertime, water temperatures averaged 66–75 ºF (19–24 ºC) with a range of 64–79 ºF (18–26 ºC) during open mouth conditions, and averaged 73–75 ºF (23–24 ºC) with a range of 63–82 ºF (17–28 ºC) during closed mouth conditions. Table 2–3 provides summary statistics of continuous water temperature measurements at four estuary locations under closed mouth conditions during 2015–2016.

[1] Previously described as coliform bacteria

Table 2–3 Summary Statistics of Continuous Water Temperature Measurements in the Santa Clara River Estuary by Season During 2015–2016

Location	Quantiles	Winter (ºC)	Spring (ºC)	Summer (ºC)	Fall (ºC)
North Bottom (VWRF Outfall channel)	Median	18.1	19.5	25.5	22.4
	Q1	13.5	18.1	24.6	17.5
	Q3	18.8	20.3	26.3	24.6
Central Bottom (Near Harbor Blvd)	Median	17.8	20.1	24.6	
	Q1	12.5	18.6	23.6	
	Q3	18.7	21	25.5	
South Bottom (Near McGrath State Beach Campground)	Median	18.1	19.9	25.4	17.1
	Q1	17.6	18.5	24.4	15.9
	Q3	18.8	20.9	26.3	19
South Surface (near McGrath State Beach Campground)	Median	17.6	20	24.2	23.8
	Q1	12.1	18.5	23.2	18.7
	Q3	18.4	20.9	25.2	25.4

Salinity

Salinity in the estuary varies over time due to competing influences of ocean exchanges of saltwater and freshwater inflows from the VWRF and Santa Clara River. Based upon continuous specific conductivity measurements collected during 2015–2016, estimated salinity ranged from 0.6–27 parts per thousand under closed–mouth conditions, which are typical of freshwater or oligohaline brackish environments. Periods of higher salinity (0.6–33 parts per thousand) have also been documented, driven by tidal exchange during open mouth conditions. Upon mouth closure, salinity approaches those of the dominant water source as the estuary fills, with timing that varies seasonally due to changing contributions from the various flow sources to the estuary.

Dissolved Oxygen

Based upon DO measurements recorded as part of routine grab sampling events during daylight hours from 2012–2016, average estuary DO concentrations were RWQCB Basin Plan (RWQCB 2018) water quality objectives on an annual basis (>7 mg/L), but fell below the minimum water quality objective for individual measurements (> 5 mg/L) at some locations on several occasions. DO varies both spatially and temporally throughout the estuary and although DO meeting the 5 mg/L objective was generally available in portions of the estuary at most times of year, widespread anoxia events are attributed to algae die–offs.

pH

On an annual basis, pH levels in the estuary generally averaged from 7.8–9.1 and ranged from 6.7–9.5, commonly exceeding RWQCB Basin Plan objectives (pH between 6.5 and 8.0 standard unit). Consistent with uptake of dissolved carbon dioxide due to algal photosynthesis, pH conditions were higher during daytime sampling and lower levels during nighttime sampling. pH was also found to be lower during open mouth than during closed mouth conditions.

Biostimulatory Substances

Based upon a subset of metrics used by the United States National Estuarine Eutrophication Assessment (NEEA) (Bricker et al. 1999), including Chlorophyll–a, total inorganic nitrogen (TIN) (sum of inorganic nitrogen including ammonium–N, nitrate–N, and nitrite–N), dissolved orthophosphate, and DO data collected between 2012–2016, the estuary is eutrophic under current conditions. Biostimulatory substances contributing to eutrophic conditions include high nutrient loading from groundwater, VWRF effluent, and riverine and local runoff sources. The associated high algal production results in highly–variable DO and pH on a basis, and algal die offs can lead to periods of near anoxia due to the oxygen demand of bacterial decomposition of algal detritus. Despite substantial reductions in nitrate concentrations in VWRF effluent following treatment process upgrades in late 2011, nutrient concentrations in the estuary remain above the saturation level for algal production, resulting in continued algal growth and variations in pH and DO conditions. In addition to potential changes in its current discharge levels being considered in its NPDES permit renewal process, the City of Ventura is evaluating treatment options for nutrient removal of ongoing discharges to the estuary.

2.1.7 LAND USE AND OWNERSHIP

The Santa Clara River watershed remains relatively undeveloped compared to other southern California rivers, with about 60 percent of the land publicly owned as part of the Angeles National Forest and the Los Padres National Forest. 35 percent of the watershed is in the Los Padres National Forest and consists primarily of higher–elevation chaparral and grasslands, with some riparian and oak woodland habitats along the waterways (California Protected Data Area Portal 2017). Most development and agriculture occur on the valley floor and in floodplain areas that parallel the river.

According to a land use assessment conducted within the 500–year floodplain of the Santa Clara River, open space is the primary land use and agriculture is secondary (AMEC Earth and Environmental [AMEC] 2005). Together these two land uses make up 90 percent of the 500–year floodplain.

Most of the Santa Clara River floodplain and the lower sections of its tributaries are privately owned. Private landholdings are mostly small, ranging from residential lots (3 percent of the lower watershed) and ranchettes from five to 40 acres (2 to 16 hectares) (8 percent), to agricultural land parcels ranging from 40 to 300 acres (16 to 121 hectares) (37 percent). The largest use of private land in the lower portion of the Santa Clara River watershed is agriculture, and includes citrus, avocado, berry, and row crop production. There are several local well fields that produce oil. A portion of the lower watershed is held in permanent conservation. The Nature Conservancy owns roughly 3500 acres (1416 hectares), and Friends of the Santa Clara River owns 230 acres (93 hectares).

2.1.8 BIOLOGICAL RESOURCES AND INVASIVE SPECIES

The relatively low level of channelization and the intermittent cycles of disturbance in the Santa Clara River watershed help maintain community succession dynamics that promote a diverse assemblage of floral and faunal communities. The biological resources of the Santa Clara River watershed have been extensively documented and studied at both a landscape and project level (e.g., Santa Clara River Project Steering Committee 1996; Amec 2005; The Nature Conservancy 2006, 2008; Stillwater Sciences and URS 2007; Stillwater Sciences 2007b, 2008; Beller et al. 2011). This section briefly discusses some of the common species and habitats that occur in the Santa Clara River watershed and the plan area.

Vegetation

Chaparral and coastal sage scrub communities dominate the uplands of the Santa Clara River watershed, and riparian and various wetland communities dominate the river itself. Many native plant species are found in the watershed, as are several problematic, non–native invasive species.

Vegetation Communities

Vegetation communities in the permit area include chamise – black sage chaparral, California sagebrush – California buckwheat scrub, laurel sumac scrub, interior live oak chaparral, and scrub oak chaparral (Figure 2–9, Figure 2–10, and Figure 2–11). Upland areas also include patches of grasslands, oak woodlands, and pine forests in the upper elevations.

The major vegetation types in the 100–year floodplain of lower Santa Clara River mainstem corridor (in Ventura County) and the lower sections of its three major tributaries (Santa Paula, Sespe, and Piru Creeks) have been mapped in detail and include approximately 278 individual plant species, 58 alliances, and 130 potential associations (Stillwater Sciences 2007b; Stillwater Sciences and URS 2007). These types are grouped into several general communities including river wash herbaceous, mixed riparian forest, mixed riparian scrub, and freshwater wetland (Beller et al. 2011). The availability of surface water, depth to groundwater, and intensity of flows influence the location and composition of vegetation communities in the river channel and floodplain. Riparian woodlands are found typically along gaining

reaches or on rarely flooded terraces. Herbaceous and scrub communities are found along losing, or periodically scoured reaches. The vegetation communities of the Santa Clara River estuary are predominantly freshwater wetland and tidal marsh, intermixed with riparian forest and adjacent sand dune communities.

Plant Species

Typical, dominant plant species found in the plan area include deerweed (*Acmispon glaber*), chamise (*Adenostoma fasciculatum*), black sage (*Salvia mellifera*), purple sage (*Salvia leucophylla*), coastal sage brush (*Artemisia californica*), quailbush (*Atriplex lentiformis*), hoary leaved ceanothus (*Ceanothus* spp.), California buckwheat (*Eriogonum fasciculatum*), coyote brush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), American dogwood (*Cornus sericea*), chaparral yucca (*Hesperoyucca whipplei*), laurel sumac (*Malosma laurina*), monkeyflower (*Diplacus aurantiacus*), ephedra (*Ephedra californica*), interior goldenbush (*Ericameria linearifolia*), interior live oak (*Quercus wislizeni*), coast live oak (*Quercus agrifolia*), manzanita (*Arctostaphylos* spp.), arroyo willow (*Salix lasiolepis*), California sycamore (*Platanus racemosa*), blue elderberry (*Sambucus nigra*), poison oak (*Toxicodendron diversilobum*), California juniper (*Juniperus californica*), scrub pine (*Pinus attenuate*), coulter pine (*Pinus coulteri*), Gooding's willow (*Salix gooddingii*), boxelder (*Acer negundo*), buckeye (*Aesculus californica*), and Fremont cottonwood (*Populus fremontii*). Within the plan area, patches of intact vegetation community containing native plant species are dispersed among areas of urban and agricultural development (Figure 2–9). Within the plan area, 41 plant species are considered rare or sensitive, including seven species listed under the CESA or ESA (Appendix A).

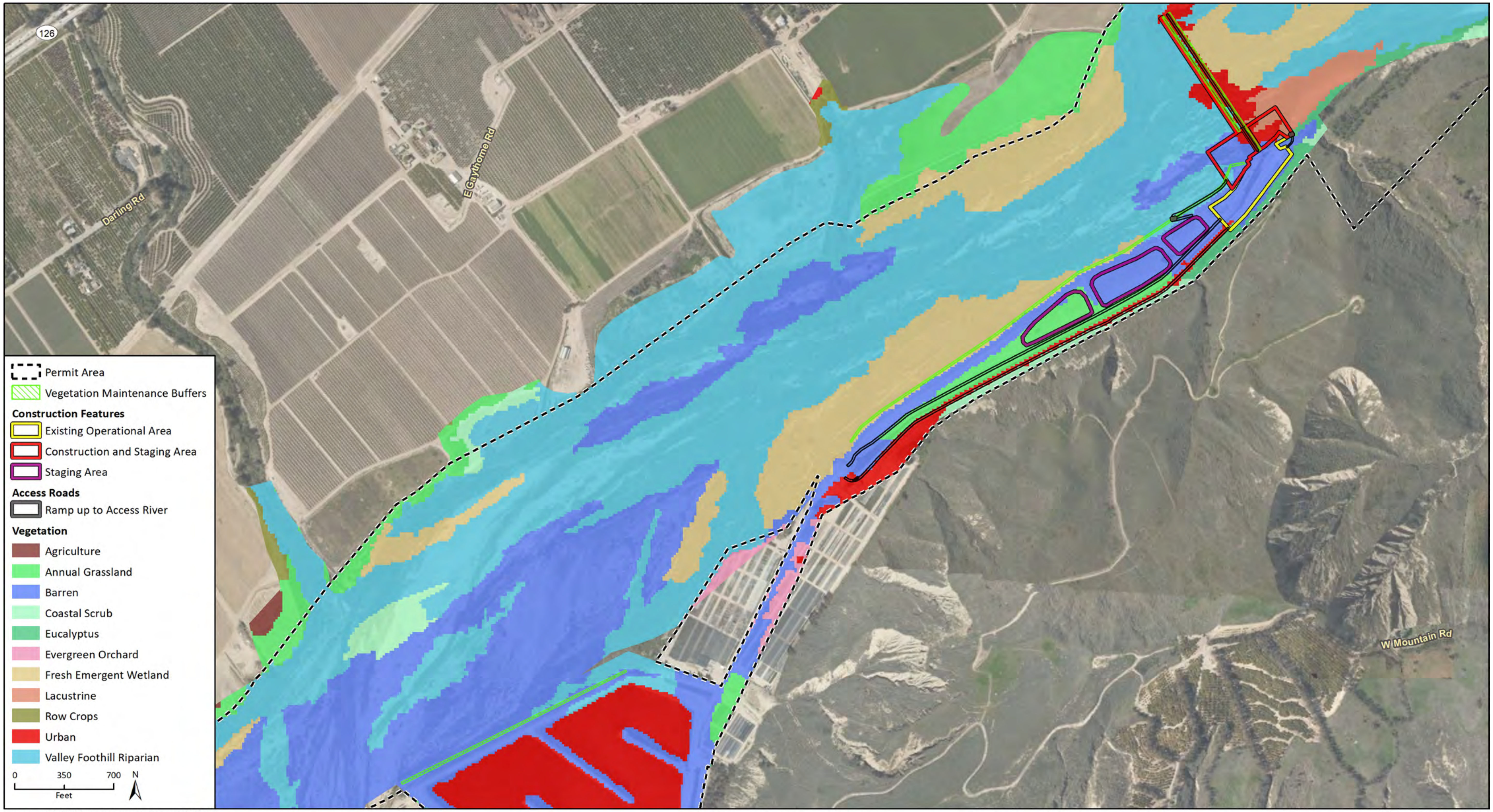
Wildlife

The variety of habitat in the Santa Clara River watershed promotes wildlife diversity in the watershed. Many animal species are distributed broadly and migrate between riparian and upland habitat, while others have very specific habitat requirements and restricted ranges. Within the plan area, 61 sensitive animal species have been identified (Appendix A), including 18 species listed under CESA or ESA; 48 total species are classified as special–status or potentially imperiled. This section provides an overview of common and special–status species, and Chapter 4 provides a detailed description of the species covered in the MSHCP.

Fish Species

Twenty–two common and special–status fish species are known to occur in the Santa Clara River system, including two that are federally endangered, one that is federally threatened, and 16 that are introduced

Figure 2–9 Vegetation Communities of the Permit Area at the Freeman Diversion



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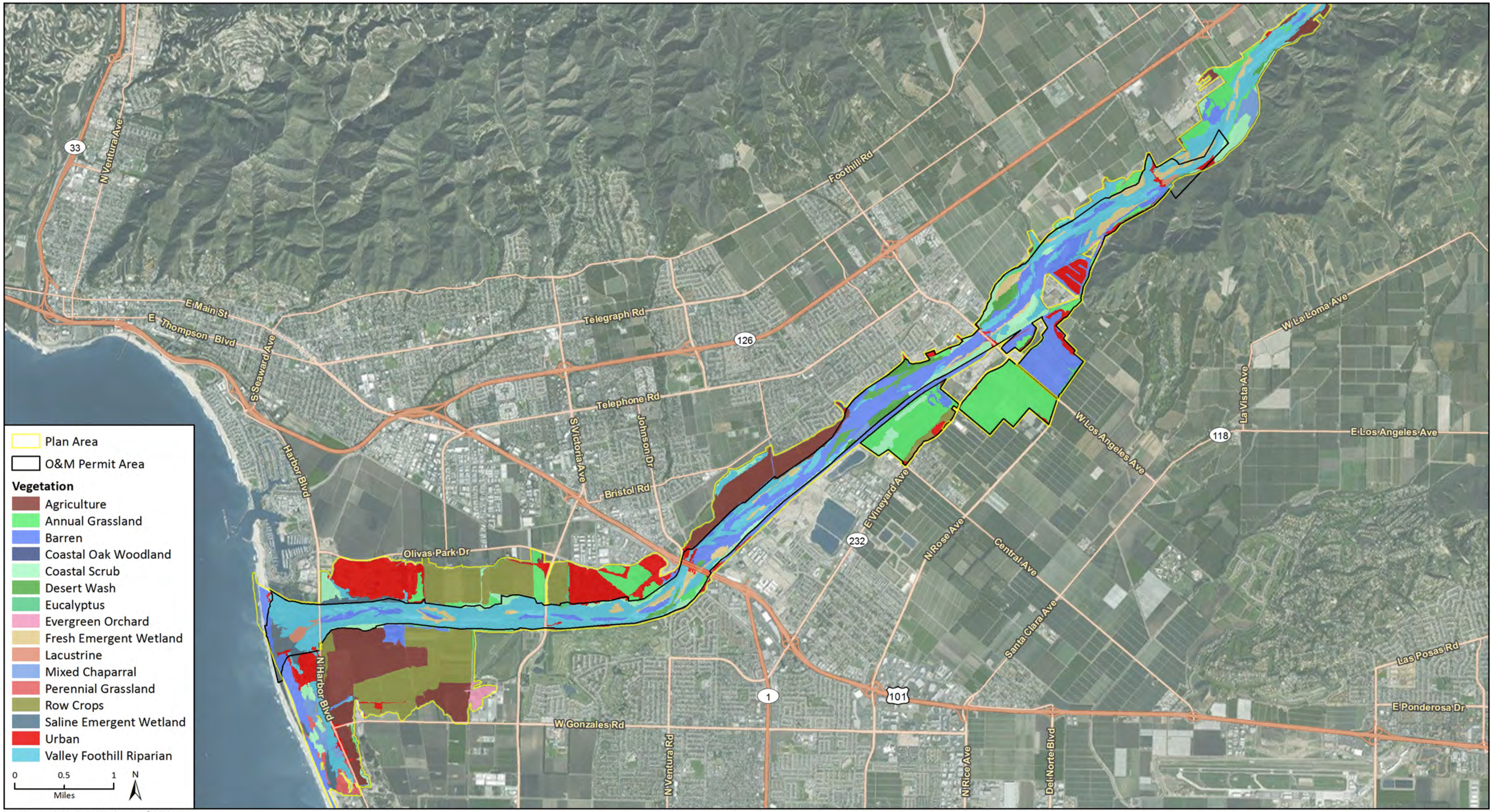
Hydrological data provided by County of Ventura, 2016.

Fig X Freeman Construction_Vegetation

Figure 2–10 Vegetation Communities of the Permit Area Below the Freeman Diversion



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Hydrological data provided by County of Ventura, 2016.

Figure 2–11 Vegetation Communities of the Permit Area Above the Freeman Diversion

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Hydrological data provided by County of Ventura, 2016.

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and potentially invasive. Two native anadromous fish species: Southern California steelhead and Pacific lamprey (*Entosphenus tridentatus*) occur in the Santa Clara River watershed. This MSHCP covers steelhead and lamprey and Chapter 4 discusses their habitat needs and life history in detail. Additional native fish species in the Santa Clara River include the federally endangered tidewater goby (*Eucyclogobius newberryi*), which occurs in the estuary, and the threespine stickleback (*Gasterosteus aculeatus*), which is distributed throughout the river system. The tidewater goby is a covered species in the MSHCP, and Chapter 4 discusses it in detail. The threespine stickleback comprises two sub–species in the Santa Clara River: the partially armored (*G. a. microcephalus*) and the unarmored threespine stickleback (*G. a. williamsoni*). The partially armored stickleback is plentiful in the Ventura County reach of the Santa Clara River, and has no federal protection. The unarmored threespine stickleback exists in the Los Angeles County reach of the Santa Clara River system and is unaffected by activities covered in the MSHCP. The Santa Ana sucker is listed as threatened in the Santa Ana River, San Gabriel River, and Los Angeles River watersheds, but is not currently listed in the Santa Clara River watershed. The Santa Ana sucker does occur in the Santa Clara River watershed and is known to readily hybridize with the introduced Owen's sucker (*Catostomus fumeiventris*). Established populations of non–native species can affect the genetics and population sizes of native species, the diversity and structure of riverine communities, and underlying biogeochemical cycles in the river (Strayer et al. 2006). One example of the impact of non–native species is the common carp (*Cyprinus carpio*), a highly invasive species in ecosystems across the United States. The USFWS has raised concerns in recent years that the feeding pattern of common carp may damage tidewater goby burrows and lead to incidental predation on eggs and larvae. The mouth of the common carp is relatively large and is shaped to help it dig in river sediment. The food is suctioned together with the sediment into the mouth and the unsuitable material is ejected back out (Lammens and Hoogenboezem 1991). The feeding pattern can result in disruption of the sediment surface, where goby excavate the small burrows to deposit their eggs. Common carp have also been implicated in the degradation of native environments through observed decreases in biodiversity and increases in turbidity, which can indirectly affect other aquatic species in the habitat (Matsuzakie, et al. 2007, Kloskowski 2011).

Due to the economic and environmental effects of non–native invasive species, increased management of riverine systems is often necessary to prevent, detect, and control invasive species (Mehta et al. 2007). United has recorded and removed non–native fish species at the Freeman Diversion since 1993. From 1993 to 2014, United operated a fish trap at the Freeman Diversion to provide passage for downstream migrant anadromous fish. Trapping results show that species composition in the Santa Clara River is dominated by non–native species and United has removed thousands of non–native individuals from the river during trapping and maintenance activities. Species removed include: common carp (*Cyprinus carpio*), Owens sucker (*Catostomus fumeiventris*), Owens and Santa Ana sucker hybrids (*Catostomus fumeiventris* + *C. santaanae*), crappie (*Pomoxis* sp.), prickly sculpin (*Cottus asper*), mosquito fish (*Gambusia affinis*), fathead minnow (*Pimephales promelas*), goldfish (*Carassius auratus*), largemouth bass (*Micropterus salmoides*), brown (*Ameiurus nebulosus*) and black (*Ameiurus melas*) bullhead, channel catfish (*Ictalurus punctatus*), green sunfish (*Lepomis cyanellus*), threadfin shad (*Dorosoma petenense*), Mississippi silverside (*Menidia beryllina*), Shimofuri goby (*Tridentiger bifasciatus*), bullfrog (*Lithobates catesbeiana*), African clawed frog (*Xenopus laevis*), red swamp crayfish (*Procambarus clarkia*), and red eared slider *(Trachemys scripta elegans)*.

Reptile and Amphibian Species

Many commonly occurring reptile species in the Santa Clara River watershed are found in both upland and riparian habitats. Others are restricted somewhat to riparian corridors and aquatic habitats. Many riparian reptile and amphibian species are believed to be in a state of decline throughout the southern California region and beyond, including the western pond turtle (*Emmys marmorata*) (Jennings and Hayes 1994). Western pond turtle is covered in this MSHCP and discussed in detail in Chapter 4.

Additionally, several highly aquatic non–native reptiles and amphibians have been introduced to the Santa Clara River watershed. Of note is the invasive bullfrog, which contributes significantly to the decline of native amphibian populations (Kats and Ferrer 2003).

Bird Species

Bird species are often highly mobile and widely dispersed but may have specific habitat preferences or requirements. Common, wide–ranging bird species in the Santa Clara River watershed and riparian corridors in the plan area include various waterfowl and swallow species. Many bird species that depend on riparian habitat are believed to be in a state of decline throughout southern California and beyond (Riparian Habitat Joint Venture 2004). Three listed riparian birds, the least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*) and yellow–billed cuckoo (*Coccyzus americanus*) are covered by this MSHCP and discussed in detail in Appendix A and Chapter 4. Invasive bird species also have significant negative impacts on some native riparian birds, particularly the brown–headed cowbird (*Molothrus ater*), estimated to parasitize the nests of over 270 species of native birds (Griffith Wildlife Biology 2013).

Mammal Species

Mammal species are often wide–ranging and widely distributed, and many depend upon the resources available in riparian corridors. The dusky–footed woodrat (*Neotoma fuscipes*) is a particularly conspicuous mammal that frequents riparian corridors. Woodrats construct nests (also referred to as houses) of small twigs and sticks that can stand over three feet tall and serve as shelter for a wide variety of other species, including snakes, lizards, and other mammals. Several species of bats, including the pallid bat (*Antrozous pallidus*) commonly roost under the bark of dead riparian trees. The MSHCP does not cover any mammal species.

Invertebrates

Invertebrate communities in the Santa Clara River watershed are widespread, diverse, and exist in virtually every habitat. The common orders of insects are well–represented in the plan area. Some examples of insect species that frequent riparian corridors include tiger swallowtail (*Papilio* spp.), red skimmer (*Libellula* spp.), stream bluet (*Argia* spp.), and the native shoulderband snails (*Helminthoglypta* spp.). Some noteworthy examples of introduced invertebrates occurring in the plan area include European honeybee (*Apis mellifera*), Asian clam (*Corbicula fluminea*), quagga mussel (*Dreissena bugensis*) and polyphagous shot–hole borer (*Euwallacea* spp.). The MSHCP does not cover any invertebrate species.

2.2 WATER RESOURCES

Water resources within United's district boundary consist of surface water and groundwater. Groundwater provides the largest source of fresh water within United's district boundary; however, surface water resources are an important component of the water supply portfolio for the region and are intertwined with groundwater management. United diverts stream flow from the Santa Clara River for groundwater recharge within its recharge basins and delivers a portion of diverted Santa Clara River water via pipelines to Pumping Trough Pipeline (PTP) users and Pleasant Valley County Water District (PVCWD) users for agricultural irrigation. Additionally, Camrosa Water District (Camrosa) diverts water from Conejo Creek to supply PVCWD users.

Groundwater resources on the Oxnard Plain are particularly susceptible to overdraft and seawater intrusion and United is tasked with protecting the aquifers within United's district boundary including the aquifer system that underlies the Oxnard Plain. Although water districts (including United) and municipalities are exploring alternative water resource options, local groundwater resources remain the primary source of fresh water for the region.

2.2.1 SURFACE WATER RESOURCES

Major tributaries of the Santa Clara River are San Francisquito Creek, Bouquet Creek, Castaic Creek, Piru Creek, Hopper Creek, Sespe Creek, and Santa Paula Creek. Four reservoirs in the watershed (Bouquet Canyon Reservoir, Castaic Lake, Pyramid Lake, and Lake Piru) can capture flow from approximately 37 percent of the watershed. These reservoirs serve various purposes, including water storage, water conveyance, flood control, and hydroelectric power generation. Several water diversions also occur on the Santa Clara River and its tributaries, redirecting surface water from the river and creeks for irrigation and ground water recharge. Figure 2–12 depicts a portion of the lower watershed and selected water resource features.

Two reservoirs occur in the upper Santa Clara River watershed: Bouquet Reservoir on Bouquet Creek and Castaic Lake on Castaic Creek. Bouquet Canyon Reservoir is a water storage facility owned, operated, and maintained by the City of Los Angeles Department of Water and Power to regulate and store water from the Owens Valley Aqueduct. United has an agreement with the Los Angeles Department of Water and Power providing for the release of flow from Bouquet Reservoir to recharge the aquifers of the Santa Clara River Valley, to the extent that they were recharged by runoff from the Bouquet Canyon watershed prior to construction of the reservoir. California Department of Water Resources (DWR) owns, operates, and maintains Castaic Lake, which serves as the terminal reservoir for the west branch of the California Aqueduct. United is the lead member of a water conservation agreement between DWR and the downstream water users. The general operations of the agreement have been developed by the downstream water users where United acts as the lead to implement the operation with DWR. The program is designed to hold the flood flows from the Castaic Creek watershed in Castaic Lake for later release in a manner that allows flows to percolate into the basins downstream of the dam and benefit the downstream water users.

Two reservoirs, Lake Piru and Pyramid Lake, are in the lower Santa Clara River watershed; both were constructed on Piru Creek. DWR owns, operates, and maintains Pyramid Lake, which is located approximately 11 miles (18 km) north of Lake Piru. The Pyramid Lake facility was constructed to create storage for the State Water Project in southern California. Lake Piru is impounded by Santa Felicia Dam, which United owns and operates. United holds the water right for a portion of the runoff from the Piru Creek watershed.

The Freeman Diversion was constructed on the mainstem of the Santa Clara River to divert surface water from the Santa Clara River into a gravity fed conveyance system used to deliver surface water to recharge basins to recharge the aquifer system of the Oxnard Plain and/or deliver diverted surface water via pipeline to water users in the most degraded water quality locations to discourage pumping in these sensitive locations. The operations of the Freeman Diversion and its associated facilities are the focus of the MSHCP and Chapters 3 and 5 provide detailed descriptions of past operations and the proposed future operations.

Lake Piru Reservoir Operations

United owns, operates, and maintains the Santa Felicia Dam which impounds Lake Piru Reservoir on Piru Creek. The Santa Felicia Project is operated and maintained under a Federal Energy Regulatory Commission (FERC) license providing a federal nexus under Section 7 of the ESA. During relicensing, NMFS and USFWS provided Biological Opinions for the project. The NMFS biological opinion resulted in a jeopardy determination and reasonable and prudent alternatives (RPAs) were included and water releases under those RPAs are discussed in more detail below. United's FERC license for the Santa Felicia Project expires in 2048. Because this is a long–term permit with a federal nexus, United is not requesting ITP coverage for activities covered under the Santa Felicia Project's FERC License in this MSHCP. However, Santa Felicia Dam water management activities are related to operation of the

Freeman Diversion and covered activities included in this MSHCP include actions that may be taken at Freeman Diversion under certain types of releases from Santa Felicia Dam. The two projects have multiple water resource benefits independently and could function on their own. The Santa Felicia Project is summarized below for reference.

The main function of Lake Piru is to retain the high flows in Piru Creek during the winter and spring months for later release when the basins of the Santa Clara River valley will benefit from the release and the facilities that receive water from the Freeman Diversion have the capability to convey water to the distal portions of the coastal basins. Based on a 2015 bathymetric survey, the current capacity of Lake Piru is nearly 82,000 acre–feet (101 million cubic meters). United strives to maintain an operational minimum pool of 20,000 acre–feet (25 million cubic meters) storage to help prevent the accumulation of sediment around the outlet works for the Santa Felicia Dam.

United’s conservation releases are designed to replenish the Piru, Fillmore, and Santa Paula basins by direct percolation. The remaining portion of the release is diverted at the Freeman Diversion and is either spread for groundwater recharge in the Oxnard Forebay or is distributed to agricultural users in the Oxnard Plain or Pleasant Valley basins via the Pumping Trough Pipeline and Pleasant Valley surface water delivery systems. The timing, duration, and flow rates of conservation releases are adjusted to optimize benefits within United’s service area. The volume of release in most years is limited by the wet season runoff from the Piru Creek watershed and, to a lesser degree, the amount of state water United purchases that is delivered via release down middle Piru Creek. United holds an allocation for 5000 acre–feet (6167 cubic meters) of State Water, of which 3,150 acre–feet (3,885,462 cubic meters) is available for release from Pyramid Lake to Lake Piru. Availability of DWR supplies varies year–to–year depending on precipitation in northern California and other variables related to the DWR Water Project delivery system.

On September 12, 2008, FERC issued a new license for the operations and maintenance of the Santa Felicia Project that encompasses the lake, dam, and associated hydroelectric facility (FERC 2008). United has prepared the Santa Felicia Water Release Plan to comply with the requirements in the FERC license, including habitat and migration releases (United Water 2012). The plan includes habitat releases of minimum 7 cfs (0.2 cms) to maintain downstream habitat for steelhead, and higher habitat release flows when the monthly cumulative precipitation is above the historic average measured at the Ventura County Watershed Protection District’s rainfall station #160. The plan also requires minimum migration releases of 200 cfs (5.7 cms) when certain triggers are met. This is intended to provide increased opportunity for fish migration in Piru Creek when the Santa Clara River has elevated flows due to storm runoff and when surface flows in the river are likely to be continuous from Piru Creek to the estuary of the Santa Clara River. Migration releases are triggered when the U.S. Geological Survey gaging station No. 11109000 (Santa Clara River near Piru, California) measures above 200 cfs (5.7 cms) at 8:00 a.m., and when the mean flow is forecast to remain above 200 cfs (5.7 cms) for the following 24 hours. Migration flow releases from Lake Piru continue as long as mean daily flows at the county line remain over 200 cfs (5.7 cms).

Based on recommendations from NMFS, the FERC license also includes conditions regarding the rate at which United adjusts water releases from the Santa Felicia Dam (i.e., ramping rates). Increases to water releases are to be conducted in incremental steps to avoid rapid increases in flow and decreases in water releases are to be conducted in a manner that does not decrease surface water elevation in lower Piru Creek by more than 2 inches (5 centimeters) per hour.

Figure 2–12 Surface Water Resources

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Hydrological data provided by County of Ventura, 2016; Stream gage data provided by USGS, 2011.

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2.2.2 GROUNDWATER RESOURCES

Groundwater makes up most of the water resources used for agricultural as well as municipal and industrial (M&I) purposes in Ventura County. It has been estimated that water used by agriculture has a recharge rate of approximately 25 percent back to groundwater, while water used for M&I recharges at only about 5 percent (United Water 2019). Otherwise, groundwater is recharged through natural recharge as well as artificial recharge (United diverting water to recharge basins to protect the groundwater aquifers within United's district boundary). The groundwater aquifers that United is charged with protecting can be divided into the UAS and the LAS (Figure 2–13). The aquifers of the UAS are recharged more readily than those of the LAS. Following a rare year of exceptionally high rainfall, natural and artificial recharge can fill the UAS in the Forebay to full conditions, applying enough pressure on the confined aquifers of the Oxnard Plain to create artesian conditions in some areas. Artesian conditions have been achieved in wet years since the construction of the Freeman Diversion, generally in the western Oxnard Plain and as far south as Port Hueneme. However, water levels in the UAS aquifers in the Mugu area, approximately 11 miles (18 kilometers) south of the Saticoy recharge basins in the Oxnard Forebay, have remained below sea level for decades. During the four years of drought between 2013 and 2016, the contour line of sea level moved steadily northward. In the fall of 2015, only the northern portion of the Forebay remained above sea level, and water levels over broad areas of the Oxnard Plain were 20 to 30 feet (6 to 9 meters) below sea level, based on well monitoring records. Similar conditions were observed in 2017. Extreme conditions such as these promote seawater and saline intrusion in its various forms. Lack of significant recharge also results in high nitrate concentrations in the Oxnard Forebay.

Description of the Groundwater Basins

The groundwater basins associated with the lower Santa Clara River are interconnected and part of a regional groundwater flow system, replenished mostly by precipitation in the watersheds of the Santa Clara River and Calleguas Creek and partially by imported water from the State Water Project. The Santa Clara River Valley is divided into six groundwater basins,[2] all of which have some degree of hydrologic connection. In order from upstream to downstream, these are the Piru, Fillmore, Santa Paula, Mound, Oxnard Forebay, and Oxnard Plain basins (Figure 2–13). The groundwater basins vary in their water production capacity and ability to be recharged. The hydraulic connection between basins also varies across the watershed.

The Oxnard Plain and Mound basins extend across the offshore marine shelf to the shelf/slope break. The Santa Clara River estuary overlies the southernmost portion of the Mound basin.

The Oxnard Forebay is recognized as the primary recharge area for the entire Oxnard Plain. The Oxnard Forebay occupies an area of approximately 10 square miles (26 square kilometers) in the northern Oxnard Plain where the Santa Clara River emerges from its valley (see Section 2.1.4 Hydrology)(Figure 2–13). Significant natural groundwater recharge occurs along the Oxnard Forebay reach of the Santa Clara River (the "critical reach"). Most of United's artificial recharge facilities are in this basin, where water spread on the surface rapidly percolates to the Oxnard Forebay and recharges interconnected groundwater basins throughout the Oxnard Plain and into the Pleasant Valley basin as well as providing some recharge to the Mound and West Las Posas basins.

Aside from the Oxnard Forebay area in the northeast portion of the basin, the Oxnard Plain is a confined groundwater basin. Various layers of silt and clay with low hydraulic conductivity impede the vertical movement of groundwater. The shallowest of these confining layers commonly exist from 50 to 100 feet (15 to 30 meters) below the land surface. This shallow "clay cap" largely isolates the shallow, semi–

[2] Under Groundwater Bulletin 118 and California Water Code Section 12924, DWR classifies areas with significant volume of stored groundwater into groundwater basins and subbasins. In this report, some areas classified by DWR as "subbasins" are discussed in this MSHCP simply as "basins."

perched aquifer from the confined aquifers below. The UAS comprises the Oxnard and Mugu aquifers, which are relatively flat–lying and exist commonly between 100 and 400 feet (30 to 120 meters) beneath the land surface. These two highly–conductive aquifers are particularly vulnerable to seawater intrusion, as the near–shore Hueneme and Mugu submarine canyons intersect them and expose the aquifers to seawater. The LAS comprises Hueneme, Fox Canyon, and Grimes Canyon aquifers. These older, deeper aquifers have more folding and faulting than the aquifers of the UAS, are more interbedded, and are generally finer–grained. The aquifers of the LAS are also subject to saline intrusion, both from direct lateral seawater intrusion and from the upwelling of brines (United Water 2016). The compaction of fine–grained sediments is another form of saline intrusion that occurs in both the UAS and the LAS and can release brines into nearby freshwater aquifers.

The Las Posas basin is in the Calleguas Creek watershed. The Las Posas basin is located to the east of the northern portion of the Oxnard Plain, and is bounded on the north by South Mountain and on the south by the Camarillo and Las Posas Hills. The western portion of this basin falls within United's district boundaries; the West Las Posas basin receives groundwater recharge from the Oxnard Plain where these basins meet just south of the Oxnard Forebay. Most of the groundwater production in this basin is from the LAS.

Oxnard Forebay

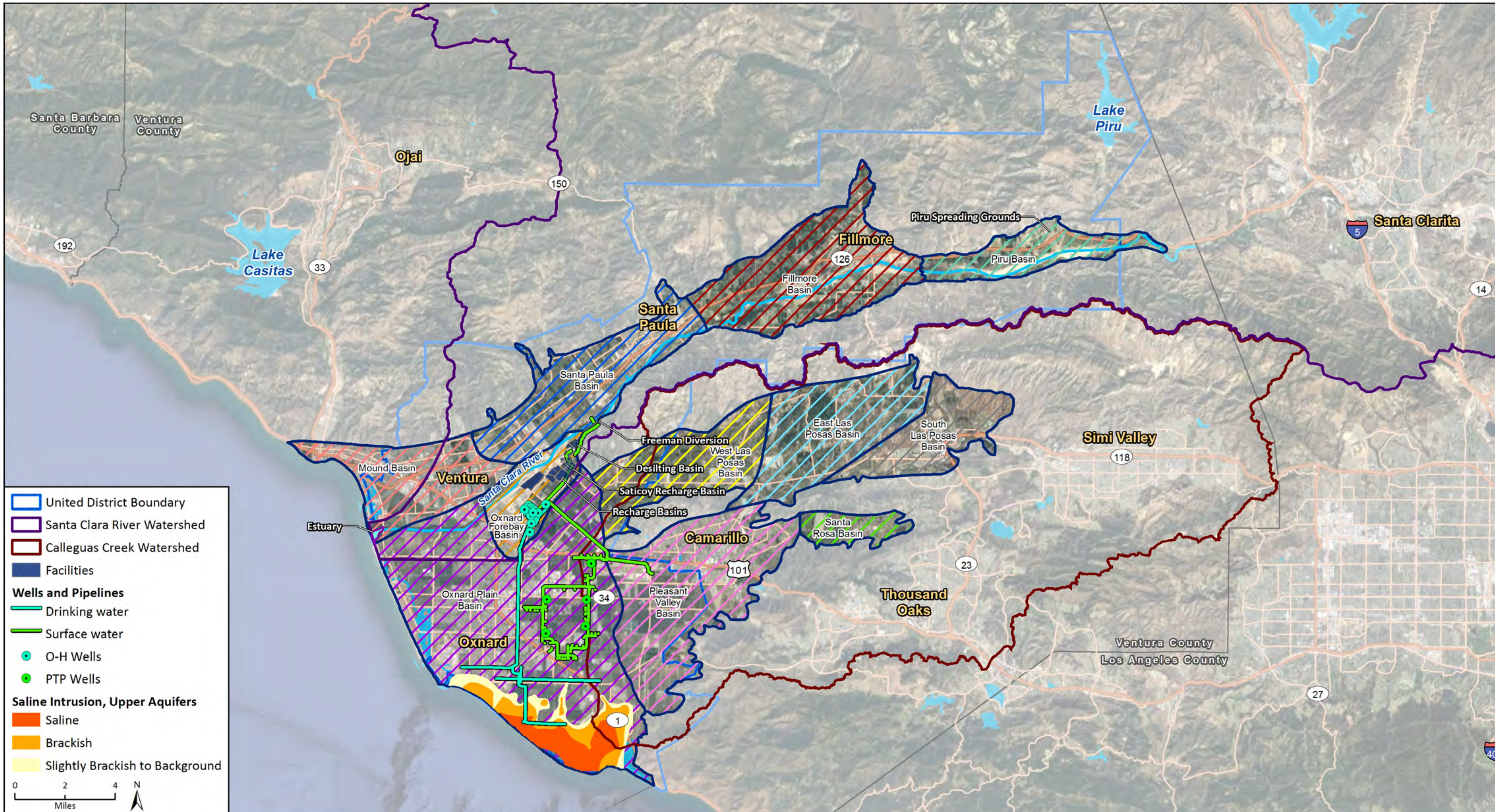
The Oxnard Forebay (underlying the critical reach) is an area of critical importance for the management of water resources in the region. Groundwater recharge in this area is necessary to sustain the existing urban and agricultural land use on the Oxnard Plain. Natural and artificial recharge to the Forebay serves to raise groundwater elevations in this up–gradient area of the groundwater flow system for the Oxnard Plain. High water levels in the Forebay increase the hydrostatic pressure in the confined aquifers, which extend from the margins of the Forebay to the coastal and offshore portions of these continuous aquifer units. Hydrostatic pressure greater than sea level is required to combat seawater intrusion. Greater heads are required in the deeper aquifer units to compensate for the density difference between freshwater and seawater.

United's artificial recharge facilities influence the water levels dramatically in the Forebay. Since construction of the Freeman Diversion, United has provided an average of 53,000 acre–feet (65,374,440 cubic meters) per year of artificial recharge to the Forebay, and recharge has exceeded 120,000 acre–feet (148,017,600 cubic meters) in some years. Figure 2–14 shows the water levels along the river in the Forebay in response to artificial and natural recharge in 2011 and 2012. Figure 2–15 shows the well locations where these data were collected.

Overdraft and Saline Intrusion

The Oxnard Plain is a world–class agricultural area because of its climate, soils, water supply, and proximity to major markets. Post–World War II, Ventura County's population expanded rapidly, placing increased demand on the region's water supply. Seawater intrusion had been recognized on the Oxnard Plain in the 1930s and became a more serious problem in the 1940s. Following a period of drought in the 1970s, the overdraft conditions on the Oxnard Plain became severe, and the SWRCB threatened intervention (adjudication) if actions were not taken to reduce overdraft. In 1982, the Fox Canyon Groundwater Management Agency (FCGMA) was created by the state legislature and given regulatory authority to manage groundwater extractions in the Oxnard Plain, Pleasant Valley, Santa Rosa, and Las Posas basins. Following its formation, the FCGMA mandated a series of pumping cuts resulting in a 25 percent reduction in municipal pumping and required documentation of efficient irrigation practices by agricultural water users in an effort to reduce overdraft on the Oxnard Plain. Recent emergency measures have required additional reductions to pumping in response to persistent drought. Despite the management actions of FCGMA, DWR still classifies the Oxnard Plain and Pleasant Valley basins as

Figure 2–13 Groundwater Basins of the Santa Clara River and Calleguas Creek Watersheds



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Hydrological data provided by County of Ventura, 2016; USGS, 2018.

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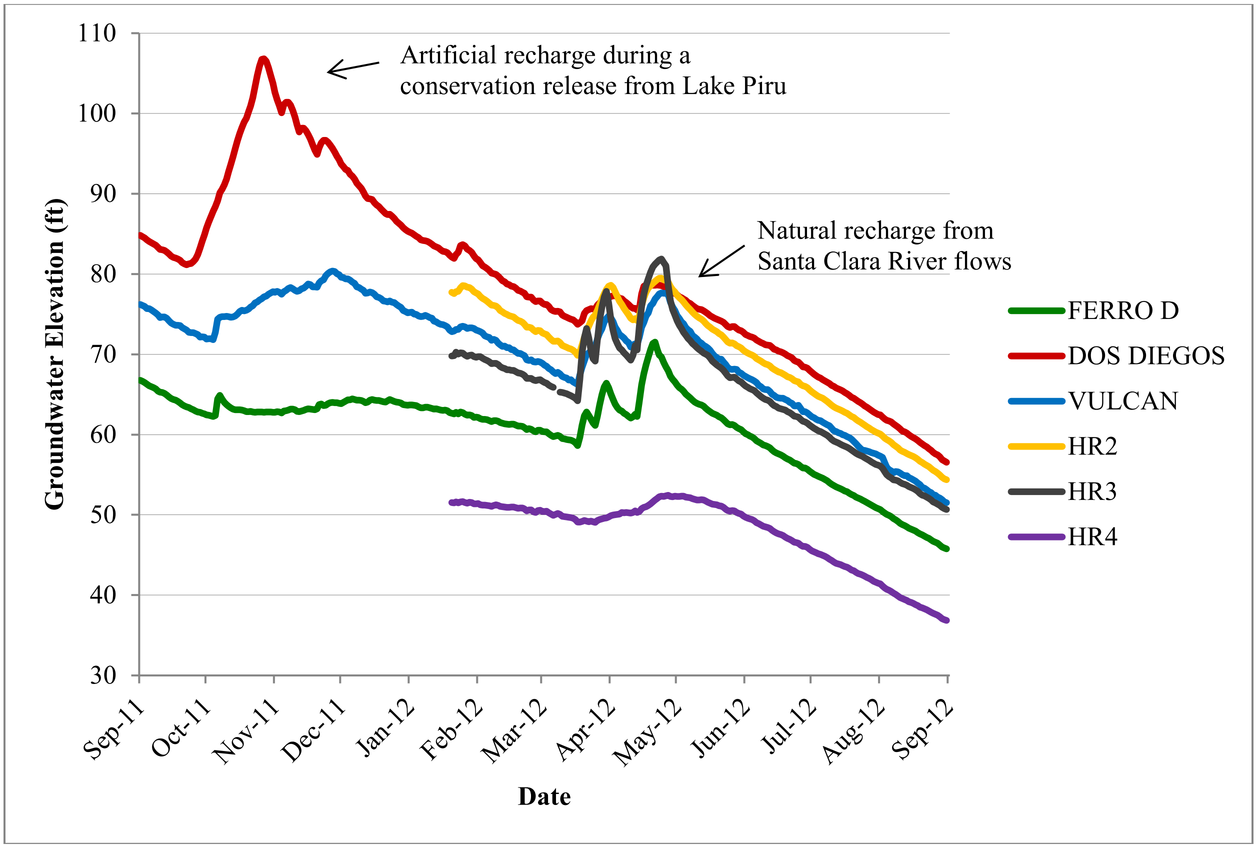
areas subject to critical overdraft.[3] These two basins are the only coastal basins in southern California listed as subject to critical overdraft.

Figure 2–14 Forebay Water Level Responses to Recharge



In the aquifers of the LAS, used at an increasing rate since the 1980s for groundwater production, broad areas of the Oxnard Plain and Pleasant Valley have remained well below sea level for decades. While LAS water levels in the Oxnard Forebay and the northwestern half of the Oxnard Plain commonly remain above sea level, water levels well below sea level are the norm in the southeastern half of the Oxnard Plain and in the Pleasant Valley basin. Even in the wettest of years, water levels in the LAS near the Oxnard Plain–Pleasant Valley boundary remain more than 30 feet (9 meters) below sea level. In times of drought water levels across the entire coastal plain, except for small areas in the northern Oxnard Plain and northern Pleasant Valley fall below sea level, with some areas more than 100 feet (30 meters) below sea level. These conditions were observed in the years 2013 to 2017.

The conditions of groundwater overdraft described above develop when groundwater extraction exceeds recharge to the coastal basins. Water quality degrades under these conditions, and saline intrusion is one of the more serious and longer–lasting effects. The amount of energy required to lift water out of the ground also increases as water levels fall. For water levels to recover following periods of drought, recharge to the groundwater basins must be greater than ongoing demands on the aquifers. Artificial recharge with surface water diverted from the Santa Clara River is one of the most effective mechanisms available, both currently and historically, to recharge these coastal basins.

[3] DWR and Sustainable Groundwater Management Act state that "a basin is subject to critical overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (DWR 2016)

Sustainable Groundwater Management Act

In 2014, the Sustainable Groundwater Management Act (SGMA) was signed into law and went into effect in January 2015. Groundwater basins in California must now be managed to achieve sustainable groundwater conditions by the year 2040 (2042 for lower–priority basins). The FCGMA became a Groundwater Sustainability Agency under SGMA, and in doing so it assumed additional management authorities. Various additional studies were conducted or are being conducted to better characterize the magnitude of overdraft on the Oxnard Plain and to identify and prioritize options to mitigate overdraft conditions.

As one of many stakeholders, United supports and participates in the development of a Groundwater Sustainability Plan under the FCGMA. United can provide input to the FCGMA as a stakeholder and can provide technical information, but does not have the authority to dictate a process or action that the Groundwater Sustainability Agency will use to achieve sustainability.

The FCGMA released its Final Groundwater Sustainability Plans for the Oxnard Subbasin, Pleasant Valley Basin, and Las Posas Valley Basin in December 2019. The plans rely on United's operations at the Freeman Diversion as the single largest source of recharge to the aquifers used for water supply. The success of the Groundwater Sustainability Plans is highly dependent upon United's ability to divert and recharge water from the Santa Clara River. The facilities and operations proposed under this MSHCP have been factored into the Groundwater Sustainability Plans, including their implications for sustainable yield.

2.3 SURFACE WATER DIVERSION FOR GROUNDWATER RECHARGE

2.3.1 FORMATION OF UNITED WATER CONSERVATION DISTRICT

The Santa Clara Water Conservation District (the predecessor to United) was established under the Water Conservation Act of 1927 and began a systematic program of groundwater recharge; primarily through the construction of recharge basins along the Santa Clara River near Saticoy, and diversion of water from the Santa Clara River through temporary earthen diversion structures into these recharge facilities. Following the discovery of seawater intrusion in the coastal areas of the Oxnard Plain in the 1930s, and worsening conditions in the 1940s, United Water Conservation District was formed in 1950 under the Water Conservation Act of 1931. Incorporating urban areas provided United a bonding capacity that the Santa Clara Water Conservation District lacked. The Santa Clara Water Conservation District was dissolved in 1953 and its assets were turned over to United.

2.3.2 INFRASTRUCTURE ADDITIONS AND IMPROVEMENTS

United constructed additional facilities in the 1950s to increase recharge capacity, deliver diverted Santa Clara River water to coastal areas, and minimize groundwater pumping in the areas that cause seawater intrusion. These facilities included Santa Felicia Dam, the improved Saticoy recharge basins, the El Rio recharge basins, the Oxnard–Hueneme delivery system, and the Pleasant Valley pipeline. The Pumping Trough pipeline was completed in 1986 to deliver surface water to the east–central Oxnard Plain, where a chronic pumping depression existed in the aquifers of the UAS. In 1991, construction was completed on the permanent Freeman Diversion structure, which replaced the temporary earthen dams that would wash out during larger river flows

United's recharge capacity expanded with the purchase of the Noble recharge basin in 1995 and the Rose and Ferro recharge basins in 2010. Currently, United does not have facilities to deliver surface water to the Ferro basin, but United plans to complete conveyance infrastructure to the Ferro recharge basin. Over

Figure 2–15 Groundwater Level Sampling Well Locations

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the past 30 years, United has invested more than 60 million dollars to build and maintain these additional facilities and manage water resources in southern Ventura County.

2.3.3 CONSTRUCTION OF THE FREEMAN DIVERSION

Since the late 1920s, United and its predecessor agency have been diverting Santa Clara River water near Saticoy for agricultural, municipal, and industrial water use. Earthen berms constructed in the river channel facilitated historic diversions, with head control gates and spill structures employed to manage diversions under varied flow conditions. These earthen berms and associated facilities were vulnerable to damage by storms and required frequent repair. The need for improved diversion facilities near Saticoy was recognized in the 1960s and early planning for a permanent structure spanning the river was underway by the early 1970s, motivated in part by destructive flooding that occurred in January 1969.

The Freeman Diversion replaced the earthen berms in 1991 and provided a fixed elevation from which to divert water. It also served the important function of providing riverbed elevation stabilization in areas upstream of the structure since channel elevations in the lower reaches of the Santa Clara River had been degraded significantly by historic instream gravel mining and river channelization. The permanent diversion structure resisted damage by floods and could resume diversion of surface water shortly after the peak flows associated with storm events.

The Freeman Diversion facility currently consists of the following primary components (with further detail provided in Table 2–4):

1) A 1,200–foot (366–meter) long, roller–compacted concrete diversion structure that spans the Santa Clara River approximately 10 miles (16 kilometers) upstream from the river mouth at the Pacific Ocean
2) Headworks with the following component elements:
    a. Roller gate
    b. Bypass channel (also referred to in some documents as the “flushing channel” or “sluicing channel”)
    c. Canal control and head control gates
    d. Trash rack
3) Denil fish ladder intended to pass upstream migrating adult steelhead
4) Fish screen bay with the following component elements[4]:
    a. Fish screens (160 feet long, 8 feet high, 3/16 inch openings) and associated wipers
    b. Auxiliary bypass gate
    c. Fish bypass pipe intended to pass downstream migrating juvenile and adult steelhead
    d. Fish trap
5) Rubicon gate that allows finer–tuned water diversion at low flow into the Freeman canal

Once water is diverted at the Freeman Diversion headworks, it enters United’s downstream conveyance infrastructure. The water moves via gravity through the Freeman canal and through infrastructure that allows the optional application of a flocculation polymer if the water is high in suspended sediment. Water can then be passed through the Desilting basin to allow suspended sediment to settle out or bypassed directly to a system of pipelines and canals that carry the water to one or more recharge basins

[4] A summary of the operational effectiveness of the existing fish passage system is provided in Chapter 5, Section 5.2.1, under Conservation Measure 1.1.1.

or, alternatively, to a screening facility where large debris and algae is filtered out and water is delivered directly via pipeline to agricultural users in lieu of groundwater pumping or to the El Rio recharge basins.

Table 2–4 Summary of Freeman Diversion Facility	
Freeman Diversion	
Date of Completion	1991 (replaced temporary earthen berms used to divert water since 1920s)
Diversion Location	Santa Clara River, river mile 10 (upstream from Pacific Ocean), Saticoy, Ventura County, CA
Purpose	Divert surface water to various recharge basins to recharge groundwater and for direct delivery to users to reduce groundwater pumping in areas of salt water intrusion, and for river grade stabilization to mitigate for river head–cutting from historic gravel mining downstream
Existing Water Rights	License 10173 and Permit 18908 144,630 AF maximum annual diversion volume 375 cfs maximum instantaneous diversion rate
Diversion Structure	1,200–ft. long roller–compacted concrete structure Elevation difference between upstream and downstream vary and can range between approximately 25 to 30 ft
Water Impoundment	No (although some incidental impoundment can result from scour and staging water for diversion)
Current Design Capacity	161,000 cfs with a 5–ft. freeboard
Fish Passage	Existing Denil fish ladder facility
Fish Screens	Existing screens– 160-ft. long, 8-ft. high, 3/16 in openings

2.4 WATER DIVERSION OPERATIONS

Historically, United has diverted water through the operation of the Freeman Diversion headworks, located on the south bank of the river. United staff operate the headworks to manage diversions and instream flows, water levels, sediment deposition and scour, and the location of the river channel. United operates the Freeman Diversion facility using a Supervisory Control and Data Acquisition (SCADA) system.

United diverts water at the Freeman Diversion in accordance with license 10173 and permit 18908[5], issued by the State Water Resources Control Board (SWRCB). License 10173 was issued on August 14, 1973, and among other things, establishes United's water right for diverting water from the Santa Clara River. Permit 18908 was issued on November 18, 1982, allowing for water appropriations; it was amended in September 1987 to provide protections for anadromous fish, particularly steelhead. Table 2–5 details the operational requirements of the license and permit.

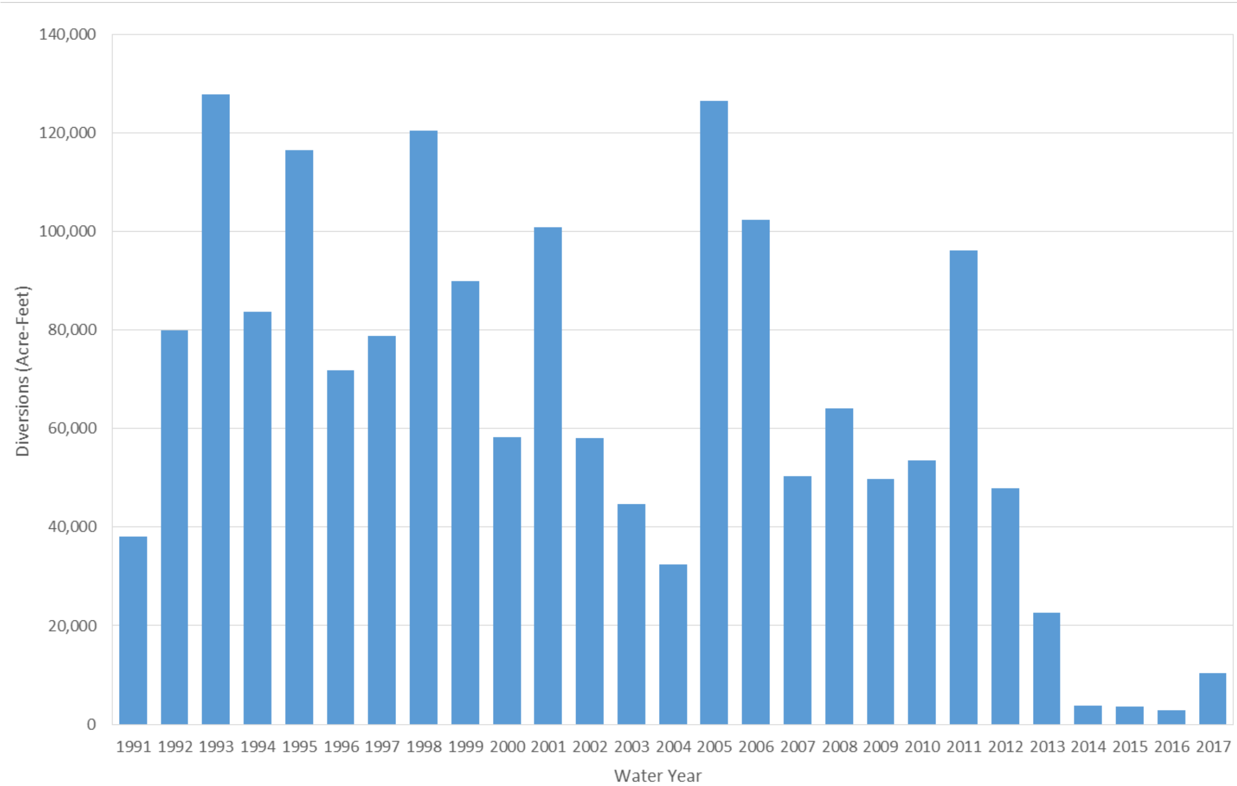
5 Permit 18908 (1992 order correcting and amending the permit) notes the following: The fish ladder shall have a hydraulic capacity of 40 cfs From February 15 through May 15 of each year, each time the flow in the Santa Clara River immediately upstream from the point of diversion subsides to 415 cfs, permittee shall bypass 40 cfs through the fish ladder for 48 hours. The total amount of water bypasses under this condition in any one year shall not exceed 500 ac-ft on a 10 year average.

Table 2–5 Freeman Diversion Permitted and Licensed Operations

Operations Component	Existing Operations Regulation		Total
	License 10173	Permit 18908	
Maximum diversion rate	375 cfs for groundwater storage and surface water deliveries combined with no individual limit over the combined limit	413 cfs for groundwater and surface water combined, with no more than 375 cfs to ground water and 38 cfs to surface water	N/A
Total annual volume for groundwater recharge	89,000 AF	30,000 AF	119,000 AF (cumulative between the permit and license)
Total annual volume for surface water deliveries	15,630 AF	10,000 AF	25,630 AF (cumulative between the permit and license)
Required instream flows	No	Yes; 40 cfs from February 15 through May 15 of each year, each time the flow upstream subsides to 415 cfs; bypassed through the fish ladder for 48 hours; bypassed water shall not exceed 500 ac-ft on a 10 year average	–

Since construction of the Freeman Diversion was completed in 1991, annual diversions at the facility have ranged between a low of 2,807 acre–feet (3,462,378 cubic meters) during the 2016 water year and a high of 127,890 acre–feet (157,749,757 cubic meters) during the 1993 water year. For the period from water years 1991 to 2017, the average annual diversion at the facility has been 64,259 acre–feet (79,262,191 cubic meters) (Figure 2–16). Over this same 27–year period, groundwater recharge to the Oxnard Forebay via United's recharge basins averaged 54,500 acre–feet (67,224,660 cubic meters) per year, with the remainder of the diverted water delivered directly to agricultural users through the Pumping Trough Pipeline and the Pleasant Valley Pipelines. These diversions and associated groundwater recharge are a critical component of water resource management on the Oxnard Plain, and changes to average annual diversions have significant consequences for water quality and availability on the Oxnard Plain (Appendix B).

Figure 2–16 **Annual Water Diversion Volume at the Freeman Diversion by Water Year**



Historically, the amount of water that United has been able to divert, consistent with its water rights, has depended upon the availability of water in the Santa Clara River and has been limited by the following factors:

- Constraints associated with the conveyance system
- Suspended sediment in the river during and following peak flows associated with storm events
- Percolation rates in the recharge basins
- Available storage capacity in the Oxnard Forebay groundwater basin
- Demand for surface water deliveries

Since initial construction, United has made operational modifications aimed at protecting steelhead.

Operational modifications to date are the following:

1. Increased instream flows to improve passage opportunities for upstream and downstream migration, as described in various scenarios formally known as the water rights permit, interim operations, and the biological opinion (before the listing of steelhead, instream flows were released in accordance with conditions in United's water right permit #18908)

2. Implementation of a smolt relocation program that included methods used during past trapping activities (2007-2014) to maintain a high smolt survival rate (S Howard pers comm) from trap to relocation sites.[6]
3. Minimized sediment sluicing operations when no connection exists between the Freeman Diversion and the estuary to avoid or minimize the potential stranding of juvenile steelhead below the diversion during or after sediment sluicing activities
4. Release of water through the bypass channel to increase attraction flows by 100–200 cfs (2.8 to 5.6 cms) near the fish ladder entrance and create favorable hydraulic conditions for entrance into the fish ladder
5. Relocation of fish by a qualified biologist prior to complete dewatering of the fishbay on the fish ladder[7]
6. Addition of flow monitoring devices on the fish ladder, auxiliary water, bypass channel, diversion crest, and smolt bypass flow pipe allowing for more precise adjustments between diversions and instream flows
7. Monitoring and measurement of discharge to ensure instream flows are met below the critical reach (when steelhead were listed, streambed percolation downstream of the Freeman Diversion was not fully understood and it was thought that bypass flows of 40 cfs (1.1 cms) at the diversion were adequate for passage downstream in the critical reach)

2.4.1 FLOW MONITORING SYSTEM

United placed and maintains continuous flow monitoring devices on the fish ladder, auxiliary water, bypass channel, diversion crest, smolt bypass flow pipe, diversion canal and Rubicon gate (for low–flow diversions). All device measurements are collected through United's SCADA system and data are stored on a database. All monitoring data are copied to a Ranch Systems cloud server at 5–minute intervals. A Ranch Systems User Interface is used to calculate flow rate from level sensors using rating equations, and to calculate total river flows upstream and downstream of the Freeman Diversion in real time based on summation of measured flows of the relevant flow paths. United staff use the Ranch Systems User Interface to monitor and guide operations and to report real–time flow data for all flow paths at the Freeman Diversion to NMFS.

United regularly performs manual discharge measurements to calibrate measurements by the various flow devices. United complies with the accuracy requirements for diversion measurement devices in Senate Bill 88 and the State Water Resources Control Board's Drought Emergency Regulations. United staff also performs manual discharge measurements in the River (just downstream of the Freeman Diversion, near the desilting basin, at the State Route 118 bridge, in the critical reach, and at the critical riffle compliance point), in order to verify accuracy of measurement devices, establish rating curves, determine percolation rates in the Oxnard Forebay, and confirm whether prescribed bypass flows for fish migration are being met.

2.4.2 DENIL FISH LADDER

The Freeman Diversion has an existing Denil fish ladder. A Denil fish ladder is a baffle fish way that uses rows of notched baffles with switch backs. The notched baffles slow the velocity of the flow, allowing fish to swim through the middle of the baffles upstream. Currently, from January 1 through May 31, United operates the Denil fish ladder when bypass flows are triggered according to RPA 2 of the 2008 NMFS biological opinion and a federal court order. United also runs the fish ladder outside of these

[6] This operational procedure was discontinued in 2016 at NMFS direction and United transitioned to notification and coordination with NMFS when United anticipated a possibility of steelhead stranding.
[7] This operational procedure was discontinued in 2016 at NMFS direction and United transitioned to notification and coordination with NMFS prior to dewatering the fish bay.

times, when there is excess discharge in the river beyond United's permitted instantaneous diversion amount. For example, in 1996, United ran the Denil fish ladder for 5 days in November and 12 days in December following early season storms. The December storm peaked at 3,800 cfs (avg. daily) where the fish ladder started running on the third day after the peak with approximately 400 cfs being bypassed. Trained biologists operate the gates of the fish ladder with assistance from Operations and Maintenance staff when needed. Discharges through the fish ladder are reported in real time to NMFS using a flow gage that is calibrated frequently (See Section 2.4.1 Flow Monitoring System).

2.4.3 STEELHEAD MONITORING SYSTEMS

United has monitored adult steelhead upstream migration since 1994. Prior to 1997, adult steelhead were captured in an upstream migrant trap at the facility's Denil fish ladder. From 1998 to 2002, fish were incidentally encountered through periodic dewatering of the fish ladder facility. In 2002, this facility was retrofitted to include a false weir with a passive, video–based migrant surveillance system, which was updated in 2010 to a computer–based surveillance system and two additional cameras were added to the weir. From 2011–2014, several additional cameras were installed to provide different viewing angles that could be used for motion detection. In 2016, an updated camera system was installed with high resolution cameras at the false weir as well as the lower Denil weirs. The current system is triggered to record video footage by an infrared scanning beam and camera–based motion detection. This system is thought to potentially undercount adult steelhead based on collection of several downstream migrating kelts observed in the facility's downstream migrant trap through 2014 that did not match observed upstream migrants. The 2016 upgrades are thought to have addressed these shortcomings, though no upstream migrants have been detected on the system since 2012. Due to permitting restrictions (NOAA 2016), the downstream migrant trap was not operated after 2015 (United unpublished data, Booth 2016, Dagit et al. 2020).

In the fall of 2018, United installed a permanent mount for a dual–frequency identification sonar (DIDSON) camera, making it possible for United staff to mount United's DIDSON camera to a platform that is easy to raise for service, then quickly lower back down for monitoring. When the camera is mounted and lowered into position, it is situated behind the trash rack to protect it from debris and the field of observation is focused on the fish ladder exit. Data from the DIDSON camera were analyzed in 2019, resulting in a number of images that show large fish entering and exiting the Denil fish ladder exit gate. However, the species of the fish is difficult to distinguish. Common carp are currently abundant in the watershed and can grow to very large sizes, making it difficult to decipher steelhead from carp on the DIDSON camera. Also, high SSCs in the river necessitate regular maintenance and cleaning of the DIDSON, and the camera only functions below about 600 mg/L SSC, resulting in a wide range of flows where there is too much background noise on the camera to observe steelhead.

2.4.4 INTERIM IMPROVEMENTS TO DATE

Since initial construction, United has made structural modifications aimed at protecting steelhead and improving the performance of the fish passage facility and monitoring systems. United completed the interim improvements in coordination with NMFS and/ or fish passage experts in the development and implementation of each improvement listed below. Structural modifications included the following:

1. Removal and replacement of the trash rack on the auxiliary water system for the fish ladder with a traveling screen with a mesh opening size of 3/32 inch (0.23 centimeter) to protect juvenile and adult fish (completed August 2018)
2. Installation the District's existing DIDSON acoustic camera permanently in the Freeman Diversion canal bay, oriented toward the fish ladder exit, including fabrication of a permanent mounting structure that would allow the camera to be raised out of the water for inspection and maintenance (completed October 2018)

3. Addition of a barrier wall behind the trash rack to minimize bedload entering the diversion system and prevent malfunction in fish screen brushes (completed in 2001)
4. Addition of a passive fish counter in the ladder (prior to the listing of steelhead, a fyke–like trap installed to monitor steelhead; after the listing, in 2003, a false weir system replaced this)
5. Enlargement of openings in the trash rack so adult fish have easier egress through the system as they exit the fish ladder (completed around 2013)
6. Modification of the smolt trap to include smaller screens and to allow for safer, automated collection of fish for the relocation program implemented from 1994 to 2014 (completed around 2001)
7. Addition of a small canal gate for smaller and more accurate adjustment of flows when balancing water diversions with instream flows at low flow (completed January 2018)
8. Installation of baffles (wooden stop–logs) behind the fish screen to evenly distribute flows through the fish screen bay (completed July 2018)
9. Realignment of vertically oriented Denil baffle in the Denil fish ladder (completed July 2018)
10. Rounding of corners in the upstream most turn–pool of the Denil fish ladder by installation of radiused steel plates (completed June 2018)
11. Installation of a seal on the smolt bypass gate valve in the fish bay, in order to improve fine control of water elevations in the fish bay for optimum fish screen performance (completed August 2018)

2.5 LITERATURE CITED

AghaKouchak, Amir, Elisa Ragno, Charlotte Love, and Hamed Moftakhari. 2018. Projected Changes in California's Precipitation Intensity-Duration-Frequency Curves.

AECOM. 2016. *Sediment Transport Analysis Addendum Santa Clara River at Freeman Diversion.* Prepared for United Water Conservation District. Santa Paula, CA. January 2016.

AMEC Earth and Environmental (AMEC). 2005. *Santa Clara River Enhancement and Management Plan (SCREMP).* Prepared for Ventura County Water Protection District and Los Angeles County Department of Public Works. Ventura and Alhambra, CA. May 2005. https://dpw.lacounty.gov/wmd/watershed/sc/docs/SCREMP_Full_Report.pdf. Accessed August 2016.

Beller, E.E., R.M. Grossinger, M.N. Salomon, S.J. Dark, E.D. Stein, B.K. Orr, P.W. Downs, T.R. Longcore, G.C. Coffman, A.A. Whipple, R.A. Askevold, B. Stanford, J.R. Beagle. 2011. Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA.

Booth, M.T. 2020. Patterns and Potential Drivers of Steelhead Smolt Migration in Southern California. North American Journal of Fisheries Management.

Bricker, S. B., C. G. Clement, D. E. Pirhalla, S. P. Orlando, D. R. G. Farrow. 1999. National estuarine eutrophication assessment. Effects of nutrient enrichment in the nation's estuaries. NOAA—NOS Special Projects Office.

Burton, C.A., Montrella, Joseph, Landon, M.K., and Belitz, Kenneth. 2011. Status and understanding of groundwater quality in the Santa Clara River Valley, 2007. California GAMA Priority Basin

Project: U.S. Geological Survey Scientific Investigations Report 2011–5052. http://www.water.ca.gov/groundwater/sgm/cod.cfm. Accessed August 2016.

California Energy Commission. 2018. California's Fourth Climate Change Assessment: Los Angeles Region Report.

California Protected Area Data Portal. 2018. (August 2017). [tabular (or GIS) data]. www.calands.org. Accessed July 2018.

Cayan, D.R., E.P. Maurer, M.D. Dettinger, M. Tyree, K. Hayhoe. 2008. "Climate Change Scenarios for the California Region" Climatic Change 87 (Suppl 1): S21–S42.

Cayan, D., M. Tyree, M. Dettinger, H. Hidlago, T. Das, E. Maurer, P. Bromirski, N. Graham, R. Flick. 2009. Climate Change Scenarios and Sea Level Rise Estimates for the California: 2009 Climate Change Scenarios Assessment. California Climate Change Center, University of California, Berkeley.

Cooper J.G. 1887. "Additions to the birds of Ventura County, California." The Auk: Ornithological Advances 4(2) April 1887: 85–94.

Dagit, R., M. T. Booth, M. Gomez, T. Hovey, S. Howard, S.D. Lewis, S. Jacobson, M. Larson, D. McCanne, and T.H. Robinson. 2020. Occurrences of Steelhead Trout (Oncorhynchus mykiss) in southern California, 1994–2018. California Fish and Wildlife 106(1): 39–58.

Department of Water Resources (DWR). 2016. Bulletin 118 Interim Update 2016. California's Groundwater Working Toward Sustainability.

Environmental Science Associates (ESA) PWA. 2013. Final Coastal Resilience Ventura Technical Report for Coastal Hazards Mapping. Prepared for The Nature Conservancy. Sacramento, CA. July 31, 2013, 39.

Fairchild Aerial Surveys. 1927. Santa Clara River. Ventura County Watershed Protection Districts archive.

Farnsworth, K.L. and J.A. Warrick. 2007. Sources, Dispersal, and Fate of the Fine Sediment Supplied to Coastal California: U.S. Geological Survey Scientific Investigations Report 2007-5224, 77pp.

Federal Energy Regulatory Commission. 2008. Order Issuing a New License. United Water Conservation District, Santa Felicia Project No. 2153–012. September 12, 2008. elibrary.ferc.gov. Docket No: P–2153–012. Accessed August 2016.

Florsheim, Joan, Edward A. Keller, David W. Best. 1991. "Fluvial sediment transport in response to moderate storm flows following chaparral wildlfire, Ventura County, southern California." Geological Society of America Bulletin,103(4): 504–511.

Griffith Wildlife Biology. 2013. Technical letter regarding results of operating brown–headed cowbird trap at the Ventura River in 2013. Prepared for Ventura Audubon. Ventura, CA. August 20, 2013.

Inman D.L. and S.A. Jenkins. 1999. Climate Change and the Episodicity of Sediment Flux of Small California Rivers. The Journal of Geology 107: 251-270.

Jennings, M. R., and M. P. Hayes. 1994. Amphibian and Reptile Species of Special Concern in California. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA.

Karl, T.R., J.M. Melillo, and T.C. Peterson (editors). 2009. Global Climate Change Impacts in the United States. Cambridge, UK: Cambridge University Press.

Kats, L.B., and R.P. Ferrer. 2003. "Alien Predators and Amphibian Declines: Reviews of Two Decades of Science and the Transition to Conservation." Diversity and Distributions. Special Issue: Amphibian Declines. 9:99–110.

Killam, D., A. Bui, S. LaDochy, P. Ramirez, J. Willis, W. Patzert. 2014. "California Getting Wetter to the North, Drier to the South: Natural Variability or Climate Change?" Climate 2(3):168–180.

Kloskowski J. 2011. Differential effects of age-structured common carp (Cyprinus carpio) stocks on pond invertebrate communities: implications for recreational and wildlife use of farm ponds. Aquaculture International 19: 1151 (2011).

Lammens E.H.R.R., W. Hoogenboezem. 1991. Diets and feeding behavior. In: Winfield I.J., Nelson J.S. (eds) Cyprinid Fishes. Fish and Fisheries Series, vol 3. Springer, Dordrecht.

Mann, John F. 1959. A Plan for Ground Water Management. Prepared for United Water Conservation District. La Habra, CA.

Matsuzakie S.S., U. Nisikawa, N. Takamura, I. Washitani. 2007. Effects of common carp on nutrient dynamics and littoral community composition: roles of excretion and bioturbation. Fundamental and Applied Limnology 168/1:27-38.

Northwest Hydraulic Consultants, Inc. (NHC). 2015. Sediment Transport and Deposition Assessment of the Freeman Diversion Conveyance System. Phase 1: Existing System Performance. Final Report. Project No: 6000088.

National Fish, Wildlife, and Plants Climate Adaptation Partnership. 2012. National Fish, Wildlife, and Plants Climate Adaptation Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington D.C.

National Oceanic and Atmospheric Administration. 2016. Seasonal Fish Passage Issues at the Vern Freeman Diversion Dam on the Santa Clara River, near Saticoy, California- C1400458. June.

Regional Water Quality Control Board (RWQCB). 2014. S*anta Clara River Watershed Section WCVC IRWM Plan Update 2014*. Los Angeles, CA.

Regional Water Quality Control Board [Los Angeles] (RWQCB). 2017. The Water Quality Control Plan: Los Angeles Region Basin Plan for the coastal watersheds of Los Angeles and Ventura counties. California Regional Water Quality Control Board, Los Angeles Region (4).

Regional Water Quality Control Board [Los Angeles] (RWQCB). 2018. Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties. Los Angeles. Available Online: https://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/ Accessed August 2018.

Riparian Habitat Joint Venture. 2004. Version 2.0. "The riparian bird conservation plan: a strategy for reversing the decline of riparian associated birds in California." California Partners in Flight. http://www.prbo.org/calpif/pdfs/riparian.v–2.pdf. Accessed August 2016.

Santa Clara River Project Steering Committee. 1996. Santa Clara River Enhancement and Management Plan Study. March 1996. http://parkway.scrwatershed.org/wkb/projects/scremp/index.html. Accessed August 2016.

Scott, K. M. and R. P. Williams. 1978. "Erosion and Sediment Yields in the Transverse Ranges, Southern California." Geological Survey Professional Paper 1030:38.

Stillwater Sciences. 2007a. Santa Clara River Parkway Floodplain Restoration Feasibility Study: Assessment of Geomorphic Processes for the Santa Clara River Watershed, Ventura and Los Angeles Counties, California. Prepared by Stillwater Sciences for the California State Coastal Conservancy. Oakland, CA.

____. 2007b. Analysis of Riparian Vegetation Dynamics for the Lower Santa Clara River and Major Tributaries, Ventura County, California. Santa Clara River Parkway Floodplain Restoration Feasibility Study. Prepared by Stillwater Sciences for the California State Coastal Conservancy and the Santa Clara River Trustee Council.

____. 2008. Santa Clara River Parkway Floodplain Restoration Feasibility Study. Prepared for the California State Coastal Conservancy, Oakland, California. July 2008.

____. 2011. Geomorphic assessment of the Santa Clara River watershed: synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences, Berkeley, California for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and the U.S. Army Corps of Engineers–L.A. District.

____. 2018. Geomorphic assessment of the Santa Clara River watershed: synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences, Berkeley, California for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and the U.S. Army Corps of Engineers.Los Aangeles District.

Stillwater Sciences and URS Corporation. 2007. Riparian Vegetation Mapping and Preliminary Classification for the Lower Santa Clara River and Major Tributaries, Ventura County, California. Volume I. Prepared by Stillwater Sciences and URS Corporation for the California State Coastal Conservancy and the Santa Clara River Trustee Council.

Swain, D. L., B. Langenbrunner, J. D. Neelin, A. Hall. 2018. "Increasing Precipitation Volatility in Twenty–First–Century California." Nature Climate Change 8(2018): 427–433.

The Nature Conservancy. 2006. Santa Clara River Upper Watershed Conservation Plan. Ventura, CA. Fall 2006. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=60244. Accessed August 2016.

____. 2008. Conservation Plan for the Lower Santa Clara River Watershed and Surrounding Areas. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=60245. Accessed August 2016

United Water Conservation District (United Water). 2012. Santa Felicia Water Release Plan, Santa Felicia Project FERC. License No. 2153. Santa Paula, CA. June 2012.

____. 2016. Saline Intrusion Update, Oxnard Plain and Pleasant Valley Basins. United Water Conservation District Open–File Report 2016–04. Santa Paula, CA. April 2016.

____. 2019. Technical Memorandum: Implementation of Groundwater Model Inputs for Simulations in Support of Groundwater Sustainability Plan Development by the Fox Canyon Groundwater Management Agency. 18 pp.

Warrick J.A. and L.A.K. Mertes. 2009. Sediment yield from the tectonically active semiarid Western Transverse Ranges of California. GSA Bulletin 121: 1054-1070.

Western Regional Climate Center. 2018. "Santa Paula, California (047957). Period of Record Monthly Climate Summary." [web data]. https://wrcc.dri.edu/cgi–bin/cliMAIN.pl?ca7957. Accessed June 20, 2018.

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3 COVERED ACTIVITIES

The covered activities in this MSHCP for which ITPs are being sought include any activity directly related to the renovation, operation, or maintenance of the Freeman Diversion that is under United's control and has the potential to result in incidental take of a covered species. Under the MSHCP, United would continue to operate and maintain the Freeman Diversion for the purposes described in Chapter 1. United would avoid and minimize effects of the covered activities on the covered species by making certain physical and operational modifications as part of the conservation program described in Chapter 5. United would also implement the monitoring program described in Chapter 6 to scientifically test a number of assumptions underlying some of the conservation measures and the effects analyses (Chapter 7), and to evaluate the effectiveness of the proposed avoidance and minimization measures. Therefore, the covered activities in this MSHCP also include the activities that encompass the conservation and monitoring programs that have the potential to result in take. The general categories of covered activities is given below and described in detail in this chapter. United requests incidental take coverage for each of the activities listed.

1. Renovation of the fish passage facility and the Freeman Diversion headworks
2. Resurfacing the downstream face of the Freeman Diversion grade control structure
3. Fish passage facility operations
4. Water diversion operations
5. Capture and relocation of downstream moving steelhead as a result of low flows from the diversion operations
6. Expansion of the Freeman Diversion off-channel water conveyance infrastructure
7. Maintenance of facilities and property
8. Conservation program activities
9. Restoring and enhancing habitat
10. Other Conservation Activities and Monitoring
11. Implementing adaptive management measures

Figure 3-1 depicts the location and extent of construction activities related to the proposed renovation of the fish passage facility and headworks, as well as the resurfacing of the downstream face of the grade control structure. Figure 3-2 depicts the components of the fish passage facility as currently designed. Figure 3-3 depicts the components of the Freeman Diversion expansion project.

The following subsections present detailed descriptions of covered activities 1-7 and brief summaries of activities 8-11. Chapter 5 (Conservation Program) and Chapter 6 (Adaptive Management and Monitoring) describe covered activities 9-10 in further detail. Specific conservation measures will be applied to each covered activity to avoid and/or minimize the potential for these activities to result in take of covered species and to minimize the impact of the taking on the population. Detailed descriptions of how conservation measures will be applied to each specific covered activity are included in Chapter 5. The potential for these covered activities to result in effects to covered species considering the application of conservation measures is analyzed in Chapter 7.

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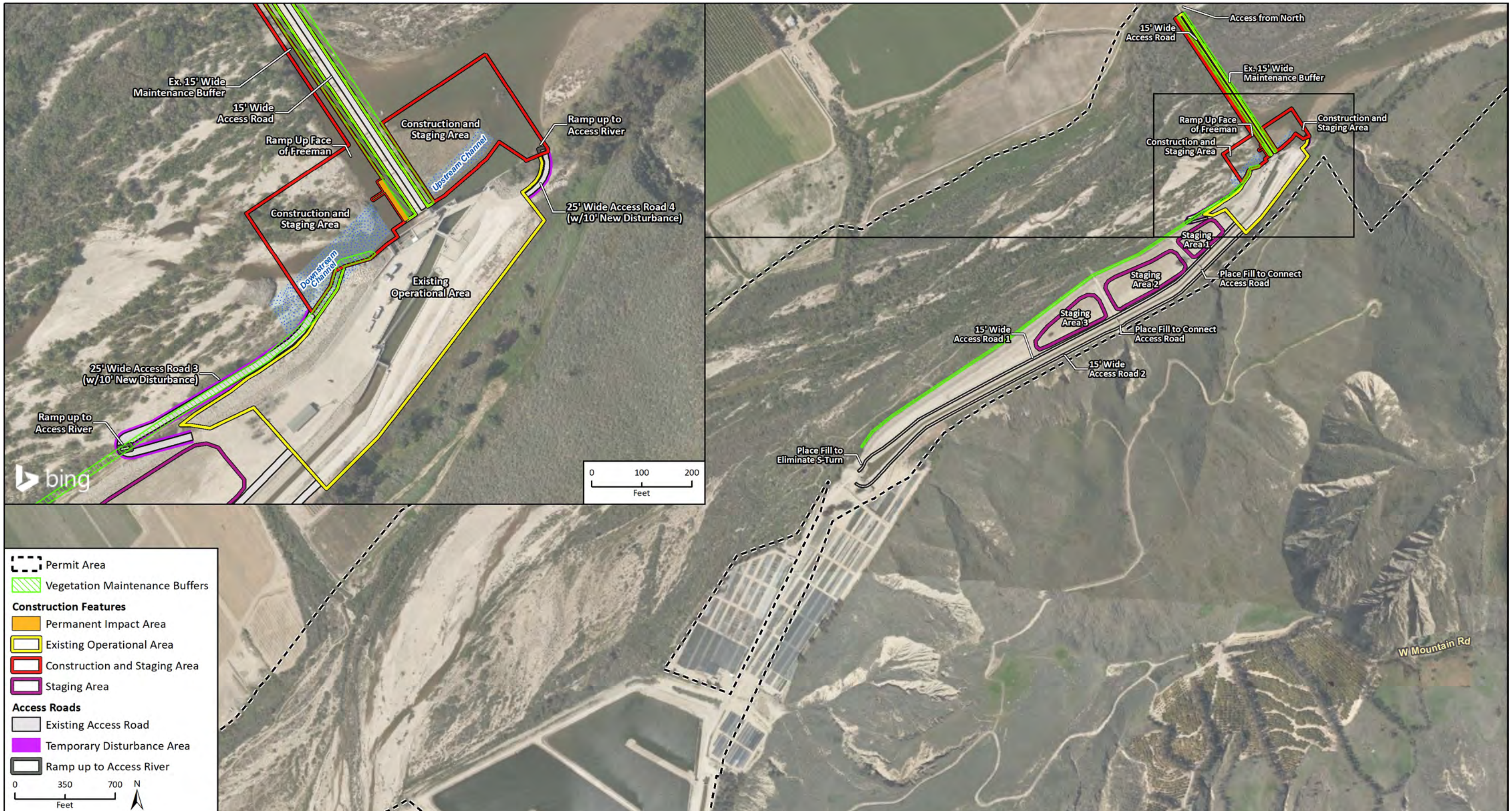
Figure 3-1 Construction and Maintenance Areas for Proposed Fish Passage Renovation



Imagery provided by Microsoft Bing and its licensors © 2020.

Figure 3-2 Fish Passage Facility Renovation Design

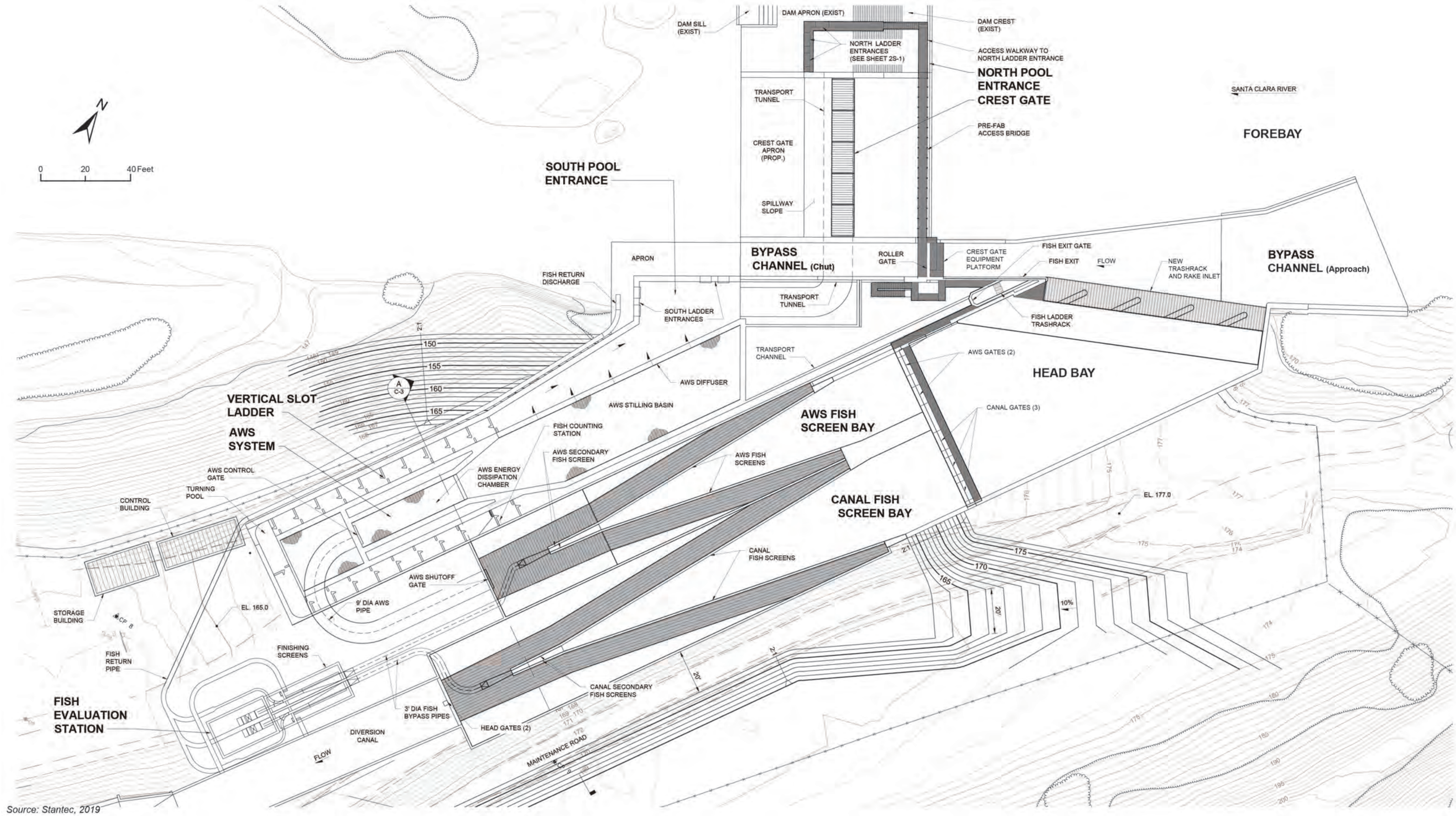
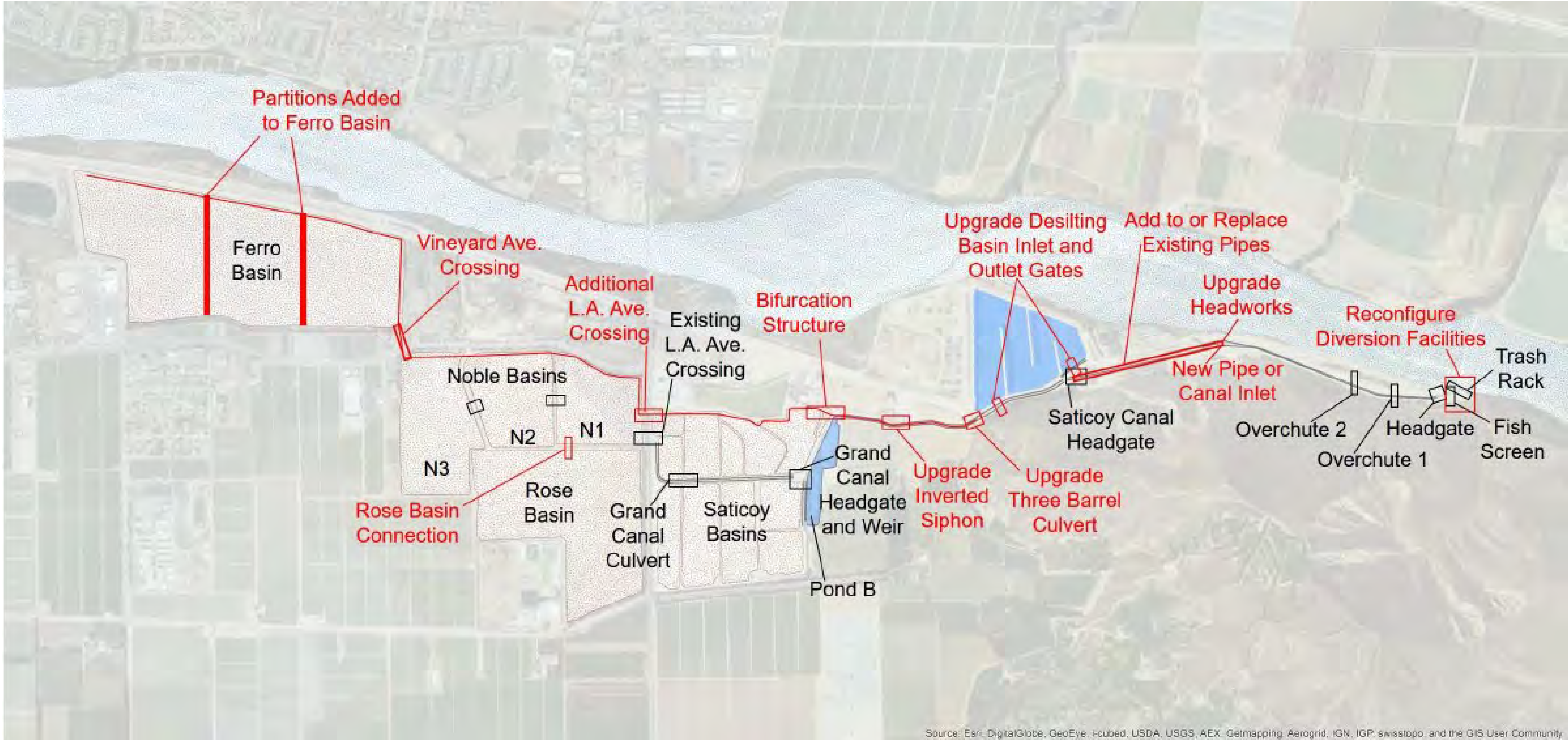


Figure 3-3 Freeman Expansion Project



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3.1 CONSTRUCTION

3.1.1 FISH PASSAGE FACILITY AND FREEMAN DIVERSION RENOVATION

United currently operates a Denil fish ladder at the Freeman Diversion and a prototype lamprey passage system. As part of the process to improve steelhead and lamprey passage at the diversion, the existing diversion facility would be renovated. Facility renovation would include replacing the Denil fish ladder with a vertical slot design fish ladder paired with crest gates and a larger auxiliary water supply system, resurfacing the downstream face of the diversion structure, replacing or modifying various diversion components surrounding the fish ladder, and updating the flow operations at the diversion. In addition to providing improved fish passage, the renovation would improve the water delivery and recharge operations of the diversion. Additionally, a lamprey-focused passage system will also be constructed.

The detailed design basis for the facility renovation is contained within the Vertical Slot Fish Ladder Hydraulic Basis of Design Report, which includes additional details on the individual components of the fish ladder as well as detailed design drawings (Appendix C). Background details on how this fish passage design was selected and developed can be found in Conservation Measure (CM) 1.1.1 in Chapter 5 - Conservation Program and in Chapter 10 - Alternatives to Take.

Facility Components

The modified fish passage system consists of the following components:

- Crest gates
- Bypass channel approach
- Roller gate
- Bypass channel chute
- Vertical slot fish way with:
  - Entrance pools
  - North entrance pool
  - Transport tunnel
  - South entrance pool
  - Vertical slot ladder
  - Fish counting station
  - Transport channel
  - Fish exit
- Auxiliary water system (AWS) with:
  - Trash rack [Inlet]
  - Head bay
  - AWS gates
  - AWS fish screen bay [AWS approach channel]
  - Primary AWS fish screen
  - Secondary AWS fish screen
  - Fish return and finishing screen
  - Evaluation station

    - Fish return discharge
    - AWS stilling basin and diffusion system
- Canal facilities with:
    - Inlet
    - Canal gates
    - Canal fish screen bay [canal approach channel]
    - Primary canal fish screen
    - Secondary canal fish screen
    - Fish return and finishing screen
    - Evaluation station
    - Fish return discharge

CREST GATES

Operating the fish ladder and the fish screens for the canal and AWS system is facilitated by maintaining a constant forebay[1] water level at elevation 161.5 feet. This provides 0.5 foot of operating freeboard before spill occurs over the fixed crest of the diversion. To better and more immediately control the forebay and to concentrate initial spill over the diversion crest to improve attraction to the ladder, a new crest gate will be installed in the diversion structure adjacent to the bypass channel, consisting of an Obermeyer gate system that would be 8 feet in height and 70 feet in length. The Obermeyer gate system consists of a rubber bladder, which can be inflated to raise shaped steel plates. In the fully raised position, the crest will be at elevation 162.0 feet, thus matching the existing diversion crest. In the fully lowered position, the gate crest will be elevation 154.0 feet. The width of the gate can be divided into sections and operated separately. This will allow for deeper flows over the gate at lower crest gate flows. The downstream face of the diversion structure below the crest gates will be filled to accommodate the fish transport tunnel, which is described below. The fill will have a downstream face shaped to provide a smooth surface for downstream passage of juvenile steelhead intended to provide a safer path for downstream migrating fish passing the diversion compared to the existing structure.

The crest gate will control the water surface at 161.5 feet over a gate discharge range from approximately 0 to 4,400 cfs. Once fully lowered, the crest gate discharge increases to approximately 4,900 cfs as the river flow increases to elevation 162.0 feet when water will start to spill over the fixed crest of the diversion. At the passage design point of 6,000 cfs, the discharge through the crest gate area increases to about 4,880 cfs. Under normal operation, the crest gate would remain in the full down position during high flows or floods providing additional flood conveyance.

BYPASS CHANNEL

The bypass channel is an existing structure that has several components discussed below. When the bypass channel is closed, water stages up and allows for water diversion via gravity. The bypass channel is opened to bypass water during the peak of storm flows that carry too much debris and sediment to divert and the bypass channel is also opened to sluice sediment that accumulates in front of the diversion headworks to prevent sediment and bedload from overwhelming the diversion intake and to maintain the thalweg on the south side of the river, preventing the river channel from migrating away from the diversion headworks and fish ladder.

[1] As used throughout Chapter 3, “forebay” refers to the inundated area upstream of the Freeman Diversion created during diversion operations and is not referring to the Oxnard Forebay aquifer that is also discussed in this MSHCP.

Approach

The bypass channel upstream of the roller gate (bypass channel approach) is 61 feet wide at its upstream end and directs flows into the diversion inlet. The channel narrows to 15 feet wide 40 feet upstream of the roller gates. The proposed fish ladder exit outlets into the bypass channel approach immediately downstream of the trash rack. Water levels and flow velocities in the bypass channel approach are controlled by the roller gate during sediment sluicing operations.

ROLLER GATE

Bypass channel flow is controlled by a single 15-foot-wide by 10-foot-high roller gate located at the downstream end of the bypass channel approach. The roller gate opens vertically against a headwall and is controlled with an electric multi-turn actuator above the gate. The roller gate will be used for maintenance only to maintain the bypass channel approach and fish ladder exit free of debris and sediment deposition. Its operation will depend on sediment deposition rates and fish passage requirements. United is proposing specific criteria for operating the roller gate that depend on timing and magnitude of flow and sediment levels (see Chapter 5) to minimize impacts to covered species.

Chute

The bypass channel downstream of the roller gate (chute) is approximately 83 feet long. For this project, the chute slab will be removed and replaced slightly higher with a vertical curve to accommodate the new transport tunnel. The full slab will be replaced from the roller gate to the existing horizontal apron. No structural changes are proposed to the chute walls. The existing slope of the bypass channel approach (3.2 percent) will be extended to be over the transport tunnel where the slope will steepen to approximately 34 percent slope until it reaches the existing apron.

VERTICAL SLOT FISH LADDER

The vertical slot fish ladder facility would include two entrance pools with a transport tunnel between them, a vertical slot style ladder, fish counting station, transport channel, and an exit. These facilities are described in more detail below.

Entrance Pools

The purpose of the entrance pools is to attract fish from the tailwater pool into the ladder and then to guide fish to the ladder once inside the entrance pool. Attraction flow discharging from the entrance pool would be a combination of fish ladder flow and AWS flow. The AWS is described below.

The design consists of two entrances, one on the north side of the crest gate and one to the south near the bypass channel. The two entrances are connected by a transport tunnel under the crest gate spillway and the bypass channel. The AWS flow enters the south entrance pool where it is combined with the flow in the ladder. The flow then discharges through one, two, three or four ladder entrance gates in the south entrance depending on operational preferences. The remainder of the flow travels through the transport channel to the north entrance pool, where it can be discharged through one or two entrance gates depending on operating preferences. The maximum entrance flow of 600 cfs would discharge through up to four entrance gates located in the north and south entrance pools.

The fish ladder enters at the southwest corner of the south entrance pool, where it is supplemented by AWS water that enters the pool through a diffuser rack on the east side of the entrance pool. Screened AWS water comes through the energy dissipation chamber located below grade on the east side of the entrance pool. AWS water is distributed to the diffuser rack through the diffuser panel, which are oriented to help guide the fish to the first pool in the fish ladder at the southwest corner of the south entrance pool.

North Entrance Pool

The north entrance pool is 20 feet by 20 feet, located immediately inside the north fish ladder entrance gates, and is formed by vertical reinforced concrete walls on the north and south sides. The existing diversion crest would form the east side of the entrance pool. The transport tunnel enters the north entrance pool on its south side.

The purpose of the north entrance is to reduce any potential delay to fish that might approach the dam from the right (north) side of the channel. Flow through the north entrance is controlled by the entrance gates in both the north and south entrance pools. Each fully open entrance gate can discharge about 150 cfs with one foot of head across it. The maximum design discharge from the north entrance is about 300 cfs, which is half of the total discharge from the ladder entrances. One entrance gate is located on the north side of the pool to attract fish from the stilling basin of the diversion.

Transport Tunnel

The transport tunnel would be 13 feet wide, 11 feet high, and 88 feet long and would connect the north entrance pool to a transport channel south of the bypass channel. The height is set to maintain a free surface at estimated tailwater elevations up to the 6,000 cfs design flow plus 1 foot of head across entrance gates. This provides free surface flow over the design flow range for fish passage. Ambient light can enter the tunnel from both its north and south ends. Additional lighting would be installed in the tunnel.

South Entrance Pool

The south entrance pool would be approximately 120 feet long and located immediately inside the south fish ladder entrance gates. The channel width would vary from 8 feet at the ladder entrance to 30 feet. When the full AWS and ladder flows are available, two, three or four south entrance gates could be open. The southeast wall would include a 120-foot-long diffuser rack described above. There would be two fish entrances on the north wall and two on the west wall directed downstream. Entrance openings would be 5 feet wide and 6 feet high with the bottom of the openings at the floor level. Flush bottom sluice gates would be mounted on the inside of the openings. The fish transport tunnel would start at the east end of the south entrance pool.

The water level in the south entrance pool would be from 0.0 to 0.4 feet above the north entrance pool. This head difference would be required to convey flow to the north entrance pool. At the minimum design flow only one entrance gate would be open. When the full AWS and ladder flows are available, two, three or four south entrance gates could be open.

Vertical Slot Ladder

As fish travel through the entrance pool, they would be guided to the fish ladder along the diffuser rack. The ladder consists of 23 steps. Ladder steps will have a 1-foot drop except the upper two pools. Each pool has inside dimensions of 8 feet wide and 10 feet long. The pools are designed to discharge through a slot into the corner of the next pool downstream, dissipating the flow energy in each pool and providing resting areas.

Fish Counting Station

United will need to monitor for fish passing the fish ladder to meet the monitoring requirements for an ESA Section 10(a)(1)(B) permit (see Chapter 6). The false weir system currently in use at the Freeman Diversion has proved most effective at detecting adult steelhead in the fish ladder, though under court order, a false weir is prohibited as a monitoring approach in the future facility at this time. Accordingly, a new fish counting system would be incorporated into the vertical slot fish ladder facility, which would primarily include the installation of a trap within or at the exit to the vertical slot fish ladder to facilitate the monitoring of upstream migrating steelhead. Due to periods of high turbidity in the Santa Clara River, normal counting equipment cannot provide reliable and accurate data because it relies on seeing the fish through the water or distinguishing the fish from background noise using sonar. However, a DIDSON camera system would be installed in the vertical slot as part of the fish counting system, also facilitating the monitoring of upstream migrants within the operational turbidity range of the equipment. The DIDSON camera would be installed within the transport channel or near the exit of the vertical slot fish ladder. Other steelhead monitoring equipment to be installed within the vertical slot fish ladder includes a passive integrated transponder (PIT) antenna in the fish ladder. Radio-telemetry antennas at the fish ladder entrance, at the counting station, and at the fish ladder exit would also be installed temporarily and as-needed to aid in the detection of upstream migrants and facilitate effectiveness monitoring studies detailed in Chapter 6.

Transport Channel

Immediately after the fish ladder is the transport channel. The transport channel would be 3 feet wide and velocities in the channel would be about 2 feet per second (fps) to facilitate fish movement through the channel toward the fish ladder exit.

Fish Exit

As fish exit the transport channel, they would pass through the fish ladder exit gate, which would be a flush bottom 3-foot-wide by 6-foot-tall sluice gate. The exit channel would expand to a 5-foot-wide channel as it nears the exit trash rack. The exit gate would be closed during sediment sluicing operations to prevent fish leaving the fish ladder from potentially being caught in the downstream flow during sluicing.

AUXILIARY WATER SYSTEM (AWS)

The descriptions in this section follow the flow of auxiliary water from the forebay to the entrance pool.

Trash Rack [Canal Inlet]

The AWS flow, along with the canal flow, enters through the main canal trash rack. The opening for the trash rack, and the trash rack itself, will be expanded by about 25% for the additional diverted flow under United's proposed future operations (see Chapter 5). The new trash rack would provide uniform and narrower bar spacing to manage debris entering the screens and canal. Trash rack bars will be spaced between 4-inches and 6-inches on center. The spacing will be as small as possible to suite the cleaning system while restricting floating debris and aquatic vegetation as much as possible to reduce impact to the fish screens (0.07 inches or 1.75 mm opening) and fish return systems downstream of the rack. Six windows, nominally 12 inches wide by 24 inches high, will be spaced equally along the length of the rack to accommodate downstream passage of steelhead kelts. Under peak diversion rate and normal forebay levels, the average approach velocity to the rack will be 2.0 fps. Bar spacing, orientation, and details will be refined during the modeling and design processes. The new trash rack will be cleaned with the Duperon trash rake system and the controls for the rake would be unchanged from the current trash rack system.

Head Bay

Flow through the trash rack would enter the head bay where it would be separated into the AWS system or the diversion [canal] system. Two new gates would serve the AWS and three new gates would pass the canal flow.

AWS Gates

New gates and new side walls will be located to provide good approach hydraulic conditions for the AWS ladder. The three additional gates would be used to divert water into the canal fish screens.

AWS Fish Screen Bay [AWS Approach Channel]

Downstream of the canal gates, the south wall of the AWS fish screens would extend above the water surface. This would allow the AWS to operate independently of the canal water supply. The approach channel to the AWS screen would be 27 feet wide. Fixed porosity baffles would be used to reduce the velocity and turbulence of water flowing in front of the screens. The total flow entering the screen facility would be 594 cfs: 24 cfs for fish bypass and 570 cfs for AWS water to the entrance pool.

Primary AWS Fish Screen

The AWS would include primary and secondary fish screens mounted on a sill. The fish screen structure is designed to provide 3 fps transport velocity in front of the screens. The surface of the water entering the screen structure would be at an elevation of 159.9 feet, providing a depth of about 7.4 feet. Vertical flat panel fish screens will be mounted on a sill providing a wetted height on the screens of about 6.5 feet. Screen panels would be vertical flat panels with stainless steel frames and profile wire screen material having 1.75-mm slots to meet juvenile fry screening requirements. The screens would be "V" shaped with flow passing through screens on the sides of the Vee. The effective length of the primary screens would be 224 feet long including support piers. Total flow through the primary AWS screens would be 526 cfs, with another 68 cfs passing the primary screens into the secondary screens.

The AWS screens would have debris cleaning systems attached to the screens. Additionally, accumulated sediment in the screen area will necessitate the installation of water jets along the floor of the screen to resuspend sediment, which would then be carried downstream in the AWS. Alternate screen types, like vertical belt screens, that would replace the screen panels and cleaning systems described above could be adapted to this layout.

Secondary AWS Fish Screen

At the entrance to the secondary screens, the channel would be 3 feet wide, with a bottom elevation matching the existing canal up to the secondary screens and narrowing to 1.5 feet wide at the downstream end. Screens with about 110 total square feet of wetted area would be installed to pass 44 cfs to the energy dissipation chamber. Screen panels would incorporate a debris cleaning system and water jets would be incorporated to resuspend sediment similar to the primary screens.

Fish Return and Finishing Screen

To accommodate a fish trapping and evaluation station, finishing screens would be provided to reduce the flow amount for holding tanks. The trapping velocity created at the downstream end of the secondary fish screens would allow trapped fish to be released to the evaluation station or to the river. To reduce the velocity through the finishing screens, the channel would be expanded to 3 feet wide and 3 feet deep. A total gross screen area of 55 sf would be provided. The channel at the downstream end of the finishing screens would be reduced to 12 inches wide. The channel then transitions to a 24-inch diameter fish return pipe that would return fish to the river near the fish ladder entrance pool.

When sampling fish, the channel would be reconfigured by replacing a short section of channel. A short shutdown of water to the finishing screens would be required. The fish return pipe would be secured to the concrete wall and hardened to protect it from debris during floods.

Evaluation Station

Flow from each screened bypass (canal and AWS) would enter the fish evaluation station in an open channel into a holding pool. The holding pool would be 30 inches wide, 10 feet long, and have a minimum operating depth of 3 feet. The holding pool would include a screen at the downstream end with a weir to maintain pool level. A 1-foot deep recess in the floor upstream of the belt screen would serve to store a brail tray to remove fish for sampling. The evaluation station would contain a non-potable water sink, work bench, service water supply, and tagging equipment. Holding pond crowding screens and picket panels for predator separation would be included. To process fish, the crowding panel would be moved to the edge of the brail and fixed in position while the brail is raised. The brail can be raised to the top of the wall for inspection or above the wall to transfer fish to separate holding tanks for evaluation. Fish would be returned to the screened water trench in the floor to be returned to the river.

Fish Return Pipe

The bypass flows and fish from the evaluation station would be diverted to a 24-inch pipe to carry the fish back to the river. The flow in the fish return pipe would be between 4 and 8 cfs from both screening facilities. The bypass flow and fish would drop into the pool to the west of the ladder entrance. The maximum fall of the bypass flow would be about 8 feet at minimum tailwater of 4.5 feet depth.

AWS Stilling Basin and Diffusion System

The screened AWS flow of about 570 cfs would pass into a 9-foot diameter pipe. A 9-foot gate attached to a headwall would be installed over the pipe outlet. The channel would be 12 feet wide and 180 feet long. A 3-foot 4-inch-high weir across the channel would be located 50 feet downstream of the gate. The weir would serve to control the location of the hydraulic jump between the weir and the AWS gate. The channel would widen into the AWS pool downstream of the weir. Water would then flow through a baffle wall consisting of perforated plates with about a 6 percent open area consisting of 2-inch diameter holes. This would cause about a 1-foot drop across the wall providing an even flow distribution. The flow would then pass through a 6-foot high by 120-foot long vertical diffusion grating into the south entrance pool. The baffle wall and diffusion grating would be parallel and oriented to lead fish to the ladder at the southwest end of the entrance pool.

CANAL FACILITIES

This section follows the water from the forebay to the head gates and canal downstream. It describes the proposed facilities in this flow path. The existing head gates and canal downstream would not change other than the expanded conveyance projects described in Section 3.1.2.

Inlet

The existing canal inlet would be maintained other than the modifications described in the "Trash Rack [Inlet]" section above under "Auxiliary Water System."

Canal Gates

Three new 9-foot-wide by 8-foot-high sluice gates, identical to the existing canal gates, would be installed south of the AWS canal gates and in line with them. The gates will be flush bottom at the same elevation as the existing gates. The new gates will have electric motor actuators. The locations of the canal gates are designed to provide even flows approaching the canal screens.

Canal Fish Screen Bay [Canal Approach Channel]

The channel between the canal gates and the entrance to the canal fish screens would be rectangular in section and 35 feet wide at the entrance to the screens. The elevation at the gates would be the same as the existing channel. The center line of the channel would be a straight line from the center of the center canal gate to the center of the pier between the two head gates. Therefore, the flow approaching the fish screens is designed to be parallel to the center of the Vee screen. The total flow entering the screen facility would be 774 cfs, 24 cfs for the fish bypass and 750 cfs for delivery to the canal downstream.

Primary Canal Fish Screen

The fish screen structure is designed to provide a flow by the screens of 3 fps. The surface of the water entering the screen structure would be at an elevation of 160.0 feet providing a depth of about 7.5 feet. The screens would be mounted on a sill providing a wetted height on the screens of about 6.5 feet, similar to the primary AWS fish screen. The 1-foot-high sill would allow for sediment accumulation before interfering with the screens and the brush cleaners. The screens would be in the shape of a “V” with flow passing through screens on the sides of the Vee. The effective length of the primary screens would be 300 feet long, including support piers. Each screen panel would be 10 feet long and 6.5 feet high. Screen panels would have stainless steel frames and profile wire screen material having 0.07-inch (1.75-millimeter) slots to meet juvenile fry screening requirements. The flow through the primary screens would be 706 cfs, with 68 cfs passing into the secondary screen reach. As with the primary AWS fish screen, the design includes a cleaning system attached to the screen to allow for the removal of debris (e.g., algae) as is accumulates. Additionally, accumulated sediment in the screen area will necessitate the installation of water jets along the floor of the screen to resuspend sediment, which would then be carried downstream in the AWS.

A floor drainpipe would provide the ability to drain water and possibly sediment under limited conditions back to the river. The drain would be normally closed at a buried plug valve to prevent fish entrainment.

Secondary Canal Fish Screen

The secondary canal fish screens would be similar to those for the AWS. At the entrance to the secondary screens the channel is 3 feet wide, decreasing to 1.5 feet wide at the bypass gate. About 110 square feet of wetted screen area would be provided to pass 44 cfs. Screen panels would incorporate a debris cleaning system and water jets would be incorporated to resuspend sediment similar to the primary screens.

Fish Return and Finishing Screen

The fish bypass would be the same as in the AWS screen facility. An 18-inch-wide bypass weir would pass flow 2 feet deep into a flume attached to the top of the weir. The 24-cfs bypass would flow down the flume and into a transition channel to a 36-inch diameter pipe. The pipe would bend in a long radius sweep to the evaluation station. Once outside of the channel, the pipe would transition into the finishing screen. The finishing screen and conveyance would be the same as described for the AWS system.

In the normal configuration, the fish return flow will be combined with the AWS fish return flow and routed to the river in a single 24-inch diameter fish return pipe. The pipe profile would be controlled to limit velocities in the pipe and at the discharge contact with the tailwater. The pipeline will be secured to the concrete wall and hardened to protect it from debris during floods.

Screened water from the finishing screens is regulated by a side gate at the pipe inlet. The screened flow from the finishing screens is combined with the finishing screen flow from the canal screens and water from the evaluation building and is all fish free. Flow can be routed through valve settings either to the canal below the head gates or to the river at the bypass channel to supplement the AWS flow in the ladder.

Evaluation Station

Fish return flow would be routed to the evaluation station through the same process as described for the AWS screen. The evaluation station would accommodate flow from both screens.

Fish Return Discharge

As described above, the bypass flows and fish from the evaluation station would be diverted to a 24-inch diameter pipe to carry the fish back to the river. The flow from the main canal screens is combined with the AWS fish return described above.

The renovation would occur mostly within the footprint of the existing facility. Consistent with the Amended Judgement and Permanent Injunction in the case of *Wishtoyo Foundation et al. vs United Water Conservation District* (Case No.: CV 16-3869-DOC (PLAx) Document 248), the construction of the fish passage would be completed and operational within two years of permit issuance. United anticipates the full extent of renovations and associated modification of water rights to occur within ten years of permit issuance. United would operate and maintain the renovated fish passage for the complete duration of the permit.

The following Conservation Measures ([CM] detailed in Chapter 5) for covered species will be implemented prior to and during demolition and construction activities:

- CM 2.1.1 Best Management Practices
- CM 2.1.2 Worker Environmental Awareness Training
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.1.7 Avoid Nests of Covered Species of Birds During Nesting Bird Season
- CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
- CM 2.2.1 Invasive Species Management
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events
- CM 2.3.2 Implement the Invasive Species Control Plan

Covered activities associated with pre-construction and construction activities with potential to result in take of covered species are described below. Covered operation and maintenance activities are described in Sections 3.2 and 3.3, respectively. CMs described in Chapter 5 would be implemented to avoid potential effects to covered species.

Project Footprint

The total footprint for the facility renovation would be approximately 15.09 acres. Of the total, approximately 2.83 acres of existing habitat would be temporarily affected by excavation and grading activities to facilitate construction of the fish passage facility and resurfacing the downstream face of the diversion grade control structure. An additional 0.03 acre of existing habitat would be permanently affected by the placement of fish passage facility components. All facility renovation effects within existing habitat will take place within the construction and staging areas displayed on Figure 3-1. Approximately 5.31 acres of existing operational and previously disturbed area would be part of the temporary construction footprint and approximately 6.92 acres of existing operational and previously disturbed area would be part of the permanent construction footprint associated with the facility renovation activities. The renovation footprint includes the areas that would be used to stage equipment and materials, provide access for equipment and personnel, and conduct pre-construction and construction activities (Figure 3-1). Table 3-1 below provides a detailed breakdown of the construction footprint associated with the various components of the facility renovation.

Table 3-1 Construction Footprint Acreages

Activity Area	Dimensions (feet)	Volume (cubic yards)	Permanent Impact Area (acres)	Temporary Impact Area (acres)
Existing Habitat Area				
Construction and Staging Area – Upstream	190 by 250	N/A	---	1.09[1]
Construction and Staging Area – Downstream	300 by 290	N/A	---	1.60[2]
Excavation for and construction of the crest gate and fish passage facility	100 by 17 by 8 and 150 by 150 by 3	3,158[4]	0.03	0.14
River sediment removal for diversion face resurfacing	1,000 by 16 by 8	3,600	---	0.37[3]
	Subtotal	6,758	0.03	2.83
Existing Operational and Previously Disturbed Area within the Construction Footprint				
Access roads	N/A	N/A	2.00	---
Borrow Area	100 by 100	2,610	0.23	---
Excavation for and construction of the fish passage facility, the AWS, and diversion canal	350 by 140 by 7 and 700 by 200 by 4	32,921	4.69	0.02
Rip rap removal	100 by 70 by 4	1,112	0.16[5]	---
Staging Area 1	230 by 180	N/A	---	0.97
Staging Area 2	600 by 180	N/A	---	2.48
Staging Area 3	445 by 180	N/A	---	1.84
Subtotal		36,643	6.92	5.31
Total Project Footprint			6.95	8.14

1 Total footprint excludes the excavation for the crest gate, which is quantified separately in the table to avoid double-counting
2 Total footprint excludes the excavation for and construction of the crest gates, and the excavation for and construction of the fish passage facility. These areas are quantified separately in the table to avoid double-counting
3 Construction footprint falls within the Construction and Staging Area boundary and is not included in the total to avoid double-counting
4 Volume represents total excavation, a portion of which will be used as backfill material
5 Construction footprint falls within the excavation for and construction of the AWS and diversion canal boundary and is not included in the total to avoid double-counting

Pre-Construction

Land Surveys and Best Management Practices

Land surveys would be conducted in the project footprint prior to demolition and construction associated with the renovation project to locate and demarcate demolition and construction areas and determine the exact placement of construction activities. Vehicles will transport surveyors and their equipment to designated areas via designated access roads. Survey work beyond the access roads throughout the construction site will be conducted on foot. The survey involves staking and flagging all work limit areas, staging areas, and access roads to delineate the demolition and construction area boundaries and minimize the area of impact. Surveys will continue throughout project construction and stakes and flagging will be replaced as needed to ensure construction activities remain within the area of impact.

Best management practices (BMPs) would be implemented prior to demolition and construction and would be maintained throughout the duration of the facility renovation. BMPs would include erosion control (e.g., dust suppression) and sediment control materials (e.g., silt fence) to isolate the demolition and construction area, reduce impacts to riparian habitat, minimize the potential for take of covered species, and prevent contact between construction site pollutants and stormwater for the duration of the project. Light-duty trucks will be required on the access roads, and hand tools and light equipment will be used at the project site for BMP installation. Additionally, temporary water diversions will be necessary to facilitate in-channel demolition and construction activities, which are described further in Section 3.1.3. Plans describing the BMPs in detail, including a Stormwater Pollution Prevention Plan (SWPPP), will be completed prior to project initiation. The SWPPP will be submitted to the Los Angeles Regional Water Quality Control Board in accordance with the National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit) 2009-0009-DWQ National Pollutant Discharge Elimination System No. CAS000002 (as amended). Further details on and discussion of BMPs are included in Chapter 5.

Temporary Facilities

Temporary facilities to be installed prior to construction start would include temporary utilities, a field office, and site security fencing. The temporary field office would be located adjacent to an existing building at the southwest corner of the current operational area. Site security fencing would be installed around the perimeter of the existing operational area using hand tools and light equipment. Temporary utilities to support construction and construction workers consisting of sanitary, potable water and power would be established. Sanitary facilities consisting of porta-potties along with a contract for regular servicing would be established based on the anticipated crew size and active work areas. All facilities would be temporary and removed at project completion. Potable water would be furnished for crews via bottled water or water dispensers within construction office trailers. Non-potable water would be supplied at the contractor's need from temporary pumps set in the river, canal or temporary wells. Pumping from fish bearing waters would include regulatory approved fish screens. Electrical power for lighting and construction activities would be provided from the existing service. Temporary power stations would be established around the work area as needed and all temporary connections would be removed at the end of the project. Site roadways and parking would include gravel surfacing to minimize dust and runoff. Roadway and work area dust control would be controlled by water spray or approved binding agents. Temporary utilities would include electrical service to the temporary field office and staging areas. Permanent electrical service is currently in place in the existing operational area. Temporary facilities would be installed in the construction footprint over a period of three days.

Construction

The construction phase of the renovation is estimated to consist of 700 calendar days of active work with a maximum of 25 construction personnel anticipated during the most intensive construction period. The construction is anticipated to be completed in phases over two years to minimize in-channel work during the wet season and steelhead migration season to the extent feasible. Prior to the start of work on the fish passage and diversion facility, and to minimize any undue delay in construction, the access road and site preparation work, including any necessary vegetation removal, will be conducted with the expectation for these activities to be completed prior to June 1st. Regardless of when in-channel work would take place, dewatering and flow rerouting would be implemented as appropriate prior to the start of in-channel work, to limit project-related impacts to covered fish and aquatic resources to the extent practicable. Therefore, the only in-water work anticipated for the project would occur during implementation of dewatering and flow rerouting activities (i.e., initial cofferdam construction and subsequent cofferdam reconfiguration). Out of channel work is expected to occur year-round.

Dewatering and Flow Rerouting

Construction activities would take place directly in and immediately adjacent to the river channel. This would require installation of temporary water diversions to protect these portions of the construction site from inundation and to minimize environmental impacts within the river channel. Dewatering systems would be developed and sequenced to maximize the use of existing fish ladder passage routes past the diversion and, if possible, to minimize the number of steelhead and lamprey migration seasons that occur during construction. Installation of dewatering systems would begin in spring around May 1 and continue until the work area is protected against anticipated peak flows.

Temporary water diversion concepts include:

- Isolation of the left bank (south) construction including the crest gate and fish ladder features
- Downstream face resurfacing diversion
- Diversion of river around work
- Groundwater dewatering within upland work zones including canal, fish screens and structures

The cofferdam and dewatering system design to isolate the left bank during renovation activities would consist of conventional sheet piles installed with a vibratory hammer. Alternate cofferdam systems may be employed (e.g., non-aggregate removable proprietary systems such as PortaDam or Aquabarrier) at the discretion and if determined to be feasible. The system can be configured in zones to allow access to the fish ladder and canal for limited periods while providing flood protection to the exposed work areas. Full isolation of the left bank work areas is the most efficient approach that would minimize the time required within the river channel. Water is expected to be present intermittently and will need to be temporarily diverted around the staging, access, and work areas. Standing surface water or groundwater is anticipated to be present consistently and will be pumped out to dewater the staging, access, and work areas throughout the duration of construction activities. Surface flows are expected to vary from less than 1 cfs to several thousand cfs during the construction period and the temporary diversion is intended to provide sufficient protection of the staging, access, and work areas under variable surface flow scenarios. Given the expectation of high river flows during the construction period, protection levels for the cofferdam segments along the upstream and downstream perimeter of the work area would be established to protect the project site to 100-year flood levels. The cofferdam would consist of materials which can be placed via excavator, loader, and/ or crane to the extent possible. The minimum expected height of the protection cofferdam would be elevation of 175-177.0 feet to include sufficient freeboard and prevent overtopping of river flows. To further isolate the work area, placement of sheet pile and pumps would be used to displace water from the work area. The pumps would extract any remaining surface water and groundwater from the work area to maintain dry staging, access, and work areas for the duration of in-channel activities. Pumped water would be discharged either downstream or into United's canal in accordance with water quality permit requirements and prescribed instream flow discharges (see Chapter 5).

A primary component of the temporary diversion would consist of pipes to route water from upstream of the work area to the canal through the fishbay. With water in the fishbay, the existing fish ladder can be operated to provide upstream fish passage around the work January through May while dewatering both the upstream and downstream staging and work areas. Temporary conveyance pipes or flumes would be constructed to directly connect the existing ladder entrance gate to the river downstream of the cofferdam. In-channel structures (rock or logs) would be placed to help attract fish to the extended ladder entrance. If the construction duration extends into a subsequent migration season after the existing Denil fish ladder is removed, then the contractor would be required to construct and operate a temporary fish passage system outside of the cofferdam. Details of the temporary fish passage system will be included in the construction documents and will be provided to the Services before implementation. Other than the use of the existing fishbay screens, no additional downstream passage facilities are anticipated during construction. Access and construction of the diversion refacing is anticipated to be staged and conducted during low flow periods (June-October or potentially December if weather conditions are dry enough). Gravel access points would be developed from the right (north) abutment above and below the diversion structure. Riverbed material would be used to grade temporary roadways. The contractor would be directed to plan and sequence its work starting at the south end and working to the north in limited sections of 50 feet to 100 feet. Sandbags, concrete blocks, or aggregate filled supersacks would be deployed to divert water around exposed incomplete work and crews. As each section is cast and completed the work area would be moved to the north along with the sandbags. Access roads would be reclaimed as the work progresses to the north abutment.

Access and Staging

Construction traffic would access the site via Hwy 118 on the south side of the Freeman Diversion. Site preparation activities for the fish passage renovation would include improving existing access roads between Highway 118 and the Freeman Diversion, developing staging areas, and creating temporary access points to the riverbed work areas to facilitate an expedient project timeline. Approximately 2 acres of access road would be graded and compacted prior to construction activity start, including at the existing Access Roads 1, 2, 3, and 4 (Figure 3-1). Access Roads 1 and 2 are located in the existing Freeman Diversion operational area. Access Road 3 extends from the southwest corner of the existing operational area to an earthen ramp and proceeds north along the river channel to an area immediately downstream of the diversion. Access Road 3 provides access to the river channel below the Freeman Diversion. Access Road 4 provides access to the area directly above the Freeman Diversion, extending northeast from the northeast edge of the existing operational area and curving north to a ramp providing access down to the river channel.

Fill material to eliminate an S-turn on Access Road 1 and for temporary crossing protection at two crossing locations on Access Road 2 would be installed using dump trucks, front-end loaders, rollers, and hand-operated equipment for soil compaction. Fill material for temporary crossing protection would be excavated from a borrow area located immediately east of United's existing Saticoy facility using an excavator. The total footprint for the fill material would be approximately 0.16 acre (2,610 cubic yards) in the footprint of existing access roads.

Upon project completion, approximately 1,600 cubic yards of base rock and gravel would be installed along access roads to help decrease the frequency and extent of future maintenance activity requirements.

To the extent possible, temporary access areas would be established within the river channel both above and below the Freeman Diversion to allow heavy equipment to access the dam and bypass channel structures. This may only be possible when flows are reduced or nonexistent. A Construction and Staging Access Area would be established above the diversion with a temporary connecting earthen ramp to Access Road 4. A second Construction and Staging Area would be established below the diversion and connected to Access Road 3. The temporary access areas would be cleared of vegetation, graded, and compacted prior to the start of construction. Equipment and materials may be staged within the in-channel access areas overnight during the construction of the crest gates and fish passage structure, and appropriate spill prevention and containment measures would be implemented in accordance with the project's SWPPP. Heavy equipment would not be stored overnight within the in-channel temporary access areas but rather at the out of channel staging areas displayed on Figure 3-1. Temporary parking would be established within the out of channel staging areas or the existing operational area for personnel, vehicle, and equipment access and material staging. Staging areas and the temporary parking area would be graded and compacted prior to the start of construction. The parking area would have approximately 20 cubic yards of gravel installed to avoid track-out from vehicles. Equipment utilized to prepare the access and staging areas would include graders, front loaders, bulldozers, dump trucks, and water trucks. Access and staging preparation activities would occur over a period of approximately 2 weeks.

Construction traffic would be cyclical with an estimated standard baseline of 30 roundtrips per day. These round trips would consist of delivery trucks (flatbed and semi), passenger cars, and pickup trucks. When excavation takes place, there may be up to 80 additional roundtrips above the standard baseline per day by a semi-truck and trailer. On days when concrete is poured, there may be an additional 40 roundtrips per day above the standard baseline consisting of concrete trucks, concrete pumpers, and work trucks.

Demolition of Existing Facilities

Demolition would occur within the footprints of the existing fish ladder structure, the diversion canal from the inlet to just downstream of the head gates, the AWS, and the associated channels. Demolition would consist of removing 950 cubic yards of cast-in-place concrete; roughly 550 cubic yards of roller compacted concrete at the existing diversion and upland canal structure, including the fish screens; approximately 200 linear feet of 30-inch high-density polyethylene pipe; and approximately 45 linear feet of 54-inch concrete pipe. Equipment used to conduct demolition activities would include track mounted rock drill, excavator with buckets and hydraulic breaker attachments (hoe rams), concrete cutters and possibly wire saws. Demolition is expected to be completed within dewatered areas in phases and would take approximately 8 weeks (non-consecutive). The concrete generated from demolition would be recycled on site. The steel within the concrete would be removed and recycled off site.

Excavation and Grading

Once demolition activities are complete, areas within the existing facility footprint would be excavated and/or graded to prepare the site for installation of the new facility components. Excavation and grading activities would consist of the following:

- Remove approximately 1,112 cubic yards (approximately 100 feet by 70 feet by 4 feet) of existing rip rap downstream of the diversion and store for replacement of rip rap once fish passage renovation is complete
- Excavate approximately 500 cubic yards (approximately 100 feet wide by 17 feet long by 8 feet deep) upstream of the grade control structure within the river channel for installation of a new crest gate
- Excavate approximately 14,311 cubic yards (approximately 350 feet by 140 feet by an average 7 feet) in the existing fish passage facility footprint for installation of new fish passage facility components
- Remove approximately 2,658 cubic yards (approximately 150 feet by 150 feet by an average of 3 feet) of river sediment as excavation and backfill for the fish ladder facility
- Grade approximately 512 square yards (approximately 60 feet by 75 feet) and install 256 cubic yards crushed rock in the existing fish passage facility footprint to prepare slab-on-grade foundation for bypass channel modifications and lower ladder and entrance pool constructed on existing roller compacted concrete (RCC) fill
- Excavate approximately 18,610 cubic yards in the existing operational area footprint for AWS and diversion canal modifications
- Excavate approximately 3,600 cubic yards (approximately 16 feet wide by 1,100 feet long by 8 feet deep) of river sediment immediately downstream of the grade control structure face to facilitate resurfacing; following completion of the resurfacing of the grade control structure downstream face, the excavated river sediment would be replaced.

Equipment used for excavation and grading would include excavators, graders, crane, front loaders, dump trucks, and water trucks. Excavation and grading activities are expected to occur over the 8-week demolition period. The excavated material would be sorted and reused with the excess being stockpiled on site. Excess material would be placed in staging area(s) and uniformly distributed.

Fish Passage and Diversion Facility Construction

CREST GATES

The crest gates would be installed adjacent to the current bypass channel. They are designed to facilitate operation of the fish ladder, the canal fish screens, and AWS system by maintaining a constant water level in the forebay and allowing more precise control of the forebay compared to the current facility. The crest gates would also concentrate initial spill over the diversion crest, maintaining a narrower downstream channel compared to the current facility. The narrower downstream channel would improve attraction to the vertical slot fish ladder compared to the current Denil fish ladder by providing less area where fish could stray away from the entrance gate and become distracted. Construction of the new crest gate would consist of the following activities:

- Notching the grade control structure approximately 10 feet deep by 73 feet long adjacent to the bypass channel, removing 336 cubic yards of existing concrete using saws, wire saw, excavator with bucket and hydraulic pavement breaker attachments, pneumatic jackhammers, concrete drills and possibly expansive grout to break concrete blocks;
- Placing a reinforced concrete foundation and sidewalls in the notch using a cement mixer to seal the exposed RCC and provide a foundation for the crest gates, requiring importation and installation of 94 cubic yards of new concrete;
- Embedding plates in the concrete side walls using a crane to provide a smooth surface for the sides of the crest gate to seal against;
- Mounting an 8-foot high by 70-foot long Obermeyer gate on the new reinforced concrete floor using a crane;
- Extending the sidewall on the north side of the crest gates down the face of the diversion to isolate the spill from the crest gates from the north fish entrance for flows up to the 100-year flow using a cement mixer truck, concrete pumper truck, and hand tools;
- Filling the downstream face of the dam below the crest gates to accommodate the new fish transport tunnel requiring installation of 243 cubic yards of slab-on-grade concrete using a cement mixer truck, backhoe, hand tools, pneumatic jack hammers, high pressure water jet, runoff water containments and treatment equipment;
- Reconfiguring the stilling basin downstream of the crest gate to provide a velocity barrier to upstream migrant covered aquatic species using a cement mixer truck, concrete pumper truck, and hand tools; and,
- Installing a new platform (284 square feet) using a crane over the bypass channel to support the Compressor Building, which would contain the compressor and other equipment required for the operation of the Obermeyer gates.

Equipment used to construct the new crest gate and install the associated infrastructure as described above would access the diversion from the construction and staging area depicted on Figure 3-1. Crest gate construction would occur over a cumulative period of 8 weeks.

BYPASS CHANNEL

The existing bypass channel is located between the south end of the dam crest and the fish ladder intake and consists of, from upstream to downstream, an approach channel, a roller gate, and a chute section. While the approach channel and roller gate would not be changed as part of the facility renovation, the chute slab from the roller gate to the end of the present chute would be modified to accommodate the new fish transport tunnel. The chute slab is also subject to scour and wear from the high sediment levels of the Santa Clara River, and requires replacement approximately once every 10 years. The current chute slab would be removed and at a higher elevation and with a vertical curve. The existing slope of the approach channel would also be extended over the new fish transport tunnel, over which the slope would be slightly steeper (34 percent slope).

To construct the new chute slab, approximately 270 cubic yards of concrete would be poured as slab-on-grade between the roller gate and the existing horizontal apron. The equipment used to construct the new bypass channel chute slab would consist of a cement mixer truck, concrete pumper truck, and hand tools. Chute slab construction would occur over a period of approximately 10 days.

ENTRANCE POOLS AND TRANSPORT TUNNEL

As described above, two new entrance pools would be constructed to maximize the ability of upstream migrants to enter the fish ladder without delay. One pool would be constructed directly north of the crest gate and the other directly south near the bypass channel, where the existing entrance pool is located. The two entrances would be connected by a transport tunnel located under the crest gate spillway and the bypass channel. The north entrance pool would be 20 feet wide (north to south) by 20 feet long (east to west). The pool would consist of vertical reinforced concrete walls on the north, south, and west sides and the north and west walls would each contain a 6-foot high by 5-foot wide entrance gate. The east side of the entrance pool would be the existing diversion spillway and the south side of the entrance pool would be the transport tunnel entrance. To facilitate personnel access, a 6-foot wide truss bridge with maintenance platforms would be installed over the bypass channel and crest gate.

The transport tunnel would connect the south end of the north entrance pool to the east end of the south entrance pool. The tunnel would be 13 feet wide, 11 feet high, and 88 feet long. Lighting additional to ambient light from the north and south ends of the tunnel would be installed inside the completed tunnel.

The south entrance pool would be 120 feet long and have a varying width between 8 feet at the ladder entrance to 30 feet at its widest point. The south entrance pool would have two entrances on the north wall and two on the west wall directed downstream. The entrance openings would be 5 feet wide by 6 feet high. Flush bottom sluice gates would be mounted on the inside of the openings for increased control of the attraction flow velocities at the entrances. The southeast wall of the entrance pool would contain a 120-foot long diffuser rack to slow water velocities entering the pool from the AWS.

Construction of the entrance pools would require approximately 270 cubic yards of slab-on-grade concrete for the foundation of the pools, and roughly 1,424 cubic yards of concrete for the pool walls. The transport channel would consist of 45 cubic yards of concrete. The equipment used to construct the new entrance pools and transport tunnel would consist of concrete trucks, concrete pumper truck, and hand tools. Entrance pool and transport tunnel construction would occur over a period of approximately 8 weeks.

VERTICAL SLOT FISH LADDER

The new vertical slot fish ladder is expected to provide upstream passage of all aquatic species from the entrance pools to the Santa Clara River upstream of the Freeman diversion. The ladder would consist of

23 “steps” and 22 pools with an overall drop of 23 feet across the entire ladder under normal low flow conditions. Each ladder “step” would have a 1-foot drop, except the upper two. Each pool would have inside dimensions of 8 feet by 10 feet, with slots on the upstream and downstream corners. The pools would terminate in an upstream three-foot wide transport channel, which would lead to an exit gate and upstream trash rack. The exit gate would be a 3-feet wide by 6-feet tall flush-bottom sluice gate.

Construction of the vertical slot fish ladder, transport channel, and exit gate would require installation of approximately 165 cubic yards of slab-on-grade concrete. The walls for these components would be constructed from 1,142 cubic yards of concrete. Equipment used to construct the new vertical slot fish ladder, transport channel, and exit gate would consist of concrete trucks, concrete pumper truck, and hand tools. Construction would occur over a period of approximately 6 months.

Lamprey-specific passage would be constructed within the fishway structure and would follow a path over the diversion on the south side of the fish ladder construction. The lamprey passage would not affect the footprint of the fish passage. A description of the lamprey passage is included in the discussion of the conservation strategy (Chapter 5).

AUXILIARY WATER SYSTEM AND DIVERSION CANAL

A new AWS and diversion canal would be constructed as part of the facility renovation activities within the footprint of the existing operational area. Construction of the new AWS and diversion canal would consist of the following activities:

- Widening the canal inlet
- Installing a new trash rack and trash rack opening
- Installing new canal gates (9-foot wide by 8-foot high) upstream of the screening canals
- Constructing a new approach channel (27 feet wide), screening canals (approximately 27 feet by 200 feet), AWS pipe (9 feet diameter), and AWS stilling basin (12 feet by 180 feet)
- Constructing a 24-inch diameter fish bypass pipe and fish return pipe system to pass downstream migrating fish from the screening canals to the downstream end of the diversion
- Constructing a fish trapping and evaluation station, with holding pools and upstream finishing screens, for monitoring
- Installing control gates to control flow through the screening canals, AWS, and diversion canal
- Installing primary and secondary fish screens and automated screen cleaning equipment leading into the fish bypass pipes to direct fish species downstream of the diversion
- Installing high-pressure pumps, floor jets, drains, and a flushing gate to control sediment around the primary and secondary fish screens

Cast-in-place concrete would be installed over much of the existing operational area once excavation activities have been completed. Approximately 2,402 cubic yards of concrete would be poured to construct the gate headwall, gate slab, walls, sill, pillars, gate walls, and floors of the screening canals, from the trash rack to the AWS and diversion canal headgates. Equipment used may include concrete trucks, concrete pumper truck, and hand tools.

Resurfacing the Downstream Face of the Freeman Diversion Grade Control Structure

The length of the downstream face of the diversion grade control structure would be resurfaced to improve downstream passage for covered fish species. Resurfacing of the grade control structure would consist of the following activities:

- Clearance of a 30-foot-wide access/work area both downstream and upstream of the existing diversion grade control structure. The resurfacing work would consist of the 1,100 linear feet north of the new crest gates. The portion of the grade control structure face within the crest gate work area would be resurfaced as part of that covered activity
- Excavation to the toe of the structure and creation of a 6-foot-wide flat work area in the bottom of the excavation to accommodate hand crews
- Installation of anchors and reinforcing steel into the face of the existing surface
- Application of concrete followed by mechanical or hand smoothing. Because of the uneven surface of the existing face, the depth of concrete would vary but would be a minimum of 6 inches.

The 30-foot-wide access/ work area would accommodate the excavation to the toe of the existing structure, placement of spoils immediately adjacent to the excavation, and vehicle access. It is anticipated that as the excavation is completed, the spoil area would be compacted and stabilized to the extent possible to allow for vehicle access, as needed. Vehicles and contractor crews would access the work area from either below (downstream) or above (upstream) the existing structure, dependent upon site conditions. Following completion of the resurfacing work, the excavated river sediment would be replaced. Equipment used to complete the resurfacing may include an excavator, concrete trucks, all-terrain forklift, portable air compressors, portable generators, pickup trucks and hand tools.

3.1.2 CONVEYANCE FACILITY IMPROVEMENTS

The Freeman Diversion headworks would be reconfigured during the renovation to accommodate an increase in diversion rate capacity from 375 cfs to 750. New construction would be necessary to accomplish increased diversions that are being considered (Figure 3-3). Currently United passes diverted water through approximately 2,500 feet of canal and pipeline with limited infrastructure or “pinch points” that provide a restrictive capacity of 375 cfs. Any such “pinch points” would require modification to allow for planned increases to 750 cfs instantaneous diversions. The conveyance facility improvements required to accommodate the higher flow are described below starting at the upstream end and moving downstream in the gravity fed conveyance system.

Headworks Pipes

The existing headworks pipes do not have the capacity to convey the increased design discharge of 750 cfs without causing extensive backwater conditions extending all the way upstream to the Freeman diversion inlet. The headworks pipes consist of a single 2,400-foot long 81-inch diameter pipe, and a parallel pipe combination with diameters of 60 and 48 inches at the upstream end, combining into a single 60-inch pipe approximately halfway to the outlet (three pipes at the inlet, two pipes at the outlet). Options for increasing the capacity of the headworks pipes include (1) installing an additional 96-inch diameter pipe, (2) replacing the existing pipes with a double 8-foot by 8-foot box culvert, or (3) replacing the existing pipes with an open channel 10-feet in depth, with a 10-foot wide bottom and 1.5:1 side slopes.

Desilting Basin

The existing desilting basin has been designed to handle peak flows of 375 cfs. Sediment deposits accumulate at the upstream end of the desilting basin, sometimes affecting hydraulic conditions at the desilting basin inlet and causing a backwater condition that extends up the headworks pipes. There currently are no means for isolating a portion of the desilting basin to allow local maintenance to occur, or for redirecting the inflow point to allow alternative distribution of the sediment deposits near the inlet. Modification or addition of inflow gates would enable the rotation of inflow points to the desilting basin, allowing for selection of the location of the initial deposition zone, and enabling partial desilting operations to occur concurrently with shut-down, drying, and maintenance of some portions of the basin.

The existing desilting basin inlet consists of a double box culvert beneath the access road, with two 6-foot by 8-foot gates on the upstream side. An additional box culvert cell and gate would be needed at the inlet and outlet of the existing desilting basin to increase capacities to 750 cfs. An additional gate would also be needed at the bypass channel outlet.

The addition of a similar (upgraded) structure immediately downstream of the existing inlet, or modification of the (upgraded) structure downstream of the road crossing, would enable flow to enter the basin at more than one location. The addition of gates and partitions within the existing desilting basin could be used to isolate individual bays for maintenance.

Downstream Conveyance Paths

Downstream of the existing desilting basin the existing conveyance path is maintained (and improved, where necessary), and an additional optional path is provided immediately downstream of the existing desilting basin, following a higher elevation, more direct path to the Ferro Basin. Additionally, the Rose Basin would be connected to Noble Basin 1 via a set of invert level pipes. All conveyance path improvements have been sized considering two design capacities (375 cfs and 750 cfs), and two resistance scenarios (earthen channel and concrete lined channel).

Bifurcation Structure

Located just downstream of the three-barrel culvert, this gated structure would include a culvert downstream of the gates to allow the new channel described immediately below to cross under the existing access road. The existing gates at the three-barrel culvert will also be used to control the bifurcated flow quantity.

New Channel along Saticoy, Noble, and Ferro Basins

A new channel, approximately 2 miles long, would be constructed along the north side of the Saticoy, Noble, and Ferro Basins, providing an additional, or higher capacity, connection between these facilities. Where the channel would parallel the Santa Clara River along the northern edge of the Ferro Basin, it would be located on the opposite side of the levee from the river but would be far enough from the river that no bank protection would be required. The channel would then cross the United access road via a new culvert. Downstream of this culvert the new channel would be constructed along the north side of the existing Saticoy basins.

New Los Angeles Avenue Crossing

A new crossing at Los Angeles Avenue would be constructed to connect the new channel from the Saticoy Basin side to the Noble Basin side. The crossing would consist of a concrete culvert under Los Angeles Avenue.

Vineyard Crossing

A crossing under Vineyard Avenue is proposed, connecting the new channel paralleling the perimeter of the Noble and Ferro basins.

Ferro Basin Improvements

Improvements to the Ferro Basin would include a new brim channel paralleling the eastern and northern perimeter, and new partitions with nominal flow though capacity. The new brim channel would require some fill of the existing side slopes. Outlet gates with pipes from the new channel (described above) bottom to the basin invert in each partition of the basin would be required.

3.2 OPERATIONS

Throughout the MSHCP, there are two different types of "operations" that are interrelated but discussed separately for the purposes of analyzing and identifying take of covered species. Facility operations include the action of opening and closing facility gates as well as directing and prioritizing water conveyance through various pathways of the facility. Water diversion and instream flow operations refer to the action of withdrawing water from the river (i.e., taking water into the diversion canal and downstream conveyance infrastructure) and/or keeping water in the river and bypassing the water downstream (i.e., not diverting the water). Instream flows are discussed in detail in Chapter 5 as part of the conservation program. Water diversion is a covered activity that is described in this chapter and discussed further in Chapter 5, because water diversions occur in opposition of instream flows (i.e., if water is bypassed for instream flows, it is not diverted and vice versa).

3.2.1 FACILITY OPERATIONS

The direction of water from the river into the diversion canal by opening the canal gates and passing water through the fish screens is a covered activity for which United seeks ITP coverage. The direction and priority of water through the components of the Freeman Diversion facility for the purpose of fish passage is described in CM 1.1.1 in Chapter 5 as part of the conservation program. The direction of water into the downstream fish trap in the evaluation station is discussed and ITP coverage is requested as part of the Monitoring Program (Section 3.5).

3.2.2 WATER DIVERSION OPERATIONS

United is permitted and licensed to divert a certain amount of water from the Santa Clara River at the Freeman Diversion (Table 3-2). Water diversions consist of capturing surface water flow from the Santa Clara River and diverting it into a channel conveyance system to be transported into delivery pipelines or recharge basins for storage and future extraction via groundwater pumping. Recharge and extraction compose United's conjunctive use projects, which were the subject of a screening assessment conducted by United (Appendix D). Following this assessment, it was determined that none of the conjunctive use projects require incidental take coverage under the ESA. However, United has determined that water diversion activities require incidental take coverage under the ESA; therefore, water diversion is discussed further below.

United's existing water rights and permits allow for diversion at the Freeman Diversion of up to 375 cubic feet per second (cfs) for groundwater recharge with up to 38 cfs for surface water deliveries at any given time and an annual maximum diversion limit of 144,000 acre-feet (AF). To maximize the potential for groundwater recharge, United has historically diverted as much water as possible, within the water right and permit limits, which include prescribed flows for steelhead. In more recent history, and under the MSHCP, a regime of restrictions on diversions and modified or increased bypass flows has been and may be implemented to provide more benefits to steelhead (which would also benefit Pacific lamprey).

As described in Appendix B, United has identified a 40 cfs critical diversion that would be needed after upstream migration releases have ceased and the Smolt Migration Protocol (see Chapter 5) is being implemented. The critical diversions are needed to maintain the surface water deliveries that combat water quality issues such as nitrate concentrations that threaten human health and safety in the disadvantaged communities of El Rio and they are also critically important for surface water deliveries that combat seawater intrusion in the Oxnard Plain. Compared to United’s current water rights (license and permit), fisheries-related limits on diversions at medium to low flows have resulted in significant yield loss for United and is preventing United from meeting its mission and purpose to protect the aquifers of the Oxnard Plain and combat water quality issues within its district boundary. Therefore, United will pursue an additional water right to increase both the maximum rate of diversion and the total annual volume of water that can be diverted. This would allow United to capture more water at the peak of storm flows when it would be less impactful to covered fish compared to the water rights operations that allow for much higher diversions at low flow. It would also allow United to divert and recharge more total water in wet years/regimes, again when it would be less impactful to covered fish, because there is much more fish passage opportunity during wet regimes. The extra water that is “banked” during wet regimes, would help offset the decrease in water that would have otherwise been available to divert at medium to low flows and during drought but for instream flow commitments to covered fish.

United would achieve this additional yield by diverting water up to a higher level of total suspended solids (TSS). United has estimated the current sustainable levels of TSS in diverted water to be around 2,580 mg/L. Through the expansion of the headworks capacity and the conveyance facility improvements discussed in section 3.1.2, United would aim to divert water up to approximately 4,000 mg/L on ascending limbs of the hydrograph and 7,000-10,000 mg/L on descending limbs of the hydrograph. Diversions during storm peaks would minimize effects to steelhead because there is more water in the river overall and/or would avoid effects to steelhead because at TSS above 2,000 mg/L adult steelhead are “very unlikely” to actively swim in an upstream direction (see Appendix E) in the Santa Clara River.

United seeks coverage for all proposed diversion activities consistent with the criteria for instream flows explained in Chapter 5. The diversion operations would occur for the duration of the permit term with “initial operations” occurring under United’s current license and permit and “future operations” occurring under United’s anticipated future water right changes (Table 3-2) anticipated by Year 10 of the ITPs.

Table 3-2 Freeman Diversion Permitted and Licensed Operations

Operations Component	Existing Operations Regulation		Total
	License 10173	Permit 18908	
Maximum diversion rate	375 cfs for groundwater storage and surface water deliveries combined with no individual limit over the combined limit	375 cfs with no more than 38 cfs to surface water	375 cfs
Total annual groundwater recharge volume	89,000 AF	30,000 AF	119,000 AF (cumulative between the permit and license)
Total annual surface water diversion volume	15,630 AF	10,000 AF	25,630 AF (cumulative between the permit and license)
Required instream flows	No	Yes; 40 cfs from February 15 through May 15 of each year, each time the flow upstream subsides to 415 cfs; bypassed through the fish ladder for 48 hours; bypassed water shall not exceed 500 ac-ft on a 10-year average	–

3.2.3 FREEMAN DIVERSION OPERATIONS ASSOCIATED WITH UPSTREAM RELEASES

Releases from Santa Felicia Dam (SFD) or Castaic Lake captured at the Freeman Diversion require activities similar to those employed under normal diversion operations. Each release varies in frequency, timing, and duration. Releases from SFD usually occur once a year and are driven by water levels in Lake Piru, water use demands on the Oxnard Plain, seawater intrusion, and water quality issues that affect human health and safety (e.g., high nitrate levels in the drinking water of El Rio). Releases from Castaic Lake are less common and predictable, but they can occur when United acquires extra imported water from the state water project. Typical releases from SFD occur between September and November; however, on occasion, upstream releases can occur in the summer and winter usually driven by water levels in Lake Piru and water quality issues that affect human health and safety.

Typical releases from SFD begin between September and October, depending on the rainfall year, with higher rainfall years resulting in earlier release start dates. Following United's FERC license, releases ramp up over several days to weeks, normally to 400 cfs. Flows percolate into the Fillmore-Piru groundwater basins first, resulting in approximately 75% of the water flow at 400 cfs reaching the Freeman Diversion. During SFD releases, sediment is mobilized and carried down to the Freeman Diversion, where the sediment settles out when the flow slows down. The settled sediment requires management in the form of sluicing through the bypass channel before the sediment overwhelms the headworks and comes into the diversion canal. Historically, sediment sluicing during SFD releases was preemptive and conducted weekly on a set schedule.

Under the proposed project, as SFD release flows are captured at the Freeman Diversion, similar sediment management activities would be necessary to maintain diversion and fish passage operations and infrastructure. Operational adjustments to the sediment sluicing activities would include the close monitoring of sediment accumulation, with sluicing events taking place only based on need and not on a set time schedule. Current estimates for sediment management predict that a sluicing event would be necessary every other week for a total of 2 hours; however, the Santa Clara River is a highly variable system and the sediment mobilized during a particular release may require more or less frequent sluicing events. In a rainfall year producing precipitation totals well above average, when groundwater mounding is occurring downstream of the Freeman Diversion, the sediment management needs are anticipated to require more frequent sluicing events that are shorter in duration. The goal of the shorter duration sediment sluicing, in addition to maintaining operational capacity, would be for the bypassed sediment and water to never connect with the estuary and CMs described in Chapter 5 would be implemented to avoid and minimize potential effects to covered species. However, unanticipated connection to the estuary is discussed in Chapter 8 under changed circumstances. United is exploring alternate sediment management methods (e.g., selective dredging), and if determined to be effective and protective of covered species, would potentially implement in conjunction with, or as an alternate to, sluicing events.

Under the proposed project, typical releases from SFD are anticipated to take place annually, beginning between September and October. Releases are anticipated to take place 3 out of 15 years in the summer period, primarily in response to human health needs (e.g., elevated nitrate levels in El Rio). In addition, releases are anticipated to take place 3 out of 15 years in the winter period, primarily to maximize the efficiency of the release due to saturated conditions in groundwater basins upstream of the Freeman Diversion (i.e., minimize loss due to percolation). SFD releases also occur following spill events at Lake Piru to maintain capacity for future inflows. Historically, spill events have occurred at Lake Piru once every 7 years on average.

3.2.4 USE OF PERMIT AREA ROADS AND ACCESS POINTS

During daily operations, United employees and contractors would use existing access roads for driving vehicles and heavy equipment to the river and diversion facility for operation, maintenance, and repair activities. Access roads include existing established roads adjacent to the recharge basins and desilting basin; roads between the Saticoy yard and the Freeman Diversion; and roads adjacent to levees, the Freeman Diversion, and the Santa Clara River.

3.2.5 CAPTURE AND RELOCATION OF DOWNSTREAM MOVING STEELHEAD AS A RESULT OF DIVERSION OPERATIONS

Data collected to date show that when flows decline to less than 80 cfs downstream of the critical reach, functional migratory connectivity from the Freeman Diversion to the estuary is lost for downstream migrating steelhead. Therefore, if the connection to the estuary is anticipated to be less than 80 cfs downstream of the critical riffle within five days, then the instream flows through the system would be routed through screened pathways to hold smolts, kelts, and macropthalmia at the diversion and/or to trap smolts, kelts, and macropthalmia for monitoring and relocation to better conditions. The capture and relocation of downstream moving steelhead and macropthalmia is anticipated to be necessary during normal seasonal diversion operations as well as during some conservation releases. Capture and relocation of downstream moving steelhead and macropthalmia when passage through the critical reach would have been possible but for United’s diversions (i.e., the critical diversions) are covered activities under the MSHCP. Capture and relocation of downstream moving steelhead and macrothalmia when passage through the critical reach would not have been possible even if the total river flows were bypassed downstream (see Booth 2020) is considered a conservation measure and an offset of impacts discussed in Chapters 5 and 7.

3.3 MAINTENANCE

The proposed maintenance activities consist of routine maintenance and non-routine repair work conducted on the Freeman Diversion facility and in the riverbed and along the banks of the Santa Clara River upstream and downstream of the diversion facility. The maintenance and repair needs of the existing diversion facility are not anticipated to differ significantly after the proposed fish passage facility renovation. Routine maintenance and repair are necessary for the continued operation of the Freeman Diversion. Covered maintenance activities would occur for the duration of the permit term and fall into two categories: (1) routine maintenance, which would have a regular and predictable schedule (e.g., quarterly or annually), and (2) repair work, which would be infrequent, occur as-needed, and is dependent on year-to-year conditions at the facility. Routine maintenance activities and their expected frequency include the following:

1. Dewatering and flow rerouting (annually)
2. Routine facility maintenance (annually)
3. Vegetation control at engineered structures, access roads, and right of way (quarterly to annually)
4. Use of permit area roads and access points (daily/weekly)
5. Access road grading, compaction, and fill (annually)

Infrequent repair activities include the following:

1. Facility repair and upgrade (buildings, canals, rip rap, bank stabilization structures, culverts, and drainages)
2. In-channel sediment and debris control

3.3.1 DEWATERING AND FLOW REROUTING

If flowing or standing water is present within a maintenance work site, dewatering and flow rerouting would be necessary to facilitate routine headworks facility maintenance and both routine and non-routine in-channel maintenance work (sediment and debris management, facility repair and upgrade, and in-channel sediment control). Routine diversion facility maintenance and in-channel maintenance work is primarily planned for the dry part of the year, therefore July 15 through November 14 is considered the "primary maintenance window" when little to no water is flowing in the Santa Clara River in most years. Activities needing to be conducted outside the primary maintenance window would be coordinated with and approved by the Services (Chapter 5, CM 2.1.1). Standing water is typically present within portions of the facility and immediately upstream and downstream of the facility, even during the summer months. While the location and extent of surface water present on-site at the time of work would dictate the need, scale (i.e., small footprint vs. maximum footprint), and precise location of dewatering and flow rerouting activities, the methods described below would generally be the same, regardless of scale or precise location. The extent of disturbance due to earthwork associated with dewatering activities is not expected to exceed the areas identified in Table 3-3 for any specific maintenance activity.

The frequency of dewatering and flow rerouting activities is conservatively estimated to be the same as the proposed frequency of routine diversion facility maintenance and/or in-channel maintenance activities, discussed in each activity's respective section and summarized in Table 3-4. This is conservative because depending on year-to-year conditions at the diversion, water may not be present during maintenance or repair work and dewatering or flow rerouting may not be required. Maintenance or repair work requiring dewatering and flow rerouting activities would be scheduled to overlap (i.e., bundled) to the maximum extent possible to minimize potential effects to sensitive resources.

The following CMs (detailed in Chapter 5) for covered aquatic species would be implemented prior to and during dewatering and flow rerouting activities:

- CM 2.1.1 Best Management Practices
- CM 2.1.2 Worker Environmental Awareness Training
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation
- CM 2.1.6 Biological Monitoring
- CM 2.2.1 Invasive Species Management
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events
- CM 2.3.2 Implement the Invasive Species Control Plan

Trained and qualified staff would be on site to ensure proper implementation of the above CMs, consistent with Chapter 5 (specifically, CM 2.1.4 and CM 2.1.6), within all dewatered areas.

Table 3-3 Potential Earthwork Associated with Maintenance Activities

Activity	Expected Footprint (acres)	Impact Type
Downstream Dewatering		
Downstream drainage channel	0.04	Temporary
Upstream or Downstream Flow Rerouting		
Borrow site	0.34	Temporary
Temporary coffer dam	0.03	Temporary
Rip Rap or Bank Stabilization		
Borrow site (also utilized for flow rerouting; not additive)	0.34	Temporary
Work area	0.34	Temporary
Additional access	0.02	Temporary
In-channel Sediment Control		
Upstream	1.4	Temporary
Downstream	0.08	Temporary

Table 3-4 Dewatering and Flow Rerouting Frequency

Maintenance or Repair Activity	Dewatering or Flow Rerouting	Frequency
Routine Facility Maintenance	Upstream & downstream dewatering	Once annually
Vegetation Control	None	Never
Use of Permit Area Roads and Access Points	None	Never
Facility Repair and Upgrade	Upstream and/or downstream dewatering; flow rerouting	Three times per 10 years
In-Channel Sediment Control (upstream)	Upstream dewatering; flow rerouting	Five times per 10 years
In-Channel Sediment Control (downstream)	Downstream dewatering; flow rerouting	Three times per 10 years

Downstream Dewatering

In recent years, a pool downstream of the diversion facility has developed and persisted year-round. The general characteristics of this pool are not expected to significantly change following renovation of the facility. This pool ranges in size from approximately 0.4 to 0.7 acre (and was non-existent as recently as

2009). The size and location of this pool are largely dependent upon sediment deposition and scour due to winter storms and facility operations. If work is required in areas inundated by this pool, partial isolation and/or dewatering may be required. The size of the area isolated and/or dewatered would be dependent upon the size and location of the pool and the maintenance needs at the time.

If standing water is present within the work area, dewatering would be conducted by pumping water out of the work site or excavating a small drainage channel and allowing water to flow downstream and out of the work site. Excavation area for the drainage channel is not expected to exceed 400 feet by 4 feet by 3 feet deep (0.04 acre; Table 3-3). Equipment used to excavate the drainage channel may include an excavator, bulldozer, dump truck, front-end loader, and skid steer. A temporary coffer dam (e.g., earthen berm or inflatable bladder dam) may also be constructed or installed to isolate the work site from portions of the pool to allow for partial dewatering. If pumping is required, then pump intakes would be screened according to current NOAA Fisheries and CDFW guidelines. The methods used to construct or install a temporary coffer dam for downstream dewatering would be similar to those described for flow rerouting, below.

Upstream Dewatering

United typically operates the Freeman Diversion by maintaining an impound within the facility and in the river channel immediately upstream. The specific facility components inundated by this impound would change with the proposed facility renovation; however, the general characteristics of the impound and its influences on operations and maintenance are not expected to differ significantly from the existing facility, with the exception of the addition of the crest gates. The installation and operation of the crest gates would promote scour immediately upstream of the gates and lower the riverbed elevation. This would result in a deeper (up to 8 feet) impound than the existing condition.

The impound would inundate the AWS fish screen bay, canal fish screen bay, head bay, bypass channel approach, and extend into the river channel adjacent to and upstream of the facility. The pool within the river channel (outside the facility footprint; forebay) can range in size from approximately 4 acres to non-existent. The size and location of the forebay is dependent upon preceding environmental conditions (rainfall and sediment transport) and operations. The size (in terms of surface extent) and location of the forebay is not expected to significantly change as a result of scour related to the crest gates.

The impound may be dewatered using a three-stage draw-down process. Not all draw-down stages are required for all maintenance activities, however the stages would be conducted in a series (i.e., stage one would be complete before beginning stage two; stage two would be complete before beginning stage three).

This first stage draw-down would dewater the AWS fish screen bay, canal fish screen bay, head bay, and most low-gradient lateral habitat of the forebay. The amount and extent of dewatered lateral habitat in the forebay would be dependent upon the characteristics of the forebay at the time. The first stage would target a draw-down rate of less than two inches per hour, through operation of United's headworks facilities. This stage would be conducted over the course of 1.5 to 2 days (dependent upon the water level in the head bay at the time). If flows are routed through the evaluation station with the trap engaged, then native fish and pond turtles would be rescued and relocated according to CM 2.1.4 or studied, measured, or tagged according to the monitoring program (Chapter 6) as appropriate. Non-native aquatic species would be removed.

Following the first stage draw-down, the head bay and fish screen bays are not expected to drain completely, but the impound would be reduced to an area confined within the footprint of the bypass channel approach (i.e., confined by vertical concrete walls) and immediately upstream of the crest gates.

The second stage draw-down would dewater the bypass channel. Water would be released under the roller gate and into the downstream pool. Prior to opening the roller gate, a block net would be installed downstream to prevent covered species from moving downstream and then subsequently stranded. This stage would be conducted over the course of approximately 1 hour. During this draw-down, the remaining impound would become divided into two sections separated by the wing wall (if this division was not already achieved at the end of stage one), one section confined within the bypass channel approach (to be dewatered during this phase) and one section immediately upstream of the crest gates (would remain wetted until the crest gates are lowered; stage three). If fish can be safely and effectively collected from the remaining wetted areas, they would be utilizing the most appropriate methods (e.g., seining, electrofishing) and any covered species detected would be rescued and relocated under CM 2.1.4. This draw-down would be conducted slowly over the course of approximately one hour, until the pool within the bypass approach channel is limited to an area immediately upstream of the roller gate. Once the pool is concentrated, the rate of release under the roller gate would be increased to promote transport of any aquatic species into the pool downstream.

The third stage would dewater the remaining impound upstream of the crest gates. The crest gates would be lowered slowly to gradually reduce the size of the pool upstream, over the course of 1 to 2 hours. Water would drain downstream over the top of the crest gates slowly, so aquatic species are not expected to be transported downstream during the gradual draw-down. Once water levels were low enough, fish would be collected from the pool (if possible to achieve in a safe and effective manner, using the most appropriate technique)any detected covered species would be rescued and relocated according to CM 2.1.4. The crest gates would ultimately be lowered completely, and the remaining pool drained. If the remaining pool does not drain completely, fish would be collected as outlined above and the residual water may be pumped downstream. CMs described in Chapter 5 would be implemented during all stages of dewatering to avoid potential effects to covered species. Specifically, CM 2.1.4 would be implemented in every dewatered area to rescue and relocate any aquatic species that may become stranded during dewatering.

Flow Rerouting

If, following dewatering, flowing water is present within the work area, flow rerouting may be conducted by establishing a temporary coffer dam. A temporary coffer dam may be established by installing material (e.g., inflatable bladder, sandbags, plywood, fence posts) or by using native streambed material (earthen berm) to establish a temporary obstruction to water flowing into the work site. The temporary coffer dam would either impound water upstream of the worksite or divert flow around the worksite. Impounded water would be pumped downstream or transported via gravity through a screened pipe, around the worksite. Screened pump intakes and screened pipes would meet current guidelines for screening by NMFS and CDFW. The temporary coffer dam would be located as close as possible to the work site and facility footprint to allow equipment access and minimize the amount of physical manipulation of the riverbed.

An earthen berm would be constructed using native material immediately adjacent to the project site or by excavating material from a nearby “borrow site.” Borrow sites would not be located in areas of standing or flowing water or in areas that could become inundated by flowing water during maintenance activities. The earthen berm may potentially require the use of materials such as concrete blocks, k-rails, sandbags, plywood, block netting, and corrugated plastic pipe. The dimensions of a temporary coffer dam are not expected to exceed a footprint of approximately 250 feet by 6 feet (0.03 acre). The dimensions of the borrow site are not expected to exceed 100 feet by 150 feet by 4 feet deep (0.34 acre; Table 3-3). Material excavated from the borrow site may also be used to stabilize and compact the work site or access route for equipment. Equipment used to build the earthen berm and/or borrow site may include an excavator, bulldozer, front-end loader, and skid steer, which would access the work area via existing access routes and/or utilizes United's 15-foot maintenance right of way (Figure 3-1). Flow rerouting is expected to be complete in 1 to 2 days, prior to commencing maintenance or repair work. After maintenance or repair work is completed, the work area would be recontoured to a condition that promotes appropriate interactions between surface flows and the facility, and the temporary coffer dam (if required) would be removed, restoring unimpeded flow.

3.3.2 ROUTINE FACILITY MAINTENANCE

Headworks Maintenance

Annual maintenance would continue to be required on specific facility structures and components associated with diversion and fish passage operations at the Freeman headworks (Figure 3-2). This routine maintenance is essential to ensure proper functioning of the facility and to remain in compliance with the bypass flows described in Section 3.2 and the conservation program in Chapter 5.

Routine headworks maintenance consists of gate maintenance, sediment removal, fish screen maintenance, and trash rack maintenance. Routine gate maintenance consists of exercising and lubricating the gates, calibrating actuators (setting full-open limits on upward and full-closed limits on downward movement), obtaining actuator motor output readings, checking the gate stems, and checking for wear on gate stem nuts. Gate actuators would be assessed and replaced as necessary. If these regular maintenance and calibration activities are not performed, improper calibration may result in damaged gate guides, gate stems, or gate nuts, and the gates may be rendered inoperable. Sediment removal within the headworks facilities may be necessary if sediment has accumulated (expected periodically in the head bay, fish screen bays and at the fish ladder entrance gates) to a point that it interferes with regular operations. Fish screen preventative and corrective maintenance consists of inspecting individual screen panels and brushes, replacing or repairing damaged panels or brushes, and cleaning accumulated debris from panels or brushes. Trash rack preventative and corrective maintenance consists of operation verification of the hydraulic system, structural maintenance (including cutting with a torch and welding), replacement of corroded components, and chain and car maintenance. Example equipment used during routine maintenance may include crane, backhoe, front loader, excavator, skid steer, dump truck, generator, jack hammer, air compressor, angle grinder, acetylene torch, impact drill, or welder.

Routine headworks maintenance activities would be conducted annually. The routine maintenance activities would occur only within the existing facility footprint where permanent infrastructure is already present and only after dewatering and flow rerouting had taken place as necessary to allow access to the necessary facility components. These routine maintenance activities, including a complete dewatering of the facility and forebay, have been conducted on an annual basis since 2016 and regularly (in most years) since the construction of the facility. All three phases of upstream dewatering and downstream dewatering are expected to be necessary on an annual basis to facilitate routine maintenance. Flow rerouting is not expected to be necessary to facilitate annual routine maintenance (though may be required for non-routine maintenance or repair activities). To decrease the extent and likelihood of need for dewatering or flow rerouting, headworks maintenance would be conducted during the summer months (July 15 through November 14) and would be scheduled to overlap with other in-channel maintenance activities to the greatest extent practicable.

Desilting Basin Maintenance

The desilting basin is operated as part of the groundwater recharge system. Diverted water is sometimes treated with a liquid polymer before it enters the desilting basin; this polymer helps aggregate suspended sediments to promote settling. The flow of water slows as it enters and travels through the desilting basin so that silt and other suspended solids have time to settle in the desilting basin and separate from the water column, prior to water continuing downstream through the diversion canal to recharge basins.

These suspended solids accumulate in the desilting basin rather than the recharge basins, where deposited fine sediments impair percolation capacity. Continuous sediment deposition in the desilting basin results in a loss of capacity and the desilting basin must be periodically cleared of accumulated sediment.

The removal of accumulated sediment is necessary to ensure that adequate capacity is available within the desilting basin for each subsequent diversion season. The sediment removal would initially involve the pumping of standing water within the desilting basin to draw down the water level and partially dry the exposed sediment. Typically, a 10,000 gallon per minute (gpm) (or less) trailer-mounted diesel pump is used to draw down the desilting basin, located near the desilting basin exit gates. Pumped water is discharged into United's conveyance canal infrastructure. This pump is usually operated from March 1 through July 1, but may be run at any time of year. Once sufficiently exposed, the accumulated sediment is removed with heavy equipment including excavators, scrapers, and dump trucks and moved to an upland receptor site(s) up to 1.4 miles away. The movement and placement of excavated material occurs on existing access roads and disturbed areas associated with past and on-going groundwater recharge operations.

Routine desilting basin maintenance would be conducted annually, consistent with current procedures. The work would take approximately six weeks to complete, typically conducted from late October through early December. On average, approximately 50,000 cubic yards of sediment is removed from the desilting basin annually, resulting in approximately 2,500 truck trips per year. Typically, heavy-duty dump trucks are used to haul the removed sediment. The initial and future operation scenarios are anticipated to result in no substantial differences in total sediment accumulation within the desilting basin and the estimate of 50,000 cubic yards of material removed annually is expected to continue through the permit term. The receptor site(s) provides adequate capacity for the desilting basin maintenance for the duration of the permit term.

The removal and placement of accumulated sediment is not anticipated to result in take of covered species; however, activities necessary to complete the maintenance including pumping of water and truck trips have the potential to result in take of covered species of birds. CMs described in Chapter 5 would be implemented to avoid potential effects to covered avian species as well as general nesting birds.

3.3.3 VEGETATION CONTROL

Vegetation control would be conducted along the right-of-way, access roads, and adjacent to all engineered structures in the riverbed, including the diversion crest, rip rap structures, access areas, levee walls, and bank stabilization structures. In accordance with Ventura County Fire Department standards,[2] United would additionally conduct vegetation control around all facilities/buildings, roads, culverts, drainages, and maintained open spaces in the permit area. This maintenance is necessary to prevent damage to critical infrastructure at the diversion facility, maintain unobstructed access to facility infrastructure, maintain visibility for inspection, and provide a firebreak to protect engineered structures and developed areas.

Vegetation control would be accomplished through herbicide application on a quarterly basis and manual removal involving hand tools and heavy equipment on an annual basis as needed. Herbicide application is generally targeted to control ruderal and emergent vegetation within control areas. Manual removal generally involved limbing, pruning, or complete removal of larger individual plants that encroach upon control areas. Examples of species expected to be subject to control activities are: European grasses (e.g., *Bromus madritensis, Bromus rubens, Stipa mileacea*), cocklebur (*Xanthium strumarium*), giant reed

[2] As of 2018, Ventura County Fire Department standards require maintenance of a 100-foot vegetation free zone around structures and a 10-foot zone around access roads. These standards may be subject to change. http://vcfd.org/fire-prevention/fire-hazard-reduction-program-fhrp

(*Arundo donax*), arboreal willows (*Salix lasiandra, Salix lasiolepis*), sandbar willow (*Salix exigua*), and mulefat (*Baccharis salicifolia*). The duration of vegetation control activities would be dependent upon the amount of recolonization that occurs in cleared areas. Each event is generally expected to be completed in three days or less. Existing access points and roads would be used for equipment access to vegetation control areas. Equipment may include a bulldozer, excavator, hand tools, and herbicide materials. Staging of heavy equipment would occur within the existing operational area. The precise impact area includes a 15-foot-wide area surrounding all engineered structures in the riverbed, including both sides of the diversion crest (1,175 linear feet), the toe of rip rap and desilting basin (5,170 linear feet), access areas, levee walls, and bank stabilization structures for an estimated disturbance area of approximately 2.59 acres. These areas have been routinely maintained using similar vegetation control measures under prior authorizations since 2004. No new areas for vegetation removal are proposed; only existing cleared areas would be maintained as clear. Some additional emergent vegetation may be removed associated with the sediment control activities described in Section 3.3.6 below (not considered routine vegetation control). Vegetation control would only be conducted in areas where the channel is dry and would not include dewatering or flow rerouting. Conservation measures described in Chapter 5 would be implemented to avoid potential effects to covered avian species as well as general nesting birds.

3.3.4 ACCESS ROAD MAINTENANCE

Access Road maintenance would not differ from maintenance during construction. The maintenance work would include vegetation control (as detailed above) and road grading, recontouring, compaction, and fill to prevent erosion and ensure access to all structures at the Freeman Diversion facility. Road maintenance is expected to occur at least once annually and would take approximately three working days to complete. Graders, front-end loaders, dump trucks, and/or excavators would be used for access road maintenance. Staging areas for the work would be within the existing operational area near the entrance areas to the access routes and would not impact the river channel or adjacent vegetation. Conservation measures in Chapter 5 would be implemented to avoid potential effects to covered avian species as well as general nesting birds.

3.3.5 FACILITY REPAIR AND UPGRADE

Repair or upgrades of existing structures or facility components would be conducted when structures or facilities are found to be deficient (due to normal wear and tear or otherwise), damaged due to high flows, or when United staff identifies a more suitable alternative. Typically, damage due to normal wear and tear is repaired during routine maintenance activities. Some larger repair activities (e.g., facility component end-of-life replacement) and upgrades can be reasonably foreseen and scheduled. If work is required in areas with flowing or ponded water worksite preparation activities such as dewatering, flow rerouting, and earthmoving to provide access or a stable work pad may be required.

Large storm events may result in erosion and/or damage to in-channel structures and facilities, such as bank stabilization structures and access areas. The repairs that are anticipated to be required during the permit term in response to such damage are each detailed in the sub-sections below. Generally, repair and upgrade activities would vary based on the damage sustained, which would also determine if repairs need to be completed immediately or can be scheduled for later. Typically, rehabilitation and repair would be conducted in-kind (i.e. not extend beyond the original structure footprint) and involve preparing the work area, removing damaged or degraded material, importing the necessary amount of replacement material, conducting necessary repairs, compacting or re-grading the damaged area, and demobilizing/recontouring the work area. These activities would be conducted on an as-needed basis and may require the use of heavy equipment, depending on the extent and severity of damage sustained. Ponded or flowing water may be present in works areas, therefore flow rerouting, dewatering, and earthmoving (described in Section 3.3.1) may be required to prepare a suitable work site and provide equipment access. Facility repair and upgrade activities requiring some degree of dewatering or flow rerouting are anticipated to occur approximately three times over a 10-year period.

Facility repair and upgrade activities (both headworks repair and banks stabilization repair) themselves are not generally expected to result in adverse effects to sensitive resources. However, necessary work site preparation activities may have adverse effects to sensitive resources. Additionally, if facility repair activities are unavoidable during the bird nesting season, they may create noise and dust that could potentially result in adverse effects to sensitive terrestrial resources. Conservation measures described in Chapter 5 would be implemented to avoid potential effects to covered species, general nesting birds, and habitat.

Headworks Repair and Upgrades

Typically repair of Freeman headworks components subjected to damage from normal wear and tear is conducted during annual routine maintenance. Infrequently, larger repairs or upgrades are required when specific components are subject to storm related damage or have reached the end of their useable lifespan. End-of-life replacements are reasonably foreseen and associated work activities would be scheduled to occur during the dry season (July 15 through November 14). Examples of these activities are: (a) repair of the concrete floor of the bypass channel chute; and (b) replacement of the Obermeyer gates. The concrete floor of the bypass channel chute historically has required resurfacing and repair approximately once every ten years. Obermeyer gates have an operational lifespan of 25 years, after which time the bladder requires replacement. These activities cannot be conducted with any ponded or flowing water within the work site and may require dewatering and flow rerouting. Examples of equipment that may be required to conduct headworks repair and upgrade activities include bulldozers, excavators, front-loaders, dump trucks, skid steers, cranes, concrete trucks, concrete pump trucks, jack hammers, pressure washers, and sand blasters.

Canal, Culvert, and Drainage Repair and Upgrade

The diversion infrastructure downstream of the headworks and fish screens is located outside of the river channel in previously disturbed areas related to the on-going operation of the Freeman Diversion. Periodic repair and upgrade to this infrastructure including the canals, gates, pipelines are necessary to ensure that adequate capacity is maintained within the system and that it is functioning as designed. Repairs would be carried out after diversions have ceased and the areas have dewatered naturally, if possible. However, should the repairs be necessary when water is present, temporary dewatering may be necessary including the installation of a cofferdam and the pumping of water within the work area(s).

Although a rare occurrence, mudslides or landslide events can deposit material from the hillside into the diversion canal downstream of the headworks and fish screens. The amount of material that is deposited into the canal is variable; however, material cleanout is necessary to ensure proper function of the diversion. Cleanouts involve the excavation of the deposited material from the canal using an excavator and skid steer, placing material in a dump truck and removing the material to an appropriate receptor site, as describe above for the desilting basin maintenance activity. Should a mudslide or landslide occur during active diversions, the material may need to be discharged to the river through the waste gate immediately upstream of the floc building. Due to the location of the infrastructure downstream of the headworks and fish screens, covered fish would not be present. However, if these activities are unavoidable during the bird nesting season, they could create noise, dust, and potential for vehicle strike to covered birds, particularly least Bell's vireo, which has been observed nesting further off the river channel than the other species. Conservation measures described in Chapter 5 would be implemented to avoid potential effects to covered avian species as well as general nesting birds.

Rip Rap and Bank Stabilization Repair and Upgrade

Rip rap is used to stabilize levees and infrastructure along the banks of the Santa Clara River and is present at the Freeman headworks and intermittently downstream of the diversion structure to the desilting basin (Figure 3-4). Rip rap is a design component of engineered structures intended to provide flow dissipation and prevent erosion, scour, and undermining of facility structures. Neglected or improper maintenance of rip rap could lead to wall or levee failure that may result in facility failure, flooding, and public safety hazard. Rip rap repair would be conducted in-kind and on an as-needed basis. The extent of rip rap repair would be dependent on the degree of damage and may be necessary as either urgent response to extreme conditions (such as in 2005) which would be covered under emergency regulations, or non-urgent response which would be a covered maintenance activity in this MSHCP.

Except for the sections of rip rap located just downstream of and adjacent to the Freeman Diversion headworks (Figure 3-4), rip rap associated with the Freeman Diversion facility is located along the outer edges of the floodplain and not adjacent to the active channel. As an example of the kind of rip rap repair needed at the facility, the section adjacent to the Freeman Diversion headworks downstream of the diversion structure has been subject in the past to a slow loss of material and has been in need of repair as recently as 2019. The following discussion of this example rip rap repair work is representative of future foreseeable needs in this same section (which is the section subject to the greatest degree of disturbance), though if more significant damage is sustained during a winter storm more repair work may be required commensurate with the amount of damage sustained.

Repair to this rip rap section (in the vicinity of the Freeman Diversion headworks downstream of the diversion structure) would occur within a maximum 100-foot by 150-foot (0.34 acre) boundary (the repair site) with a 15-foot installation height, immediately downstream of the Freeman Diversion and within the river channel. Repair may involve importing 3 to 4-ton rip rap rock and necessitate the use of heavy equipment in the river channel. Equipment used in-channel at the repair site may include a crane, excavator, and front-end loader. Immediately downstream of the diversion facility, a “borrow site” would be established in-channel, from which materials would be excavated to build a stable work pad within the repair site to facilitate rip rap placement. Excavation dimensions for the borrow site would be a maximum of 100 feet by 150 feet by 4 feet (0.34 acre; same borrow site as under Section 3.3.1). Excavation equipment used in the borrow site may include an excavator, mini excavator, or bulldozer. Access would be provided by a downstream access road that utilizes United’s 15-foot maintenance right-of-way. In addition, a small temporary access area (15 feet by 50 feet, 0.02 acre) would be established between the repair site and the borrow site to accommodate the movement of equipment between the two sites. Staging would be within the existing operational area. After repairs are complete, the site would be recontoured to conditions that promote connectivity between surface flows and the facility.

Rip rap repair is anticipated to be required no more than three times in a ten-year period. Repair is planned for when the channel is dry, but if work must occur when flowing or standing water is present in the maintenance footprint, flow rerouting and/or dewatering would be conducted according to the methods described in Section 3.3.1. Conservation measures in Chapter 5 would be implemented to minimize potential effects of proposed rip rap repair to steelhead.

3.3.6 IN-CHANNEL SEDIMENT CONTROL

United’s ability to divert water and operate the fish passage structure at the Freeman Diversion are dependent on maintaining the thalweg of the Santa Clara River near the south bank of the facility. The streambed material of the Santa Clara River is highly mobile and storm events can result in substantial scour and/or deposition that directly affect the characteristics and location of surface flows both upstream and downstream of the Freeman Diversion facility. This redistribution of sediment may shift the thalweg of the river away from the facility and thereby eliminate or interfere with United’s ability to divert water or operate the fish passage structure. This scenario necessitates the use of equipment in-channel to redistribute and recontour sediment to ensure proper interactions between surface flows and the facility.

Examples of in-channel sediment control activities include excavation of accumulated sediment near the fish ladder entrance or exit gates, establishing a low-flow channel to or from the bypass channel, or grading to redistribute deposits that interfere with flows adjacent to the facility. Specific examples of needed sediment control from as recently as 2019 include the following:

a) A sand/gravel bar on the south bank upstream of the bypass channel approach. This bar shunted flow towards the north bank and away from the facility. Increasing development of this bar may have resulted in complete disconnection of the facility from the thalweg upstream. This was evidenced by the reduction in maximum capacity flows in 2019 through the bypass channel (typically capable of passing 3,000 cfs, 2019 winter maximum was limited to approximately 1,700 cfs).
b) A sand/gravel deposit between the wing wall and dam crest. This deposit interfered with flow over the diversion crest and therefore United's ability to accurately measure river discharge and provide bypass flows in compliance with the conservation measures in Chapter 5.
c) Several feet of sand accumulated at the fish ladder entrance gates. This leads to a disconnection between the north entrance gate and its actuating stem (i.e., inoperable and needs repair), burying it and rendering it inaccessible without dewatering and sediment excavation. The south gate became stuck in the open position and the orifice beneath the gate blocked with sand.

Sediment control activities upstream of the diversion are expected to be required approximately five times over a 10-year period. Sediment control activities downstream of the diversion are expected approximately three times over a 10-year period, except for excavation of the north fish ladder entrance gate, which may be required annually. Sediment control activities, both upstream and downstream would be conducted within the active riverbed, in areas that are regularly subjected to a natural cycle of disturbance (i.e., scour and deposition). Sediment control activities would not be conducted in areas with mature riparian vegetation; however, some recently recruited (early successional) vegetation may be cleared. The area disturbed due to any single sediment control event is not expected to exceed 0.08 acre downstream and 1.4 acres upstream for a maximum potential total of 1.48 acres of surface disturbance (4,710 cubic yards combined upstream and downstream excavation based on depth of 2 feet). The specific location of these disturbance areas would be dependent upon the conditions on-site at the time of the activity. Sediment control activities may involve the use of a grader, excavator, front-end loader, dump truck, bulldozer, or skid-steer loader within the channel.

These activities are planned to occur during the dry season, but if standing or flowing water is present in the channel, United would implement upstream or downstream flow rerouting and/or dewatering as described in Section 3.3.1. Conservation measures in Chapter 5 would be implemented to minimize potential effects of sediment control activities to covered aquatic species.

3.4 HABITAT RESTORATION AND ENHANCEMENT

In Chapter 5, United proposes habitat restoration work following temporary disturbances for construction activities to reestablish any disturbed riparian or riverine habitat.

3.5 OTHER CONSERVATION PROGRAM ACTIVITIES AND MONITORING

The Conservation Program (Chapter 5) and the associated monitoring and research activities (Chapter 6) are intended to promote and support the conservation of species, however there are activities under these programs that may affect covered species. Chapters 5 and 6 provide detailed descriptions of these activities, which generally encompass the following:

- Operating a downstream-migrant fish trap at the Freeman Diversion
- Conducting surveys for covered species
- Handling individuals
- Relocating/transporting individuals
- Measuring and documenting species condition during rescue and handling events
- Collecting samples from individuals (e.g., fin clip, scale, etc.)
- Marking and tagging individuals
- Removing non-native predators, competitors, and parasitic species
- Removing invasive plants

United would implement these activities as needed (and as described in Chapters 5 and 6) for the duration of the permit term.

3.6 ADAPTIVE MANAGEMENT MEASURES

Adaptive management measures are intended to provide adjustments in covered activities and conservation measures informed by future monitoring results. Adaptive Management is outlined in Chapter 6.

3.7 LITERATURE CITED

Amended Judgement dated December 1, 2018 in *Wishtoyo Foundation, et al. v. United Water Conservation District*, Central District of California Case No. 2:16-cv-03869-DOC-PLA (ECF No. 248).

Booth, Michael. 2020. Patterns and Potential Drivers of Steelhead Smolt Migration in Southern California. *North American Journal of Fisheries* Management. DOI: 10.1002/NAFM.10475

4 COVERED SPECIES

Covered species in this MSHCP are those intended to be listed in the ITPs issued under ESA and CESA. Under ESA, NMFS, and USFWS provide assurances under the "No Surprises" policy for species not currently listed but that have the potential to become listed in the life of the HCP. Under CESA there is no "no surprises" policy and CDFW will only issue an ITP for currently listed species. The *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* provides the following recommendation for selecting covered species:

> *The Services require applicants to include as HCP covered species all ESA-listed wildlife species for which incidental take is reasonably certain to occur, unless take is addressed through a separate ESA mechanism (e.g., Section 7 consultation with another Federal agency, separate incidental take permit, etc.), or to explain or demonstrate in the HCP why take is not anticipated or will be avoided during implementation of covered activities (e.g., inclusion of measures that will avoid potential for take) (USFWS and NMFS 2016).*

The HCP Handbook also suggests:

> *Species that may be ESA-listed during the permit term and are expected to be taken from proposed activities should be considered for inclusion as a covered species. Common species, or species that have very low likelihood of becoming ESA-listed, should not be covered by the HCP because every species included involves commitments of time and money by both the applicant and the Services.*

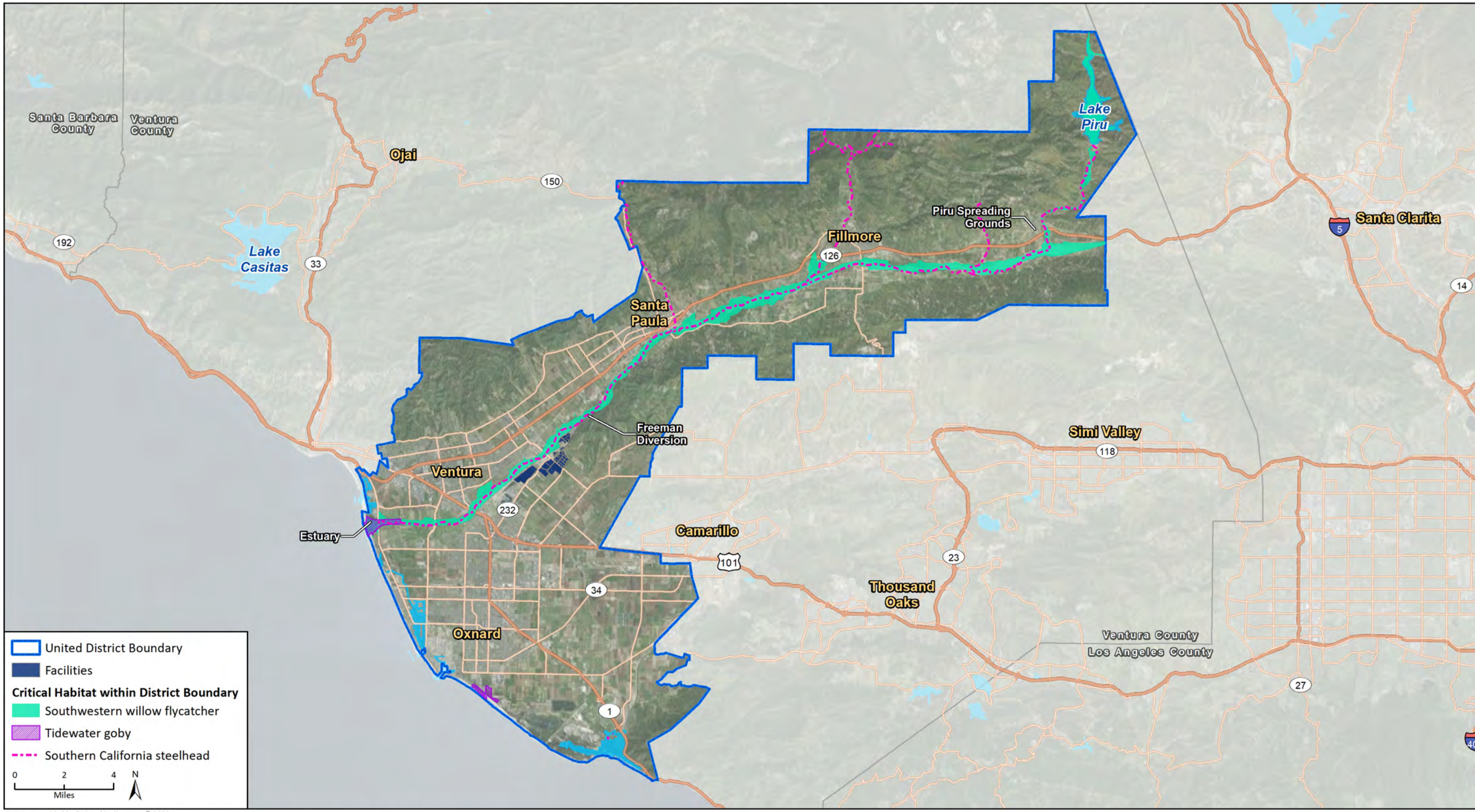
Based on this guidance, United has identified 7 taxa of special-status species or subspecies (distinct population segments) for coverage, of which four are federally endangered, one is federally threatened, and two have no current federal status (Table 4-1). Three of the covered species are listed as endangered by the State of California, two are considered Species of Special Concern, and two have no special state status. Despite the differing levels of taxonomic classification, all taxa considered for ITP coverage are described as "species" in this document to ease communication. Three of the identified species have designated critical habitat in the District boundary and MSHCP plan and permit areas: Southern California steelhead, southwestern willow flycatcher, and tidewater goby (Figure 4-1). A small portion of least Bell's vireo critical habitat falls in the District Boundary, but is not in the MSHCP plan or permit area. It is not necessarily the case that take of any given covered species currently occurs, but take could occur in the future due to activities such as facilities modifications and diversion/instream flow operations. Take could also occur if avoidance measures were not incorporated into the MSHCP.

Table 4-1 Covered Species

Species	Federal Status	State Status	Critical Habitat Designated
Fish			
Pacific lamprey (*Entosphenus tridentatus*)	None	SSC	No
Southern California steelhead (*Oncorhynchus mykiss*)	E	None	Yes
Tidewater goby (*Eucyclogobius newberryi*)	E	None	Yes
Reptiles			
Western pond turtle *(Actinemys marmorata)*	None	SSC	No
Birds			
Least Bell's vireo *(Vireo bellii pusillus)*	E	E	Yes, but not in plan or permit area
Southwestern willow flycatcher *(Empidonax traillii extimus)*	E	E	Yes
Yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	T	E	No

E = endangered, T = threatened, SSC = California Species of Special Concern

Figure 4-1 Designated Critical Habitat for Special-Status Species in the District Boundary



Imagery provided by Esri and its licensors © 2020.
Hydrological data provided by County of Ventura, 2016; Critical habitat data provided by U.S. Fish and Wildlife Service, 2018.

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4.1 SELECTION OF COVERED SPECIES

In selecting the 7 covered species, United used a screening assessment (Appendix A) that evaluated information from published literature, agency database records, local survey knowledge, and input from local experts, MSHCP stakeholders, and the MSHCP resources agencies. United has elected to cover species that could be affected by the covered activities (Chapter 3) defined in the MSHCP and that are either federally or state listed or considered sensitive with potential to be listed in the permit term.

4.2 DESCRIPTION OF COVERED SPECIES

4.2.1 PACIFIC LAMPREY (ENTOSPHENUS TRIDENTATUS)

Description

The Pacific lamprey is a jawless, anadromous fish native to the Pacific coasts of North America and Asia. The species has three developmental stages: larvae (*ammocoete*), juvenile (*macrophthalmia*), and adult. Larvae reside entirely in freshwater, before transforming into juveniles, which migrate to the ocean where they feed parasitically and grow into adults. Adults return to freshwater where they spawn and die.

Freeman Diversion

Larvae emerge from spawning gravels about 1 to 2 months after spawning, depending on water temperature, at a size of about 0.3 inch (8 millimeters) (Meeuwig et al. 2005, Brumo 2006). After emergence, they burrow into substrate within low velocity depositional habitats such as pools and backwaters with fine sediments and organic debris (Torgensen and Close 2004, Dawson et al. 2015). Larvae create burrows where they reside, occasionally shifting position in sediment or dispersing in the stream (Shirakawa et al. 2013). Larval lamprey can make-up a large portion of the benthic biomass and are an important component of the stream ecosystem (Dawson et al. 2015). In addition to processing nutrients, their burrowing and feeding behaviors can alter physical and geochemical properties of the streambed (Shirakawa et al. 2013).

Water temperature requirements for larval Pacific Lamprey have not been well described. Meeuwig et al. (2005) found a sharp decline in survival and increase in development abnormalities in embryos as temperature during development increased from 18ºC to 22ºC. However, larvae appear to tolerate higher temperatures than embryos. Four lamprey species from eastern North America were found to have incipient lethal water temperatures ranging from 28°C to 30.5°C after being acclimated at 15°C (Potter and Beamish 1975), but it is uncertain whether Pacific lampreys have a similar tolerance. Larval Pacific Lamprey are commonly found in locations with temperatures >24 ºC. For example, in the Red River, Idaho, Claire (2004) found larvae at temperatures up to 26.7°C, but reported that substrate temperatures averaged 2.2°C less than stream temperatures. Thus, it is likely that they can behaviorally thermoregulate through burrowing. Temperature requirements in southern California populations have not been studied and they may be more resilient than more northern populations.

Depending on growth rate, the larval phase lasts approximately 4 to 8 years, during which time individuals grow to about six inches (15 centimeters) (Dawson et al. 2015). Due to a long rearing stage and limited upstream dispersal capability larvae are thought to require perennial water over their entire freshwater lifecycle, however there is some evidence that they can survive intermittent streams in isolated pools or by burrowing into the hyporheic zone.

After reaching sufficient size, larval Pacific Lamprey transform into juveniles in late summer to fall (Dawson et al. 2015). During this metamorphosis, they develop eyes, a suctoral disc, sharp teeth, more-defined fins and counter-shaded coloration (with silvery sides) in preparation for migration to the ocean (McGree et al. 2008, Manzon et al. 2015). Typically, out-migration occurs at night in the winter and spring and is associated with high-flow events (Goodman et al. 2015). Timing migration with high-flow events has the benefit of providing turbid water for concealment and the potential to carry migrating juveniles rapidly to the ocean. Once they transform, juveniles generally do not initiate feeding until they enter saltwater (Manzon et al. 2015). During this time, they utilize body reserves for energy, shrinking somewhat in size. Out-migrants are usually about 5 inches (13 centimeters) in length (Goodman et al. 2015). Juvenile lampreys are slow swimmers compared to most fishes (Moursund et al. 2000, Dauble et al. 2006). Applegate (1950) observed that migrating sea lamprey (*Petromyzon marinus*) juveniles oriented upstream and drifted passively with the current, indicating that current velocity may be a good surrogate for out-migration rate. If out-migration rate is determined by current velocity, then the time it takes to reach the ocean would be reduced substantially by traveling at high stream-flow velocities during storm events (Goodman et al. 2015).

Once they reach the ocean, juvenile Pacific Lamprey begin to feed parasitically on fish and smooth-skinned marine mammals, attaching to their host and feeding on a combination of body fluids and flesh. Typically, larger hosts survive the feeding. Little is known about the marine phase, but lamprey appear to select hosts broadly (Beamish 1980, Orlov et al. 2009, Murauskas et al. 2013). Their distribution and movement in the ocean are largely unknown. Adults have been captured off the Revillagigedo Archipelago (18 degrees N) and as far south of any known freshwater populations (Renaud 2008). Adults have been caught often in Bering Sea trawls (63° N), although freshwater populations are not commonly found north of the Aleutian Mountains (Orlov et al. 2008). After 1 to 3 years, adults migrate into freshwater at a length of approximately 20 to 30 inches (50 to 80 centimeters) (average 24 inches [60 centimeters] for the Santa Clara River) (Chase 2001).

The specific oceanic behavior and distribution are not known for lamprey that ultimately enter the Santa Clara River. Selection of spawning rivers is poorly understood, but not based on natal origin, as with salmonids. Instead, lamprey are thought to enter rivers exhibiting suitable characteristics for spawning and rearing (Goodman et al. 2008, Waldman et al. 2008, Moser et al. 2015). Available information for anadromous lamprey, including Pacific lamprey, suggest that attraction to a given river is affected by proximity, flow volume, physical characteristics of the river plume, and possibly the presence of ammocoete pheromones (Moser and Close 2003, Vrieze et al. 2011, Meckley et al. 2014, Reid and Goodman 2016a). This results in considerable dispersion between basins that creates a regional meta-population structure without genetic isolation (Goodman et al. 2008, Spice et al. 2012).

Entry from the ocean and upstream migration depends on the river mouth being open and sufficient flow for passage upstream, two closely associated variables. Lamprey adults have adapted to these variables by responding rapidly and opportunistically to high-flow events that simultaneously breach estuary beach berms and support suitable passage conditions in upstream riverine reaches. This pattern of migration in response to increased flow events has been observed in the Santa Clara River (Chase 2001).

Adult Pacific Lamprey typically enter freshwater between January and May, with the peak migration into the Santa Clara River typically in May (Chase 2001). Recent research suggests that two distinct adult life history strategies, analogous to summer and winter steelhead, may occur in some river systems: one, an "ocean maturing" life history that likely spawns several weeks after entering fresh water, and two, a "stream-maturing" life history—the more commonly recognized life history strategy of spending one year in fresh water prior to spawning (Clemens et al. 2013, Parker 2018). The adult freshwater residence period for the stream maturing life history can be divided into three distinct stages: (1) initial migration from the ocean to holding areas, (2) pre-spawning holding, and (3) secondary migration to spawning sites (Robinson and Bayer 2005, Clemens et al. 2010, Starcevich et al. 2014).

Once adults enter freshwater, they stop feeding and primarily expend energy towards upstream migration and sexual maturation (Johnson et al. 2015). Overall, upriver migration distances can be extensive. For example, lampreys can travel hundreds of miles up the Columbia River into Idaho, or hundreds of miles to the headwaters of the Sacramento River (Evermann and Meek 1896, Goodman and Reid 2012, Moser et al. 2015, Reid and Goodman 2016b). Unlike most salmonids that can swim through or jump over high-velocity barriers, lamprey are specialized anguilliform swimmers, with high-efficiency but relatively low-speed swimming characteristics (Mesa et al. 2003, Reid and Goodman 2016b). Swimming lamprey are often challenged by structural features (e.g., waterfalls, dams, fish ladders) (Goodman and Reid 2017). When they encounter a physical barrier or higher velocity fields, lamprey may shift to a suctorial mode of movement, alternatively sucking onto the surface with their mouth and snapping forward or making very short swimming bursts (Reinhardt et al. 2008, Kemp et al. 2009, Keefer et al. 2010, Goodman and Reid 2017). Often, they travel along the shallow periphery or even out of the water over wetted surfaces of a feature. This allows them to climb substantial waterfalls, beyond the leaping or swimming ability of salmonids; however, simple angular edges or porous surfaces (grates) can block their passage. Consequently, lamprey are often blocked by artificial instream structures, but can pass natural barriers that block salmonids, extending their distribution further upstream if suitable, low-gradient habitat exists in higher reaches (Goodman and Reid 2012, Reid and Goodman 2016a).

The initial upstream adult migration typically ceases in the summer when individuals seek out over-summer holding habitat, consisting of large cobble or boulder substrates, bedrock crevices, large wood and root masses, undercut banks structure and root masses or man-made structures such as bridge abutments (Robinson and Bayer 2005, Gunckel et al. 2009, Lampman 2011).

Spawning in the Santa Clara River was reported to occur from late January through April (Chase 2001), but generally starts later and continues until June in more northerly populations (Brumo et al. 2009, Gunckel et al. 2009). Spawning generally takes place at daily mean water temperatures from 10–18°C (50–64°F), with peak spawning around 14–15°C (57–59°F) (Stone 2006, Brumo 2006). Spawning lampreys build redds that are approximately 20 inches (50 centimeters) in diameter. Redds are typically constructed by both males and females in gravel and cobble substrates within pool and run tailouts and low gradient riffles(Pletcher 1963, Kan 1975, Stone 2006, Brumo et al. 2009, Gunckel et al. 2009). A single female can lay from 30,000 to 250,000 eggs (Kan 1975, Wydoski and Whitney 2003). Adults senesce and die after spawning and their carcasses are an important source of marine derived nutrients for aquatic ecosystems (Kan 1975, Beamish 1980, Johnson et al. 2015).

Habitat Characteristics and Use

The natural distribution of Pacific Lamprey in California includes most streams with suitable habitat and anadromous access, although they generally do not occupy the coastal drainages less than approximately 20 square miles (50 square kilometers), even when suitable habitat is available (Swift and Howard 2009, Goodman and Reid 2012 and 2017, Reid and Goodman 2016a). The primary factors controlling distribution of adult lamprey are anadromous access, suitable over-summering habitat, and suitable spawning habitat. The principal habitat suitability characteristics for larvae are the presence of perennial water, suitable oxygenated fine sediments (sands and silts), and water temperatures generally below 72 °F (22 °C).

Status and Distribution

The Pacific Lamprey population has decline considerably and its geographic distribution has been reduced compared with historical levels, particularly in southern portions of its range (Moser and Close

2003, Nawa 2003, Moyle et al. 2009, Luzier et al. 2011, Reid and Goodman 2016a). In 2003, 11 conservation groups formally petitioned the USFWS to list Pacific lamprey under ESA (Nawa et al. 2003). The petition indicated a likely decline in abundance and distribution of lamprey in some portions of its range and the existence of both long-term and proximate threats. However, the petition did not provide sufficient information regarding how the petitioned range (California, Oregon, Idaho, and Washington) or any subcomponent qualified as a listable entity under FESA. Therefore, the USFWS determined that listing lamprey was not warranted at that time (USFWS 2004, 69 Federal Register [FR] 77158). Nevertheless, the USFWS did recognize the declining status of lamprey throughout much of its range along the west coast of the United States.

To address the conservation needs of the species, the USFWS established the Pacific Lamprey Conservation Initiative (PLCI) (Luzier et al. 2011, Goodman and Reid 2012). The USFWS plans to improve the status of lamprey by proactively engaging in a concerted, collaborative conservation effort that will facilitate opportunities to address threats, restore habitat, increase knowledge of lamprey, and improve their distribution and abundance. United has participated as a stakeholder since 2009, contributing to regional and local assessments as part of the conservation assessment process and providing information relevant to the status and biology of Pacific lamprey in the Santa Clara River and nearby basins (Goodman and Reid 2012, 2015, Reid 2015). The Pacific Lamprey is included as a covered species in the MSHCP because of the possibility of listing by the USFWS; the species is listed by the CDFW as a species of special concern (CDFW 2016a).

The natural freshwater range of lamprey extends from the Río Santo Domingo in Baja California north along the west coast to Alaska and south to Japan (Ruiz-Campos and Gonzalez-Guzman 1996, Renaud 2011), with marine records as far south as the Revillagigedo Archipelago (18° N), off Mexico (Renaud 2008). The Santa Clara River population has represented historically the largest documented population south of Point Conception (Chase 2001, Swift and Howard 2009). The only historical populations south of Point Conception in California that may have been of similar size are those in the Ventura River. The Ventura River has provided little habitat and offered only occasional observations of lamprey since the construction of the Casitas and Matilija dams. More southern streams (Santa Margarita and San Luis Rey) have supported scattered observations of lamprey since the 1940's (Swift and Howard 2009). Pacific lamprey have returned to the San Luis Obispo Creek and observations of spawning and successful recruitment occurred in 2017 and 2018, following modification of a passage barrier in the estuary (Reid and Goodman 2016a). One or 2 scattered adults have been observed in the Ventura, Santa Clara, and Santa Ana rivers (United unpubl. data, Krueger 2017, McLaughlin 2018, Reid and Goodman 2016a).

The status of southern California populations of lamprey is of considerable concern. Recent conservation assessments and surveys indicated functional loss of all populations south of San Luis Obispo, with only isolated larvae or juveniles found in two basins south of Point Conception (Santa Clara and Ventura) since 2001 (Swift and Howard 2009, Goodman and Reid 2012, Reid 2015, Reid and Goodman 2016a, Reid and Goodman unpublished data). It is unclear if this represents local (southern population) extirpations, a general northward range contraction, or a combination of the two. As of 2016, the Big Sur River in Monterey County was the southernmost stream known to be occupied by lamprey (Reid and Goodman 2016a). However, lamprey have returned to San Luis Obispo Creek, 100 miles (160 kilometers) south of Big Sur, with observations of spawning and successful recruitment in 2017 and 2018, following modification of a passage barrier in the estuary (Reid and Goodman, unpublished data). With the recent observations of few, dispersed adults in the Ventura (1 to 2 individuals) (McLaughlin 2018), Santa Clara (Booth 2017) and Santa Ana rivers (Krueger, Orange County Mosquito and Vector Control District, personal communication, 2017) (Reid and Goodman, unpublished data), the Santa Clara River should be considered within the current range of Pacific lamprey.

Threats to Pacific lamprey include:

- Obstruction of adult upstream passage by dams, diversions, and other restricted connectivity to the ocean
- Dewatering of stream channels through diversions, groundwater pumping and arid climate conditions
- Adverse water quality, especially due to high temperatures and eutrophication
- Risks associated with small population sizes, such as loss of genetic diversity, absence (or very low levels) of larval pheromones to attract migrating adults, and reduced encounter probabilities for spawning adults
- Urbanization
- Logging
- Mining
- Estuary modification

Oceanographic conditions and declining prey populations for ocean-phase adults may also be influencing population dynamics, but these are poorly understood at this time (Murauskas et al. 2013, Clemens et al. 2019).

Occurrence in Plan and Permit Areas

The natural distribution of lamprey appears to have included all larger drainages with suitable habitat and anadromous access in California (Swift and Howard 2009, Goodman and Reid 2012, 2015, 2017, Reid and Goodman 2016a). Therefore, all streams with perennial habitat in the Santa Clara River watershed can be considered potential fresh-water habitat for lamprey, with actual distribution and use subject to the constraints of suitable habitat and barriers to passage (Reid 2015). All historical records for lamprey in the Santa Clara drainage occur in the Freeman Diversion on the mainstem and Sespe Creek.

Based on recent lamprey surveys and habitat assessment (Reid 2015), the Sespe Creek mainstem and the perennial reach of the Santa Clara River near Santa Paula are the two principal areas for potential spawning and rearing in the Santa Clara Drainage. The remainder of the mainstem from the ocean to Sespe Creek acts as a seasonal migration corridor for both adults and out-migrating juveniles during times of adequate instream flow (Reid 2015). No lamprey are documented in the mainstem Santa Clara River upstream of the Freeman Diversion, in any tributaries of the Santa Clara River other than Sespe Creek, or in any tributaries of Sespe Creek itself (Reid 2015). There were no specific lamprey surveys conducted in these streams during the 1990's and before lamprey were known to be present in the drainage. There were also no observations or anecdotal accounts of lamprey (larvae, emigrating juveniles, or adults) in other fish surveys similar to those that encountered lamprey in Sespe Creek. Lamprey surveys were carried out throughout the Santa Clara River drainage downstream of Santa Felicia Dam in summer and fall 2014, including Santa Paula and Sespe creeks (Reid 2015). No lamprey were encountered. These surveys took place after a period of severe drought, and it is not clear if lamprey will return naturally once conditions improve and flows increase, or whether they have been permanently lost from the system.

Historical records in the mainstem Santa Clara River include extensive observations of migrating adults and downstream migrant juveniles and larvae at the Freeman Diversion (Villa and Palmer 1983, Puckett and Villa 1985, Chase 2001). In the 1990's, even with incomplete monitoring, as many as 908 upstream migrant adult lamprey were encountered in the Freeman Diversion fish ladder during a single season in 1994 (Chase 2001, Swift and Howard 2009). No lamprey have been documented in the mainstem Santa Clara River upstream of the Freeman Diversion, much of which has intermittent flow. Nevertheless, recent surveys have identified extensive suitable spawning and rearing habitat in a perennial reach that was not surveyed in the past, near the 12th Street Bridge in Santa Paula (Reid 2015). The most recent record of adults (45 individuals) in the Santa Clara River was at the Freeman Diversion fish ladder in 2001 (Swift and Howard 2009). The most recent observations include a large larva observed in lower Sespe Creek near Fillmore in 2004, an out-migrant juvenile caught and released at the Freeman Diversion in 2006 (Swift and Howard 2009), and a spawned out adult female detected in the fish screen bay in April 2017 (United Water unpublished data).

In lower Sespe Creek (Santa Clara confluence to Pine Canyon), spawned-out adults and out-migrant juveniles were seen near the mouth of the Sespe Canyon in 1975, as documented in the collections of the Natural History Museum of Los Angeles County (Natural History Museum 1975, Villa and Palmer 1983, Puckett and Villa 1985). There were also multiple observations of larvae near Fillmore through 2004 (Swift and Howard 2009). There is no record of lamprey in middle Sespe Creek (Hot Springs Creek downstream to Pine Creek), perhaps because survey access is difficult. However, a lamprey larva survey was conducted at the confluence of Tar Creek in August 2005, but no larvae were encountered (Reid 2015). In upper Sespe Creek (upstream of Hot Springs Creek, 2,300- to 3,300-foot [700- to 1,000-meter elevation), spawning adults have been documented near Beaver Campground (McCammon 1953) to within 1 mile (2 kilometers) of Lion Canyon (U.S. Forest Service 1979). Both adults and larvae are documented from Howard Creek to Bear Creek during the period from 1981 to 1991 (Natural History Museum 1981, Swift and Howard 2009). Prior to extensive surveys in 2014 (Reid 2015), surveys targeting lamprey larvae (using ABP-2 electro-fishing equipment) were conducted in selected sites from Lion Canyon upstream in 2004, 2005, 2011 and 2012, but no larvae were encountered (Reid and Goodman 2016a). No lamprey were detected in 2014 during a survey of the entire Sespe drainage (Reid 2015). The surveys also provided information on the distribution of suitable, perennial rearing habitat. Larvae occupy perennial reaches with fine substrates. They are relatively resident but do periodically swim up into the water column to reposition or move downstream. Larvae were documented as far downstream as the Freeman Diversion.

In the Santa Clara River, adults enter the system starting in the winter with the opening of the sandbar at the estuary and continue migrating into May or as long as the mouth remains open (Chase 2001). Initial arrival at Freeman was observed between 6 and 16 following breaching of the bar (1991-1997). They then move upstream and usually over-summer, spawning the following spring (McCammon 1953, Chase 2001). Spawning in Sespe Creek likely occurs from late January through April or May, based on observation of actual spawning and appearance of spawned out adults in lower Sespe Creek and downstream in the Santa Clara River (McCammon 1953, Puckett and Villa 1985, Chase 2001, United Water unpublished data). It has been suggested that some Santa Clara River lampreys may survive spawning, perhaps returning to the ocean. This is based on live, spawned-out individuals observed at the Freeman Diversion from 1994 to 1997 (Chase 2001). However, it is more probable that these were moribund post-spawned individuals and would not have survived re-entry to saltwater.

Out-migration of juveniles is associated generally with high-flow events (Goodman et al. 2015). In the Santa Clara River drainage, high-flow events can reach the ocean from November through May. Due to their association with punctuated rain events and high flows, this creates a broad possible out-migration window for lamprey, where out-migration is tied to availability of flow events (Goodman et al. 2015). The longest potential route from rearing habitat to the ocean in this system would be about 62 miles (100 kilometers) (near the Tule Creek and Sespe Creek confluence), well within the lamprey's capacity to travel in a few nights of high flow (Goodman et al. 2015, Reid 2015, Reid and Goodman 2016b).

4.2.2 SOUTHERN CALIFORNIA STEELHEAD (*ONCORHYNCHUS MYKISS*)

Description

Steelhead are the anadromous form of *O. mykiss*, spending part of their life in the ocean and part in fresh water. Coastal rainbow trout are the resident form of *O. mykiss* fish, spending their entire life in fresh water. Residents have the potential to seed downstream habitats with juveniles that exhibit the anadromous life-history trait, leading to a range of migratory behaviors. Therefore, for the purposes of this MSHCP, any *O. mykiss* with the potential for anadromy and access to the ocean is considered a "steelhead."

Aquarium of the Pacific

Juvenile steelhead are lightly to heavily spotted, with small black spots on a lighter background on the body and the dorsal, caudal, and adipose fins. Juvenile and larger freshwater resident fish have an iridescent red to pink stripe running lengthwise down each side. Anadromous fish lose the pink stripe and present an overall silvery appearance with a "steely" blue-gray color dorsally. Anadromous juvenile fish, called smolts, undergo a series of changes that allow for higher salinity tolerance and a more silvery appearance, which continues as they feed and grow in the ocean. Once an adult steelhead returns to freshwater to spawn, the silvery appearance slowly diminishes. The presence of an adipose fin also separates them from all other native freshwater fish in anadromous streams in coastal southern California (Moyle 2002).

Historically, *O. mykiss* were present in most coastal California streams, with various levels of crossover between the resident and anadromous forms. Both resident and anadromous forms occupied coastal rivers, and resident forms occupied isolated lakes and streams with no access to the ocean. Definitive records documenting the historic occurrence of steelhead in many of the smallest streams in this region do not exist, but it is assumed that many contained *O. mykiss*, when no natural barriers were present and conditions were favorable, particularly during wet years or wet periods of multiple years. Southern California steelhead still occupy between 37 and 43 percent of the coastal drainages they historically occupied in the geographic boundaries of the Southern California Steelhead Distinct Population Segment (DPS) (Good et al. 2005). Between 2000 and 2019, the anadromous form of *O. mykiss* has been recorded in the Santa Maria River, Santa Ynez River, Gaviota Creek, Arroyo Hondo, tributaries to Goleta Slough, Mission Creek, and Carpinteria Creek in Santa Barbara County; Ventura and Santa Clara rivers in Ventura County; Malibu and Topanga creeks in Los Angeles County; San Juan Creek in Orange County; and San Mateo Creek in San Diego County.

Threats to steelhead include restricted distribution, loss of significant portions of habitat range, deterioration of habitats, artificial barriers to upstream migration, modified river flows, and introduction of non-native species (Moyle 2002). Dams, surface-water diversions, and groundwater extraction driven by agricultural and urban development are thought to have had the most severe impact on steelhead populations in the region of the Santa Clara River Watershed (NMFS 2012).

Habitat Characteristics and Use

The ocean phase of adult steelhead is not well understood. Some steelhead appear to range broadly across the north Pacific, while others stay close to their natal streams (NMFS 2012). Steelhead do not appear to congregate in large schools in the ocean like other salmonids (NMFS 2012). Adults enter southern California coastal streams to spawn during or after periods of high flows resulting from winter rains. Steelhead spend 1 to 2 years in the ocean before returning to spawn for the first time in central and southern California streams (Shapovalov and Taft 1954).

Typically, steelhead migrate upstream when stream-flows rise during winter storm events (Moyle 2002) and after sandbars at the mouths of the rivers breach (Shapovalov and Taft 1954). Depending on rainfall, upstream migration and spawning occurs in winter and early spring, typically from January through March, in most southern California streams (Shapovalov 1944a, 1994b, NMFS 1996, United 2016b). Data from the Freeman Diversion, which has been collected each season since 1993 suggest that adult steelhead and smolts migrate through the Santa Clara River primarily between March and May; however, data are biased toward effort after January 1. Eighteen adults have been observed and documented at the Freeman Diversion and all adults, including kelts, were observed migrating in March and April between 1993 and 2020 (United 2016b; United unpublished data). Additionally, Fukushima and Lesh (1998) described the migration period for the Santa Clara River as beginning as early as November and extending through June based upon information provided by CDFW and NMFS biologists, but do not cite any specific empirical data to support their conclusions.

Unlike other anadromous Pacific salmonids that are semelparous, steelhead are iteroparous and may return to the ocean after spawning, then return to freshwater to spawn in subsequent years (Shapovalov and Taft 1954, Moyle 2002). In Waddell Creek, Shapovalov and Taft (1954) observed that kelts returned to sea almost immediately after spawning, while others were observed migrating downstream as late as December of the following season. However, most kelts were observed migrating downstream during April-June, which coincides with the end of the peak of upstream migration of adults, presumably following spawning.

Water must be approximately 7 inches (18 centimeters) deep or greater, with velocities below about 3 feet (1 meter) per second for larger adult fish to pass upstream. Vertical barriers must have pools below them with depths at least 1.5 times the barrier height to allow fish passage (Bjornn and Reiser 1991). Juvenile steelhead require cool, well-oxygenated water, typically under about 70 °F (21 °C) (Barnhart 1986). Steelhead can withstand warmer temperatures for short durations (Spina 2007) and are estimated to have a maximum thermal threshold of 88 °F (31 °C) (Sloat and Osterback 2013).

Steelhead spawn in gravel substrate at pool heads, tail-outs, or in riffles (Moyle 2002). Optimal size of gravel substrate ranges from 0.2 to 4 inches (0.6 to 10 centimeters) (Bjornn and Reiser 1991). A female will dig a pit in the gravel with her caudal fin and deposit her eggs. Often more than 1 male will then fertilize the eggs before the female covers the eggs with the same gravel, creating a redd (Moyle 2002).

During incubation, sufficient water must circulate through the redd to supply embryos with oxygen and remove waste products. Abundant fine sediments can interfere with this process and result in embryo mortality (Bjornn and Reiser 1991). Juvenile steelhead emerge from the gravel in approximately 5 to 8 weeks, generally between March and April, depending on water temperature and spawning time (Shapovalov and Taft 1954, Moyle 2002). In water temperatures around 60 °F (15.5 °C), steelhead can emerge from the gravel in as few as three weeks (Barnhart 1991).

After emergence, juvenile steelhead inhabit the slowest flowing shallow water at the stream margins and gradually move to deeper and faster water as they mature. Instream cover, such as cobbles, boulders, undercut banks, large and small woody material, and overhanging vegetation, is important for juvenile steelhead survival.

In freshwater, steelhead feed primarily on terrestrial and aquatic invertebrates. Mean prey size is typically less than 0.1 inch (0.5 centimeter), although diets also include small terrestrial mammals, crayfish, and fish (Merz 2002).

In California, juveniles generally spend 1 to 3 years in freshwater before migrating to the ocean as smolts during spring (Shapovalov and Taft 1954, Entrix 1996). Smolts have been observed at the Freeman

Diversion as early as January and as late as mid-July; however, most smolts arrive at the Freeman Diversion from March 15 through May 31, even if surface water connection to upstream tributaries occurs earlier suggesting that photoperiod is a significant driver for smolt downstream migration (Booth 2020). Booth (2020) also showed that smolts tend to stop active downstream movement when temperatures increase and presumably residualize to a freshwater rearing life history at least for that season or may mature in freshwater and not undergo migration to the ocean at all. Finally, Booth (2020) showed that many smolts arrive at the Freeman Diversion after functional connectivity between the Freeman Diversion and the estuary is no longer available even if total river flows were to be bypassed for instream flows.

In some watersheds, coastal lagoons can provide important rearing habitat for juvenile steelhead (Shapovalov and Taft 1954, Smith 1990, Bond 2006). Steelhead rearing in lagoons usually attain a larger size before entering the ocean than those rearing in streams, and larger juvenile steelhead have a greater likelihood of surviving and returning in subsequent years to spawn (Bond 2006). However, to what extent steelhead undergo lagoon rearing in the Santa Clara River is unknown and may be challenging given the hydrologic conditions (Booth 2020).

Status and Distribution

In 1997, NMFS listed Southern California steelhead (*O. mykiss*) as a federally endangered evolutionarily significant unit (ESU) (62 FR 43937). The ESU included populations from the Santa Maria River in southern San Luis Obispo County to Malibu Creek in Los Angeles County. In 2002, NMFS extended the southern boundary of the ESU to the California-Mexico Border (67 FR 21586). In 2005, NMFS designated final critical habitat (Figure 4-1) for the Southern California Steelhead ESU (70 FR 52488). In 2006 following a status review, NMFS replaced the ESU designation with a DPS designation (71 FR 834). The Southern California steelhead DPS encompasses all naturally spawned steelhead from the Santa Maria River (inclusive) to the U.S. border with Mexico. The DPS encompasses *O. mykiss* that exhibit anadromy below impassible barriers that block upstream migrating adults. NMFS issued a final recovery plan for the Southern California DPS in 2012 (NMFS 2012), and a five-year review summary and evaluation of the Southern California Coast Steelhead Distinct Population Segment in 2016 (NMFS 2016). The recovery plan identifies the Santa Clara River Watershed as critical for the survival and recovery of endangered steelhead. The recovery plan identifies two specific recovery actions regarding the Freeman Diversion in particular: (1) develop and implement operating criteria to ensure the pattern and magnitude of water releases from the diversion provide the essential habitat functions to support the life-history and habitat requirements of adult and juvenile steelhead, and (2) develop and implement plans to physically modify the diversion to allow natural rates of steelhead migration between the estuary and upstream habitats (NMFS 2012).

In its critical habitat designation, NMFS developed a list of PCEs (also referred to as physical or biological features [PBF]) (70 FR 52488). PBFs are considered essential for the conservation of steelhead. They involve those sites and habitat components that support one or more steelhead life stages and in turn contain physical or biological features essential to steelhead survival, growth, and reproduction, and the overall conservation of the DPS. These PBFs are the following:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development
2. Freshwater rearing sites with:
    a. Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility
    b. Water quality and forage supporting juvenile development

   c. Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks
3. Freshwater migration corridors free of obstruction and excessive predation, with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival
4. Estuarine areas free of obstruction and excessive predation with:
   a. Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater (smoltification)
   b. Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels
   c. Juvenile and adult forage, including aquatic invertebrates and fish, supporting growth and maturation

Occurrence in Plan and Permit Areas

Dagit et al. (2020) summarized existing monitoring programs and anecdotal observations from 1994–2018 for the Southern California steelhead DPS and reported 177 adult steelhead returns across the entire range (noting that this is an undercount due to sporadic monitoring efforts in only a few watersheds). Of the 177 observed adult steelhead, 16 were observed in the Santa Clara River at the Freeman Diversion. Since publication of that paper, 2 adult steelhead were observed in March 2020 leaping over the false weir and activating motion-sensor cameras after ascending the Denil fish ladder at the Freeman Diversion. Data on the historic and current population size and distribution of steelhead in the Santa Clara River watershed are limited. Moore (1980) estimated the historic annual run size in the Santa Clara River system to be around 9,000 adult steelhead. However, determining an accurate run size for the historic population is challenging because no thorough surveys have been conducted and the watershed was stocked with hatchery steelhead from northern rivers in the early 1900s. Stoecker and Kelley (2005) consider the Santa Clara River to be a migration corridor from the ocean to spawning and rearing habitats upstream in Santa Paula, Sespe, and Piru creeks (and to a lesser extent, Pole and Hopper creeks), although occasionally steelhead are found rearing in the perennial reaches of the mainstem Santa Clara River. Currently, much of the mainstem is considered low-quality steelhead habitat, but historically may have provided over-summering habitat for adult fish and rearing habitat for juveniles (Stoecker and Kelley 2005).

According to Titus et al. (2006) Santa Paula Creek was a principal steelhead spawning tributary prior to 1948, and small numbers of steelhead were caught there each year by anglers until 1973. Another record from 1957 reports the presence of steelhead from the Sespe Gorge area to the mouth of Sespe Creek. In March 1987, steelhead were electro-fished on Santa Paula Creek, 4 miles (6.5 kilometers) upstream of the Santa Clara River confluence and 0.3 mile (0.5 kilometers) downstream of the Harvey Diversion Dam. Some reports indicate steelhead were found primarily in pools immediately downstream of the Harvey Diversion Dam, but a 2010 account indicates fish were captured farther downstream, approximately 1.7 miles (2.7 kilometers) upstream of the confluence with the Santa Clara River. Additionally, between March and May 2008, approximately 95 smolts were reported by United near the Freeman Diversion.

A 1983 study found steelhead present only in the lower 6 miles (10 kilometers) of Santa Paula Creek, but sampling methods were considered relatively inefficient (CDFW 2016b). Surveys of the Santa Paula Creek watershed in 2007 found steelhead only in reaches upstream of the Sisar Creek confluence (Stillwater 2007a). Since the construction of the Freeman Diversion in 1991, United has collected intermittent steelhead migration data in the fish ladder and a downstream migrant fish trap (United

2016b). In the mainstem Santa Clara River, over 2,000 steelhead smolts have been captured at the Freeman Diversion between 1995 and 2011, but abundance has varied greatly from year to year. Smolt counts have ranged from very few (less than 5 individuals, 1998, 1999, 2002, 2004, 2005, 2013, 10 to 40 individuals, 2003, 2011, 2012, and 2014), to moderate (around 100 to 200 individuals, 1995, 1996, 2001, 2008, 2009, 2010), and to relatively high abundance (413 in 1997 and 839 in 2000). Some (if not all) of the variation in smolt counts is due to changes in trapping efficiency resulting from operating conditions at the diversion (e.g., high flow conditions in which smolts may traverse the fish ladder or wash over the face of the dam and evade capture) (United 2016b). However, the ability of adult steelhead to migrate through the mainstem river and successfully spawn in tributary streams, and variation in environmental conditions, also drives variation in smolt abundance for steelhead populations (NMFS 2012).

Upon entering or exiting the Santa Clara River mouth at the ocean, steelhead must navigate the Santa Clara River Estuary (SCRE). Most of the year, the SCRE is closed by a sand bar, creating a lagoon. Studies of steelhead in the San Gregorio and Scott Creek lagoons to the north have demonstrated that steelhead use a rearing strategy that includes 1 to 2 years of residency in upstream habitats, followed by lagoon-rearing on the order of weeks to months before smolts emigrate to the ocean. Although a closed sand bar and dry conditions in the river upstream of the lagoon may force extended periods of lagoon rearing, little is known regarding habitat use within the SCRE. Although no steelhead have been documented in routine seining surveys conducted by the City (Stillwater 2018), 7 stranded steelhead in the size range of 10 to 12 inches (25 to 30 centimeters) were identified following an artificial breaching event in October 2010 (Cardno 2010, Swift et al. 2018). This suggests the SCRE lagoon, at least in some years, has suitable habitat for steelhead rearing when the lagoon mouth is closed. However, although these stranded steelhead were not tagged, it is highly probable that the fish stranded in the lagoon in October 2010 were some of the same 64 fish that were transported as smolts from the Freeman Diversion to the lagoon in the spring of the same year (Swift et al. 2018). If these were the same fish, observations of the length and girth of the stranded fish indicated that these fish grew substantially through the summer months while rearing in the lagoon. Thus, the SCRE may potentially provide rearing habitat for juvenile steelhead, for at least short periods, particularly when water quality conditions are favorable.

However, under open-mouthed conditions, steelhead likely use the lagoon habitat primarily as a migratory corridor with only short periods of residency. A study of Santa Clara River steelhead smolts captured at the Freeman Diversion further supports this hypothesis. As part of a larger study of southern California steelhead outmigration survival, movement, and straying, Kelley (2008) captured 133 steelhead smolts upstream of the Freeman Diversion and tagged 81 of them with acoustic and PIT tags prior to release in the SCRE. Acoustic receivers were placed outside of the estuary, to detect fish that migrated into the ocean. Under open-mouth conditions, Kelley (2008) found most of these steelhead smolts spent less than three days in the estuary before migrating to the ocean, and half of the smolts migrated to the ocean within 2 days of release.

Evidence to support the presence of native steelhead in the Santa Clara River watershed includes historic accounts of fish presence, genetic information (i.e., specific southern California steelhead mitochondrial DNA haplotypes and nuclear microsatellite alleles that only occur in southern *O. mykiss* populations), genetic uniqueness in watersheds, and genetic relatedness between watersheds indicating possible gene flow from the ocean (Clemento et al. 2009, Abadía-Cardoso et al. 2016). Abadía-Cardoso et al. (2016) also looked at the proportion of sampled individuals that possessed single nucleotide polymorphisms unique to anadromous (as opposed to resident) fish. They found that most populations in southern California had very low frequencies of alleles associated with anadromy, consistent with their limited opportunities to express an anadromous life history. In the Santa Clara River, a higher frequency was observed of the alleles associated with anadromy in samples from the Sespe River than from Piru Creek (no other results were reported).

An early mitochondrial DNA study (Nielsen et al. 1997) on southern California *O. mykiss* suggests some genetic introgression from northern steelhead occurred (i.e., alleles from Northern California *O. mykiss* were found in southern *O. mykiss*). However, it is unclear the degree to which hatchery fish influenced the abundance estimates reported in older accounts. The genetic results of Clemento et al. (2009) indicate that, in the Santa Clara River, relatively little genetic introgression occurred between wild populations and stocked hatchery fish. More recently, Abadía-Cardoso et al. (2016) assessed the genetics of southern and Baja California *O. mykiss* populations to describe 2 major lineages: native coastal steelhead and introduced hatchery rainbow trout. Individuals from the Santa Clara River tributaries (including Piru, Santa Paula and Sespe creeks) were of native coastal steelhead descent, consistent with the results of Clemento et al. (2009).

Past stocking may have temporarily increased run sizes and population numbers, resulting in a greater number of steelhead migrating into and out of local rivers than otherwise would have occurred. However, because genetic results (Clemento et al. 2009, Abadía-Cardoso et al. 2016) indicate there was no substantial introgression between wild and stocked fish in the Santa Clara River watershed, these stocked fish were either taken out of the population by sport fishing, were unable to successfully survive conditions in the system, and/or did not successfully spawn. It should be noted that in the Clemento et al. (2009) and Abadía-Cardoso et al. (2016) studies, samples taken for genetic analyses were not systematically collected within the watershed, meaning that introgressed individuals may have been present but not sampled. No data exist that would inform an assessment of what proportion of historic southern California steelhead in the Santa Clara River were wild versus stocked fish. Regardless of the historic population size of steelhead, humans have negatively altered habitat conditions for steelhead in the Santa Clara River drainage. No focused studies have been undertaken to determine current population size and distribution in the Santa Clara watershed. The most current and complete data on southern California steelhead have been collected downstream of the Freeman Diversion, about 11 miles (18 kilometers) upstream of the SCRE ocean inlet. All spawning and most rearing habitat for steelhead is located on tributaries above the Freeman Diversion. Steelhead must pass the Freeman Diversion to access this habitat. In addition, all smolts produced in the watershed must pass the structure to access the estuary and ocean. Since 1995, 14 southern California steelhead adults are known to have successfully passed through the diversion’s fish ladder (United 2016b). The most recent observation of upstream migrating adults occurred in 2012 when 2 adult steelhead were documented passing the Denil fish ladder at the Freeman Diversion successfully.

Once upstream of the Freeman Diversion Dam and given the appropriate hydrologic conditions, steelhead can migrate up Santa Paula Creek, Sespe Creek, and possibly into the lower portion of Piru Creek downstream of Santa Felicia Dam and into Hopper Creek. Efforts are underway to address several barriers on these creeks that restrict migration and expand the suitable spawning and rearing habitat available for upstream migrating adults. Santa Paula Creek has two fish ladders: one at the Harvey Diversion, and one at a U.S. Army Corps of Engineers (USACE) flood control channel. Both fish ladders were damaged during floods in 2005 and as of 2020 the diversion fish ladder may be impassible due to continued downcutting of the stream bed at the entrance to the fish ladder. The USACE fish ladder requires continual maintenance and appears frequently impassible due to down-cutting of the stream bed at the entrance of the fish ladder, and inundation by debris and riparian vegetation growth. Sespe Creek has no sizeable diversions or fish barriers along its length. On Piru Creek, Santa Felicia Dam is a complete upstream barrier to any southern California steelhead that could make it there, but it can pass steelhead downstream during spill events into lower Piru Creek. Reliable historical documentation of anadromous adults in Piru Creek does not exist. Genetic evidence does indicate steelhead in the Piru watershed are native to the region (Clemento et al. 2009, Abadía-Cardoso et al. 2016).

4.2.3 TIDEWATER GOBY (EUCYCLOGOBIUS NEWBERRYI)

Description

Photo courtesy Steve Howard

Gobies are small, semi-translucent, cylindrical fish, reaching about three inches (7.5 centimeters) total length with little sexual dimorphism related to size. The pelvic fins fuse into an oval disc on the ventral side of the chest. The small scales are embedded in the skin and usually not visible. Scales are absent from the head and the anterior third of the body. Breeding females develop dark brown or blackish color on the body and dorsal and anal fins. The head and tail remain brownish or greenish. The dorsal quarter of the first dorsal fin remains cream colored or yellowish orange. This area is translucent in smaller, non-breeding individuals and is one of the best identification characteristics separating it from similar gobies in California. Many of these characteristics are similar or identical between northern and southern tidewater goby (*E. kristinae*). The southern tidewater goby has been recognized recently as a second species in *Eucyclogobius* (Swift et al. 2016). The oval disc of the fused pelvic fins, the presence or absence of cephalic canals, and genetics separate the southern fish from all other gobies.

Habitat Characteristics and Use

Populations of goby usually are found in coastal lagoons and the upper low salinity areas of larger estuaries. Many of these estuaries are flushed by high freshwater flows during the winter, from about late November to late April. Within a few weeks or months, flows recede, and barrier sand bars develop, usually closing the lagoons off from the ocean for several dry months. Gobies occupy the open water of these lagoons, their vegetated margins, adjacent marshes, and often move into the lower portions of the tributary streams if the gradient is low and no barrier is present (more than 6 inches [15 centimeters] high) to upstream movement. Clean, unconsolidated sandy substrate is needed for breeding burrows, but non-breeding individuals range over mud, rocks, vegetated areas, and among algal mats and dense macrophytes.

In the spring (April or May), after lagoons have stabilized, male gobies excavate burrows into sandy substrate about 4 to 8 inches (10 to 20 centimeters) long and hollow out an area under the sand. The adult females actively compete for access to the burrows. Dominant females deposit 300 to 600 eggs in a burrow and the male guards it for several days depending on water temperature. Females can produce a clutch of eggs about every 2 weeks (USFWS 2005).

Gobies are micro-carnivores and will consume almost any animal small enough to be swallowed whole, such as snails, mysid shrimp, amphipods, isopods, chironomid larvae, various other aquatic insects, ostracods, and oligochaetes. They feed both day and night and forage largely on the bottom substrate.

Status and Distribution

Primary threats to gobies are actions that disrupt the normal or natural changes in coastal lagoons. These lagoons are usually at the downstream end of larger drainages impacted extensively by a variety of anthropogenic disturbances to water quality, sediment load, and flow regime. Major threats include destruction, modification, or curtailment of goby habitat due to alteration of flow regimes from construction of dams, diversions, and levees, decreased water quality, and competition and predation from invasive species (USFWS 2005).

The tidewater goby was federally listed as endangered on March 7, 1994 (59 FR 5494). Critical habitat was designated on November 20, 2000, for populations in Orange and San Diego counties, south of the

Los Angeles Basin (65 FR 69693, USFWS 2000b). On January 31, 2008, revised critical habitat was established in Del Norte, Humboldt, Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles counties (73 FR 5920) (Figure 4-1), and on February 6, 2013, critical habitat was formally designated (78 FR 8745). In its critical habitat designation, USFWS developed a list of PBFs that include (78 FR 8745):

- Persistent, shallow (in the range of approximately 0.3 to 6.5 feet [0.1 to 2 meters] deep), still-to-slow-moving lagoons, estuaries, and coastal streams with salinity up to 12 parts per thousand, which provide adequate space for normal behavior and individual and population growth that contain one or more of the following
- Substrates (e.g., sand, silt, mud) suitable for the construction of burrows for reproduction,
- Submerged and emergent aquatic vegetation, such as sago pondweed (*Potamogeton pectinatus*), ditch grass (*Ruppia maritima*), broadleaf cattail (*Typha latifolia*), and bulrush (*Scirpus* spp.), that provides protection from predators and high flow events
- Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity

A recovery plan for the goby was finalized on December 7, 2005 (USFWS 2005). On March 13, 2014, the USFWS proposed reclassifying the goby from endangered to threatened (79 FR 14340), but down-listing of the species has not yet been finalized.

Historically, the range of goby was entirely within the coastal zone of California, covering nearly its entire length. It occurred from the mouth of the Smith River in Del Norte County south to Agua Hedionda Lagoon in San Diego County. Large gaps existed in this range, with very few records along the north coast from the Russian River to south of the Eel River. No records are known from the Carmel River south to Arroyo de la Cruz in the Big Sur area (Swift et al. 1989). These gaps are areas occur where the coastline is steep and stable lagoons do not develop at the mouths of streams.

A recent paper by Swift et al. (2016) found historical accounts of goby (*E. newberryi*) to be erroneous as the original distribution covers 2 species: northern tidewater goby (*E. newberryi*) and southern tidewater goby (*E. kristinae*). Populations and individuals south of Palos Verdes are now southern tidewater goby with the southernmost distribution of northern tidewater goby now just including areas south of Topanga Creek (Santa Monica).

The goby has been extirpated at many locations, and many other existing localities are so small or ephemeral that a continuous population is not supported. In 2005, 23 (17 percent) of 134 documented historical locations for the northern tidewater goby were considered extirpated, and 55 to 71 of the locations (41 to 52 percent) were considered so small or degraded that long-term persistence is uncertain (USFWS 2005). However, these numbers may be slightly different now that southern tidewater goby are differentiated from northern tidewater goby.

Occurrence in Plan and Permit

Critical habitat for the northern tidewater goby was first established in the Santa Clara River in 2008. The Santa Clara River lies in Ventura Recovery Unit 2 and is 1 of only 3 original populations in this unit. The other two are the Ventura River mouth and Ormond Beach wetland. The Santa Clara River population has been identified as the largest and most robust in this recovery unit and the preferred source for fish to establish new populations during the recovery process.

The CNDDB shows record of goby collections from the SCRE mouth to 2.5 miles (4 kilometers) upstream, between Ventura and Oxnard in 1974, 1984, and 1995. The last record shows observations were made in 1999 of 9 adults. The City of Ventura Sanitation Department has supported once- to twice-yearly status surveys for northern tidewater gobies in the lower Santa Clara River that show the population was robust from 2004 through 2010, with at least tens of thousands of fish present (Entrix 2004, 2007a, 2007b, 2008a, 2008b, 2009, Cardno Entrix 2010). 2013-2016 surveys found very few gobies, however, presenting the possibility that the population suffered a precipitous decline: zero gobies were captured during 2013-2014 seine hauls, 10 were captured in 2015, and 12 in 2016), (Stillwater 2018). Competition and predation by non-native species, potentially exacerbated by dry water year reductions in berm breach frequency, and untimely artificial breaches are thought to have contributed to their decline in the SCRE (Swift et al., 2018).

4.2.4 WESTERN POND TURTLE (*ACTINEMYS MARMORATA*)

Description

The pond turtle is medium-sized with a carapace ranging from 3.3 to 8.5 inches (8.5 to 21.5 centimeters) in length for adults (Stebbins 2003). Hatchlings are approximately 1 inch (2.5 centimeters) in carapace length, with tail lengths almost as long as the carapace. Pond turtles have unkeeled carapaces that can be drab dark brown, olive brown, or blackish in color, usually with a pattern of lines or spots radiating from the centers of the scutes. The plastron lacks hinges and has six pairs of shields that can be cream or yellowish in color with large dark brown markings, or they can be unmarked. The legs have black speckling and may show cream to yellowish coloring. The head usually has black spots on it and may show cream to yellowish coloring, with the throat and neck being uniformly light in color.

Photo courtesy Sara Dowey, 2016

Habitat Characteristics and Use

Pond turtles are diurnal primarily, though some nocturnal activity occurs in summer (Holland and Bury 1998). The species is highly aquatic, typically basking on structures or plant material at water level and rarely by floating at the surface. Turtles will quickly slide into the water and dive to escape threats. Pond turtles are usually active from February to November, though may be active all year at warm, southern latitudes. In winter, pond turtles hibernate underwater, often in the muddy bottom of a pool or may overwinter on land up to 0.3 mile (0.5 kilometer) from the nearest watercourse (Holland 1994). If summer droughts result in the disappearance of wetted habitat, pond turtles may aestivate by burying themselves in soft bottom mud or move to upland areas to shelter under dense brush, logs, leaves, or woodrat nests (Slavens 1995, Lemm 2006).

Adult pond turtles do not mate until they are approximately 8 to 10 years old. Reproduction typically begins with mating in April and May. From April through August, females climb onto land to dig a nest to lay a clutch of 2 to 11 eggs. While some females may lay 2 clutches in a year, most are thought to lay eggs every other year. Hatchlings emerge in early fall or overwinter in the nest (Holland 1994).

Pond turtles eat a wide variety of foods including aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, carrion, and occasionally frogs and fish (Holland 1985, 1994, Bury 1986). The greatest single threat to this species is habitat destruction. Over 90 percent of the wetland habitats in its historic range in California have been eliminated due to agricultural development, flood control and water diversion projects, and urbanization (57 FR 45761). Associated with these threats are increased habitat fragmentation and other attendant effects on genetic variability. Other localized threats include contaminant spills, grazing, off-road vehicle use (58 FR 42717), and predation by non-native, introduced predators such as bullfrogs (Holland 1994).

Status and Distribution

The western pond turtle currently has no federal listing status. In 1992, USFWS was petitioned to consider the species for listing (57 FR 45761) (USFWS 1993) but after formal review declined to list the species. However, they reclassified both recognized subspecies (*E.m.marmorata* and *E.m.pallida*) as Category 2 candidates for listing (58 FR 42717), a designation that was later abandoned for all candidate species. The western pond turtle is listed as a California Species of Special Concern (Jennings and Hayes 1994, CDFW 2019).

In California, the pond turtle's range extends from the Oregon border south, along the coastal ranges into northern Baja California, from sea level to above 5,905 feet (1,800 meters) above sea level. Preferred habitats include ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with abundant vegetation, and rocky or muddy bottomed woodlands, forests, and grasslands. In streams, pond turtles prefer pools over shallower areas. Adequate structure, such as logs, rocks, cattail mats, and exposed banks, is required for basking (Stebbins 2003). Genetic structure within the distribution has been proposed (Spinks and Shaffer 2005), with southern California populations thought to contain important cryptic genetic diversity.

Occurrence in Plan and Permit Areas

The CNDDB contains several documented historical occurrences of the pond turtle in the plan area (CDFW 2016b). Field surveys conducted in 1977 revealed 7 locations contributing to a large population of pond turtles on Sespe Creek, about 0.6 mile (1 kilometer) southwest of the junction with Highway 126. In 1987, surveys found moderate-sized population at three locations including: the Santa Clara River mouth, Lake Piru, east of Sespe Wildlife Area, and Santa Paula Creek, southeast of Ojai and north of Santa Paula. Year-round trapping surveys in 2012-2016 consistently found adults south of the Piru Lake spillway, and from 2009-2016 reports were made of sightings on the Santa Clara River from southwest Santa Paula, just above the South Mountain Road bridge crossing, upstream to Fillmore. Western Pond Turtles have been observed regularly between 2011 and 2018 in the main channel and on flooded side channels on Nature Conservancy properties from Hanson east and upstream to Taylor. They have also been observed in the main channel and in wet side channels on the Hedrick Ranch Nature Area from 2010 to 2016.

Pond turtles have been observed, more than 10 to 20 at a time, in the Santa Clara River immediately above and below the Freeman Diversion facilities throughout the spring and summer months. They are occasionally encountered in the fish trap and fish bay (United 2016a). Additional surveys conducted between 2010 and 2012 for the City of Santa Paula regularly identified approximately 25 to 30 individuals on the Freeman Diversion and plunge pool (BioResource 2013). Five adults have been recorded in the screened fish bay from 1994 to 2016, and 60 adults and hatchlings were captured in the fish trap from 1994 to 2014. The fish trap was not in operation after April 2014.

4.2.5 LEAST BELL'S VIREO (*VIREO BELLII PUSILLUS*)

Description

The least Bell's vireo is 1 of 4 subspecies of Bell's vireo in the *Vireonidae* family. It is a small songbird identified by its distinctive call and gray and white feathers. Its coloration is dull, ashy gray on the head with grayish olive on its back, wings, and feathers and pure white underneath, including the underwing coverts. It has a short, superciliary streak over its dark eye, two wing bars, and dull white on the narrow margins of the wings and tail (USFWS 1998).

Photo courtesy
B.M. Peterson, USFWS 2016

Habitat Characteristics and Use

Vireo is found typically in structurally diverse woodlands located in riparian areas. Habitat requirements critical to the continued existence of this species include dense cover within 6 feet (2 meters) of the ground for nesting and a dense, stratified canopy for foraging. Ideal habitat consists of a well-developed overstory with a dense shrub understory, often characterized as an early successional stage. Typical breeding habitat consists of an understory of dense riparian subshrub or shrub thickets, with a mature riparian overstory. While willow-dominated habitat is often used by the vireo for nesting, plant species composition does not appear to be as important as the structure of the habitat (Griffith and Griffith 2000).

Vireo migrate up to 1,990 miles (3,200 kilometers) from breeding grounds in California and northern Baja California, south to southern Baja California (USFWS 1998). Most vireos begin migrating in late-July through late-September, with some individuals overwintering in the United States (NatureServe 2016). The species returns north to its breeding grounds in late March (NatureServe 2016). The typical breeding season is April through August.

Vireo is insectivorous, preying on a variety of insects including beetles, bugs, grasshoppers, caterpillars, and moths. Prey is gleaned mostly from foliage but is also obtained from vegetation surfaces while the prey hovers in the air. Foraging typically occurs in areas near nesting sites in riparian habitats and adjacent chaparral, scrub, and oak woodlands. These birds are highly territorial and establish home ranges of 0.5 acre to 4.5 acres (2,000 to 18,000 square meters), although ranges can be as large as 10 acres (40,500 square meters) in some cases (Greaves 1989, USFWS 1998).

Habitat loss and fragmentation are primary factors in the decline in vireo populations (Riparian Habitat Joint Venture 2002). Clearing of riparian woodlands, diking of rivers, livestock grazing, urbanization, and development of dams in the vireo's range has resulted in loss of riparian habitat. Impounding upstream and diverting water has lowered water tables downstream, which reduces the amount of dense vegetation (USFWS 1998). Vireo is a common host for the brown-headed cowbird (*Molothrus ater*) and brood parasitism is a contributing factor in the vireo's decline (Riparian Habitat Joint Venture 2002). Historically, habitat for the vireo was not accessible to the cowbird, so no defense mechanisms against brood parasitism evolved (USFWS 1998). Over the past decade, vireos have increased dramatically at several sites along the Santa Clara River where cowbird control has been performed consistently.

Status and Distribution

The least Bell's vireo was federally listed as endangered in 1986 (51 FR 16574). Critical habitat was established for least Bell's vireo in 1994 (59 FR 4845), and a draft recovery plan has been completed (USFWS 1998). A five-year status review for the least Bell's vireo was completed in 2006 (USFWS

2006) and recommended down-listing of the species. USFWS is currently developing a habitat suitability model and collecting data to explore either down-listing or delisting the least Bell's vireo, but no change in listing status has occurred to date. The least Bell's vireo is listed as endangered by the state of California (CDFW 2016a). The critical habitat designation contained PBFs as (59 FR 4845):

> *Riparian woodland vegetation that generally contains both canopy and shrub layers, and includes some associated upland habitats. Vireos meet their survival and reproductive needs (food, cover, nest sites, nestling and fledgling protection) within the riparian zone in most areas. In some areas they also forage in adjacent upland habitats.*

Historically, least Bell's vireo extended from the interior of northern California near Red Bluff in Tehama County, south through the Sacramento and San Joaquin valleys, and the Sierra Nevada foothills. It also occurred in the Coast Ranges from Santa Clara County south to approximately San Fernando, Baja California, Mexico, in Owens Valley, Death Valley, and in scattered oases in the Mojave Desert (USFWS 1998). The species was listed as endangered in 1986 after the population experienced a dramatic decline. Since 1986, the population has expanded north from San Diego County into the valleys of Santa Ynez, Ventura, and Riverside counties.

Occurrence in Plan and Permit Areas

The Santa Clara River is considered one of the most important sites for vireo recovery. The plan area falls in the Santa Clara River population unit for least Bell's vireo. Habitat occurs in patches along the river and the location and quality of these patches varies from year to year based on river conditions. In 1996, this area represented three percent of pairs recorded in southern California (USFWS 1998). In 1997, 60 pairs were detected along the Santa Clara River. In the last five-year status review conducted for the least Bell's vireo, 117 territories were estimated for the years 2001 to 2005, 4 percent of least Bell's vireo territories in the United States (USFWS 2006).

The CNDDB has several records of vireo sightings within the plan area from 1910 to May 2017. Included in these records are surveys upstream and downstream of the Freeman Diversion from the years 1991, 2012, and 2013. During these surveys, 6 pairs and 2 males were seen in 1991. Twenty-two pairs, 7 males, 4 adults, and 51 young in 2012, and 28 pairs, 5 males, 1 transient, and 48 young in 2013. Many surveys for vireo have occurred and continue to take place all along the Santa Clara River and its tributaries (e.g., Werner 2013a, 2015a). The population appears to be rapidly expanding into the available habitat in the watershed (CDFW 2016b).

United has performed breeding surveys for vireo annually from 2012 to 2019 (Table 4-2) in the Santa Clara River both upstream and downstream of the Freeman Diversion (Griffith Wildlife Biology 2013, 2014, 2015, 2016, 2017, 2018, and 2019) and surveys are underway in 2020. Many surveys for vireo have occurred and continue to take place all along the Santa Clara River and its tributaries (e.g., Werner 2013a, 2015a). The population appears to be rapidly expanding into the available habitat in the watershed (CDFW 2016b).

The focused surveys have been conducted along the Santa Clara River at locations in the plan area with suitable habitat for vireo, and where covered activities could have an effect (Figure 4-2). Each year, the number of territorial sites for vireos detected in the survey area increased (Table 4-2). Most of the new locations were in young willows that developed into vireo-quality habitat during the survey years. Some of the increase represented a higher density in already occupied habitat. After nesting, breeding territories broke down, and essentially all types of habitat in the study area were utilized for foraging.

Figure 4-2 Observations of Vireo Pairs in the Bird Study Area around the Freeman Diversion During Survey Years 2012-2019

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Table 4-2 Territorial Sites for Least Bell's Vireos Detected in the Survey Area

Year	Number of Territorial Sites	Percent with Paired Vireos
2012	26	95
2013	27	96
2014	35	94
2015	42	88
2016	65	96
2017	85	95
2018	93	99
2019	87	100

Summarizing from Griffith Wildlife Biology (2012-2019), in 2012, 18 pairs of vireos were visualized on the site and produced at least 21 nests from which 15 pairs had 16 successful nests (1 pair double brooded), fledging at least 51 young (3.4 young per pair). For 2013, 21 of the 25 pairs seen on-site completed at least 24 nests (13 nests observed, 11 nests known only from family groups); of these 19 of the 21 pairs had 20 successful nests (1 pair double brooded), fledgling at least 48 young (at least 2.53 young per pair). This is lower than the actual number of young per pair since counts were not obtained for the 11 family group nests. For 2014, 19 of the 33 pairs in the study area were monitored partially or fully, where they were observed completing at least 21 nests (14 nests directly observed and 7 according to family groups). At least 13 out of 16 were successful, producing 36 fledglings (2.77 per pair). In 2015, 21 of the 37 pairs on-site were monitored partially or fully, and 22 pairs built at least 25 nests (13 nests directly observed and 12 according to family groups). At least 17 out of 20 were successful, producing at least 43 fledglings (a minimum of 2.53 per pair). In 2016, 39 vireo pairs built at least 40 nests, 36 of which were successful. Of the 36, 12 were fully monitored and 24 according to family groups. The 12 nests produced 44 young (3.67 per pair) whereas the 24 nests produced at least 43 offspring (1.79 per pair). In 2017, using upstream and downstream data, 54 vireo pairs produced at least 65 nests, of which 50 nests were successful. Of the 50, 23 were monitored and 27 were known by family group. The 23 monitored s 4-2a-d). In 2018, 46 pairs produced at least 48 nests, of which 42 nests were successful. Twelve of the 42 successful nests were fully monitored, and numbers of eggs, nestlings, and fledglings are known for those nests. The 12 fully monitored nests fledged 39 young (3.25 young/parent pair). Finally, in 2019, complete data was documented on 46 pairs, which had at least 48 nests of which 47 were successful. Observed successful nests produced at least 112 young, and possibly up to 160 young extrapolating from data collected (Griffith 2019).

From 2012 to 2015, two cowbird traps were operated in the survey area during the nesting season between April 1 and June 30, and several more traps were operated just upstream and downstream of the study area (Griffith Wildlife Biology 2015). No evidence of brood parasitism by the brown-headed cowbird was detected from 2012 to 2015. In 2012, no free flying cowbirds were observed. In 2013, 1 free-flying male cowbird was detected. In 2014, 3 lone free-flying male cowbirds were detected. In 2015, 1 free flying male cowbird was detected. In 2016, no cowbird traps were operated in the main river channel, but there was 1 trap operated slightly off-site from April–May. Free flying cowbirds were seen regularly in the study area, but no brood parasitism was observed. In 2017, limited trapping was done, and extensive cowbird numbers were reported in the study area. Parasitism was reported upstream (4 out of 21) but not downstream (0 out of 7) of the Freeman Diversion (Griffith Wildlife Biology 2017). In 2018, five cowbird traps were operated from April to November. During the trap operation period 1,090 cowbirds were removed, including 142 during the breeding season (April 1 through July 14; 75 male, 61 females, 6 juvenile) and 948 during the non-breeding season (July 15 through November 30; 294 males, 258 females, 396 juveniles).

4.2.6 SOUTHWESTERN WILLOW FLYCATCHER (*EMPIDONAX TRAILLII EXTIMUS*)

Description

The flycatcher is a small passerine bird in the *Tyrannidae* family, measuring approximately 5.7 inches (14.5 centimeters) in length. It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars are visible (juveniles have buffy wingbars) and the eye ring is faint or absent. The upper mandible is dark, and the lower is light yellow grading to black at the tip. Their song sounds like a sneezy "fitz-bew" or a "fit-a-bew" and the call is a repeated "whit." The southwestern willow flycatcher is 1 of 4 currently recognized willow flycatcher subspecies: *Empidonax traillii extimus*, *E. t. adastus*, *E. t. brewsteri*, and *E. t. traillii* (Phillips 1948, Unitt 1987, Browning 1993).

Photo courtesy USDA.gov 2015

Habitat Characteristics and Use

The flycatcher breeds in dense riparian habitats, typically near surface water or saturated soil. Riparian patches used for nesting vary widely in size and shape, mean patch size is 21.2 acres (85,800 square meters), and the median size is 4.4 acres (17,800 square meters) (USFWS 2002). Throughout its range, the flycatcher arrives on breeding grounds in late April and May. Nesting begins in late May and early June, and young fledge from late June through mid-August (Whitfield 1990, Maynard 1995). As a neotropical migrant, the southwest willow flycatcher flies to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, USFWS 2002).

The flycatcher is an insectivore, foraging in dense shrub and tree vegetation along rivers, streams, and other wetlands. The bird typically perches on a branch and makes short direct flights or sallies to capture flying insects. Declines in flycatcher populations have been attributed to loss, modification, and fragmentation of habitat, and brood parasitism by brown-headed cowbirds (Whitfield 1990, Sferra et al. 1995, Finch and Stoleson 2000).

Status and Distribution

The southwestern willow flycatcher was federally listed as endangered on February 27, 1995 (60 FR 10695) and critical habitat (Figure 4-1) was designated on July 22, 1997 (62 FR 39129). This designation was vacated in 2001, with a new proposal for critical habitat issued in 2004, and the final designation on October 19, 2005 (70 FR 60886). USFWS proposed a revision to the critical habitat on August 15, 2011 (76 FR 50542) and reopened the comment period on July 12, 2012 (77 FR 41147). Final critical habitat was designated on January 3, 2013 (78 FR 344) (see Figure 4-1). The species is listed as endangered by the State of California (CDFW 2016a). A final recovery plan was issued in August 2002 (USFWS 2002). The designation of critical habitat included establishment of PBFs as (78 FR 344) riparian habitat along a dynamic river or lakeside in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) made up of trees and shrubs, and some combination of the following:

- Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 6.5 to 98.5 feet (2 to 30 meters). Lower-stature thickets 6.5 to 13 feet (2 to 4 meters tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests
- Areas of dense riparian foliage at least from the ground level up to approximately 13 feet (4 meters) above ground or dense foliage only at the shrub or tree level as a low, dense canopy;

- Sites for nesting that contain a dense (about 50 to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground)
- Dense patches of riparian forests interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of un-uniformly dense habitat. Patch size may be as small as 0.25 acre (1,000 square meters) or as large as 175 acres (708,000 square meters)
- A variety of insect prey populations found in or adjacent to riparian floodplains or moist environments

The historic and current breeding range of the flycatcher includes southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987). It is known to winter from the west coast of central Mexico to northern South America. Range-wide, the population is comprises extremely small, widely-separated breeding groups including unmated individuals. The distribution of breeding groups is highly fragmented, often separated by considerable distance.

The final critical habitat designation for southwestern willow flycatcher includes almost 50 miles (80 kilometers) of the Santa Clara River, from the estuary upstream to Interstate 5, approximately 26 miles (42 kilometers) of Piru Creek upstream from its confluence with the Santa Clara River, and a small portion of Castaic Creek, excluding portions of Castaic Creek and Santa Clara River covered under the Newhall Land and Farm Conservation Easement and Management Plan, (78 FR 344).

Occurrence in Plan and Permit Areas

The plan area includes areas with the primary constituent elements that make up critical habitat for the flycatcher. The recovery plan reported 13 known territories in the Santa Clara River watershed (USFWS 2002, CDFW 2016b). Recovery efforts in the Santa Clara watershed focused from Bouquet Canyon Road to the Pacific Ocean; in Piru Creek from its headwaters to the Santa Clara River; in San Francisquito Creek from 3 miles (5 kilometers) upstream of Drinkwater Reservoir to Drinkwater Reservoir; and in Soledad Canyon from Soledad Campground to Agua Dulce. Piru Creek, San Francisquito Creek, and Soledad Canyon are outside the area affected by the MSHCP covered activities.

The CNDDB shows records of flycatchers within the plan area, along the Santa Clara River, in 2007, 2008, and 2009. Two adults were seen near Fillmore in 2007, 2 adults and 2 juveniles were seen near Santa Paula in 2008, and 1 male was seen 3 miles (5 kilometers) east of Santa Paula in 2009. Surveys for flycatcher at Heritage Valley Park in Fillmore detected breeding pairs in 2005 (1 pair), 2006 (2 pairs, Gallo 2007), and 2008 (3 pairs, Griffith Wildlife Biology 2008). At least 1 breeding pair was detected near the Santa Paula Wastewater Recycling Facility Project in 2008 (BioResource 2008). Protocol-level surveys conducted by the Ventura County Watershed Protection District in 2013 and 2015 detected 6 willow flycatchers of undetermined subspecies in a 2.7 miles (4.3 kilometers) stretch of the Santa Clara River approximately 6 miles (10 kilometers) downstream of the Freeman Diversion in 2015 (Werner 2013b, 2015b).

United has performed breeding surveys for southwestern willow flycatcher annually from 2012 to 2019 in the Santa Clara River both upstream and downstream of the Freeman Diversion (Griffith Wildlife Biology 2013, 2014, 2015, 2016, 2017, 2018, 2019) (Figure 4-3). Focused surveys have been conducted at suitable habitat locations within the plan area along the Santa Clara River and where covered activities could have an effect. No willow flycatchers were documented in 2012 and 2015. One male willow flycatcher was documented in 2013, but the subspecies was not confirmed, and no mate or offspring were observed. A willow flycatcher pair was documented in 2014 exhibiting breeding behavior, but no nests or offspring were documented. A willow flycatcher pair was documented in 2016 and 2017 nesting on the north bank of the Santa Clara River, downstream of the Freeman Diversion near Ellsworth Barranca, and successfully fledged offspring (3 in 2016, 1 in 2017). In 2018, 1 individual female, of unknown breeding status, was observed on June 10 and July 17 along the Santa Clara River around Saticoy (Griffith 2018). The solitary female was not observed on several other surveys between May 8 through July 30, 2018.

4.2.7 YELLOW-BILLED CUCKOO (*COCCYZUS AMERICANUS*)

Description

The cuckoo is a member of the *Cuculidae* family. Members of this family have a zygodactyl foot with two toes pointed forwards and two backwards, moderate to heavy bill, and a ring of bare skin around the eye (Dunn and Alderfer 2011). The cuckoo is about 12 inches (30.5 centimeters) long and weighs approximately 2 ounces (56 grams). It is a long slender bird, with short dark legs and plumage a brownish-gray above and white below, with rufous primaries on the wings. The lower mandible is yellow, and the underside of the tail feathers has a bold black and white pattern. Males and females look similar, although males may have a slightly larger bill and more distinct oval markings on the undertail. Juveniles have a fainter tail pattern and may have a dark bill (Dunn and Alderfer 2011).

Photo courtesy Wildreturn 2015

Habitat Characteristics and Use

Breeding and nesting habitat includes riparian woodlands of deciduous trees with a dense understory near water (Wiggins 2005). Because nests are constructed generally in willows, but foraging occurs in the cottonwood canopy, multi-story structure is required (Laymon and Halterman 1987). The cuckoo's breeding season is June through August (Nevada Partners in Flight 1999). Cuckoos are a neo-tropical migrant, wintering in tropical deciduous and evergreen forests of South America. The primary foraging strategy of the cuckoo is gleaning, although it has been known to sally or drop to the ground while foraging. Cottonwoods, which support a diverse community of native insects, are important foraging habitat (Laymon and Halterman 1989). Cuckoos are loosely territorial, with territory size ranging from 20 to 100 acres (81,000 to 405,000 square meters). Declines in cuckoo populations are attributed to habitat loss, habitat fragmentation, and pesticide use (Wiggins 2005).

Status and Distribution

The species was listed as endangered by the State of California on March 26, 1988 (CDFW 2016a). The Western DPS of the yellow-billed cuckoo was federally listed as threatened on November 3, 2014 (79 FR 59991) and critical habitat was proposed on August 15, 2014 (79 FR 48547). No proposed critical habitat occurs in the plan area. A five-year status review was initiated on June 18, 2018 (83 FR 28251).

The cuckoo is a migratory bird with historic range in California, New Mexico, Arizona, Nevada, Washington, Oregon, British Columbia, Utah, Colorado, Wyoming, Idaho, Texas, and northern Mexico. Wintering areas for this species are unknown but believed to be in South America, possibly as far south as Argentina. It was believed to be common and widespread in California and Arizona and common in riparian areas of New Mexico. The cuckoo is now considered extirpated from Washington, Oregon, and British Columbia, but still breeds in small numbers in California, southern Nevada, Utah, southern Wyoming, and northern Mexico (NatureServe 2016).

Occurrence in Plan and Permit Areas

The cuckoo has been observed infrequently in the Santa Clara River watershed and is documented to have historically nested in the Santa Clara River area, as evidenced by numerous egg-set records dating from 1920 through 1942. These are held at the Western Foundation of Vertebrate Zoology (Hall 2014, CDFW

Figure 4-3 Observations of Flycatcher Pairs in the Bird Study Area around the Freeman Diversion During Survey Years 2016 and 2017

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2016b). The CNDDB also holds record of nests and egg collections at three separate locations within the plan area in 1904, 1920-21, 1924, and 1942. These sires were on Sespe Creek, west of Fillmore, the Santa Clara River near Santa Paula, and the SCRE. The record also shows that in 1977 survey sites in Santa Paula and the SCRE were revisited, but without sightings.

In 1971, a cuckoo was sighted near Santa Paula on the Santa Clara River (CDFG 2005 cited in Stillwater 2007b). In 1997 and 1998, two were sighted in the upper portion of the watershed, although it was noted these were likely migrants (Labinger and Greaves 2001 cited in Stillwater 2007b). In 2003, a cuckoo was observed on the Santa Clara River west of Fillmore (CDFG 2005 cited in Stillwater 2007b). Migrant cuckoos were mapped previously along the Santa Clara River at Hedrick Ranch (10 miles [16 kilometers] upstream of the study area) (Greaves 2006). A single individual was heard vocalizing near the River Ridge Golf Club on the lower Santa Clara River in 2009 (eBird 2016). In both 2011 and 2014, a single adult yellow-billed cuckoo was observed in high-quality habitat along the Santa Clara River near Santa Paula (Hall 2014). Suitable habitat exists for this species throughout the watershed (Laymon and Halterman 1989).

United has performed surveys for cuckoo annually from 2012 to 2018 in the Santa Clara River both upstream and downstream of the Freeman Diversion (Griffith Wildlife Biology 2013, 2014, 2015, 2016, 2017, 2018, and 2019 forthcoming). The focused surveys have been conducted at locations in the permit area with suitable habitat for the cuckoo and where covered activities could have an effect. In 2015, United began to implement nesting protocol surveys, including taped vocalization playback. No cuckoos have been observed during the surveys in the permit area or off-site in the surrounding habitat.

4.3 LITERATURE CITED

Abadía-Cardoso, A., Pearse, D.E., Jacobson, S., Marshall, J., Dalrymple, D., Kawasaki, F., Ruiz-Campos, G. and Garza, J.C. 2016. “Population genetic structure and ancestry of steelhead/rainbow trout (*Oncorhynchus mykiss*) at the extreme southern edge of their range in North America.” *Conservation Genetics* 17: 675-689.

Applegate, V.C. 1950. *Natural History of the Sea Lamprey (*Petromyzon marinus*) in Michigan.* U.S. Fish and Wildlife Service Special Scientific Report 55, Washington, DC.

Barnhart, R. A. 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) --Steelhead.* U.S. Army Corps of Engineers TR EL-82-4. Washington, DC.

-----. 1991. “Steelhead (*Oncorhynchus mykiss*).” Trout. Stackpole Books, Harrisburg, Pennsylvania. J. Stolz and J. Schnell, editors. 324-336.

Beamish, R. J. 1980. “Adult Biology of the River Lamprey (*Lampetra ayresii*) and the Pacific Lamprey (*Lampetra tridentata*) from the Pacific Coast of Canada.” *Canadian Journal of* Fisheries and Aquatic Sciences 37:1906–1923.

Beamish, R.J. and T.G. Northcote. 1989. “Extinction of a Population of Anadromous Parasitic lamprey, *Lampetra tridentate*, Upstream of an Impassable Dam.” *Canadian Journal of Fisheries and Aquatic Sciences* 46:420-425.

BioResource Consultants, Inc. 2008. *Santa Paula Wastewater Recycling Facility Least Bell’s Vireo and Southwestern Willow Flycatcher Monitoring Program. 2008 Annual Progress Report*. Prepared for the City of Santa Paula. December 2008.

-----. 2013. *Santa Paula Wastewater Recycling Facility Least Bell's Vireo and Southwestern Willow Flycatcher Monitoring Program. 2012 Annual Progress Report*. Prepared for the City of Santa Paula. March 2013.

Bjornn, T. C. and D. W. Reiser. 1991. "Habitat requirements of salmonids in streams." *Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats*. W. R. Meehan. American Fisheries Society. Bethesda, MD:83-138.

Bond, M. H. 2006. *Importance of Estuarine Rearing to Central California Steelhead (*Oncorhynchus mykiss*) Growth and Marine Survival*. University of California, Santa Cruz. Santa Cruz, CA.

BonTerra. 2007. *Results of Focused Presence Absence Surveys for the Southwestern Willow Flycatcher and Least Bell's Vireo at the NorthLake Specific Plan Project Site, Near the Community of Castaic in Unincorporated Los Angeles County, California*. Prepared for U.S. Fish and Wildlife Service. Washington, DC. September 14, 2007.

Booth, Michael. 2020. Patterns and Potential Drivers of Steelhead Smolt Migration in Southern California. *North American Journal of Fisheries* Management. DOI: 10.1002/NAFM.10475

Browning, M. R. 1993. "Comments on the taxonomy of *Empidonax traillii* (Willow Flycatcher)." *Western Birds* 24:241-257.

Brumo, A. F. 2006. *Spawning, larval recruitment, and early life survival of Pacific lamprey in the South Fork Coquille River, Oregon*. Master's thesis. Oregon State University, Corvallis, OR.

Bury, B. R. 1986. "Feeding Ecology of the Turtle *Clemmys marmorata*. *Journal of Herpetology* 20(4):515-521. (December 1986).

Cbec Eco Engineering, Inc. 2015. *Santa Clara River Estuary Habitat Restoration and Enhancement Feasibility Study - Existing Conditions Technical Report*. Prepared for Wishtoyo Foundation and Ventura Coastkeeper. http://www.wishtoyo.org/santa-clara-river-estuary-restoration/. Accessed June 2018.

California Department of Fish and Game (CDFG). 1976. *At the Crossroads: A Report on California's Endangered and Rare Fish and Wildlife*. State of California, Sacramento, CA.

California Department of Fish and Wildlife (CDFW). 2005. *Life History Account for the Yellow-breasted Chat. California Wildlife Habitat Relationship System*. California Interagency Wildlife Task Group, California Department of Fish and Game. https://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx. Accessed June 2016.

-----. 2016a. *State and Federally listed Endangered and Threatened Animals of California*. http://www.dfg.ca.gov/wildlife/nongame/t_e_spp/. Accessed July 2016.

-----. 2016b. "RareFind 5." [electronic database]. *California Natural Diversity Database (CNDDB).* https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data. Accessed June 2016.

-----. 2019. Natural Diversity Database. August 2019. Special Animals List. Perioudic publication. 67 pp.

Cardno Entrix. 2010. *2010 Survey for Tidewater Goby,* Eucyclogobius newberryi*, in Santa Clara River Estuary*. Prepared for the City of Ventura. Ventura, CA.

Chase, S. 2001. “Contributions to the life history of adult Pacific lamprey (Lampetra tridentata) in the Santa Clara River of southern California.” *Bulletin of the Southern California Academy of Sciences* 100(2):74-85.

Claire, C. W. 2004. Pacific lamprey larvae life history, habitat utilization, and distribution in the South Fork Clearwater River drainage, Idaho. Master’s thesis. University of Idaho, Moscow.

Clemens, B. J., M. G. Mesa, R. J. Magie, D. A. Young and C. B. Schreck. 2012. “Pre-spawning migration of adult Pacific lamprey, Entosphenus tridentatus, in the Willamette River, Oregon, U.S.A.” *Environmental Biology of Fishes* 93:245–254.

Clemens, B. J., L. Weitkamp, K. Siwicke, J. Wade, J. Harris, J. Hess, L. Porter, K. Parker, T. Sutton, and A. M. Orlolv. 2019. Marine biology of the Pacific lamprey *Entosphenus tridentatus*. Reviews in Fish Biology and Fisheries 29: 767–788.

Clemento, A. J., E. C. Anderson, D. Boughton, D. Girman, and J. C. Garza. 2009. “Population Genetic Structure and Ancestry of Oncorhynchus mykiss Populations Above and Below Dams in South-central California.” *Conservation Genetics* 10:1321-1336.

Dagit, R., M.T. Booth, M. Gomez, T. Hovey, S. Howard, S.D. Lewis, S. Jacobson, M. Larson, D. McCanne, and T.H. Robinson. 2020. Occurrences of Steelhead Trout (Oncorhynchus mykiss) in southern California, 1994-2018. *California Fish and Wildlife* 106(1): 39-58.

Dauble, D.D., R.A. Moursund and M.D. Bleich. 2006. *Swimming behaviour of juvenile Pacific lamprey,* Lampetra tridentata. Environmental Biology of Fishes 75:167–171.

Dawson, H.A., B.R. Quintella, P.R. Almeida, A.J. Treble and J.C. Jolley. 2015. “The ecology of larval and metamorphosing lamprey.” In Docker 2015.

Docker, M.F. editor. 2015. *Lamprey: Biology, Conservation and Control, Volume 1.* Springer: Dordrecht, Netherlands.

Dunn, J.L and J. Alderfer. 2011. *National Geographic Field Guide to the Birds of North America. Sixth Edition*. National Geographic Society. Washington D.C.

eBird. 2016. eBird.org. [Electronic database]. The Cornell Lab of Ornithology. http://ebird.org/content/ebird/. Accessed July 2016. Record confirmed by personal communication from David Pereksta (observer) July 15, 2016 email to Evan Lashly.

Entrix, Inc. 1996. *Results of fish passage monitoring at the Vern Freeman Diversion Facility, Santa Clara River, 1995*. Report prepared for United Water Conservation District. pp. 1-28.

-----. 2004. *VWRF Discharge Beneficial Uses on the Distribution and Utilization of Santa Clara River Estuary Tidewater Goby* Eucylcogobius newberryi. Prepared for Nautilus Environmental. September 17, 2004.

-----. 2007a. *Report of Survey for Tidewater Gobies in the Santa Clara River Lagoon.* With Aquatic Bioassay and Consulting. 21 May 2007.

-----. 2007b. *Report of survey for tidewater gobies in the Santa Clara River lagoon.* With Aquatic Bioassay and Consulting, Inc. 23 October 2007. Prepared for the City of Ventura.

-----. 2008a. *Results of survey for tidewater gobies, Eucyclogobius newberryi, in the Santa Clara River lagoon*. With Aquatic Bioassay and Consulting, Inc. 8 May 2008. Prepared for the City of Ventura.

-----. 2008b. *Results of Survey for Tidewater Gobies, Eucyclogobius newberryi, in the Santa Clara River Lagoon.* With Aquatic Bioassay, Inc. 14 October 2008. Prepared for City of Ventura. November 21. 2008.

-----. 2009. *2009 Survey for Tidewater Goby, Eucyclogobius newberryi, in Santa Clara River Estuary.* Prepared for the City of Ventura. November 19. 2009

Evermann, B.W. and S.E. Meek. 1896. "A Report upon Salmon Investigations in the Columbia River Basin and Elsewhere on the Pacific Coast in 1896." *Bulletin of the United States Fish Commission*. Washington, D.C.

Finch, D. M., and S. H. Stoleson, editors. 2000. *Status, Ecology, and Conservation of the Southwestern Willow Flycatcher.* General Technical Report RMRS-GTR-60. US Department of Agriculture, Forest Service, Rocky Mountain Research Station. Ogden, UT.

Gallo, J. 2007. *Final Report to United States Fish and Wildlife Service for 2006 Regarding Protocol Reporting for Southwestern Willow Flycatcher and Least Bell's Vireo*. Washington, DC. January 28, 2007.

Good, T. P., R. S. Waples, and P. Adams (eds.). 2005. "Updated status of federally listed ESUs of West Coast salmon and steelhead." U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NMFS-NWFSC-66. 598.

Goodman, D.H. and S.B. Reid. 2012. Pacific lamprey (Entosphenus tridentatus) Assessment and Template for Conservation Measures in California. U.S. Fish and Wildlife Service, Arcata, California. Pp. 1-128. https://www.fws.gov/arcata/fisheries/reports/technical/plci_ca_assessment_final.pdf. Accessed June 2016.

-----. 2015. *Regional Implementation Plan for Measures to Conserve Pacific lamprey* (Entosphenus tridentatus), *California - South Coast Regional Management Unit*. U.S. Fish and Wildlife Service. Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report Number TR 2015-26, Arcata, California.

-----. 2017. "Climbing above the Competition: Innovative Approaches and Recommendations for Improving Pacific Lamprey Passage at Fishways." *Ecological Engineering* 107: 224–232.

Goodman, D.H., S.B. Reid, M.F. Docker, G.R. Haas, and A.P. Kinziger. 2008. "Mitochondrial DNA Evidence for High Levels of Gene Flow among Populations of a Widely Distributed Anadromous Lamprey Entosphenus Tridentatus (Petromyzontidae)." *Journal of Fish Biology* 72: 400–417.

Goodman, D.H., S.B. Reid, N.A. Som, and W.R. Poytress. 2015. "The Punctuated Seaward Migration of Pacific Lamprey (Entosphenus tridentatus): Environmental Cues and Implications for Streamflow Management. Can*adian Journal of Fisheries and Aquatic Sciences* 72(12): 1817-1828.

Greaves, J. M. 1989. "Maintaining Site Integrity for Breeding Least Bell's Vireos." *Proceedings of the California Riparian Systems Conference: protection, management, and restoration for the 1990s*.

D. L. Abell, technical coordinator. 1988 September 22-24, Davis, CA. Gen. Tech. Rep. PSW-GTR-110. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture.

Griffith, J.T., and J.C. Griffith. 2000. "Cowbird Control and the Endangered Least Bell's Vireo: A Management Success Story." *Ecology and Management of Cowbirds and their Hosts: Studies in the Conservation of North American Passerine Birds*. Austin, TX: University of Texas Press. 342.

Griffith Wildlife Biology. 2008. *The Status of the Least Bell's Vireo and Southwestern Willow Flycatcher at Heritage Valley Park, Fillmore, California in 2008*. Prepared for Griffin Industries. Fillmore, CA. September 4, 2008.

-----. 2013a. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2012*. Prepared for United Water Conservation District. Santa Paula, CA. February 15, 2013.

-----. 2013b. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2013*. Prepared for United Water Conservation District. Santa Paula, CA. October 22, 2013.

-----. 2014. The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2014. Prepared for United Water Conservation District. Santa Paula, CA. October 14, 2014.

-----. 2015. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2015*. Prepared for United Water Conservation District. Santa Paula, CA. January 5, 2015.

-----. 2016. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2016*. Prepared for United Water Conservation District. Santa Paula, CA. May 6, 2017.

-----. 2017. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy, California in 2017*. Prepared for United Water Conservation District. Santa Paula, CA. March 28, 2018.

-----. 2018. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy and Piru, California in 2018*. Prepared for United Water Conservation District. Santa Paula, CA. December 30, 2018.

-----. 2019. *The Status of the Least Bell's Vireo and Four Other Riparian Bird Species at United Water Conservation District, Saticoy and Piru, California in 2019*. Prepared for United Water Conservation District. Santa Paula, CA. December 28, 2019.

Gunckel, S.L., K.K. Jones, and S.E. Jacobs. 2009. "Spawning Distribution and Habitat Use of Adult Pacific and Western Brook Lampreys in Smith River, Oregon." *American Fisheries Society Symposium* 72:173-189.

Guthrie, D. A. 2006. *Bird surveys along a Portion of the Santa Clara River and its Tributaries Upstream from the Castaic Creek Confluence, Near Valencia, California, 2006*. Prepared for Valencia Corporation. Valencia, CA. October 11, 2006.

Hall, L. 2014. Comment letter to USFWS regarding designation of critical habitat for the western distinct population segment of the yellow-billed cuckoo. 50 CRF 17. Docket ID. FWS-R8-ES-2013-0011-0110.

Holland, D. C. 1985. "Western Pond Turtle (*Clemmys marmorata*): Feeding." *Herpetology Review* 16:112-113.

-----. 1994. *The Western Pond Turtle: Habitat and History.* Final Report. DOE/BP-62137-1. Bonneville Power Administration, U. S. Department of Energy, and Wildlife Diversity Program, Oregon Department of Fish and Wildlife. Portland, OR.

Holland, D. C., and R. B. Bury. 1998. Clemmys marmorata (Baird and Girard 1852) Western Pond Turtle. In P. C. H. Pritchard and A. G. J. Rhodin (eds.) The Conservation Biology of Freshwater Turtles. Chelonian Research Monographs 2(2).

Hovey, T. E. 2004. "Current Status of Southern Steelhead/Rainbow Trout in San Mateo Creek, California." *California Fish and Game Scientific Journal* 90(3): 140-154. Summer 2004.

Jennings, M. R., and M. P. Hayes. 1994. *Amphibian and Reptile Species of Special Concern in California*. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA.

Johnson, N.S., T.J. Buchinger and W. Li. 2015. "Chapter 6, Reproductive Ecology of Lamprey." in Docker 2015.

Kan, T. T. 1975. *Systematics, Variation, Distribution and Biology of Lamprey in the Genus Lampetra in Oregon*. Unpublished doctoral dissertation. Oregon State University, Corvallis, OR.

Keefer, M.L., W.R. Daigle, C.A. Peery, H.T. Pennington, S.R. Lee, and M.L. Moser. 2010. "Testing Adult Pacific Lamprey Performance at Structural Challenges in Fishways." *North American Journal of Fisheries Management* 30:376–385.

Kelley, E. 2008. Steelhead Smolt Survival in the Santa Clara and Santa Ynez River Estuaries. Prepared for the California Department of Fish and Game. University of California, Santa Barbara, August 2008. 61 pp.

Kemp P.S., T. Tsuzaki, and M.L. Moser. 2009. "Linking Behavior and Performance: Intermittent Locomotion in a Climbing Fish." *Journal of Zoology* 277:171–178.

Krueger, Laura. 2017. Orange County Mosquito and Vector Control District, personal communication, 2017

Labinger and Greaves. 2001. Summary report of avian studies (1994-1999) following the ARCO/Four Corners January 17, 1994 oil spill on the Santa Clara River, California. Report prepared for U.S. Fish and Wildlife Service, Ventura, California.

Lampman, R. T. 2011. Passage, migration, behavior, and autoecology of adult Pacific lamprey at Winchester Dam and within the North Umpqua River Basin, OR. Master's thesis. Oregon State University, Corvallis.

Laymon, S. A. and M. D. Halterman. 1987. "Can the Western Subspecies of the Yellow-billed Cuckoo be Saved from Extinction?" *Western Birds* 18(1):19-25.

-----. 1989. A Proposed Habitat Management Plan For Yellow-Billed Cuckoos In California. USDA Forest Service General Technical Report. PSW-110. 272-277.

Lemm, J. 2006. *Field Guide to Amphibians and Reptiles of the San Diego Region (California Natural History Guides*). University of California Press. Berkeley, CA.

LSA Associates, Inc. (LSA). 2006. *Southwestern Willow Flycatcher and Least Bell's Vireo Survey Results*. Interstate 5 HOV/Truck Lanes Project, Unincorporated areas of Los Angeles County and the City of Santa Clarita, California. LSA Project No. SIB0601, Task 306.05.

Luzier, C.W., H.A. Schaller, J.K. Brostrom, C. Cook-Tabor, D.H. Goodman, R.D. Nelle, K. Ostrand and B. Streif. 2011. *Pacific Lamprey (*Entosphenus tridentatus*) Assessment and Template for Conservation Measures*. U.S. Fish and Wildlife Service. Portland, OR.

Manzon, R.G., J.H. Youson and J.A. Holmes. 2015. "Chapter 4 Lamprey Metamorphosis." in Docker 2015.

Maynard, W. R. 1995. *Summary of 1994 Survey Efforts in New Mexico for Southwestern Willow Flycatcher* (Empidonax traillii extimus). Contract #94-516-69. New Mexico Department of Game and Fish, Santa Fe, NM.

Moser M.L., and D.A. Close. 2003. "Assessing Pacific Lamprey Status in the Columbia River Basin." *Northwest Science* 77:116-125.

McCammon, G. 1953. *The Pacific lamprey, Entosphenus tridentatus, in Sespe Creek, Ventura County*. Field Correspondence - April 15, 1953, California Department Fish and Game. Whittier, CA. 3.

McGree, M., T.A. Whitesel, and J. Stone. 2008. "Larval metamorphosis of individual Pacific lampreys reared in captivity." *Transactions of the American Fisheries Society* 137:1866-1878.

Meckley, T.D., E. Gurarie, and C.M. Wagner. 2014. "Coastal Movements of Migrating Sea Lamprey (*Petromyzon marinus*) in Response to a Partial Pheromone Added to River Water: Implications for Management of Invasive Populations." *Canadian Journal of Fisheries and Aquatic Sciences* 71(4): 533-544.

Meeuwig, M.H., J.M. Bayer, and J.G. Seelye. 2005. "Effects of Temperature on Survival and Development of Early Life Stage Pacific and Western Brook Lamprey." *Transactions of the American Fisheries Society* 134:19-27.

Merz, J. E. 2002. "Seasonal Feeding Habits, Growth, and Movement of Steelhead Trout in the Lower Mokelumne River, California." *California Fish and Game* 88(3):95-111.

Mesa, M.G., J.M. Bayer, and J.G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lamprey. Transactions of the American Fisheries Society 132: 483-492.

Moore, M.R. 1980. *An assessment of the impacts of the proposed improvements to the Vern Freeman Diversion on anadromous fishes of the Santa Clara River system, Ventura County, California*. Prepared for the Ventura County Environmental Resources Agency. Contract Number 670. July 1980.

Moser, M.L., P.R. Almeida, P.S. Kemp and P.W. Sorensen. 2015. "Chapter 5: Lamprey Spawning Migration." In Docker 2015.

Moursund, R.A., D.D. Dauble and M.D. Bleich. 2000. *Effects of John Day Dam Bypass Screens and Project Operations on the Behavior and Survival of Juvenile Pacific Lamprey* (Lampetra tridentata). Final report to U.S. Army Corps of Engineers. Portland. Batelle, Pacific Northwest National Laboratory, Richland, WA. 34.

Moyle, P. B. 2002. *Inland fishes of California: Revised and Expanded*. University of California Press: Berkeley, CA.

Moyle, P.B., L.R. Brown, S.D. Chase, and R.M. Quiñones. 2009. Status and Conservation of Lamprey in California. American Fisheries Society, Symposium 72, Bethesda, Maryland.pp. 279-292.

Murauskas, J. G. A. M. Orlov, and K. A. Siwicke. 2013. Relationships between the abundance of Pacific lamprey in the Columbia River and their common hosts in the marine environment. Transactions of the American Fisheries Society 142: 143–155.

Natural History Museum of Los Angeles County. 1975. Dead lamprey collected in Sespe Creek near Fillmore about 10.8 km upstream of confluence with Santa Clara River on May 24, 1975. Collection number 35227.001. Collectors M.A. Bell and T.R. Haglund. https://www.idigbio.org/portal/records/148d8b43-3976-4e69-86b3-18f99695e148. Accessed June 2020.

-----. 1981. Collection number 45700.001. Six lamprey collected from Sespe Creek at Bear Canyon, 3 miles east of Piedra Blanca Camp, in mucky side pool on May 8, 1981. Collector S. Sweet. https://www.idigbio.org/portal/records/61b02351-e7cb-4a8a-9af8-3f79b36cc5ed. Accessed June 2020.

NatureServe. 2016. *NatureServe Explorer: An online encyclopedia of life.* [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer. Accessed May 2016.

Nawa, R.K., J.E. Vaile, P. Lind, T.M. K Nadananda, T. McKay, C. Elkins, B. Bakke, J. Miller, W. Wood, K. Beardslee, and D. Wales. 2003. "A Petition for Rules to List: Pacific lamprey (*Lampetra tridentata*), River Lamprey (*Lampetra ayresi*), Western Brook Lamprey (*Lampetra richardsoni*), and Kern Brook Lamprey (*Lampetra hubbsi*) as Threatened or Endangered under the Endangered Species Act." January 23, 2003.

Nevada Partners in Flight. 1999. *Bird Conservation Plan*. L. Neel, editor. November 29, 1999.

Nielsen, J. L., C. Carpanzano, M. C. Fountain, and C. A. Gan. 1997. "Mitochondrial DNA and Nuclear Microsatellite Diversity in Hatchery and Wild *Oncorhynchus mykiss* from Freshwater Habitats in Southern California." T*ransactions of the American Fisheries Society* 126:397-417.

National Marine Fisheries Service (NMFS). 1996. *Factors for Decline, a Supplement to the Notice of Determination for West Coast Steelhead*. Silver Spring, MD.

-----. 2008. Biological Opinion issued by NMFS related to United Water's proposed operation of the Freeman Diversion and the fish-passage facility. Silver Spring, MD. 44.

-----. 2012. *Southern California Steelhead Recovery Plan*. National Marine Fisheries Service, Southwest Regional Office, Protected Resources Division, Long Beach, CA.

-----. 2016. *Five-year Review: Summary and Evaluation of Southern California Coast Steelhead Distinct Population Segment*. National Marine Fisheries Service. West Coast Region. California Coastal Office. Long Beach, CA.

Orlov, A. M., R. J. Beamish, A. V. Vinnikov, and D. Pelenev. 2009. "Feeding and Prey of Pacific Lamprey in Coastal Waters of the Western North Pacific. American Fisheries Society, Symposium 69, Bethesda, Maryland. pp. 875-877.

Orlov, A.M., V.F. Savinyh and D.V. Pelenev. 2008. Features of the spatial distribution and size structure of the Pacific lamprey, Lampetra tridentata, in the North Pacific. Russian Journal of Marine Biology, 2008, Vol. 34, No. 5, pp. 276–287.

Parker K. A. 2018. Evidence for the genetic basis of inheritance of ocean and river-maturing ecotypes of Pacific Lamprey (*Entosphenus tridentatus*) in the Klamath River, California. Master's thesis. Humboldt State University, Arcata, California.

Phillips, A. 1948. "Geographic Variation in Empidonax traillii." *The Auk* 65:507-514.

Pletcher, F. T. 1963. *The Life History and Distribution of Lamprey in the Salmon and Certain Other Rivers in British Columbia, Canada*. Unpublished Master's thesis. University of British Columbia, Vancouver. B.C.

Potter, I. C., and F. W. H. Beamish. 1975. Lethal temperatures in ammocoetes of four species of lampreys. Zoologica 56: 85–91.

Potter, I.C., B.J. Hill, and S. Gentleman. 1970. Survival and behavior of ammocoetes at low oxygen tensions. Journal of Experimental Biology. 53:59-73.

Puckett, L.K. and N.A. Villa. 1985. *Lower Santa Clara River Steelhead Study. State of California Department of Fish and Game.* Report Prepared under Interagency Agreement No. B54179 funded by the California Department of Water Resources. Sacramento, CA.

Reid, S.B. 2015. *Assessment of Occupancy and Potential Habitat for Pacific Lamprey (Entosphenus tridentatus) in the Santa Clara River Basi*n. Report to United Water Conservation District. Santa Paula CA.

Reid, S.B. and D.H. Goodman. 2016a. "Pacific Lamprey in Coastal Drainages of California: Occupancy Patterns and Contraction of the Southern Range." *Transactions of the American Fisheries Society* 145(4): 703-711.

Reid, S.B. and D.H. Goodman. 2016b. "Free-swimming Speeds and Behavior in Adult Pacific Lamprey, *Entosphenus tridentatus*." *Environmental Biology of Fishes* 99(12): 969-974.

Reid, S.B. and D.H. Goodman unpublished data

Reinhardt, U.G., L. Eidietis, S.E. Friedl and M.L. Moser. 2008. "Pacific Lamprey Climbing Behavior." *Canadian Journal of Zoology* 86:1264–1272.

Renaud, C.B. 2008. "Petromyzontidae, Entosphenus tridentatus: southern distribution record, Isla Clarión, Revillagigedo Archipelago, Mexico." *Check List* 4(1): 82–85.

-----. 2011. Lamprey of the world. An annotated and illustrated catalogue of lamprey species known to date, FAO Species Catalogue for Fishery Purposes. No. 5. Rome, FAO. pp. 1-109.

-----. 2018. "Loss of dendritic connectivity in southern California's Urban Riverscape Facilitates Decline of an Endemic Freshwater Fish." *Molecular Ecology* 27: 369-386.

Robinson, T. C. and J. M. Bayer. 2005. Upstream migration of Pacific lampreys in the John Day River, Oregon: behavior, timing, and habitat use. Northwest Science 79: 106–119.

Riparian Habitat Joint Venture. 2002. "Least Bell's vireo (Vireo bellii pusillus)." *The Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Riparian-Associated Birds in California.* A project of California Partners in Flight and the Riparian Habitat Joint Venture. Stinson Beach, CA.

Ruiz-Campos, G. and S. Gonzalez-Guzman. 1996. "First Freshwater Record of Pacific Lamprey, *Lampetra tridentata*, from Baja California, Mexico." *California Fish and Game* 82:144-146.

Ryan Ecological Consulting. 2008. *The Results of Least Bell's Vireo Surveys Santa Clara River Weir Field Downstream of Highway 101*. Ventura County Watershed Protection District. Ventura County, CA. April-July 2008. Prepared for PBS&J. July 14, 2008.

Sferra, S. J., R. A. Meyer, and T. E. Corman. 1995. *Arizona Partners in Flight 1994 Southwestern Willow Flycatcher Survey*. Nongame and Endangered Wildlife Program Technical Report 69. Arizona Game and Fish Department. Phoenix, AZ.

Shapovalov, L. 1944a. *Preliminary report on the fisheries of the Santa Ynez River system, Santa Barbara County, California*. California Department of Fish and Game. Inland Fish. Admin Report No. 44-14.

-----. 1944b. *Preliminary report on the fisheries of the Santa Maria River system, Santa Barbara, San Luis Obispo and Ventura Counties, California*. California Department of Fish and Game. Inland Fish. Admin Report No. 44-15. pp. 1-11.

Shapovalov, L., and A. C. Taft. 1954. "Life Histories of the Steelhead Rainbow Trout (*Salmo qairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with Special Reference to Waddell Creek, California, and Recommendations Regarding Their Management." California Department of Fish and Game, Fish Bulletin. No. 98.

Shirakawa, H., S. Yanai, and A. Goto. 2013. Lamprey larvae as ecosystem engineers: physical and geochemical impact on the streambed by their burrowing behavior. Hydrobiologia 701(1):313–322.

Shuford, W. D., and T. Gardali, editors. 2008. *California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds No. 1*. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

Slavens, K. 1995. "The status of the western pond turtle in Klickitat County, including notes on the 1995 survey of Lake Washington, King County." Unpublished report. on file at the Washington Department of Fish and Wildlife. . Kelso, WA.

Sloat, M. R., and Osterback, A. K. 2013. "Maximum Stream Temperature and the Occurrence, Abundance, and Behavior of Steelhead Trout (*Oncorhynchus mykiss*) in a Southern California Stream." *Canadian Journal of Fisheries and Aquatic Science*. 70: 64–73.

Small, A. 1994. *California Birds: Their Status and Distribution*. Vista, CA: Ibis Publishing.

Smith, J. J. 1990. *The Effects of Sandbar Formation and Inflows on Aquatic Habitat and Fish Utilization in Pescadero, San Gregorio, Waddell and Pomponio Creek Estuary/Lagoon Systems, 1985–1989*. Report prepared by San Jose State University under Interagency Agreement 84-04-324 for the California Department of Parks and Recreation, Sacramento, California.

Spice, E.K., Goodman, D.H., Reid, S.B. and M.F. Docker. 2012. "Neither Philopatric nor Panmictic: Microsatellite and mtDNA Evidence Suggests Lack of Natal Homing but Limits to Dispersal in Pacific Lamprey." *Molecular Ecology* 21:2916-2930.

Spina, A. P. 2007. "Thermal Ecology of Juvenile Steelhead in a Warm Water Environment." *Environmental Biology of Fishes* 80: 23–24.

Spinks, P.Q. and H.B. Shaffer. 2005. "Range-wide Molecular Analysis of the Western Pond Turtle (*Emys marmorata*): Cryptic Variation, Isolation by Distance, and their Conservation Implications." *Molecular Ecology* 14(7): 2047-2064.

Stebbins, R. C. 2003. *A Field Guide to Western Reptiles and Amphibians. 3rd Edition*. Houghton Mifflin Company. New York, NY.

Stillwater Sciences. 2007a. *Santa Paula Creek Watershed Planning Project : Steelhead Habitat and Population Assessment*. Technical memorandum. Prepared for Santa Paula Creek Fish Ladder Joint Powers Authority and the California Department of Fish and Game. Sacramento, CA. December 2007.

-----. 2007b. *Focal Species Analysis and Habitat Characterization for the Lower Santa Clara River and Major Tributaries Ventura County, California. Final Report.* Prepared for the California Coastal Conservancy. Sacramento, CA.

-----. 2018. *City of Ventura Special Studies – Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California*. Final Report. Prepared for City of Ventura. February 2018.

Stoecker, M. and E. Kelley. 2005. *Santa Clara River Steelhead Trout: Assessment and Recovery Opportunities*. Prepared for the Santa Clara River Trustee and Council and the Nature Conservancy. Ventura, CA.

Stone, J. 2006. "Observations on Nest Characteristics, Spawning Habitat, and Spawning Behavior of Pacific and Western Brook Lamprey in a Washington Stream." *Northwestern Naturalist* 87:225-232.

Swift, C.C. and S.R. Howard. 2009. "Current Status and Distribution of the Pacific Lamprey South of Point Conception, Coastal Southern California, USA." *American Fisheries Society Symposium* 72:269-278.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. "The Status and Distribution of the Freshwater Fishes of Southern California." *Bulletin of the Southern California Academy of Science* 92(3):101-167.

Swift, C. C., J. L. Nelson, C. Maslow, and T. Stein. 1989. "Biology and Distribution of the Tidewater Goby, *Eucyclogobius newberryi* (*Pisces: :Gobiidae*), of California." Natural History Museum of Los Angeles County. 404:1-19.

Swift, C.C., B. Spies, R.A. Ellingson, and D.K. Jacobs. 2016. "A New Species of the Bay Goby Genus Eucyclogobius, Endemic to Southern California: Evolution, Conservation, and Decline." PloS One11: e0158543.

Swift, C.C., J. Mulder, C. Dellith, and K. Kittleson. 2018. Mortality of Native and Non-native Fishes during Artificial Breaching of Coastal Lagoons in Southern and Central California. Bulletin, Southern California Academy of Sciences. 117(3):157-168.

Titus, R. G., D. C. Erman, and W. M. Snider. 1994. History and Status of Steelhead in California Coastal Drainages South of San Francisco Bay. Draft. Department of Fish and Game, *Fish Bulletin.*

Torgensen, C. E. and D. A. Close. 2004. Influence of habitat heterogeneity on the distribution of larval Pacific lamprey (*Lampetra tridentata*) at two special scales. Freshwater Biology 49: 614-630.

Unitt, P. 1987. "Empidonax traillii extimus: an endangered subspecies." *Western Birds* 18:137-162.

United Water Conservation District (United). 2016a. Fish passage data collected at the Freeman Diversion. [Unpublished raw data]. Santa Paula, CA

-----. 2016b. *Fish passage monitoring at the Freeman Diversion, 1993-2014*. Santa Paula, CA. http://www.unitedwater.org/images/stories/Resource-Conservation/Freeman-Diversion/Monitoring-Reports/Booth_2016-focal_spp_report.pdf.

-----. 2016c. Species observations submitted to the California Natural Diversity Database. [Unpublished data]. Santa Paula, CA.

United Water Conservation District (United), Rincon Consultants, Inc., and Cardno Entrix. 2015. *Screening Assessment, Covered Activities and Covered Species*. Prepared for United Water Conservation District. Santa Paula, CA. Updated February 2015.

U.S. Forest Service (USFS). 1979. *Fish and Habitat Surveys of Sespe and Santa Paula and Their Principal Tributaries.* Cited from Appendix V in Stoecker and Kelley (2005).

U.S. Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants, notice of a 1-year petition finding on the western pond turtle. Federal Register 58:42717-42718.

-----. 1998. *Draft Recovery Plan for the Least Bell's Vireo (Vireo bellii pusillus)*. Prepared by U.S. Fish and Wildlife Service, Region 1. Portland Oregon.

-----. 2000b. "Endangered and Threatened Wildlife and Plants, Designation of Critical Habitat for the Tidewater Goby." Final rule. *Federal Register* 65(224):69693-69717.

-----. 2002. *Final Recovery Plan Southwestern Willow Flycatcher* (Empidonax traillii extimus). Prepared for U.S. Fish and Wildlife Service, Region 2. Albuquerque, New Mexico.

-----. 2004. "Endangered and Threatened Wildlife and Plants, 90-Day Finding on Petition to List Three Species of Lamprey as Threatened or Endangered." *Federal Register* 69(247): 77158-77167.

-----. 2005. *Recovery Plan for the Tidewater Goby* (Eucyclogobius newberryi). Portland, OR.

-----. 2006. *Least Bell's Vireo (Vireo bellii pusillus) 5-year Review Summary and Evaluation*. Carlsbad Fish and Wildlife Office. Carlsbad, CA.

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS). 2016. Habitat Conservation Planning and Incidental Take Permit Processing Handbook. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. https://www.fws.gov/midwest/endangered/permits/hcp/hcphandbook.html.

Villa, N.A. and R.L Palmer. 1983. *Lower Santa Clara River Steelhead Study - A Status Report.* California Department of Fish and Game. Sacramento, CA. October 1983.

Vrieze L. A, R. A. Bergstedt, and P.W. Sorensen. 2011. "Olfactory-mediated stream Finding Behavior of Migratory Adult Sea Lamprey (*Petromyzon marinus*)." *Canadian Journal of Fisheries and Aquatic Sciences* 68: 523–533.

Waldman J., C. Grunwald and I. Wirgin. 2008. "Sea lamprey *Petromyzon marinus*: An Exception to the Rule of Homing in Anadromous Fishes." Biology Letters 4(6):659–662. September 2008.

Werner, S.M. 2013a. *Least Bell's Vireo (Vireo bellii pusillus) Protocol Survey and Territory Mapping on the Santa Clara River Oxnard, Ventura County, 2013*. Prepared by Scott Werner for the Ventura County Watershed Protection District. September 2013.

-----. 2013b. Southwestern Willow Flycatcher (Empidonax traillii extimus) Protocol Survey on the Santa Clara River Oxnard, Ventura County, 2013. Prepared by Scott Werner for the Ventura County Watershed Protection District. September 2013. 35pp.

-----. 2015a. *Least Bell's Vireo (Vireo bellii pusillus) Protocol Survey and Territory Mapping for the Santa Clara River Levee Improvements Downstream of Union Pacific Railroad (SCR-3), Ventura County, 2015*. Prepared by Scott Werner for Aspen Environmental Group and the Ventura County Watershed Protection District. September 2015.

-----. 2015b. Southwestern Willow Flycatcher (Empidonax traillii extimus) Protocol Survey for the Santa Clara River Levee Improvements Downstream of Union Pacific Railroad (SCR-3, Ventura County, 2015). Prepared by Scott Werner for Aspen Environmental Group and the Ventura County Watershed Protection District. September 2015. 35pp.

Whitfield, M.J. 1990. *Willow Flycatcher Reproductive Response to Brown-Headed Cowbird Parasitism*. Unpublished Master's Thesis. California State University, Chico. Chico, CA.

Wiggins, D. 2005. *Yellow-billed Cuckoo (*Coccyzus americanus*): a Technical Conservation Assessment*. USDA Forest Service, Rocky Mountain Region. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5182002.pdf.

Wydoski, R. S. and R. R. Whitney. 2003. *Inland Fishes of Washington. Second Edition, Revised and Expanded*. American Fisheries Society: Bethesda, MD and University of Washington Press: Seattle, WA. 35.

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5 CONSERVATION PROGRAM

The conservation program outlined in this chapter is intended to meet the permit issuance criteria for the two federal permits (listed below). United has established a set of biological goals and objectives for the MSHCP, as required by the HCP Handbook (USFWS and NMFS 2016), to guide the management actions that make up the conservation program. This chapter describes these goals and objectives, along with the conservation program (outlined in conservation measures) established to achieve or exceed the ITP issuance criteria.

To meet the statutory requirements for approval and issuance of ITPs under Sections 7 and 10 of the ESA, the Services must find that, based on the conservation strategy in this MSHCP:

1. The taking will be incidental[1];
2. The applicant will, to the maximum extent practicable, monitor, minimize, and mitigate the impacts of such taking;
3. The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild;
4. The applicant will ensure that the conservation plan will include any measures that the Services may require as being necessary or appropriate; and
5. There are adequate assurances that the conservation plan will be funded and implemented, including any measures required by the Services (see Chapter 8, *Implementation* for a discussion of changed and unforeseen circumstances, and Chapter 9, *Cost and Funding*, for a discussion of funding sources and funding assurances).

5.1 BIOLOGICAL GOALS AND OBJECTIVES

The purpose of identifying biological goals and objectives is to establish a framework for the management actions that make up the MSHCP conservation program. The goals and objectives were developed to be commensurate with the level of effects and amount of potential take or potential effects expected to result from the covered activities. According to the HCP Handbook, biological goals are "descriptive, open-ended, and often broad statements of desired conditions that convey a purpose." The goals describe the desired outcome of the MSHCP and provide the rationale behind the minimization and mitigation that make up the conservation program. Biological objectives are "… the incremental steps taken to achieve a goal. Objectives are derived from goals, and they provide a foundation for determining conservation measures, monitoring direction, and evaluating effectiveness of the conservation strategy." The goals and objectives of this MSHCP are as follows:

Goal 1 Provide conditions that approximate an unimpeded steelhead and lamprey migratory corridor in the lower Santa Clara River.

> **Objective 1.1**: Provide physical and fluvial conditions at and through the Freeman Diversion to approximate unimpeded migration of adult and juvenile steelhead and lamprey.

[1] Incidental means, with respect to an act, a non-intentional or accidental act that results from, but is not the purpose of, carrying out an otherwise lawful action (50 CFR 229.2)

Objective 1.2: Minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) to and from the Santa Clara River estuary and the Freeman Diversion, for the permit term.

Goal 2 Maintain or improve habitat for least Bell's vireo, southwestern willow flycatcher, yellow-billed cuckoo, and western pond turtle in the Santa Clara River.

Objective 2.1: Minimize impacts of renovation of the Freeman Diversion to riparian and riverine habitat for the covered species and to individuals of the covered species.

Objective 2.2: Minimize impacts of maintenance of the renovated Freeman Diversion on riparian and riverine habitat for the covered species and to individuals of the covered species.

Objective 2.3: Mitigate the loss of riparian habitat for covered species through on-site riparian restoration at 1:1 ratio within 5 years or purchase of equivalent mitigation credits at an approved mitigation bank.

5.2 CONSERVATION MEASURES

To achieve the biological goals and objectives of this MSHCP, United has developed conservation measures covering the physical design of facilities and their operations; avoidance, minimization, and mitigation of potential take to the maximum extent practicable; and restoration, conservation, and enhancement of habitat. A description of the conservation measures follows, under their corresponding goals and objectives. Conservation measures are provided in a text box along with their corresponding action items. A general discussion follows each text box, to provide context on why and how each conservation measure was developed and provide additional details on how United will implement each conservation measure.

5.2.1 CONSERVATION MEASURES UNDER GOAL 1, OBJECTIVE 1.1

CONSERVATION MEASURE 1.1.1

CONSERVATION MEASURE 1.1.1

Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion

A vertical slot fish passage facility with north and south entrances and associated crest gates will be constructed, operated, and maintained at the Freeman Diversion.

Development of Conservation Measure

The Freeman Diversion was constructed in 1991 and included a fish passage facility, required at the time of construction by California Fish and Game (now CDFW) and the State Water Resources Control Board. The permanent diversion structure resists damage by floods and can resume diversion of surface water shortly after the peak flows associated with storm events.

The Freeman Diversion facility currently consists of the following primary components:

1) A 1,200–foot (366–meter) long, roller–compacted concrete diversion structure that spans the Santa Clara River approximately 10 miles (16 kilometers) upstream from the river mouth at the Pacific Ocean

2) Headworks with the following component elements:
    a. Roller gate
    b. Bypass channel (also referred to in some documents as the “flushing channel” or “sluicing channel”)
    c. Canal control and head control gates
    d. Trash rack
3) Denil fish ladder intended to pass upstream migrating adult steelhead
4) Fish screen bay with the following component elements:
    a. Fish screens (160 feet long, 8 feet high, 3/16 inch openings) and associated wipers
    b. Auxiliary bypass gate
    c. Fish bypass pipe intended to pass downstream migrating steelhead
    d. Fish trap
5) Rubicon gate that allows finer–tuned water diversion at low flow into the Freeman canal

Following construction of the Freeman Diversion, southern California steelhead were listed as federally endangered and United pursued incidental take coverage under Section 7 of the ESA. A federal nexus was established through the Bureau of Reclamation based on a loan agreement, and Reclamation consulted with NMFS regarding the operation of the Freeman Diversion Project; this culminated in a final jeopardy biological opinion (BO) with reasonable and prudent alternatives (RPA) in 2008. Reclamation concluded that it had no authority to adopt or enforce the RPA and thus the BO was not adopted by Reclamation. However, United agreed to a process in which a panel of fish passage experts would evaluate fish passage at the Freeman Diversion. The panel was given criteria and guidance from NMFS to evaluate the current fish passage system (i.e., the Denil fish ladder) and was charged with recommending feasible options to improve fish passage. Based on their assessment, the panel made the determination that “the existing fishway was not an adequate fish passage system” (VFDFPP 2010). The Panel recommended that the Vertical Slot Fishway and the Hardened Ramp concepts receive further consideration as potential alternatives for a new passage facility at the diversion. The Panel provided recommendations for improving passage through the existing facility, but concluded that “these potential improvements to the existing fishway, when performed together, are essentially the same as, and with no apparent cost advantage over the vertical slot or nature-like fishways.” (VFDFPP 2010).

The new fish passage facilities are designed to meet the criteria and guidance stated by NMFS northwest region (NMFS 2011), NMFS southwest region (NMFS 1997), and California Department of Fish and Wildlife (CDFW) Statewide Fish Screening Policy and applicable sections of the California Salmonid Stream Habitat Restoration Manual Part XII (CDFW 2009). Additionally, in an Amicus Brief filed by NMFS on January 19, 2018 in litigation brought against United by third parties, NMFS provided guidance for choosing a preferred alternative that is expected to meet issuance criteria for an incidental take permit under Section 10(a)(1)(B) of the ESA. United used this guidance to design the Freeman Diversion fish passage facility renovation. Criteria for the new facility design also include the ability to pass flows of 750 cubic feet per second (cfs) into the diversion canal once United acquires a modified future instantaneous diversion right anticipated in 2027.

During litigation of a citizen lawsuit brought by Wishtoyo, *et al*. against United, the hardened ramp, a gated partial notch, and infiltration gallery were discussed in detail. In the meantime, United also pursued more detailed investigation of the vertical slot alternative recommended by the panel and, prior to the court issuing a ruling in the case, United concluded that a vertical slot fish passage system would be the best alternative to meet the needs of the biological resources in the river while balancing the water resource needs of the community. This decision was bolstered by the fact that a vertical slot fish passage facility could be protected during catastrophic floods and remain functional, because flood years offer significant fish passage opportunities. United's board directed staff to proceed with the third administrative draft of the MSHCP focused on a vertical slot alternative, which was submitted to the resource agencies on September 7, 2018.

Just 16 days later, the Court issued a decision in the case. Among other things, the Court required United to proceed with design work on the hardened ramp and gated notch, while also recognizing that the vertical slot or infiltration gallery could continue to be studied. At the time of its ruling, however, the Court was not aware of the considerable progress and conclusions that United had reached regarding the vertical slot.

Immediately after the trial, but prior to issuing its decision, the Court requested from NMFS (although not a party to the litigation) "…which alternative fish passage design (or designs) should the Court specify?" (INSERT CITATION). In their January 19, 2018 Amicus Brief, NMFS recommended two design alternatives be considered further:(1) the Northwest Hydraulics Consultants, Inc., November 2017 report, (p. 44) Alternative 2 (the "notch alternative"); and (2) the hardened ramp described in AECOM et al. (2016). The Amicus Brief went on to state:

> In an effort to promote efficiency and level of cost control, United and NMFS could benefit from the following process: (1) develop each alternative to the 70% feasibility design level; (2) make modifications to each alternative to achieve NMFS's recommended steelhead passage goal and six related objectives (described below); (3) carry out a process with NMFS's input for comparing and selecting the preferred alternative; (4) conduct physical modeling of the preferred alternative; (5) advance the preferred alternative to 100% design; and (6) construct and implement the preferred alternative.

NMFS' six fish passage objectives presented in the Amicus Brief that were "expected to result in safe, timely, and effective upstream and downstream passage for migrating steelhead" (Spina Decl. in support of the Amicus Brief at 6:11-8:16) were the following:

(a) Improve steelhead-passage opportunity spatially (through the project impact area) …[2] for all flows between 45 to 6,000 cfs;

(b) Not interrupt steelhead-passage opportunities by facility operations for sediment management or other maintenance;

(c) Create upstream and downstream passage in the form of ramps;

(d) Preclude nuisance attraction flows over the range of steelhead passage flows;

(e) Steelhead should not be challenged by or be required to transit partially open gates and/or weirs; and

(f) Install fish screens that protect all life stages of steelhead, by fish screen designs meeting the most recent NMFS fish-screening guidelines that work in conjunction with any proposed ramps and associated headworks.

[2] The other part of this sentence refers to steelhead migration timing which is discussed in detail in other sections of the MSHCP and is not an engineering design criterion.

The Court's September 23, 2018 judgment in the litigation directs United to "strongly consider" and reject "only with clearly articulable reasons" the fish passage design objectives identified in the Amicus Brief.

Thereafter, United continued design work on the hardened ramp, gated notch, and vertical slot fish passage design alternatives. At a status conference on June 3, 2019, the Court requested that United and NMFS technical staff and engineers meet to decide on a pathway to selecting a fish passage alternative to carry forward in the MSHCP. United and NMFS biologists, ESA practitioners, and engineers met and developed an Action Plan and Schedule (Action Plan). On June 12, 2019, United submitted the Action Plan to the Court detailing a process to select a preferred fish passage alternative to carry forward in the MSHCP. The Action Plan involved bringing each of the three alternatives to a hydraulic basis of design stage, so that NMFS could then provide guidance on each hydraulic basis of design report and prepare a guidance document that synthesized comments on each fish passage design alternative. United could then consult all of the guidance in order to make a final decision on which fish passage design alternative to carry forward in the MSHCP. Following the Action Plan, and after careful consideration of all of the guidance, United selected the vertical slot fish passage system as the preferred functional and most practicable alternative to be carried forward in the MSHCP (see Chapter 10 for comparison to other alternatives).

The current design for the vertical slot has undergone several iterations and is a traditional style of fish ladder with a long history of successful operation in passing steelhead and salmon. It was developed by the International Pacific Salmon Fisheries Commission to provide fish passage through a large land slide area at Hell's Gate on the Frasier River in British Columbia. Due to the slide, there was a large sediment debris load, and the vertical slot ladder design is proven to pass both sediment and debris load in high sediment conditions.

Discussion

The vertical slot fish passage facility (Figure 5-1) is intended to be constructed and operated in a manner that approximates unimpeded upstream and downstream passage of steelhead. The fish passage facility has been designed with the intention to meet and exceed criteria recommended in the NMFS Anadromous Salmonid Passage Facility Design manual (NMFS 2011) as well as to meet or exceed all relevant fish passage design criteria recommended in the Amicus Brief and the Court's December 1, 2018 Amended Judgment.

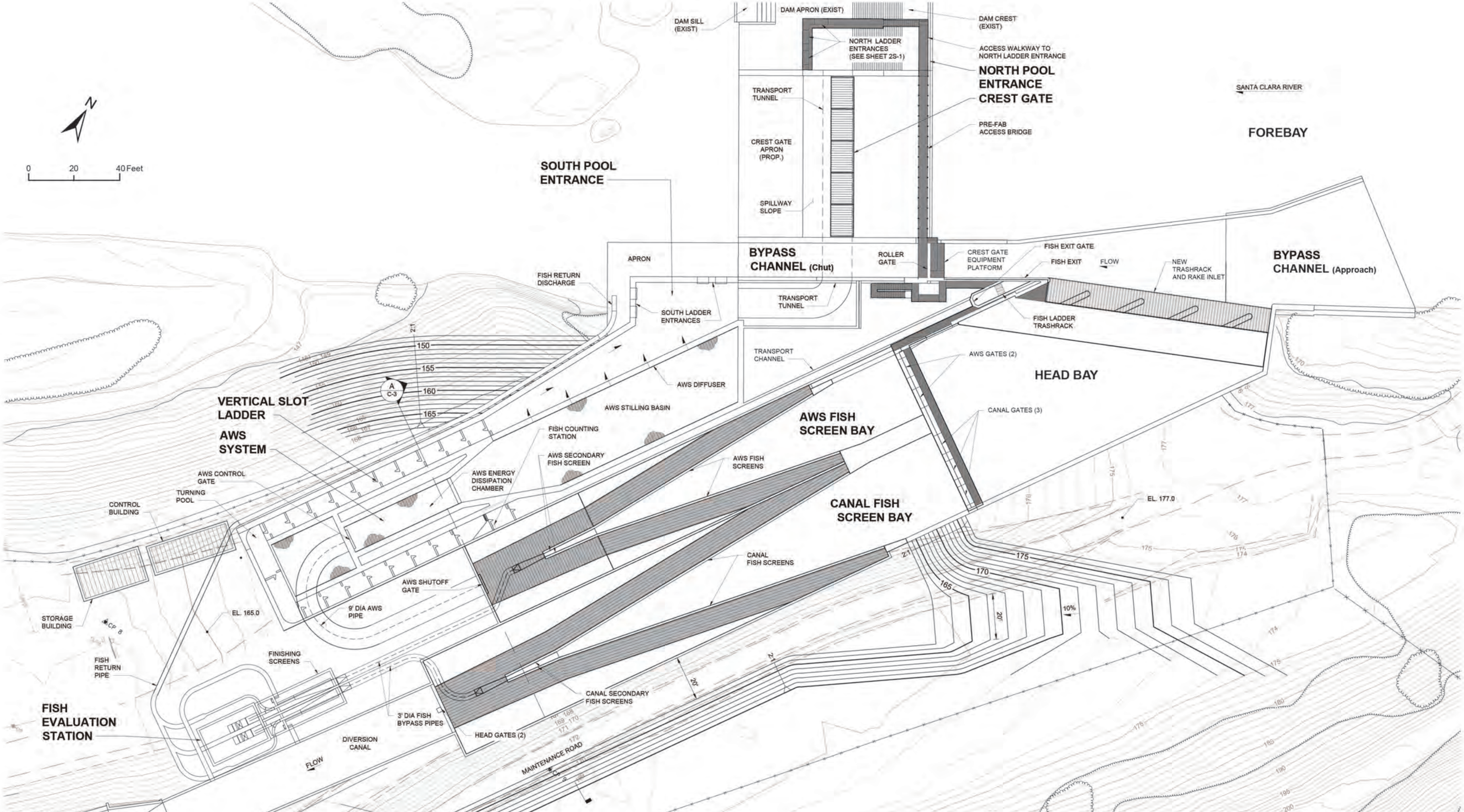
The fish passage facility would consist of a system of flow pathways that will provide spatial concentration of flows to the south side of the river, fish passage attraction flow, reliable fish passage, updated monitoring ability, and reliable diversions. The system consists of the following components:

- Crest gates
- Bypass channel approach
- Roller gate
- Bypass channel chute
- Vertical slot fish way with:
    - Entrance pools
    - North entrance pool
    - Transport tunnel
    - South entrance pool
    - Vertical slot ladder

    - Fish counting station
    - Transport channel
- Fish exit
- Auxiliary water system (AWS) with:
    - Trash rack [Inlet]
    - Head bay
    - AWS gates
    - AWS fish screen bay [AWS approach channel]
    - Primary AWS fish screen
    - Secondary AWS fish screen
    - Fish return and finishing screen
    - Evaluation station
    - Fish return discharge
    - AWS stilling basin and diffusion system
- Canal facilities with:
    - Inlet
    - Canal gates
    - Canal fish screen bay [canal approach channel]
    - Primary canal fish screen
    - Secondary canal fish screen
    - Fish return and finishing screen
    - Evaluation station
    - Fish return discharge

Each component of the fish passage system is summarized in Chapter 3, with further engineering focused details provided in the hydraulic basis of design report (Appendix C). The following discussion outlines the details of the updated fish passage system that are relevant to the conservation of southern California steelhead and form CM 1.1.1.

Figure 5-1 Fish Passage Design



Source: Stantec, 2019

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It is United's understanding that the declaration supporting the Amicus Brief was written for a ramp design passage alternative (NMFS Supervisor of Fisheries Bioengineering and Hydropower pers comm.). Some criteria do not directly apply to the vertical slot alternative because it is not a ramp; however, the vertical slot as currently designed is expected to meet the intent of criteria presented in the Amicus Brief that the "overarching goal of the preferred alternative should be to provide or approximate unimpeded passage characteristics" (Spina Decl. at 6:7-11).

Each guidance item from the Amicus Brief, and a discussion of how United has met that guidance through design, follows.

Guidance Item A: "Improve steelhead-passage opportunity … for all flows between 45 to 6,000 cfs."

The Vertical Slot passage system is designed to operate between flows ranging from 35 cfs to more than 6,000 cfs with attraction flow varying within that range. To assess how attraction flow conditions would relate to migrating adult steelhead, United synthesized data from water years 2017-2019. Based on real-time suspended sediment data collected at the Freeman Diversion in water years 2017-2019, United assessed what the attraction flow would have been for the vertical slot fish passage system under the proposed diversion and instream operations of this MSHCP (see CM 1.2.1 and CM 1.2.3). During those three water years, the water passing through the fish ladder entrance gates would have provided 100 percent of the attraction flow approximately 94 percent of the time when suspended sediment was 1,800 mg/L or below, which is in the upper range where pre-spawning steelhead adults are "unlikely[3]" to be actively swimming in an upstream direction through the fish passage structure (total range 500-2,000 mg/L; see Appendix E). When attraction flow is at 100 percent, all the water passing downstream passes through the entrance gates with no potential nuisance flows over the crest or crest gates of the diversion. For the rest of the time when suspended sediment is below 1,800 mg/L (6 percent of the remaining time), a minimum 20 percent attraction flow would have been provided for the proposed Vertical Slot passage system. The percent attraction flow increases as suspended sediment decreases to the range where steelhead are "likely" or "very likely" to actively swim in an upstream direction, however the 1,800 mg/L comparison point was selected as a conservative estimate (in the upper range) of what is an "unlikely" condition for adult steelhead to actively swim in an upstream direction.

Guidance Item B: Passage opportunities "should not be further interrupted by facilities operations for sediment management or other periodic maintenance, for all steelhead-passage flows."

The design for the Vertical Slot passage system has been modified so that interruption for sediment management will be minimized. The proposed modification to the crest gate design will reduce the amount of time sediment sluicing would be required compared to the current facility. Based on actual operations for the past four years, interruption for sediment management would occur for approximately 0.5 percent of the time when suspended sediment would be 1,800 mg/L or below. At this rate, a typical sediment sluicing event that occurs for approximately 2 hours would be expected to provide reliable passage with no further interruption to the fish ladder operations for at least 16 days.

Guidance Item C part 1: "Create upstream and downstream passage in the form of ramps, such as: [bullet item 1] Ramps built at slope less than or equal to 5 percent; durable and resistant to high–storm flows."

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3 Based on the based available scientific and commercial data, it was determined that pre-spawning, adult steelhead are "unlikely" to actively swim in an upstream direction when suspended sediment is in the range of 500-2,000 mg/L (see Appendix E).

The Santa Clara River is episodic with highly variable flows. Flows during the primary steelhead migration season can be less than 1 cfs to as much as 144,000 cfs observed in 2005. Both United and NMFS share the concern that the fish passage alternative must be operable after large storms as this is when much of the opportunity for steelhead migration exists in Southern California. Within the Santa Clara River watershed, the Army Corps fish passage system on Santa Paula Creek, a large concrete fish passage system was destroyed by storm flow in 2005 and has yet to be rebuilt or modified to provide reliable upstream fish passage. The Vertical Slot passage system will be built off river, protecting it from the destructive high flows and providing reliable passage after flows have subsided and when migrating adult steelhead would be expected to actively swim in an upstream direction.

The part of the guidance referring to slopes is only applicable to a ramp fish passage design and does not apply to a vertical slot.

Guidance Item C part 2: "Create upstream and downstream passage in the form of ramps, such as: [bullet item 2] Ramps that provide hydraulic conditions [for all life stages of migrating steelhead]. Suitable hydraulic design criteria to be developed on a case by case basis as guided by [Anadromous Fish Passage Facility Design (NMFS 2011)]."

The Vertical Slot passage system would be designed and built to appropriate hydraulic conditions as outlined in NMFS criteria established in the 2011 guidelines.

Guidance Item C part 3: "Create upstream and downstream passage in the form of ramps, such as: [bullet item 3] Ramps designed in conjunction with headworks and screening facilities to provide safe downstream passage for juvenile, smolt, and kelt life stages, and prevent the potential for steelhead passage over the dam crest or under sluice gates for all steelhead-passage flows."

The recently modified crest gate design for the fish passage system is expected to provide a smooth transition from the diversion crest to the tail water below the diversion for downstream migrating steelhead. Operations will be determined to minimize or eliminate gate operations that will have very small openings that could potentially harm steelhead.

Guidance Item D: "Preclude nuisance attraction flows over the range of steelhead-passage flows."

During elevated flows, steelhead are expected to migrate up the edges of the river. Flows spilling over the diversion crest could create an attraction flow that will lead upstream migrating steelhead away from the passage entrances and to the turbulent water falling over the crest. The updated Vertical Slot passage system design addresses this concern by increasing the size of the crest gates so that flows up to 6,000 cfs will pass through the crest gates, and the fish ladder entrance gates will be on the edges of the flows over the crest gates intended to allow upstream migrating fish to directly approach the entrances to the fish passage system, assuming they swim up the sides of the channel in high flows with high turbidity as is commonly accepted in the fisheries community.

Guidance Item E: "Steelhead should not be challenged by, or required to transit, partially open gates and/or weir structures."

The Vertical Slot passage system will have gates at both the entrance and exit. These gates are there, in part, to protect the ladder during destructive high flows. When the flows subside, the gates can be operated fully open or in a manner that maximizes attraction flow.

Guidance Item F: "Install fish screens that protect all life stages of steelhead from impingement and entrainment."

The Vertical Slot passage design incorporates fish screens that meet NMFS criteria.

Design Summary

Under the supervision of the Court, United and NMFS collaborated to complete the Action Plan, as set forth below, United and its consultants have collaborated with NMFS in order to address the main concerns raised by NMFS, in particular: (1) provide at least 20 percent attraction flow during a conservative interpretation of the period of time when pre-spawning steelhead adults are expected to be actively swimming in an upstream direction; (2) operate at all flows ranging between 45 cfs to 6,000 cfs; and (3) provide uninterrupted migration opportunities. While number 3 has been a challenge given the need to manage sediment in a high sediment river for any fishway, United has proposed minimization measures (see CM 1.2.6) whereby sediment management and periodic maintenance would be reduced to occur less than 0.5 percent under a conservative estimate of when adult steelhead are expected to actively swim in an upstream direction (i.e., a two-hour maintenance interruption will provide reliable fish passage for over 16 days).

Fish Passage Facility Operations

The following section details the operations of the new Freeman Diversion headworks. It includes an outline of an approach that prioritizes various system flow pathways to both maximize attraction flows at the fish ladder entrance and maintain flows and pathways that protect smolts by passing them through the system as efficiently as possible (CMs 1.2.1 through 1.2.4 provide in-depth discussion of instream flow operations downstream of the facility).

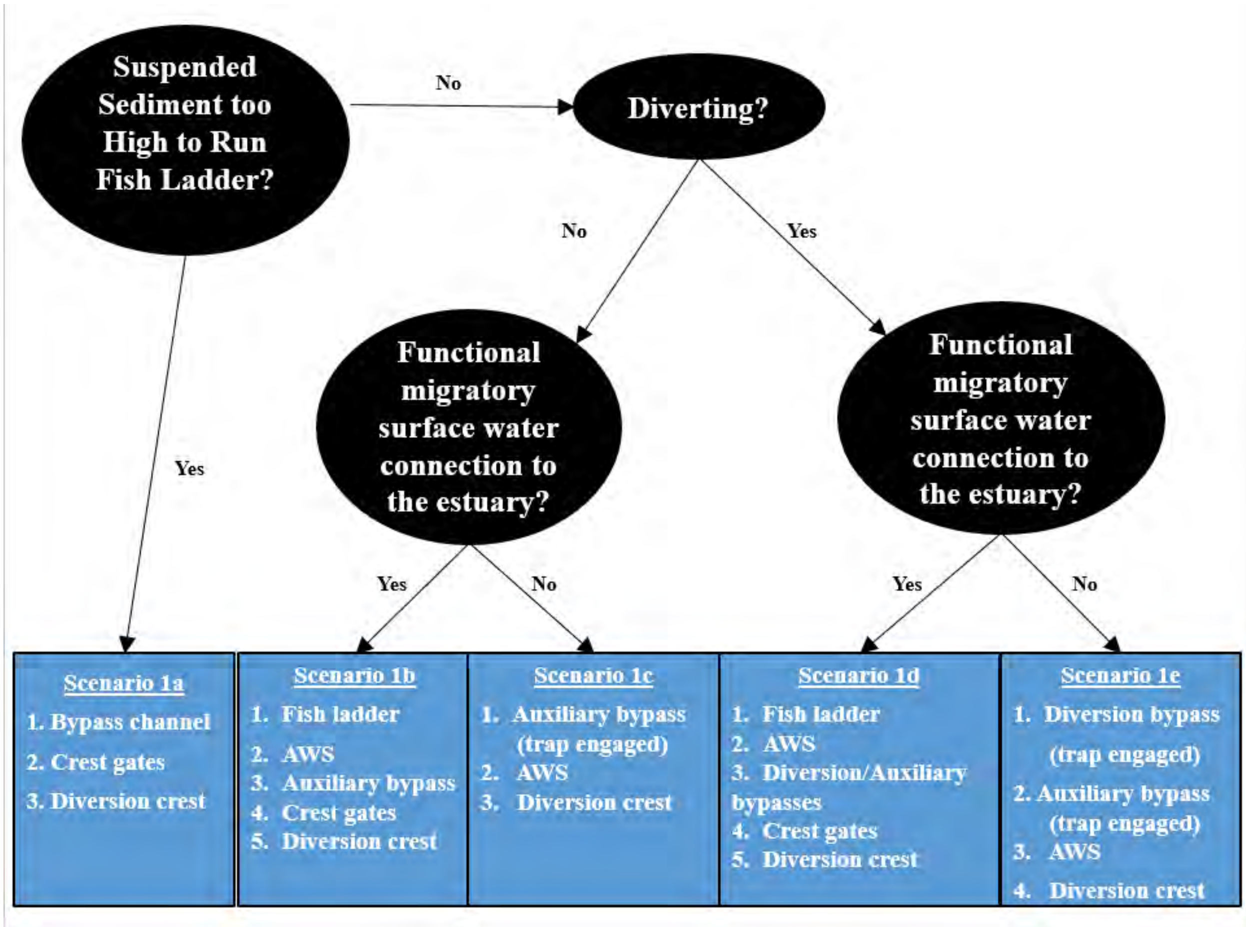
United would direct water through various pathways in the facility using a set of prioritization rules based on time of year, hydrologic connection between the Freeman Diversion and the Santa Clara River estuary, SSC in the river, water availability, projected flows, and whether or not operational triggers for instream flows have been met. The flow charts in Figure 5-2 through Figure 5-4 show the priority order for the system pathways for flow releases at the fish passage facility for a variety of scenarios. One of the three flow charts will be followed, depending on conditions.

- **Scenario 1** (Figure 5-2) would be followed when no instream flow protocols have triggered, but flows are still bypassing the diversion.
- **Scenario 2** (Figure 5-3) would be followed January 1 to May 31 when the steelhead adult upstream migration trigger (the Sespe trigger) has been met and the instream flows in CM 1.2.1 or CM 1.2.3 are being implemented.
- **Scenario 3** (Figure 5-4) would be followed between March 15 to May 31 when smolt migration instream flows are prescribed (CM 1.2.4), but no adult upstream migration flows are being implemented.

Scenario 1 – Facility Operation Protocol when Water is Flowing in the River, but no Instream Flows are Prescribed

Scenario 1 could occur any time of the year when water is flowing in the river, but no instream flows are prescribed. This would occur during any storm events from June 1 to December 31, or from January 1 to March 14 when there has not been an operational trigger for adult upstream-migration flows. Scenario 1 is further divided into Scenarios 1a through 1e, described below.

Figure 5-2 Flow Chart Outlining Scenario 1



Scenario 1a

Under Scenario 1a, SSC in the river would be above approximately 4,000 – 7,000 mg/L, and all of the water will be passed through the bypass channel to promote growth of the scour pool upstream of the diversion. The remaining flows would run through the crest gates to help maintain a well-defined channel to the fish ladder entrances. Any additional flows would go over the diversion crest.

To operate the Freeman Diversion and fish ladder effectively, United must temporarily bypass storm flows containing high levels of mobile bedload material and high SSCs, a practice known as a “turn-out.” Turn-outs protect the facility from sediment and also promote scouring of accumulated sediments from upstream of the Freeman Diversion and allow them to pass downstream. Turn-outs would be predominantly scheduled based on high SSC in the river and occur when SSC is above approximately 4,000 – 7,000 mg/l (subject to adaptive management). However, the timing and duration of turn-outs is also dependent on factors including the origin of the sediment peak (local runoff or from upstream watershed), anticipated duration of sediment peak, peak flow magnitude, time of day, staffing, and other operational considerations. Sluicing sediment from upstream of the diversion during a turn-out when steelhead are “unlikely” to “very unlikely” to actively swim in an upstream direction would promote more potential storage for accumulating sediments when the fish ladder is running, and when adult steelhead are more “likely” to “very likely” to actively swim in an upstream direction (Appendix E).

In addition to sediment sluicing during turn-outs, sediment sluicing events are required on the receding limb of the hydrograph, to also clear accumulated sediments after the fish ladder is running and/or diversions have been initiated as described in more detail in CM 1.2.6.. While sediment sluicing events on the receding limb are occasionally necessary for proper functionality of the facility, sediment sluicing events may be potentially harmful to upstream migrating fish, depending on: where the fish is located at the time of the sluicing event; when the sluicing event happens on the receding limb of the hydrograph; and how fast flows decrease on the upstream side during the sluicing event or on the downstream side once the flows are turned in again. Given this uncertainty, sluicing operations under Scenario 1a will reduce the frequency and duration of sediment sluicing events required during the receding limb of the hydrograph when adult steelhead are more likely to actively swim upstream.

Scenario 1b

This scenario would most likely occur when there is maintenance required for the diversion facility, but there is low SSC in the river. When diversions are not occurring for reasons other than high SSC, and there is expected to be continuous surface flow between the diversion and the estuary, bypassed water would be prioritized to provide adult steelhead and lamprey passage through the fish ladder, in case an adult steelhead or lamprey seeks to migrate outside of the primary migration season. In the updated fish passage design, a separation of source water at the canal gates would allow United to run the fish ladder and lamprey passage even when it is not diverting. If the capacity of the fish ladder and lamprey passage is exceeded, then additional water would be directed through the AWS for attraction flow and the AWS bypass to provide further fish passage downstream and/or monitoring and tagging of juvenile steelhead through the Monitoring Program (Chapter 6). Because no diversions occur under this scenario, the diversion bypass would not be in operation. Additional flow not passed through the fish ladder, lamprey passage, and AWS system would pass through the crest gates, and then any further additional flow would go over the diversion crest.

Scenario 1c

The conditions for this scenario are the same as for Scenario 1b, except in this case the instream flows cannot provide functional migratory connectivity to the estuary (initially < 160 cfs at the critical riffle, but subject to adaptive management). Passage upstream is not expected nor is passage downstream promoted, due to the lack of connection with the estuary. Therefore, United would operate the screened facilities (i.e., AWS only since diversions are not occurring) at full capacity and will engage the monitoring facility in the evaluation station and activate capture and relocation (CM 1.2.5) to prevent potential downstream migrants from stranding in the critical reach. In this scenario all instream flows are normally passed through the AWS. In the rare cases the AWS cannot pass all the instream flows, the crest gates would remain closed so that the remaining flows will pass over the crest of the diversion structure. Although downstream migrants are less likely to occur at this time of the year, should they occur, these operations will provide a safer pathway to the estuary or other agreed upon relocation site with the Services and minimize the potential for early or late season arrivals to pass into the lower river where there is a high stranding risk under these conditions.

Scenario 1d

At the end of a turn-out (as detailed under Scenario 1a), United would start “turning in” river flows into the facility for fish ladder operation and/or diversion. Starting in the 2016-2017 winter season, United experimented with diverting water at higher SSCs than it has done historically. United successfully initiated diversions when the SSC in the river was within the range of 4,000 to 7,000 mg/L (based on multiple lab-based SSC measurements and turbidity measurements correlated with SSC). With the planned future improvements to the diversion intake, United will explore potential options to turn in at higher SSC balanced with sustainable sediment management practices and may make adjustments to operations depending on experimentation and engineering options in consultation with the Services under adaptive management.

When conditions are such that United is diverting at maximum capacity, instream flows are not prescribed, and there is continuous surface flow from the diversion to the estuary, any excess water will be prioritized first to pathways that provide adult steelhead and lamprey upstream passage (fish ladder and AWS) and then to pathways that promote further downstream passage (diversion and AWS bypasses and crest gates). Any remaining water would flow over the diversion crest.

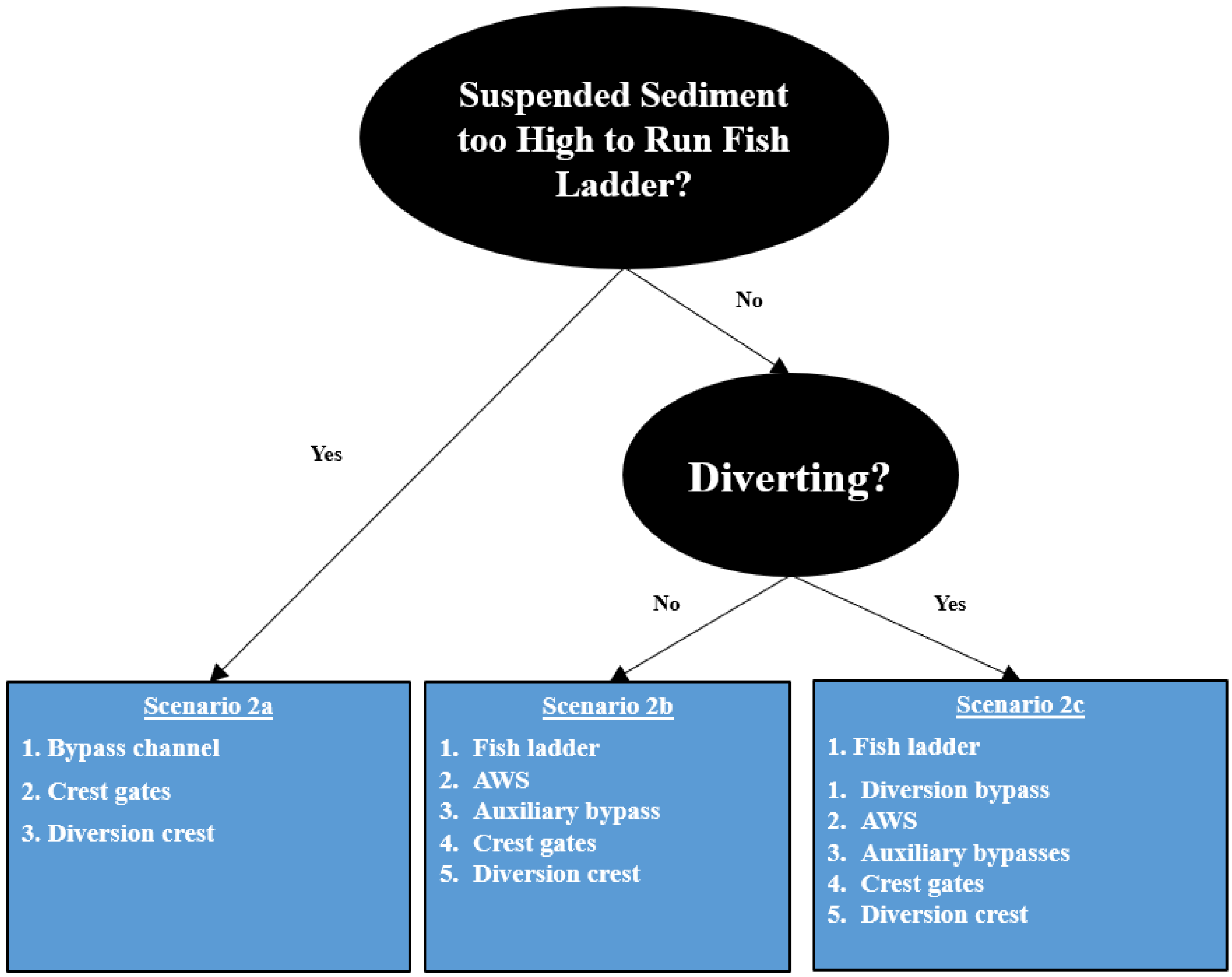
Scenario 1e

The conditions for Scenario 1e are similar to Scenario 1d, with the exception that remaining flows beyond what is diverted cannot provide functional migratory connectivity to the estuary (initially < 160 cfs at the critical riffle, but subject to adaptive management). Under this scenario, excess water would be prioritized first to the evaluation station and then to the screened AWS to prevent downstream migrants from stranding in the critical reach. To accomplish this, the diversion bypass with the screened facility at the evaluation station will be prioritized first because water diversions are in operation and this would allow for monitoring studies, tagging, and relocation of downstream moving steelhead and lamprey. The remaining flow would be directed through the AWS until flows are high enough to trigger Scenario 1d (flows can maintain functional migratory connectivity to the estuary).

Scenario 2 – Primary Adult Migration Season – January 1 through May 31 when Instream Flows for Adult Upstream Migration are Prescribed

Figure 5-3 shows priority operations for Scenario 2 when the instream flow operational trigger has been met for steelhead upstream migration. Under this scenario, the main priority is to operate the fish ladder in the most effective manner possible to promote upstream migration through the facility. When United turns in water following a turn-out, SSC generally exceed 4,000 – 7,000 mg/L, and it is "very unlikely" that adult steelhead would be actively swimming in an upstream direction (see Appendix E). Therefore, the fish ladder should always be in operation prior to when adult steelhead would be ready to ascend the vertical slot ladder, unless a sluicing event for sediment management is required at that time. However, United would seek to minimize sluicing events when suspended sediment concentration is less than 1,800 mg/L and would conduct pre-emptive sediment sluicing operations when SSC in the river exceed 1,800 mg/L (CM 1.2.6). Scenario 2 is further divided into Scenarios 2a, 2b, and 2c, described below.

Figure 5-3 Flow Chart Outlining Scenario 2



Scenario 2a

If bypass flows for upstream migration have triggered, but the river contains too much sediment to turn in and start operating the fish ladder (> 4,000 – 7,000 mg/L, see description under Scenario 1a), then all of the water will be passed through the bypass channel to promote growth of the scour pool upstream of the diversion. The remaining flows would run through the crest gates to help maintain a well-defined channel to the fish ladder entrances. Any additional flows would go over the diversion crest.

Scenario 2b

Scenario 2b would occur if bypass flows have triggered for adult upstream migration flows; United can effectively turn-in water to the facility and operate the fish ladder (SSC < 4,000-7,000 mg/L); and United cannot divert for some reason (e.g., unforeseen maintenance to the diversion facility). The fish ladder would be prioritized. Additional water would then pass through the AWS system and the auxiliary bypass. If additional water is available, the crest gates would be opened to the extent that they do not decrease the elevation of the impounded water required to operate the fish ladder. All remaining water would go over the diversion crest.

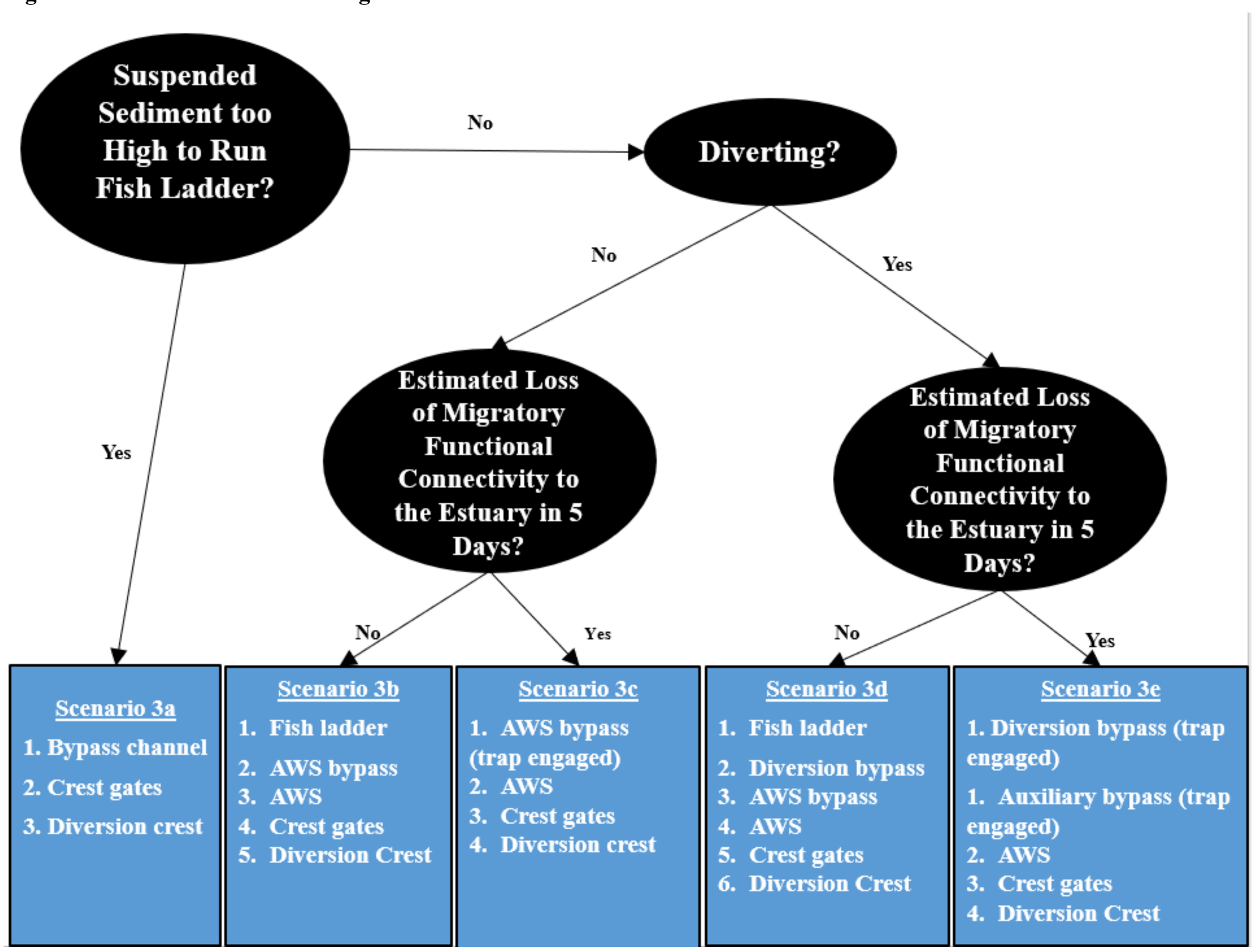
Scenario 2c

When instream flows for upstream migration have triggered and water diversion is not limited, then the prescribed flows would be bypassed with the priority order: fish ladder, diversion bypass (trap may be engaged for monitoring or not engaged), and then the AWS system and auxiliary bypass. If there is any additional water, the crest gates would be opened to the extent that they do not decrease the elevation of the impounded water required to operate the fish ladder. Any remaining water would go over the diversion crest, which would be a rare occurrence.

Scenario 3 – Primary Smolt Migration Season – March 15 through May 31

This scenario occurs during the primary smolt migration season from March 15 to May 31. Scenario 3 is implemented when the instream flow operations for downstream migration are being implemented and flows for upstream adult migration have not triggered or adult flows triggered previously but could not be maintained and downstream migration flows are being implemented according to the smolt migration protocol (see CM 1.2.2 and CM 1.2.4). The purpose of the priority operations for this scenario is to promote safe and efficient upstream and downstream passage of smolts and juveniles through the facility (Figure 5-4). If flows would decrease below functional migration connectivity with the estuary in 5 days, then the instream flows through the system would be routed through the evaluation station and screened pathways to hold smolts, kelts, and lamprey juveniles at the diversion and/or to trap smolts, kelts, and lamprey juveniles for monitoring and relocation to better conditions under CM 1.2.5.

Figure 5-4 Flow Chart Outlining Scenario 3



Scenario 3a

If bypass flows for downstream migration are prescribed, but the river contains too much sediment to turn in and start operating the fish ladder (> 4,000 – 7,000 mg/L, see description under Scenario 1a), then all of the water will be passed through the bypass channel to promote growth of the scour pool upstream of the diversion. The remaining flows would run through the crest gates to help maintain a well-defined channel to the fish ladder entrances. Any additional flows would go over the diversion crest.

Scenario 3b

When there are no diversions and functional migratory connectivity to the estuary can be maintained for more than 5 days, water would be passed through the fish ladder and AWS system. Fish would then be trapped at the evaluation station for monitoring studies (see Chapter 6) or passed through the AWS bypass if no monitoring is occurring. The remaining water would pass through the crest gates and then over the diversion crest.

Scenario 3c

If United were not diverting water and flows would decrease below functional migration connectivity with the estuary in 5 days, water would be routed through the screened AWS and the AWS bypass with the trap would be engaged at the evaluation station to trap downstream moving fish from the AWS bypass. Covered fish would then be tagged and bypassed for monitoring studies (see Chapter 6) or relocated according to CM 1.2.5 below.

Scenario 3d

If United is diverting and functional migratory connectivity to the estuary can be maintained for more than 5 days, then water that is not being diverted would be passed through the fish ladder. Part of the water for diversions can also be directed through the evaluation station to allow for monitoring studies and/or water can be passed all the way through the diversion bypass back to the river (depending on the study, United need to trap, tag, and relocate fish or trap, tag, and send through the bypass back to the river; see Chapter 6 for more details). Any remaining flow would be directed through the AWS system, then the crest gates, then the diversion crest.

Scenario 3e

If United is diverting and functional migratory connectivity to the estuary cannot be maintained for more than 5 days, then water would be passed through the diversion bypass with the trap engaged at the evaluation stations, then through the auxiliary bypass with the trap engaged at the evaluation station. Steelhead caught at the station that are large enough would then be tagged and incorporated into Monitoring studies (see Chapter 6) or relocated under CM 1.2.5. Steelhead that are not large enough to tag, would be relocated under CM 1.2.5.

CONSERVATION MEASURE 1.1.2

CONSERVATION MEASURE 1.1.2

Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion

United will construct, operate, and maintain a migration passage structure at the Freeman Diversion specific for lamprey. Design features of the structure will be such that lamprey will be able to migrate upstream, past the Freeman Diversion and will not be blocked by the existing facility design.

Development of Conservation Measure

A lamprey specific fish passage system is being designed with input from Western Fishes, a recognized expert in lamprey passage. The engineering team is proceeding with a lamprey passage system that incorporates a tube passage system that enters at the vertical slot entrance pool and directs lamprey over the diversion and through a counting apparatus.

Several features at the existing Freeman Diversion fishway impede or prevent lamprey passing. This conservation measure will be implemented at the Freeman Diversion to approximate unimpeded lamprey migration in the Santa Clara River through fish passage facility renovation, operation, and maintenance. The general design will follow successful approaches developed at Van Arsdale Dam (50 feet high) on the Eel River and other barriers in California (Goodman and Reid 2017, Reid 2017), and similar pathways used at large dams on the Columbia River (Moser et al. 2011). The design approach takes advantage of climbing behavior, routing lamprey through large-diameter pipes to travel up and over the structure. Thus, successful design of passage facilities and conservation measures will consider physical capabilities and behaviors of lamprey (Goodman and Reid 2017).

Discussion

Lamprey have relatively low absolute swimming speeds compared to steelhead, and unlike steelhead, they do not jump (Moser and Mesa 2009). They are efficient anguilliform swimmers in low velocity waters (< 2 feet per second). However, they can use a burst-attach-burst mode of locomotion (dyno-climbing) when high velocity corridors are unavoidable and appropriate surfaces are available (Keefer et al. 2010, Kirk et al. 2016). When a smooth attachment surface without sharp angles is present, lampreys use their sucking mouth disk to attach and climb. Smooth rounded surfaces are common in nature but rare in artificial structures, such as many existing fishways. Waterfalls, high velocity corridors, and angular features that interfere with suction cause lamprey to move to shallow, low-velocity peripheral areas and dyno-climb along wetted paths in the spray zone (Reinhardt et al. 2008, Petersen-Lewis 2009, Zhu et al. 2011, Goodman and Reid 2017).

The historical presence of larvae and adults upstream of the Freeman Diversion indicates lamprey are capable of passing the diversion structure itself or the existing fishway. However, both structures contain numerous features that would inhibit lamprey passage. A preliminary assessment and recommendations have been developed for lamprey passage at the existing Freeman Diversion (Reid 2017).

Specific passage for lamprey at the fishway will ensure that minimal impediment occurs to migrating lamprey. A gradual drop in water released downstream at the diversion will prevent lamprey from being stranded and provide extended opportunity for their up-stream migration when flows drop, and the river mouth closes. Diversion screening will be used that accounts for approach velocity and with sufficient pore size to avoid entrainment or impingement of lamprey larvae over 1 year and lamprey juveniles (Rose and Mesa 2012, Moser et al. 2015, Goodman et al. 2017). A lamprey monitoring station will provide information on timing and abundance and allow for adult monitoring when authorized for research (e.g., radio or pit tagging studies). Relocation procedures will use mesh fine enough (0.125 to 0.1875-inch) to ensure retention of juveniles and larger larvae and will be managed to avoid holding of predatory fishes that would consume lamprey juveniles. Lamprey will be released into the Santa Clara River Estuary when the river mouth is open, and off the beach or pier beyond the surf line when the river mouth is closed. Juveniles will be monitored at the Freeman Diversion to allow for better understanding of outmigration characteristics in the Santa Clara River (including timing, abundance, and relation to flow events).

5.2.2 CONSERVATION MEASURES UNDER GOAL 1, OBJECTIVE 1.2

CONSERVATION MEASURE 1.2.1

CONSERVATION MEASURE 1.2.1

Instream Flow Commitment for Upstream Migration - Initial[4] Operations (maximum instantaneous diversion of 375 cfs)

United will implement a comprehensive upstream migration strategy that provides instream flows and limits diversions under United's current water rights from January 1-May 31 aimed at approximating unimpeded migration of adult steelhead and lamprey from the estuary, through the affected reach, up to the Freeman Diversion.

Development of Conservation Measure

The adult upstream migration strategy includes five operational protocols developed with careful consideration of balancing the need to provide instream flows that provide a functional migration corridor for adult steelhead and lamprey and minimize the impact of diverting flows with United's need to divert flows to fulfill its mission and purpose of managing and protecting the aquifers within its district boundary. The upstream migration strategy is based on (1) an evaluation of historic hydrographs to gain an understanding of storm frequency, duration, flow magnitudes, and their relationship to estuary sand berm breaching; (2) experience gained from past operations of the Freeman Diversion, including observations made and data collected at the existing adult fish passage facility; (3) experience with steelhead migration timing in the Santa Clara River basin generally, and more broadly in adjoining basins; (4) direct observations and measurements of flow and knowledge of the common physical channel characteristics within the affected reach, particularly within the critical reach and at the critical riffles; and (5) the careful review and consideration of adult steelhead behavioral patterns, including their capabilities and requirements for upstream migration as understood using the best available science.

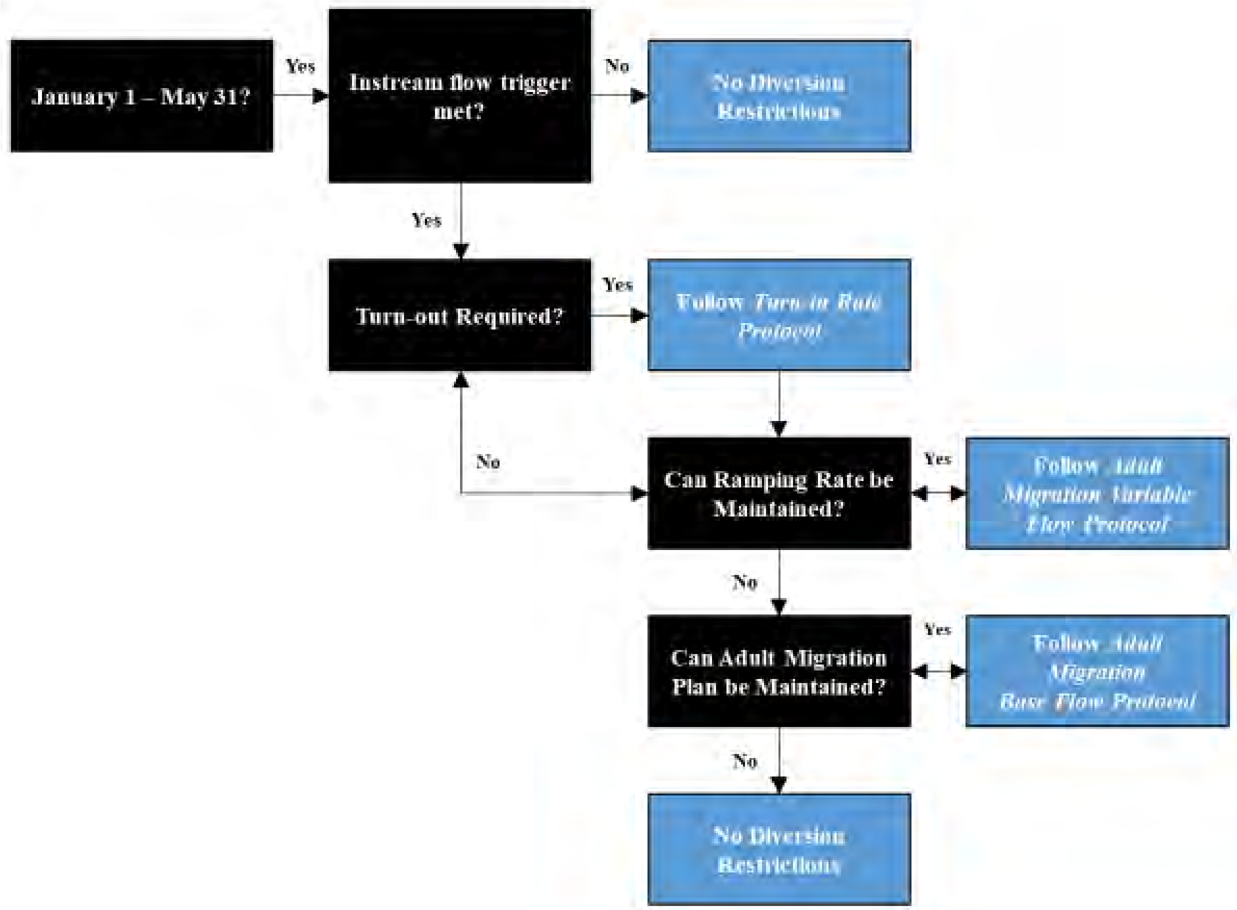
Discussion

Under the proposed initial operations, United will divert up to the maximum instantaneous diversion rate of 375 cfs, but the diversions will be managed carefully with a set of criteria to approximate unimpeded upstream migration of steelhead and lamprey to the maximum extent practicable. The upstream migration strategy consists of five interrelated operational protocols (Figure 5-5):

1. Turn-In-Rate Protocol (TRP)
2. Adult Migration Variable Flow Protocol (VFP)
3. Adult Migration Base Flow Protocol (BFP)
4. Transition Protocol
5. Pulse Protocol

[4] Initial Operation in the context of this MSHCP refers to those operations previously known as and modified from "Scenario 6" in supporting effects analyses studies.

Figure 5-5 Upstream Migration Strategy



The protocols designate the rate that United brings in water to the diversion facility as well as the magnitude, duration, and timing of instream flows with the aim of generally following the shape of the no-diversion hydrograph of the Santa Clara River with a few operational exceptions to help promote upstream movement of adult steelhead and discourage holding behavior in the critical reach.

Trigger Criteria for Implementation of Instream Flows

To avoid implementation of instream flows during small storm events when the magnitude and duration of runoff from the watershed are insufficient to provide a functional migration corridor downstream of the Freeman Diversion for approximately 1-2 days, instream flow trigger criteria were developed.

United has spent several years investigating and analyzing an appropriate gauge from which to base operational decisions. This has involved substantial work and consultation with USGS and NMFS that ultimately resulted in the selection of the Sespe Creek Gauge. As part of this evaluation and in consultation with the USGS, United considered gauge locations directly on the Santa Clara River. However, after discussing the potential for two gauges, at the State Route (SR) 118 bridge and the US-101 bridge, the USGS indicated it could not reliably gauge the sites and collect meaningful data (Hill 2016). In contrast, the USGS has measured the flow in Sespe Creek (USGS 11113000) for over 80 years, and this gauging station has been very reliable over that period. Moreover, these flows are available in real-time from the USGS, which enables United to make operational decisions quickly as flow conditions change.

Therefore, United proposes to use the Sespe Creek Gauge (USGS 11113000) to determine if the trigger for upstream migration protocols is met. A similar trigger, based on Sespe baseflow instead of the cumulative runoff threshold, has been implemented since 2009 and has proven to be an appropriate triggering mechanism. Analysis of historic data indicated that the Sespe trigger works well because (i) Sespe Creek watershed provides an average of 51 percent of the total river flow upstream of the Freeman Diversion, (ii) the Sespe trigger does not cause false triggers due to local runoff near the Freeman diversion which recede very quickly, (iii) its upstream location and proximity to the Freeman Diversion make it a good indicator of storm induced flow events that are extensive enough to provide a functional migration corridor to the estuary for steelhead and lamprey, including estuary breaching events, and (iv) the rating of the USGS 1113000 gage is generally good and the gage experiences few gage outages.

For these reasons, United considers criteria based on the Sespe gage to be the most appropriate trigger for implementing the VFP and BFP. The Sespe trigger is defined as the 24-hour rolling average flow in Sespe Creek (calculated based on USGS Gage 1113000) that exceeds the Sespe cumulative runoff threshold by 200 cfs. Sespe flows are calculated based on USGS gage 1113000, and the rolling average and the cumulative runoff threshold are calculated based on the same date and time. The Sespe cumulative runoff threshold is based on the cumulative runoff in Sespe Creek for each water year (in acre-feet, starting on October 1). The cumulative runoff threshold values are highly similar to baseflow, which was used historically, but have the benefit of being calculated based on readily available and accurate flow data (flows at USGS gage 1113000) using a transparent and reproducible calculation method.

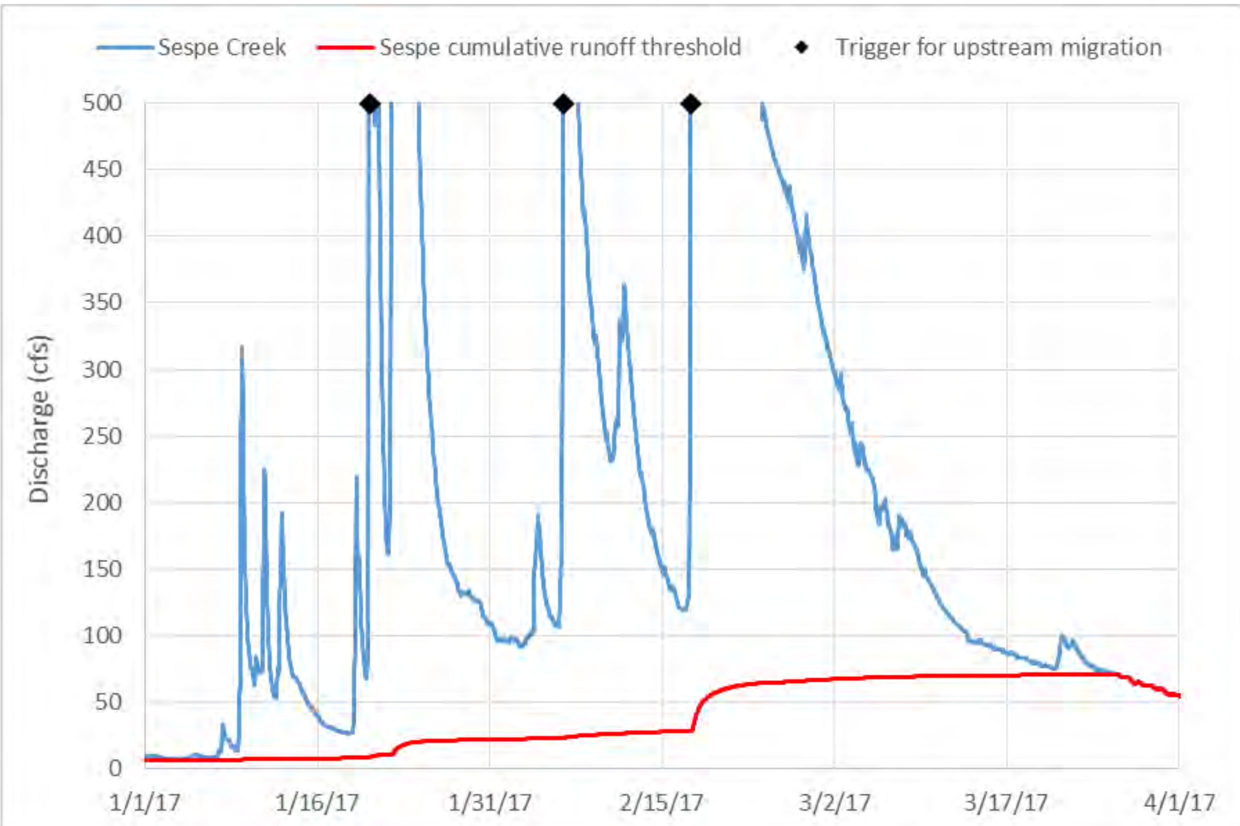
The cumulative runoff threshold is calculated as follows. First, a mathematical relationship was established between Sespe Creek baseflow (cfs) and Sespe Creek cumulative runoff (acre-feet) for each water year, based on hourly USGS gage 1113000 data from 2004-2019. The equation is then used to calculate the “average baseflow” (on hourly basis):

Average baseflow = -8.357E-10 * cumulative runoff^2 + 8.15E-4 * cumulative runoff + 6

Second, using calculations and formulas embedded in an excel spreadsheet, average baseflow is adjusted to ensure it does not exceed the actual flows in Sespe Creek, declines with decreasing Sespe flows at the end of the rainfall season, and increases during smaller storm events on a larger receding limb. This calculation yields the cumulative runoff threshold, which is then compared with the 24-hr rolling average Sespe flow to determine if the instream flow trigger is met.

Figure 5-6 provides an example of the calculated instream flow trigger based on the Sespe cumulative runoff threshold. Using this method, the first trigger occurred on January 20, 2017, and instream flows would have been implemented from that date onwards. For the storm event starting on January 9, 2017, the trigger for upstream migration was not met.

Figure 5-6 Example Hydrograph using the Sespe Cumulative Runoff Threshold as a Trigger for Instream Flows



Historically, the main disadvantage of the Sespe trigger was that the baseflow calculation was not well defined and therefore subjective, which is why the instream flow trigger was developed. The occurrence and timing of triggers for upstream migration calculated based on the cumulative runoff threshold is almost identical to those based on the previous trigger that relied on baseflow, except that the exact timing differs slightly (usually less than one hour difference, up to three hours difference). The appropriateness of the trigger based on the cumulative runoff threshold can therefore be assessed based on previous analyses on the trigger using baseflow.

Berm breaching events have been monitored by the City of Ventura, and United used these data to inform fish passage operations that were focused on storms that resulted in breaching of the sand berm. The Sespe Creek trigger was developed based on river hydrology and sand berm breaching data to provide migration opportunities when conditions are conducive for upstream migration of steelhead and lamprey. Some low magnitude storms (< 80 cfs) will not breach the sand berm, resulting in conditions that are not conducive to allow fish to enter the river for upstream migration nor sustain their migration.

There have been a few storms in the period of record that did not initiate the trigger and yet the sand berm still breached. These short duration events resulted in a delayed breach that occurred after flows had already receded below the flow target for upstream migration through the critical reach. These small storm events filled the estuary over a number of hours to a point where the sand berm breached by the force of a full or filling estuary, in contrast to larger triggering storms (storms that would meet the Sespe Creek trigger) that breach the estuary sand berm quickly following a storm peak and with enough time for steelhead to migrate upstream.

Increased flow events occasionally occur on the Santa Clara River mainstem during the period of January 1 to May 31, but corresponding tributary flows do not meet the Sespe Creek trigger and these events are often too short in duration to provide meaningful passage opportunities for steelhead and lamprey. In these cases, United would divert up to the maximum 375 cfs, and flows exceeding 375 cfs would be bypassed as instream flows according to flow split priority orders outlined in CM 1.1.1, however diversion up to 375 cfs and excess flows would be a rare event.

Development of Turn-in Rate Protocol

The TRP was developed to minimize potential harm or injury to steelhead from rapid reductions in flow in the affected reach. During a turn-out, the canal gates would be closed, and river and flows would go through the bypass channel, crest gates, and then over the dam crest when the capacities of the bypass channel and crest gates are exceeded. Upon turn-in, United would open the head and canal gates to start diverting water and to regulate water levels upstream of both gates. Gates are usually operated via a SCADA system but can be manually operated. Artificial increases in river recession rates downstream of the diversion result from opening head/canal gates to start diversions, but the rate of opening the head/canal gates affects the recession rates downstream.

The rate at which turn-in occurs has an effect on downstream flows, with rapid turn-ins resulting in potentially sharp and immediate reductions in flows downstream. Depending on the prevailing flow conditions at the time, an immediate turn-in of 375 cfs could result in a corresponding sharp reduction in flow downstream that could result in stranding of fish and migration delay. United analyzed historic unimpeded river recession rates to provide perspective on how rapidly stage changes occurred in the Santa Clara River in the affected reach. Assuming steelhead and lamprey evolved behaviors to successfully navigate flow changes within the range of what would be observed under a no diversion scenario (PacifiCorp 2004), historic discharge data and stage-discharge relationships for the river reach downstream of the diversion were used to estimate unimpeded river discharge and stage recession rates (United 2016). The "no diversion" recession rates were analyzed relative to periods when turn-in events occurred historically.

United developed maximum hourly turn-in rates for operations based on the observed range of unimpeded hourly river recession rates from January 1991 – September 2007 (United 2016). Unimpeded recession rates increase with total river discharge, so turn-in rates were calculated separately for different ranges of total river discharge observed during the runoff recession period. Within each total discharge range category, the 75th percentile of the observed hourly recession rates was used to calculate maximum diversions in the TRP (Table 5-1). While based on the same data, the 75th percentile proposed here is significantly slower than the turn-in limit proposed in United's 2016 report based on the maximum recession rate minus the 90th percentile recession rate (United 2016). Because turn-in rarely occurs directly after the peak of the storm when unimpeded recession rates are highest, maximum observed unimpeded recession rates will likely not be exceeded when turning in. In addition, the increased recession rates caused by turn-in occur an average of 4.5 hours per year (based on 2017-2020 hourly flows at the Freeman diversion), a very small fraction of the total number of hours of decreasing river discharge rates annually. Therefore, the TRP will minimize increases in unimpeded recession rate in the Santa Clara River downstream of the Freeman Diversion and thereby avoid potential harm to steelhead and lamprey from turning in.

Table 5-1 shows the median total river recession rate during turn-in for each discharge interval, which is calculated as the sum of the turn-in rate (75th percentile) and the 50th percentile unimpeded river recession, and compares it with the maximum unimpeded river recession rates. The median total river recession rates are significantly lower than the maximum river recession rates, which exceed 2 inches/hr for all discharge intervals.

Table 5-1 Maximum Turn-in Rates (75th Percentile Unimpeded Recession Rate) Compared to 50th percentile and maximum Unimpeded river recession rates. Total River Recession Rate during Turn-in is Calculated as sum of 50th Percentile Recession Rate and Maximum Turn-in Rate

Discharge Interval	Max. Turn-in Rate (75th Percentile River Recession Rate)		50th Percentile River Recession Rate		Max. River Recession Rate		Total River Recession Rate during Turn-in	
cfs	cfs/hr[1]	inch/hr	cfs/hr	inch/hr	cfs/hr	inch/hr	cfs/hr	inch/hr
124-199	14	0.6	7	0.3	45	2.1	21	0.9
200-449	28	0.8	14	0.4	172	5.9	42	1.2
450-599	54	1.2	27	0.5	234	5.6	81	1.7
600-899	64	1.1	33	0.5	355	7.4	97	1.6
900-1,199	96	1.3	52	0.7	334	4.5	148	2.0
1,200-1,499	111	1.3	60	0.7	450	5.9	171	2.0
1,500-2,499	189	1.7	122	1.1	550	6.1	311	2.8
2,500-4,999	542	3.3	329	2.0	1,334	8.0	871	5.3
>5,000	895	3.6	537	2.1	4,150	20	1,432	5.7

[1] Maximum turn-in rates are shown for reference, in practice, diversion rates would not exceed 375 or 750 cfs based on water right restrictions

Turn-In Rate Protocol

Operationally, it is difficult to use total river flow on an hourly basis to select the appropriate maximum turn-in rate and account for the instantaneous rate of river recession. Instead, TRP uses a generalized turn-in ramping schedule based on the actual discharge upon turn-in to ensure the ramping schedule can be implemented by United's operators. Maximum hourly turn-in rates (diversions) for a range of initial discharge intervals are shown in Table 5-2 (375 maximum diversion rate) . These maximum turn-in rates were calculated assuming an initial discharge at the mid-point of the discharge range and an unimpeded river recession equal to the 50th percentile natural river recession (Table 5-1).

The TRP applies to situations when United re-initiates diversions at high river discharge (i.e., performs a turn-in by opening the canal gates and bringing water into the diversion canal). Water diversion after periods of turn-out will be initiated and gradually increased by assigning an hourly incremental change in the maximum diversion rate (Table 5-2), until the final maximum diversion rate is achieved according to the Adult Migration Variable Flow Plan (Variable Flow Plan) or the Adult Migration Baseflow Plan (Baseflow Plan) (discussed below). The starting and incremental turn-in rates depend upon total river discharge at the time of turn-in. Total river flow and instream flow requirements dictate actual hourly diversion rates, so diversion rates may be lower than the hourly maximum specified, but they will not exceed those prescribed in Table 5-2.

Table 5-2 Maximum Hourly Diversions at the Freeman Diversion According to the Turn-in Rate Protocol (375 cfs maximum diversions)

Hour	Initial Santa Clara River Discharge (cfs)							
	≥2500	1500-2499	1200-1499	900-1199	600-899	450-599	200-299	125-199
Hour 1	375	189	111	96	64	54	28	14
Hour 2		375	222	192	128	108	56	28
Hour 3			318	256	192	136	84	42
Hour 4			375	320	256	164	112	56
Hour 5				375	310	192	140	56
Hour 6					338	220	154	56
Hour 7					366	248	168	56
Hour 8					375	276	182	56

* Instream flow requirements under VFP and BFP (Table 5-2) supersede the TRP. Therefore, diversion rates for a given hour may be lower than the maxima specified in this table .

Development of the Adult Migration Variable Flow and Baseflow Protocols

Both the VFP and BFP are based on a specific minimum flow criterion designed to provide a more than adequate functional upstream migration corridor for adult steelhead and lamprey. This criterion is the provision of 160 cfs downstream of the critical reach, which represents the locations in the Santa Clara River posing the greatest challenge to upstream migrating steelhead and lamprey. The minimum 160 cfs flow was derived in large part from the results of a field study conducted by Thomas R. Payne and Associates (TRPA 2005) that was focused on evaluating adult steelhead passage conditions within the critical reach, but also on the reviews of other salient information and literature pertaining to steelhead passage and represents the best available site-specific data for steelhead passage criteria in the Santa Clara River; however, the assumptions that stem from these studies will be subject to Monitoring and Adaptive Management discussed in Chapter 6.

The TRPA study reach included the portion of the river where a series of critical riffles were identified and measured in 2004 and 2005. These riffle areas are formed primarily from gravel and cobble substrates exposed at lower flow levels that create a local increase in gradient and decrease in depth. In conducting the study, TRPA (2005) utilized a modified form of the Oregon Method and depth criteria by Thompson (1972). The Oregon Method measures the depth and water velocity along cross sectional transects located at riffles suspected of being passage barriers. Thompson recommended a depth of 0.6 foot over at least 25 percent of transect widths and at least 10 percent of the flow is provided in a single channel. TRPA modified Thompson's proposed criteria by 1) reducing the minimum water depth to 0.5-foot, and 2) using an absolute minimum channel width of 5 feet and depth greater than 0.5-foot deep in a single channel at least 10 feet wide, rather than a proportion of the channel width (TRPA 2005). Rationale for these modified criteria were based upon information from Powers and Orsborn (1985), Puckett and Villa (1985), Dettman and Kelley (1986), Entrix, Inc. (1994, 1995, 1996), Santa Ynez River Technical Advisory Committee (1999), and Lang et al. (2004). The Harrison et al. (2006) study, also conducted in the Santa Clara River, applied passage criteria that assumed a minimum 0.6-foot depth across a continuous section of the channel, 10 feet wide. The most recent CDFW fish passage criterion for adult steelhead passage is 0.7-foot, but the study acknowledges that the minimum depths may be revised as new information develops (CDFW 2017).

The TRPA related passage depth criterion to fish body length, but body depth has also been used (e.g., by R2 and Stetson [2008]) in developing the North Coast Instream Flow regulations for SWRCB. A rough conversion of fish length equals five times fish body depth was used (R2 and Stetson 2008). The corresponding body depth for the longest reported fish in the Santa Clara River basin (~27.5 inches) would be 0.46 foot. TRPA's recommended depth criterion of 0.5 foot should therefore provide clearance under a fish as it swims through passage constrictions. Snider (1985, cited in R2 and Stetson 2008) observed that the limiting passage depth for steelhead in Brush Creek (Mendocino County) was 0.45 foot.

TRPA recommended a passage lane width to be ≥ 5 feet (that also meets the 0.5-foot depth criterion), but also analyzed based on a ≥ 10 feet criterion. For the North Coast Instream Flow Policy, a 2-foot wide minimum corridor was used, but this was considered the minimum required, not the one offering the most protection (R2 and Stetson 2008). In a neighboring system to the north of the Santa Clara River, Stillwater and Kear (2012) used a 10-foot criterion for steelhead passage in the Santa Maria River, with the logic that extra width would reduce predation risk and that a 10-foot width criterion provided a safety factor for cases when sampling may have missed the most restrictive passage section. Harrison et al. (2006) likewise applied a minimum 10-foot width criterion. NMFS (2011) recommends a minimum width criterion of 4 feet for artificial transport channels at upstream passage facilities, but United could not find rationale for that guidance. In general, there does not appear to be a strong empirical basis for selecting a suitable passage lane width; criteria tend to be based to some extent on professional opinion, plus allowances for uncertainty and the desired level of protection. R2 reviewed the TRPA analysis and other information and surmised a 5-foot or greater width of channel with a depth of ≥ 0.5 foot should provide conditions that would allow adult steelhead migration in the lower Santa Clara River (R2 2014).

In terms of flows, TRPA concluded that flows ≥120 cfs should provide suitable upstream adult steelhead passage conditions through the critical reach using the 0.5-foot minimum depth and minimum 5-foot width criteria (TRPA 2005). More protective criteria or use of the Oregon Method without modification resulted in higher minimum flows ranging from 142 cfs to over 330 cfs. However, those minimum flows were based upon the average flow from multiple transects, including two transects for which stage-discharge relationships could not be estimated. If only transects with defined stage-discharge relationships are considered, the minimum flow that met the 0.5-foot depth and 5-foot width criteria was 127 cfs (Highway 118 riffle during May 2005). Therefore, the target flow specified in CM 1.2.1 of 160 cfs is higher than the minimum flows suggested by TRPA, providing more protective conditions supporting upstream migration than the minimum flow.

Channel morphologies of the critical riffles are subject to potential change and modification due to scour and deposition events that can result from storm-induced high flow events. United is aware of these potential changes and will implement monitoring measures (EMM-01) to evaluate the stability of the critical riffles and determine whether adjustments in operations are warranted.

The VFP was developed by evaluating the decay of historic hydrographs in Sespe Creek, an unimpeded (non-dammed) tributary to the Santa Clara River. In a 2008 BO, NMFS used an analysis of discharge decay rates in Sespe Creek and the Santa Clara River for developing ramping rates (NMFS 2008). The flow recession rate included in the VFP uses the median flows in Sespe Creek on the receding limb of the hydrograph. The recession rates of the Sespe Creek are a good representation of those at the Freeman Diversion, given that over 50 percent of the runoff at the Freeman Diversions originates from Sespe Creek. In addition, a long record of flows is available from Sespe Creek, largely undisturbed from development (diversions and dams) and therefore well-suited for calculation of natural recession rates. This is not the case for flow records at or near the Freeman Diversion, which have been in various locations over time, of lesser quality, and affected by anthropogenic activities. The durations of specified flows included in the VFP and BFP were developed from limited information about migration rates for steelhead in the Carmel River and the Santa Clara River. Dettman and Kelley (1986) found that adult steelhead in the Carmel River migrated 15 miles in one to 10 days, with four days being the average. In the Santa Clara River, two adult steelhead were detected passing the Freeman Diversion on April 15 and

16, 2012. The storm during which these fish migrated up the Santa Clara River peaked in the afternoon of April 13 and based on suitable water depths at the critical riffle, no migration would have been possible until that time, despite the river-mouth being open previously. These data suggest that it took these fish a maximum of two to three days to migrate approximately 11 miles, and enter and pass the Freeman Diversion fish ladder, assuming migration started at the estuary on April 13. The operating criteria included in VFP (30 days) and BFP (18 days) are intended to provide the maximum amount of opportunities for steelhead to migrate from the ocean to the Freeman Diversion while balancing water resources needs.

The VFP and the BFP were developed to maximize the migration opportunities after a storm-induced, elevated discharge event. As a result, both plans seldom reach the entire maximum duration of 30 days for the VFP and 18 days for the BFP. On average, the VFP would reach its entire 30-day duration 0.46 times per year with most of them occurring multiple times in wet years. Because the BFP is only implemented if the higher bypass flows in the VFP cannot be implemented, they would be implemented less frequently. The average number of days that the VFP would be implemented per year is 27.4 days while the BFP would be implemented 4 days per year on average. These numbers do not include the ramp downs at the end of each event. On average, the BFP would reach the maximum duration of 18 days for 0.9 events per year. Most instream flow events would either retrigger to the higher VFP schedule from a new storm event and start the countdown again or are terminated early with the scheduled ramp down due to naturally insufficient flows in the river to maintain 160 cfs at the critical riffle.

Adult Migration Variable Flow and Baseflow Protocols

The VFP and the BFP are both used to determine target instream flows after a storm event. The VFP dictates conditions immediately after (1) the Sespe Creek trigger has occurred between January 1 and May 31, and (2) when flows in the Santa Clara River exceed the median Sespe recession rate (Days 1-8 in Table 5-3). The BFP is applied when bypass flows in the VFP are not able to be maintained even with all water in the river being bypassed. The VFP aims to mimic the receding limb of the hydrograph based on the median decline rates of Sespe Creek, an unimpeded (non-dammed) drainage. United would gradually adjust flows at the Freeman through hourly adjustments in the SCADA system. Under this protocol, the amount of water diverted is limited to allow enough water for prescribed instream flows criteria downstream of the critical riffle for a 30-day period following the peak of a triggering storm event in Sespe Creek (Table 5-3). The selection of the 30-day duration is intended to ensure ample time for adult steelhead to migrate upstream between the estuary and the Freeman Diversion after the storm peak. When total river flow (i.e., all flows bypassed and no diversion) decreases to the point where there is not enough water to maintain instream flows in accordance with the VFP, then the BFP is implemented.

The flows that would be provided at a minimum at the critical riffle under the VFP (Table 5-3) were based on historic recession rate of median flows in Sespe Creek 1 – 8 days after the storm peak in Sespe Creek. The minimum flows do not exactly match these historic flows, and were rounded and modified as needed for operational constraints.

Table 5-3 Adult Steelhead Migration Instream Flow Commitments below the Critical Riffle for January 1 – May 31 under the VFP and the BFP

Day from Trigger[1]	Minimum Flow at Critical Riffle under the VFP	Minimum Flow at Critical Riffle under the BFP
1	650	160
2	450	160
3	350	160
4	280	160
5	235	160
6	205	160
7	185	160
8	170	160
9	160	150
10	160	140
11	160	130
12[3]	160	120
13	160	110
14	160	100
15	160	90
16	160	2/3 of previous day[2]
17	160	2/3 of previous day[2]
18	160	2/3 of previous day[2]
19	160	End Instream Flow Commitment
20	160	
21	150	
22	140	
23	130	
24[3]	120	
25	110	
26	100	
27	90	
28	2/3 of previous day[2]	
29	2/3 of previous day[2]	
30	2/3 of previous day[2]	

[1] Day 1 is assigned to the peak of the hydrograph from the triggering storm in Sespe Creek The trigger is based on an instantaneous value although operational changes will occur on the day that the peak occurred.

[2] Ramping down flow is measured directly below the Freeman Diversion using flow monitoring devices installed at the headworks

[3] If day 12 of the BFP or Day 24 of the VFP is on or after March 15 then operations default to CM 1.2.2 – Instream Flow Commitment below the Freeman Diversion for Downstream Migration

The BFP limits the amount of water diverted in favor of maintaining instream flows through the critical reach according to the schedule outlined in the third column of Table 5-3. Given that flows sufficient to meet upstream migration criteria through the critical reach would no longer be available, the remaining flows measured at the Freeman Diversion will be reduced by one-third (1/3) per day for three days, at which time no further flows will be released and United will divert all the remaining river flow. If day 12 of the BFP or Day 24 of the VFP falls within March 15–May 31, then CM 1.2.2-Instream Flow Commitment below the Freeman Diversion for Downstream Migration supersedes the VFP and the BFP.

Development of Transition Protocol

The transition from one flow plan to another could create a sudden decrease in flows between the Freeman Diversion and the estuary. NMFS biologists have expressed concern that such a sudden decrease in flow may trigger premature holding behavior from adult steelhead and delay migration. This plan provides a smooth transition between flow plans.

The river recession rates in the plan were established using guidance from the 2008 Freeman Diversion Biological Opinion. Flow changes under the Transition Protocol will occur at a recession rate that mimics the 50 percent occurrence when transitioning between the various bypass flow plans. During implementation of the transition protocol, total river recession rates therefore equal natural river recession rates plus the additional recession rates by the Transition Protocol. By implementing the protocol, the additional recession rates by the Transition Protocol will remain much less than 2 inches per hour for most flow ranges (except ≥ 2,500 cfs), protecting steelhead from stranding below the diversion and preventing a sudden cessation of flows that may trigger adult steelhead holding behavior.

The unimpeded recession rates in the Santa Clara River were analyzed using the hourly data of the total river flow at the Freeman Diversion when available from 1991 to 2007. The analysis showed that the 50th percentile recession rates observed in the river near the Freeman Diversion remains below 2 inches per hour within the flow range that this protocol would be implemented (750 cfs – 80 cfs)(Table 5-4).

Table 5-4 Recession and Stage 50th Percentile at Different Discharge Intervals

Discharge Interval (cfs)	Discharge Recession, 50th Percentile (cfs/hr)	Stage Recession, 50th Percentile (inches/hr)
124-199	7	0.3
200-449	14	0.4
450-599	27	0.5
600-899	33	0.5
900-1,199	52	0.7
1,200-1,499	60	0.7
1,500-2,499	122	1.1
2,500-4,999	329	2.0

Transition Protocol

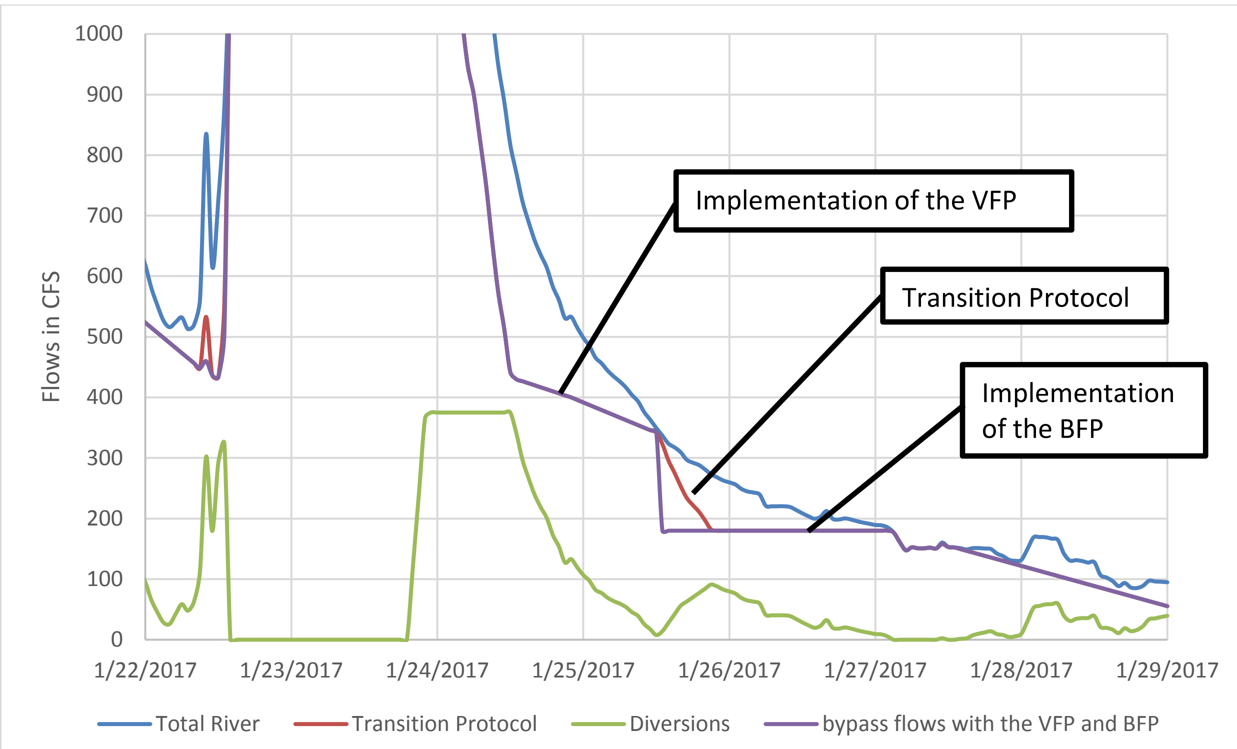
When implementing the VFP and when there is no longer sufficient water in the river to maintain the prescribed flows in accordance with the protocol, then the Transition Protocol will be implemented to gradually reduce the bypass flows to those prescribed in the BFP. At the time that the VFP cannot be sustained, the total bypass flows will be recorded. United would begin to increase its diversions at an hourly rate in accordance with Table 5-4.

For example, if the total bypass flows downstream were 500 cfs at the cessation of the VFP then United would start diverting 27 cfs the first hour and an additional 27 cfs per hour thereafter until the bypass flows subside below 450 cfs. At this time, the hourly increase in diversions will be reduced to an additional 14 cfs each hour.

This plan will also be implemented when transitioning between the BFP and the SMP. For example if bypass flows were at 190 cfs at the Freeman Diversion under the BFP and percolation resulted in discharge at the critical riffle to subside to 159 cfs, then an hourly increase in diversions of 7 cfs per hour would be implemented until the flow conditions prescribed in the SMP are met.

Figure 5-7 is an example of the Transition Protocol between the VFP and the BFP as indicated on the graph. In this example, diversions would have temporarily ceased while attempting to maintain the VFP. At that point, bypass flows would be reduced by allowing the gradual increase of diversions in accordance with Table 5-4. Because the bypass flows fell between the flow range of 200 to 449 in the table, diversion of 14 cfs would be implemented the first hour. On the second hour of this plan, diversions would increase by another 14 cfs to a total of 28 cfs. Additional diversion increases of 14 cfs/hour would be implemented until the bypass flows fell below 199 cfs and then additional diversion increases would occur at 7 cfs per hour until the bypass flows provided the 160 cfs at the critical riffle as detailed in the BFP.

Figure 5-7 Example Hydrograph Demonstrating the Transition Protocol



Development of Pulse Protocol

The Pulse Protocol has been developed to mimic small storms in order to encourage the upstream migration of steelhead when flows are stable (Figure 5-8). Flow pulses will be implemented when stable flows have been released for an extended period of time below the Freeman Diversion. The basis of the Pulse Protocol is that after a couple of days where flows are stable at 160 cfs at the critical riffle and when more than 50 cfs is being diverted, United will temporarily release an additional pulse of water. The flow pulse will then be reduced at the same rates that are observed in the transition protocol until the bypass flows reach 120 cfs at the critical riffle. Releases will be maintained at 120 cfs until the additional volume of water released during the pulse has been equivalent to what would have been released under the VFP or the BFP.

Pulse Protocol

Both the VFP and the BFP have periods where 160 cfs is to be maintained at the critical riffle for upstream steelhead migration. If flows of 160 cfs have been maintained at the critical riffle for more than 2 days and United is diverting more than 50 cfs, then United would implement a flow pulse following Table 5-5 through Table 5-7 below depending on the amount being diverted. Table 5-5 flows are to be implemented if diversions are greater than 50 cfs and less than 100 cfs. Table 5-6 flows are to be implemented if diversions are greater than 100 cfs and less than 150 cfs and Figure 5-7 flows are to be implemented if diversions are greater than 150 cfs. The first column in each table is the amount of additional flows to be bypassed over what was being released to maintain 160 cfs at the critical riffle. Table flows with the lesser discharge rate would be implemented if it is anticipated that fall below 160 cfs within the time that the table flows would be implemented. For example if flows were being maintained at 160 cfs for two days, with current diversions of 180 cfs, although it was anticipated that the total river flow was going to fall to a point where bypass flows would not be able to be maintain for more than 20 hours then Table 5-6 would need to be implanted because the duration of flows in Table 5-7 would extend beyond the time possible to maintain 160 cfs.

Flow pulses would occur when flows have been stable at 160 cfs for at least 2 days. United proposes conducting up to two flow pulses per storm and no more than 4 per year, but effectiveness will be evaluated through monitoring and appropriate modifications made through Adaptive Management (see Chapter 6).

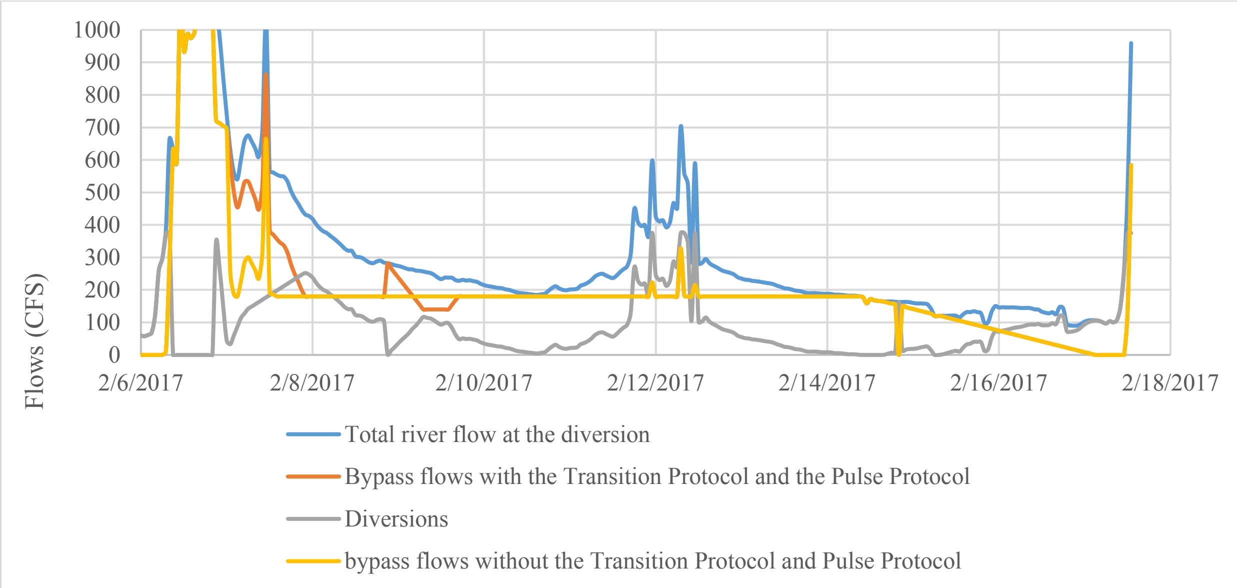
Table 5-5 When Diversions are >50 cfs and less than 100 cf

Duration Hour	Additional Bypass Flows	Hourly Decrease in Bypass Flows
1	50	-50
2	36	14
3	22	14
4	8	14
5	-6	14
6	-20	14
7	-34	14
8	-32	-2
9	-18	-14
10	-6	-12
11	0	-6

Table 5-6 When Diversions are > 100 cfs and Less than 150 cfs		
Duration Hour	**Additional Bypass Flows**	**Hourly Decrease in Bypass Flows**
1	100	-100
2	86	14
3	72	14
4	58	14
5	44	14
6	30	14
7	16	14
8	2	14
9	-12	14
10	-26	14
11	-40	14
12	-40	0
13	-40	0
14	-40	0
15	-40	0
16	-40	0
17	-40	0
18	-40	0
19	-30	-10
20	-16	-14
21	-2	-14
22	0	-2

Table 5-7 When Diversions are > 150 cfs		
Duration Hour	**Additional Bypass Flows**	**Hourly Decrease in Bypass Flows**
1	150	-150
2	136	14
3	122	14
4	108	14
5	94	14
6	80	14
7	66	14
8	52	14
9	38	14
10	24	14
11	10	14
12	-4	14
13	-18	14
14	-32	14
15	-40	8
16	-40	0
17	-40	0
18	-40	0
19	-40	0
20	-40	0
21	-40	0
22	-40	0
23	-40	0
24	-40	0
25	-40	0
26	-40	0
27	-40	0
28	-40	0
29	-40	0
30	-40	0
31	-40	0
32	-40	0
33	-40	0
34	-36	-4
35	-22	-14
36	-8	-14
37	0	-8

Figure 5-8 Example Hydrograph of the Pulse Flow Protocol



At the initiation of the pulse flow, diversions of over 100 cfs were occurring so Table 5-6 would be used to determine the magnitude and duration of the pulse. On the first hour, an additional 100 cfs would be release above the 180 cfs being released to maintain 160 cfs at the critical riffle (assuming 20 cfs of percolation). The first hour would release a total of 280 cfs. The remainder of the river can be diverted at this time. In this example, this was 4 cfs on the first hour. During the second hour of operation, an additional 14 cfs will be diverted. Diversions would increase by 14 cfs per hour for 11 hours or until flows at the critical riffle reach 120 cfs. Flows will be maintained at 120 cfs at the critical riffle for seven hours. A gradual increase in bypass flows to reach 160 cfs will then occur at a ramping rate of no greater than 14 cfs per hour to end the pulse flow back to the flow plans that were being implemented. The pulse flows are designed to promote migration of steelhead downstream of the diversion and yield neutral. The frequency and magnitude of the pulse flows can be modified through adaptive management (Chapter 6) and may be redesigned in shape magnitude or duration to optimize steelhead migration opportunity.

CONSERVATION MEASURE 1.2.2

CONSERVATION MEASURE 1.2.2

Instream Flow Commitment downstream of Freeman Diversion for Downstream Migration – Initial Operations (maximum instantaneous diversion of 375 cfs)

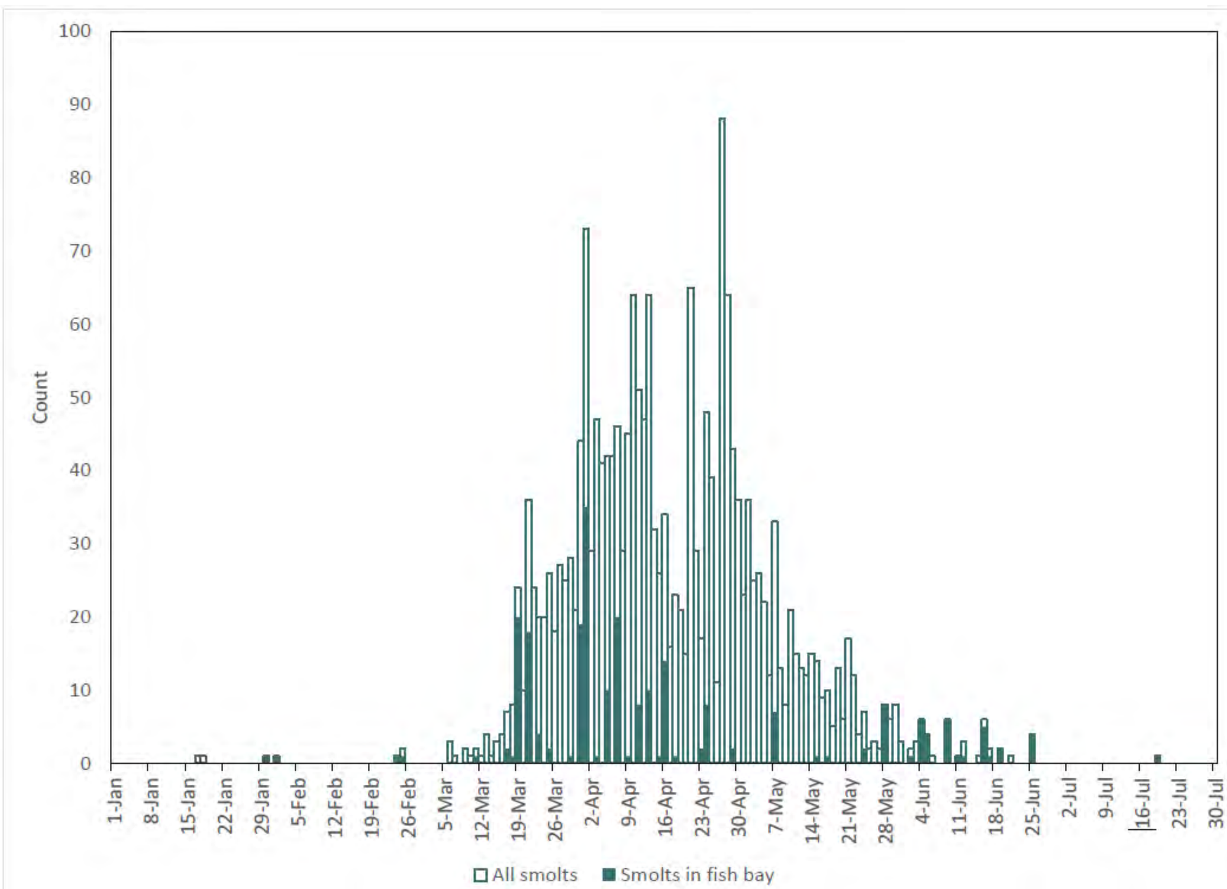
United will implement a Smolt Migration Protocol (SMP) to facilitate downstream migration of steelhead smolts and juveniles, and lamprey juveniles in the Santa Clara River downstream of the Freeman Diversion, through the affected reach, into the estuary from March 15- May 31.

Development of Conservation Measure

It is essential for the recovery and sustainability of the southern California steelhead population to provide a functioning downstream migration corridor that will facilitate the migration of steelhead smolts and lamprey juveniles from the Santa Clara River to the ocean. CM 1.2.1 (focused on instream flows for upstream migration) combined with CM 1.2.2 (focused on instream flows for downstream migration) represent the two key measures designed to meet a primary objective of this MSHCP central to the Southern California Steelhead Recovery Protocol for the Santa Clara River: “Provide a pattern and magnitude of instream flows downstream of the Freeman Diversion for steelhead and lamprey migration through implementing specific instream flow operations" (NMFS 2012 Goal 1, Objective 1.2).

The timing of this measure is based in part on monitoring data collected from operating a downstream migrant trap at the Freeman Diversion from 1994 through 2014. In 2014, trap operation ceased under direction from NMFS. During the years that United operated the trap, United experienced a wide range of flow conditions and highly variable smolt captures ranging from 0 to 839 per year (Booth 2020). Monitoring indicated the majority of downstream migrating steelhead smolts (~95 percent) arrive at the Freeman Diversion between mid-March and late May (Figure 5-9), the basis for the March 15 – May 31 primary migration period under CM 1.2.2. Booth (2020) showed that the majority of smolts arrive at the Freeman Diversion during this window even when flows connecting the upstream tributaries occur earlier in the year and even if there is not enough flow for smolts to make it from the Freeman Diversion to the estuary under a no diversion scenario. The paper also conducted an analysis of trapping patterns for other more common fish species and applied an "effort" calculation based on different pathways of flows through the facility. These analyses demonstrated that the pattern of arrival of smolts was likely not an artifact of sampling effort and trapping efficiency and the majority of smolt arrivals at the Freeman Diversion did in fact occur between March 15-May 31 most likely driven by photoperiod and then flow related independent variables (time since peak of storm and flow connection to upstream tributaries). The migration window was also based on information from adjoining watersheds that share the same Southern California Steelhead BPG.

Figure 5-9 Timing of Steelhead Smolt Migration from the Santa Clara River, California



Note: based upon captures at the fish trap located at the Freeman Diversion (1993-2014) (Booth 2016)

To address uncertainty regarding the migration, United completed a review of salient literature, which relied heavily on a single study conducted on the Napa River. That study observed rates of 3.9 to 9.6 miles per day, with a mean of 5.6 miles per day, by 12 tagged smolts (Sandstrom et al. 2012). Similar results were obtained by Kelly (2008). Based on this data, smolts in the Santa Clara River would require one to three days to travel from the Freeman Diversion to the estuary. To protect safe migration conditions for smolt emigration, United factored two additional days into CM 1.2.2 operations, such that migration flows are provided downstream of the critical riffle when prescribed flows can be maintained for a minimum of five days.

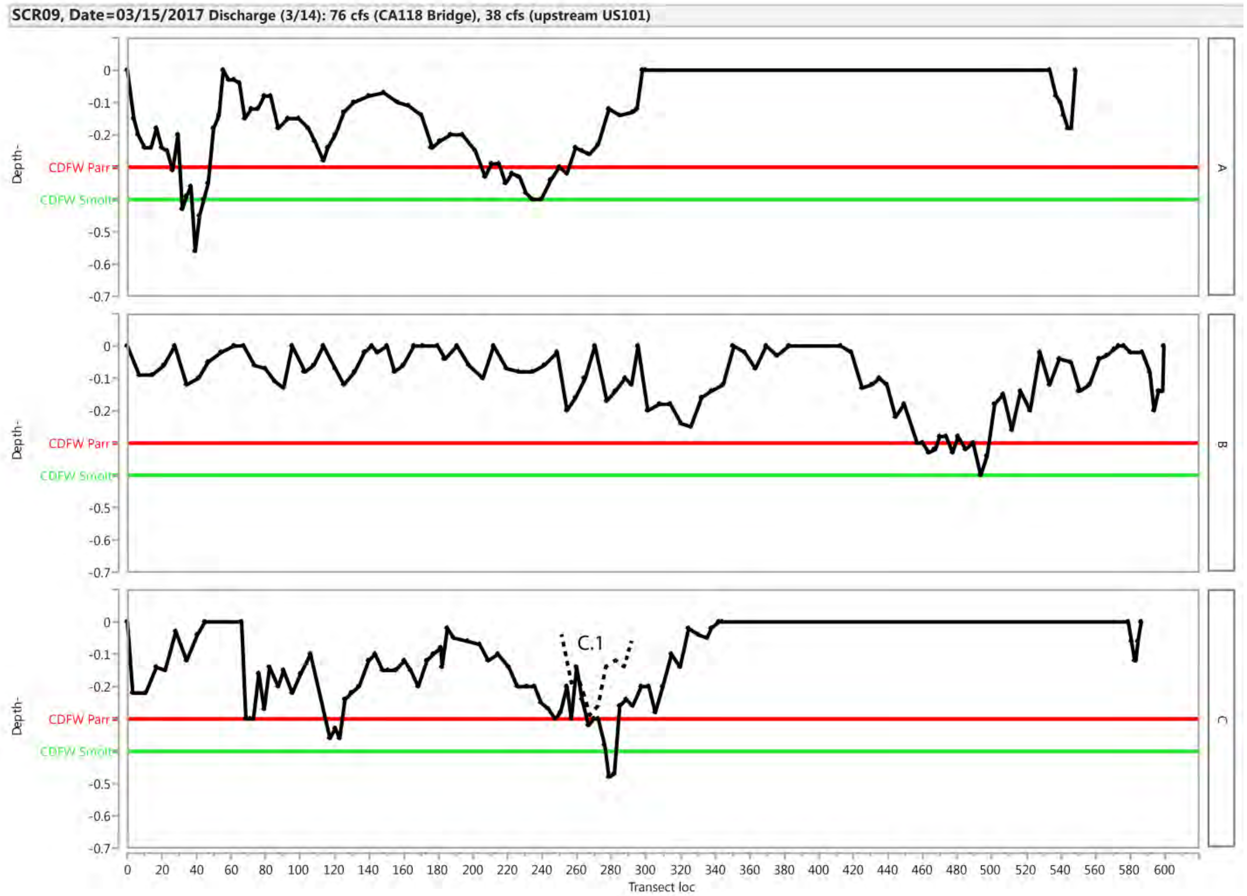
As mentioned under CM 1.2.1, TRPA concluded that flows ≥120 cfs should be sufficient to provide conditions suitable for upstream adult steelhead passage through the critical reach using the 0.5-foot minimum depth and minimum 5-foot width criteria (TRPA 2005). Compared to smolts, upstream migrating adult steelhead are large fish that require greater depths to facilitate volitional migration. Therefore, flows ≥120 cfs should also conservatively provide conditions suitable for the downstream migration of steelhead and lamprey. The lower 80 cfs threshold value for smolt migration is based on United's observations of conditions downstream of the critical riffle as part of follow-up monitoring to the TRPA studies, in 2010, 2017, and 2018 (United Water 2010, United unpublished data). These observations suggested that the likelihood of a continuous, functional migratory connection to the estuary decreases substantially when flows decline below 80 cfs at the critical riffle, which could also increase the potential for stranding, predation, and thermal stress to smolts migrating through the critical reach.

In March 2017, United collected supplemental data at a series of cross-sections established at several wide, complex, multi-channel riffle-type areas (critical riffle) between the SR 118 and US-101 bridges. Measurements were taken under flow conditions ranging from 120 cfs to 76 cfs and the change was documented in downstream passage corridor width and depth as flows receded. Discharge measurements were taken upstream and downstream of the critical riffle site itself, at the SR 118 bridge and just upstream of the US-101 bridge. Percolation of 40 to 60 cfs was documented between the sites, and discharge at the critical riffle site itself was expected to be 10-20 cfs lower than the measurements recorded at the SR 118 bridge. The lowermost flow measured 76 cfs at the SR 118 bridge (Figure 5-10 and Figure 5-11), which only provided relatively narrow threads of suitable smolt passage condition (as indicated by smolt depth criterion – 0.4 foot, CDFW 2017) in two of the three cross-sections at the critical riffle (United Water 2010).

At approximately 60 cfs (measured at the critical riffle), water depths were too shallow (~0.25-foot) to provide safe passage conditions for smolts (United Water 2010). In March 2018, United collected additional data at the same site. No large channel-reshaping flows had occurred since the 2017 winter and the site remained similar in 2018 (United unpublished data).

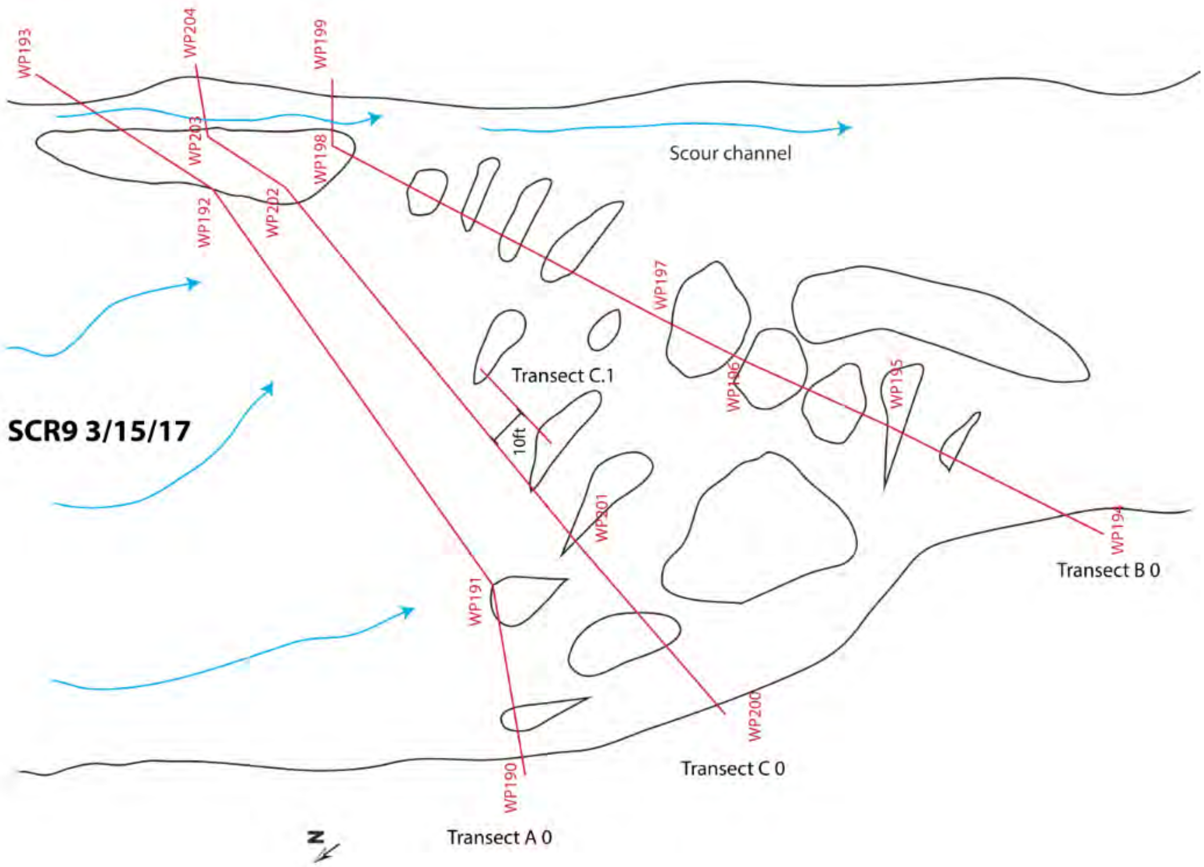
United considers the 80 cfs threshold flow to be based on the best available science, and to represent a reasonable and protective threshold from which to base operations and implement further measures designed to protect steelhead. Specifically, once flows decline to 80 cfs and below, United will continue to provide passage for downstream migrants through implementation of CM 1.2.5, which involves actively monitoring and relocating all downstream migrants at the downstream fish passage facility. More detail on rationale and methodology for the relocation program is provided under CM 1.2.5.

Figure 5-10 Graphical Representation of Three Horizontal Cross-sections Measured in the Critical Reach



Note: measurements taken near SR 118 bridge on March 15, 2017, with CDFW (2017) smolt (0.4 ft) and parr (0.3-foot) criteria superimposed on profile. Flow estimated at 76 cfs. Units are feet. Data collected by United and provided by Booth (2017, unpublished data).

Figure 5-11 Three Horizontal Cross-sections Measured in the Critical Reach



Note: location near the SR 118 bridge on March 15, 2017, with CDFW juvenile and smolt criteria superimposed on profile. Flow estimated at 76 cfs. Data collected by United and provided by Booth (2017, unpublished data).

Discussion

The SMP has two elements. The first provides instream flows in the affected reach during periods when smolts are most likely to be migrating downstream to the estuary (March 15 – May 31); the second gives a stepped-down flow curtailment process for flows < 80 cfs, linked to the downstream fish monitoring operation described in CM 1.2.5. The best available science, summarized above, suggests that flows below 80 cfs are too shallow to allow smolts to migrate safely downstream without the potential for stranding or isolation in pools, and that migratory connectivity to the estuary is lost. This conservation measure works in parallel with CM 1.2.1 for adult upstream migration during the March 15–May 31 period. The provision of flows for downstream unimpeded migration will not preclude United from diverting the maximum instantaneous rate of 375 cfs under initial operations. However, the SMP will regulate when and how the facility can operate, with limitations on the quantity and timing of diversions reflective of the instream flow commitment to provide a downstream migration corridor for steelhead and lamprey.

The SMP will be triggered under two conditions: 1) when CM 1.2.1 for adult upstream migration has been triggered by flow in Sespe Creek during March 15 – May 31, and flows have decreased to 120 cfs downstream of the critical riffle; and 2) any other time during this window when at least 80 cfs flows downstream of the critical riffle can be maintained for five days, while allowing the diversion of 40 cfs to provide critical diversions for surface water deliveries as described in Appendix B. Flows (greater than

120 cfs) that allow steelhead smolt downstream migration are also provided prior to March 15 as part of the instream flow commitment for adult upstream migration described in CM 1.2.1. Figure 5-12 presents a flow chart detailing the implementation of CM 1.2.2 for downstream smolt migration.

Once CM 1.2.2 triggers, instream flows of 120 cfs will be maintained downstream of the critical riffle for as long as possible while diverting a minimum of 40 cfs. If this flow cannot be maintained, instream flows of remaining total river flow down to 80 cfs will be maintained downstream of the critical riffle while diverting 40 cfs. When total river flow is not sufficient to maintain 80 cfs at the critical riffle and also divert 40 cfs, United will initiate a three-day step-down flow curtailment process, reducing flows by 1/3 increments until there are no further releases to the affected reach and all flow is diverted. During the three day ramp-down, bypass flows will be routed through a screened path at the Freeman Diversion to provide flow for smolts already downstream of the Freeman Diversion to travel to the estuary and to avoid and minimize the potential for more smolts to pass the Freeman Diversion in a downstream direction immediately prior to instream flow curtailment, which would most likely lead to their stranding or isolation in downstream pools.

To implement the SMP, forecasted flows downstream of the critical riffle are needed five days in advance. Two methods and implementation processes will be used, depending upon the flow conditions, as follows:

1) To minimize the potential for stranding smolts downstream of the diversion when flows recede to a level that no longer supports safe migration, United will monitor smolts five days before flows are predicted to recede below 80 cfs through the affected reach. This prediction will be based on monitoring the recession rate of the storm or base flows in the river and using a standard recession curve.

2) The five-day prediction will be needed when flow events occur from March 15 – May 31 that are too small to trigger CM 1.2.1 for adult upstream migration. If sufficient flow occurs in the river (less 40 cfs critical diversions) to maintain at least 80 cfs for more than five days, then flows in accordance with this measure will be released to approximate downstream unimpeded migration. Percolation downstream of the Freeman Diversion will be estimated either by the latest measured losses in the reach from prior instream flows or from the most recent relationship between groundwater levels and percolation rates downstream. The predicted flows downstream of the critical riffle can be estimated using estimated losses downstream and the expected recession rate as calculated in item 1.

Example of Proposed Smolt Migration Protocol

This section provides hydrograph examples to illustrate implementation of CM 1.2.2. Figures 5-14 and 5-15 provide example hydrographs of flows in the Santa Clara River and Freeman Diversion illustrating different conditions under which the SMP would be initiated. Figure 5-14 illustrates initiation of the SMP starting on March 15, 1997, the first day of the primary smolt migration window. A storm event prior to March 15 in that year that would have triggered CM 1.2.1 for adult upstream migration flows. However, the adult migration flows would ramp down after the required 15-day period, and United would divert most of the total river flow. On March 15, the SMP would be initiated, because there would be sufficient flow in the river to meet both the critical diversions of 40 cfs and the target 80 cfs at the critical riffle for at least five days. The initial flow provided would have been 120 cfs, but as of March 30, there would have been insufficient flow to maintain critical diversions of 40 cfs, and 120 cfs at the critical riffle, so flows at the critical riffle would be decreased to 80 cfs. Starting on April 4, 1997 there would not have been sufficient flow in the river to maintain the SMP; trap and transport would have been initiated and flows downstream of the diversion allowed to decrease by one-third each day.

Figure 5-12 Decision Process for Initiating CM 1.2.2, Instream Flow Commitment for Downstream Migration of Steelhead Smolts and Juveniles and Pacific Lamprey Juveniles

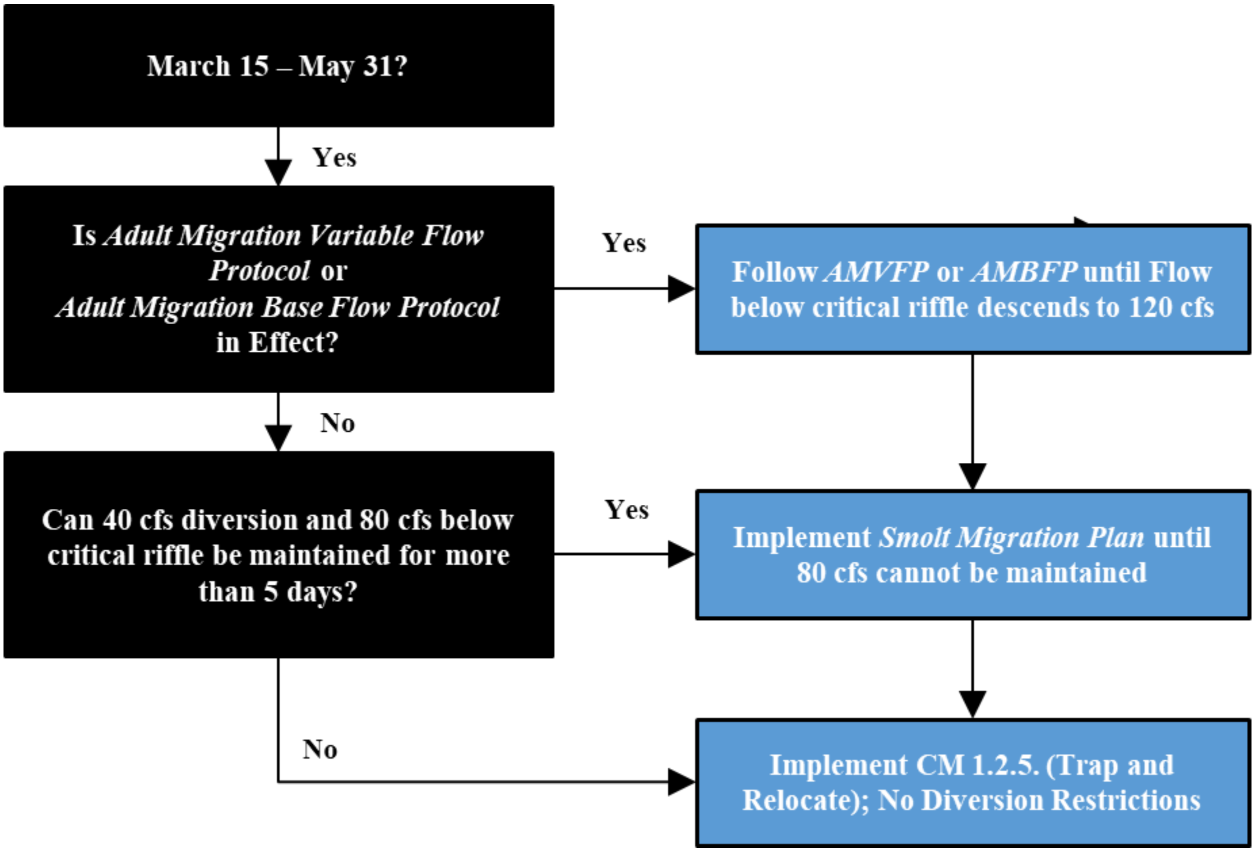


Figure 5-13 illustrates a flow scenario that would result in transition from the Adult Migration Base Flow Protocol (CM 1.2.1) to the SMP under initial operations. In this example, based on flows from March 15 – April 15, 1997, a storm peaking on April 14 would have triggered CM 1.2.1 for adult upstream migration, and this protocol would have remained in effect until April 25 (day 12), when flows downstream of the critical riffle would have been reduced to 120 cfs. The SMP would have maintained 120 cfs downstream of the critical riffle and a minimum of 40 cfs diversion until May 6, when total flow would have been insufficient. At this point, the SMP would have maintained 80 cfs downstream of the critical riffle, and a minimum of 40 cfs diversion until May 8, when total river flow would have been insufficient to meet this demand, and, flows downstream of the critical riffle would have been reduced by one third for three days.

A final example illustrating initiation of only the SMP when the adult upstream migration flows have not been triggered, is displayed in Figure 5-14. On April 15, 1958, the flows in Sespe Creek increased by 190 cfs, which would not have been enough to trigger initiation of CM 1.2.1 for adult migration, but it would be enough to trigger CM 1.2.2 (Figure 5-15). Flows of 120 cfs (and then 80 cfs), downstream of the critical riffle, would have been provided until May 7, when they would have no longer been maintained. At this point, flow downstream of the diversion would have been decreased by one third for three days, after which all flow would have been diverted.

Figure 5-13 Example Hydrograph of Initial Operations During Initiation of the SMP for March 15 - April 15, 1997

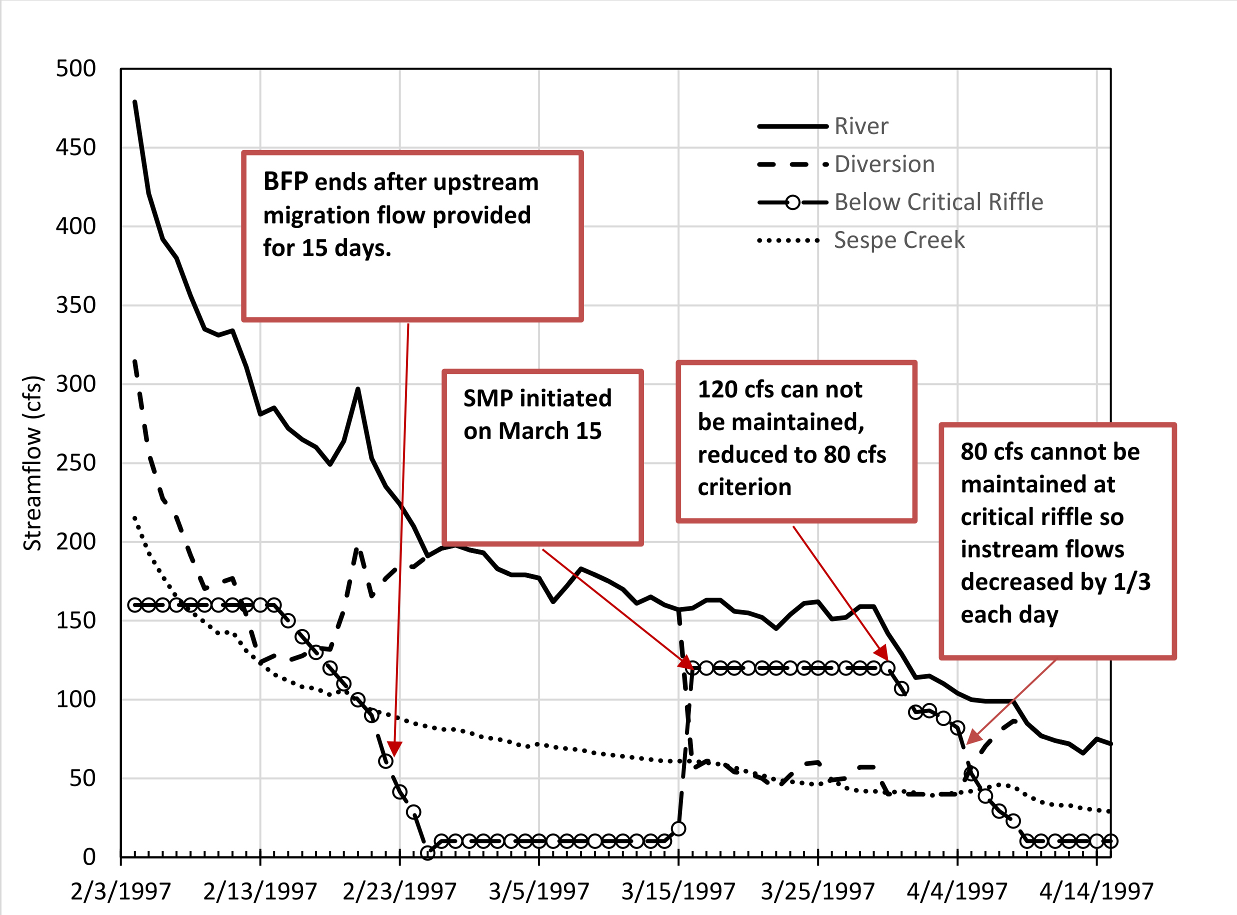


Figure 5-14 Example Hydrograph of Initial Operations during Transition of the BFP to the SMP on Flow for April 15 - May 16, 1958

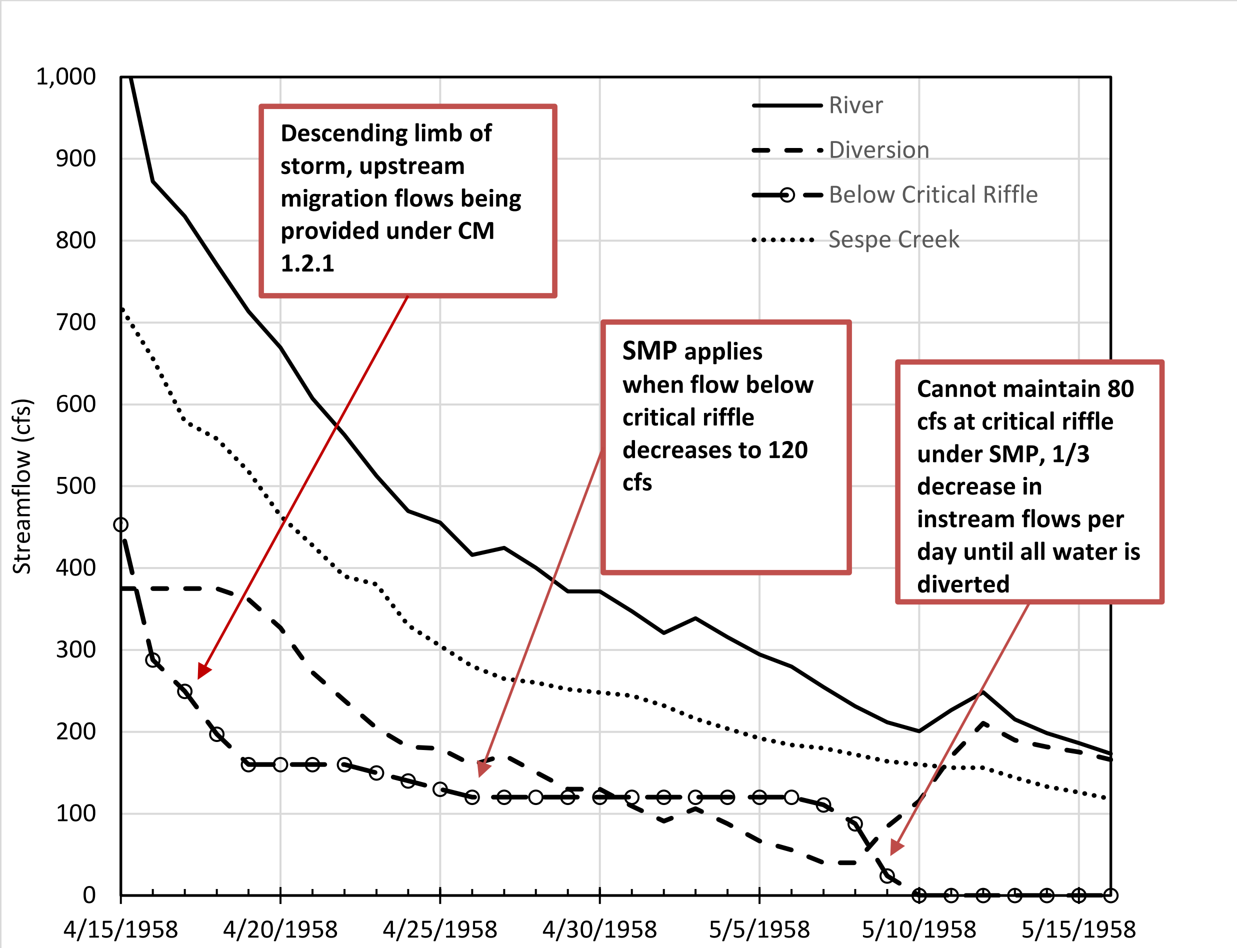
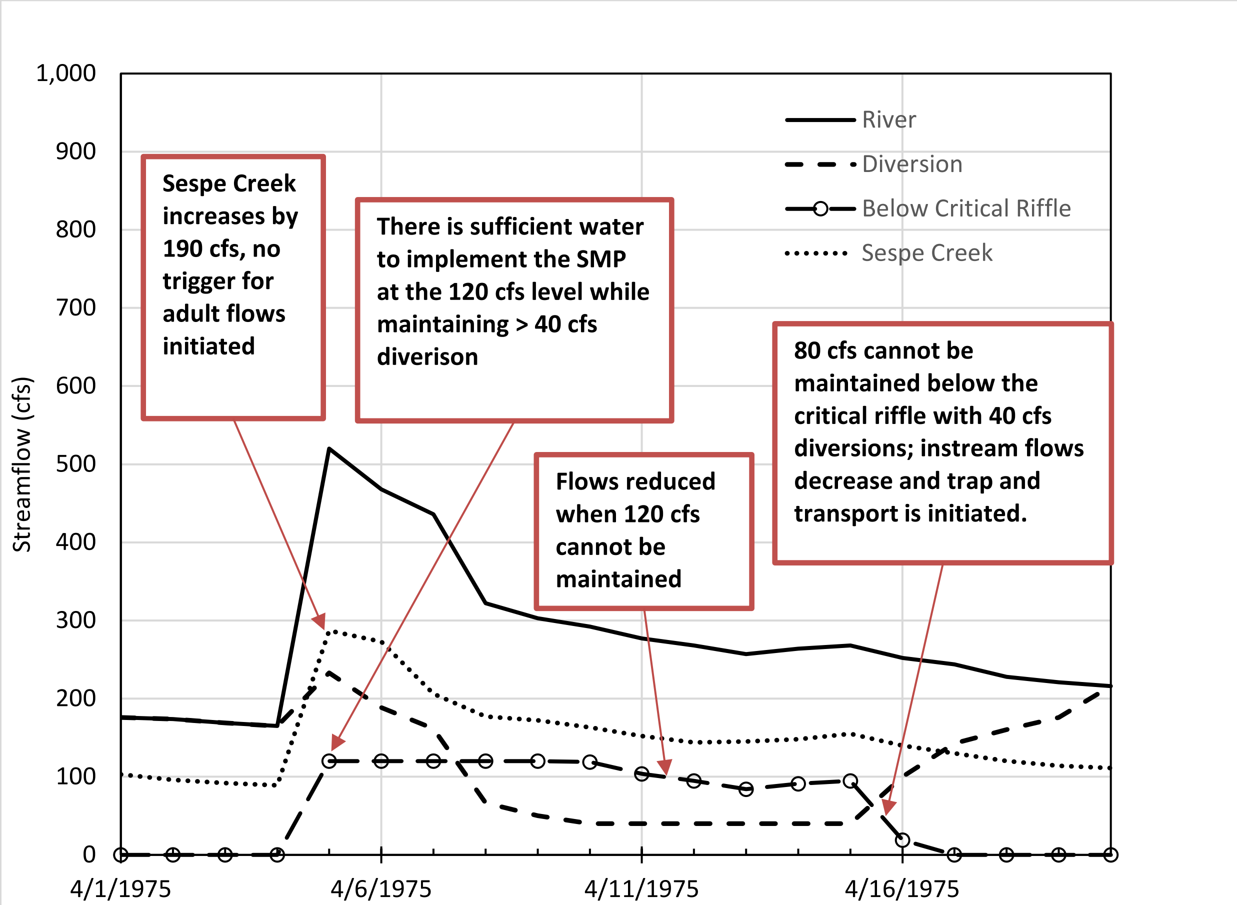


Figure 5-15 Example Hydrograph Showing Application of Initial Operations SMP, Illustrated by Flows in Early April 1975



CONSERVATION MEASURE 1.2.3

CONSERVATION MEASURE 1.2.3

Instream Flow Commitment Downstream of Freeman Diversion for Upstream Migration - Future Operations (water right change to maximum instantaneous diversion rate – 750 cfs)

United will implement a comprehensive upstream migration protocol to manage diversions and approximate unimpeded upstream migration during the migration season of January 1–May 31 to the maximum extent practicable for adult steelhead and lamprey from the estuary, through the affected reach, up to the Freeman Diversion.

Note: This measure is nearly identical to CM 1.2.1, with modifications to address increased water right.

The increased maximum diversion rate is designed to meet United's water resource needs and fulfill its mission and purpose with no increased effects to a functioning upstream migration corridor for covered aquatic species. The upstream migration plan under this conservation measure is modified from CM 1.2.1 in the following ways:

- The TRP assigns an hourly incremental rate (Table 5-7) to achieve the final maximum daily diversion, up to a maximum of 750 cfs, over a maximum time-period of four hours.
- The maximum diversion rate for the VFP and BFP is increased to 750 cfs (Table 5-8).

The 750 cfs limit does not impact the implementation of these two plans.

Discussion

This discussion is limited to the differences from CM 1.2.1 that an increased water right (to 750 cfs) have on the upstream migration plan.

Table 5-8 Maximum Hourly Diversions at the Freeman Diversion According to the Turn-in Rate Protocol (750 cfs maximum diversions)*

Hour	Initial Santa Clara River Discharge (cfs)								
	≥5000	2500-4999	1500-2499	1200-1499	900-1199	600-899	450-599	200-449	125-199
Hour 1	750	542	189	111	96	64	54	28	14
Hour 2		750	378	222	192	128	108	56	28
Hour 3			567	318	256	192	136	84	42
Hour 4			750	414	320	256	164	112	56
Hour 5				510	384	310	192	140	56
Hour 6				574	448	338	220	154	56
Hour 7				638	512	366	248	168	56
Hour 8				702	566	394	276	182	56

* Instream flow requirements under VFP and BFP (Table 5-2) supersede the TRP. Therefore, diversion rates for a given hour may be lower than the maxima specified in this table .

Increasing the maximum diversion rate to 750 cfs provides United the opportunity to maintain diversion yields while implementing instream flow conservation measures. In other words, this approach is intended to allow United to commence diversions (turn-in) at higher flow rates to avoid and/or minimize effects to steelhead and lamprey while also meeting the water resource needs of United's constituents.

Beginning diversion at high flow rates can result in operational issues from sediment and debris accumulation at the headworks (canal gates, fish ladder entrance, fish screens, etc.) and within the canals and debris basin. These operational issues bring about complete shutdown of the Diversion, including the fish passage facility. To accommodate higher diversion rates and associated additional sediment and debris, upgrades to the diversion facility and associated infrastructure, along with operational modifications, will be required.

Furthermore, as discussed in Chapter 2, climate change predictions for Ventura County generally forecast increased precipitation variability, resulting in longer dry periods, fewer but more intense storms, and more frequent wildfires. This shift will shorten the period that surface flows are present in the Santa Clara River and increase the potential sediment loads carried by these flows. The ability to instantaneously divert higher amounts of water and manage higher loads of sediment will increase the future reliability of Freeman Diversion project in the face of climate change while simultaneously minimizing its potential to result in adverse effects to migrating fish.

Example of Proposed Plan

This section provides examples of hydrographs to illustrate how implementation of various components of CM 1.2.3 could occur under different storm-induced flow conditions. These examples are the same time periods as for CM 1.2.1, but they show the diversion rates up to 750 cfs and illustrate how increased diversions may impact these hydrographs. Figure 5-16 offers an example hydrograph under the VFP operations is provided in. This figure shows flows in the Santa Clara River and Freeman Diversion under CM 1.2.3 during February 6-18, 1994. The Sespe Creek trigger would have been initiated on February 7, 1994. When flows receded, diversions would have been restricted such that flow downstream of the critical riffle would approximate unimpeded recession rate as is the objective of the VFP. The VFP would have been followed until February 16, 1994 when flows increased and the Sespe Creek trigger would have been re-initiated.

Figure 5-16 Example Hydrograph of Low Flow Proposed Operations under the VFP for February 6 - 18, 1994

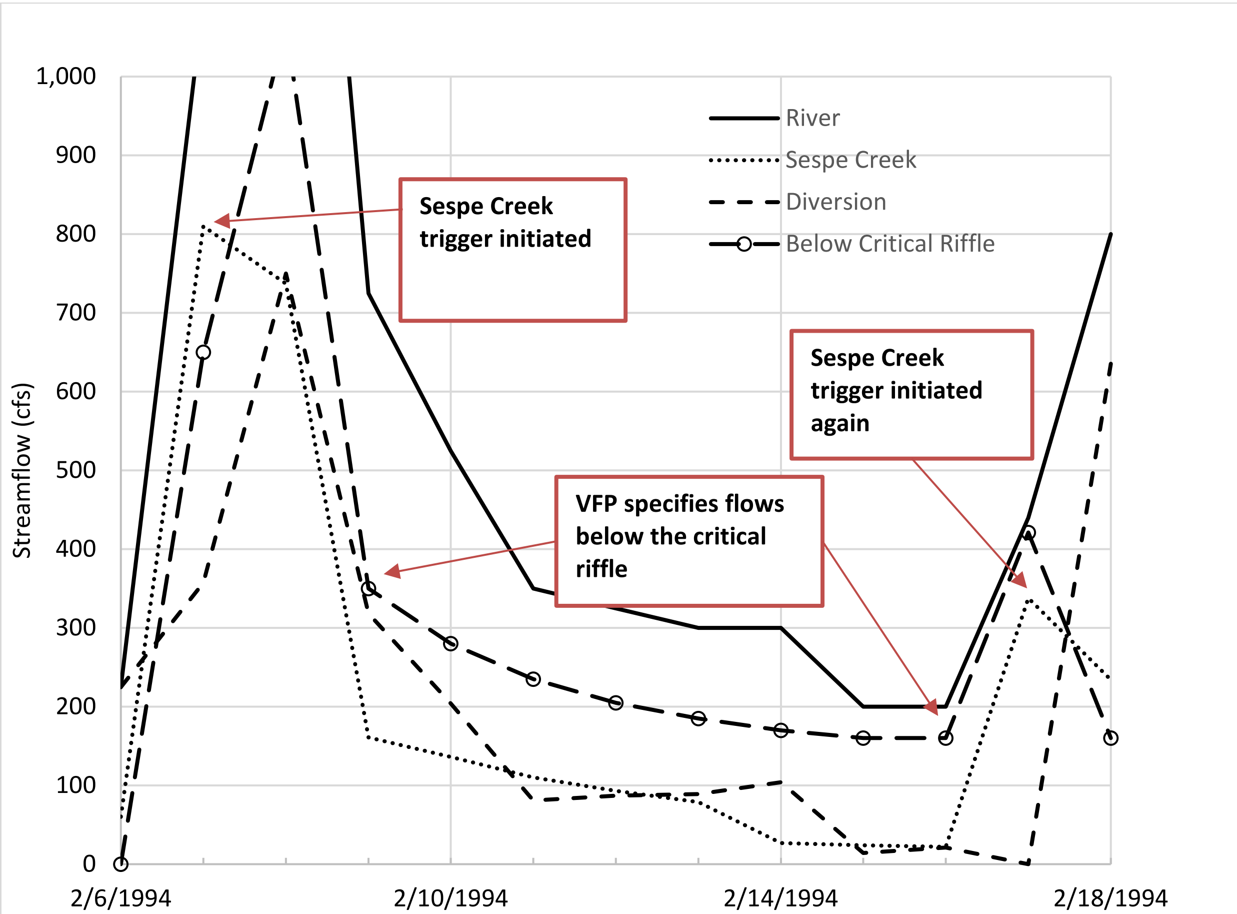


Figure 5-17 provides an example hydrograph showing flows in the Santa Clara River and Freeman Diversion from January 17 to February 6, 1971. The Sespe Creek trigger would have been initiated on January 18, 1971. Flows in the Santa Clara River dropped the following day such that the VFP would not have been followed. At that point, instream flows would have switched to the BFP for 18 days, after which United would have been allowed to divert all river flow.

Figure 5-17 Example Hydrograph under the BFP for January 17 - February 6, 1971

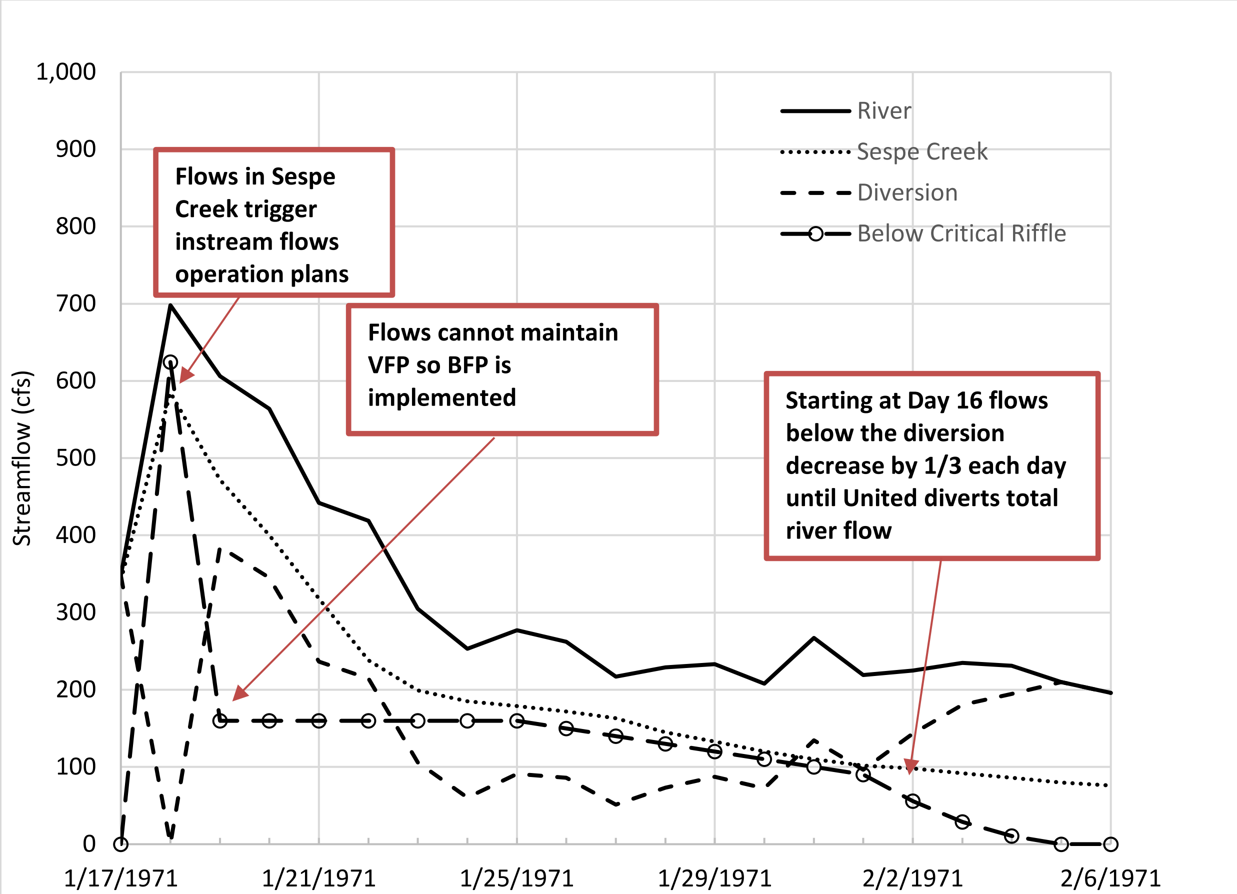
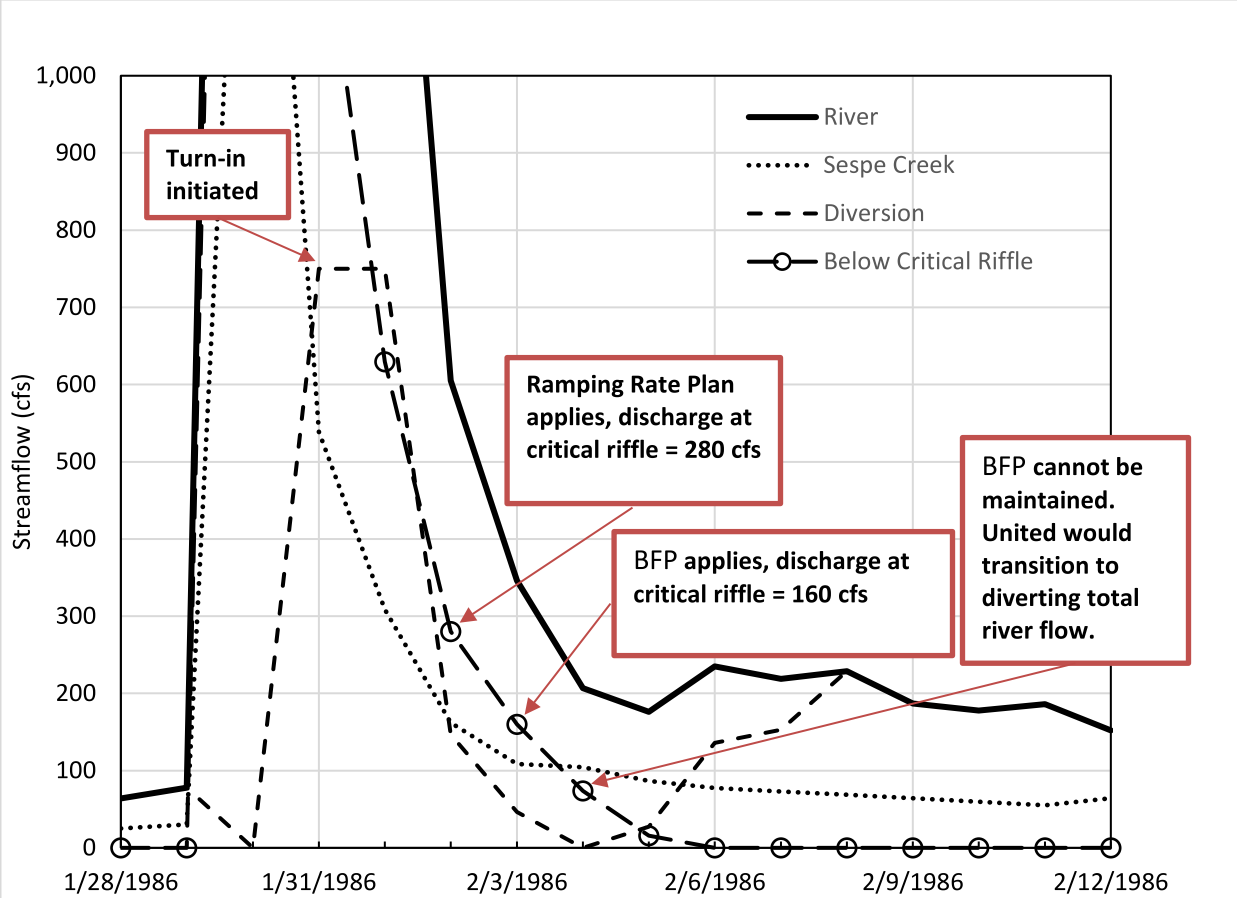


Figure 5-18 offers an example hydrograph showing the cessation of the BFP and operations reverting to full water diversion. This figure shows total river flow in the Santa Clara River and at the Freeman Diversion from January 28 to February 12, 1998. In this example, the Sespe Creek trigger would have been initiated on January 30 and turn-in would have restarted on January 31, 1998. On day five (February 3), the *VFP* (235 cfs) would not have been maintained, so the *BFP* (160 cfs) would have applied. On day 6 (February 4), the BFP would not have been maintained (160 cfs), so diversion would have been incrementally increased. By February 6, United would have been diverting total river flow.

Figure 5-18 Example Hydrograph of Early Termination under the BFP for January 28 - February 12, 1986



CONSERVATION MEASURE 1.2.4

CONSERVATION MEASURE 1.2.4
Instream Flow Commitment Downstream of Freeman Diversion for Downstream Migration–Future Operations   ***(Water Right Change to Maximum Instantaneous Diversion Rate – 750 cfs)***
United will implement the SMP to facilitate downstream migration of steelhead smolts and juveniles, and lamprey juveniles in the Santa Clara River downstream of the Freeman Diversion, through the critical reach, into the gaining reach downstream or the estuary from March 15–May 31.
Note: The SMP is nearly identical to that laid out in CM 1.2.2 except that the maximum diversion rate is 750 cfs instead of 375 cfs.

The increased maximum diversion rate is designed to meet United's water resource needs and fulfill its mission and purpose with no increased effects to a functioning upstream migration corridor for covered aquatic species. Except for the increased maximum diversion rate (from 375 cfs to 750 cfs), the SMP under CM 1.2.4 is implemented identically to CM 1.2.2. To avoid repetition, the discussion for this CM 1.2.4 is limited to a summary and the single example from CM 1.2.2 that is modified under future operations.

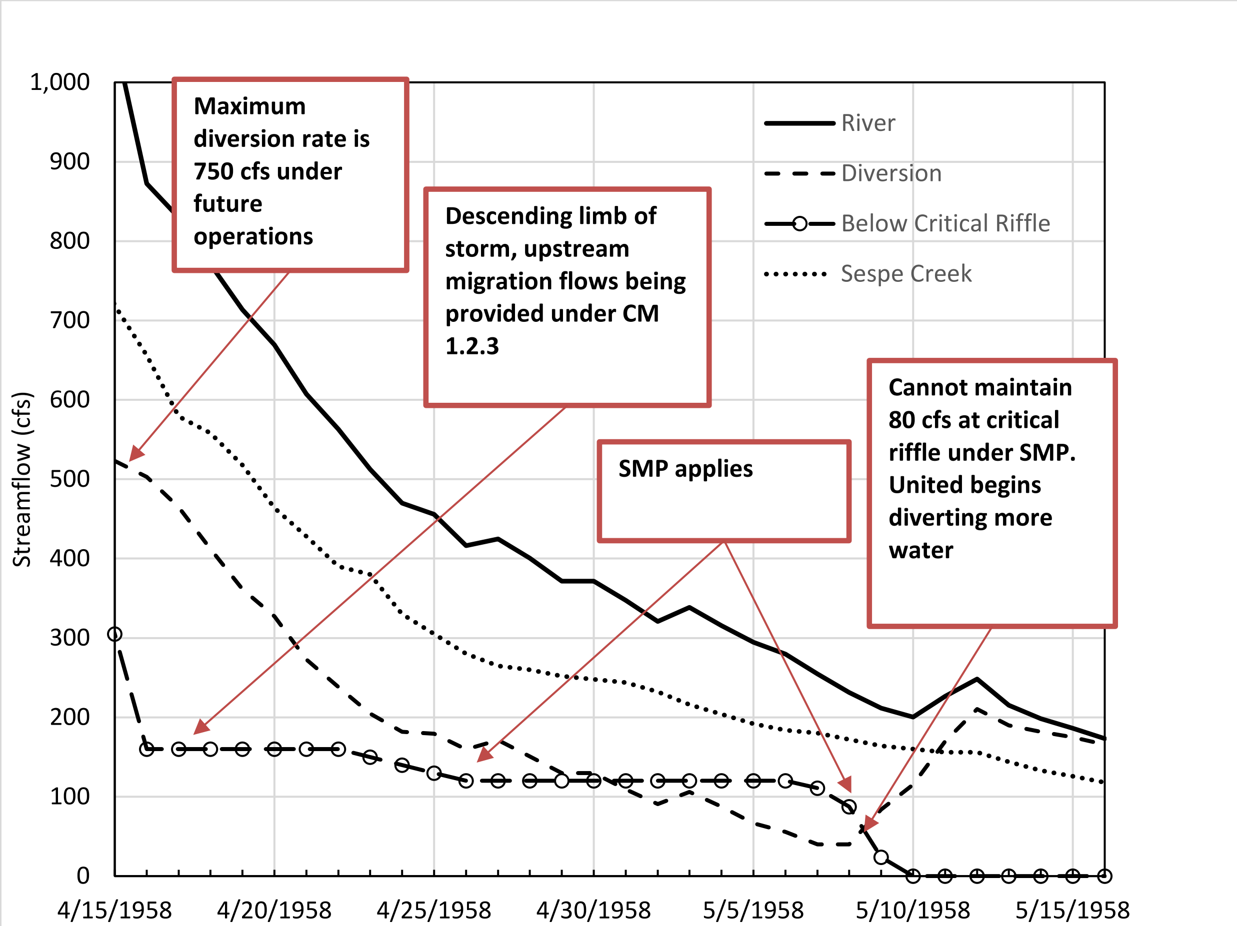
Discussion

Increasing the maximum diversion rate to 750 cfs provides United the opportunity to offset, to some degree, the reductions in otherwise available diversion yield due to instream flow conservation measures. It also allows United to commence diversions (turn-in) at higher flow rates to reduce effects to migrating steelhead and lamprey and thus provide natural migration cues and sufficient flow for unimpeded rates of migration between the diversion and the ocean. Consequently, diversion commencement at high flow rates can also result in operational issues from sediment and debris accumulation at the headworks (canal gates, fish ladder entrance, fish screens, etc.) and within the canals and debris basin. These operational issues can result in a complete shutdown of the diversion facility including the fish passage facility. However, over two decades operating the Freeman Diversion have provided data to suggest diversions can commence at higher total SSC than previously thought. However, to accommodate higher diversion rates and associated additional sediment and debris, upgrades to some of the diversion infrastructures and operational modifications will be required.

Summary and Example of Proposed Instream Flow Commitment

This section provides hydrograph examples to illustrate implementation of the Downstream Passage Habitat Conservation Measures. The examples under CM 1.2.2 for initial operations provide illustrations of the implementation of CM 1.2.4 as well. Figure 5-19 shows slight change to the earlier examples where it illustrates a flow scenario that would result in transition from the BFP to the SMP under future operations. In this example, based on flows from April 15 to May 16, 1958, a storm peaking on April 14 would have triggered CM 1.2.2 for adult upstream migration and would have remained in effect until April 25 (day 12), when flows downstream of the critical riffle would have declined to 120 cfs. The SMP would have maintained 120 cfs downstream of the critical riffle, and a minimum of 40 cfs diversion until May 6, when total flow would have been insufficient to meet this level. At this point, the SMP would have maintained 80 cfs downstream of the critical riffle and a minimum of 40 cfs diversion until May 8, when total river flow would have been insufficient to meet this demand, and, flows downstream of the critical riffle would have been reduced by one third for three days.

Figure 5-19 Example Hydrograph of Future Operations during Transition of the BFP to the Smolt Migration Protocol from April 15 - May 16, 1958



CONSERVATION MEASURE 1.2.5

CONSERVATION MEASURE 1.2.5

Relocate Downstream Moving Steelhead and Lamprey at Low Flows

Under CM 1.2.5 downstream moving steelhead and lamprey will be relocated according to a relocation protocol when flows downstream of the critical riffle are expected to be below a level that provides migratory functional connectivity with the estuary within five days (initially 80 cfs downstream of the critical riffle but subject to adaptive management).

Development of Conservation Measure

Data collected to date show that when flows decline to less than 80 cfs downstream of the critical reach, functional migratory connectivity from the Freeman Diversion to the estuary is lost for downstream migrating steelhead. Thus, any downstream migrating fish passing the Freeman Diversion under those conditions is likely to be subjected to excessive stress, potential injury, or death from predation, poaching, or physiological limitations as a result of stranding. CM 1.2.5 is intended to minimize or reduce the risks to steelhead and Pacific lamprey downstream migrants by safely monitoring the fish at the Freeman Diversion facility and then relocating them either upstream or downstream, depending on their appearance and condition (i.e., parr and fry would be relocated upstream; smolts, kelts, and lamprey juveniles would be relocated downstream near the estuary if the sand berm is open and upstream if the sand berm is closed). Any other native species incidentally found in the process of this protective measure for anadromous fish, will be salvaged and relocated according to CM 2.1.3.

There are two periods[5] and associated triggers for CM 1.2.5:

- January 1 – March 14, when adult steelhead instream flows cease
- Starting March 15, when flow predictions indicate that flows will recede to below functional migratory connectivity to the estuary within 5 days until May 31 or until no O. mykiss have been observed in the trap for at least a week and no new precipitation is forecast, whichever comes last.

During the dates of the SMP, United will calculate percolation rates and flow recession downstream of the Freeman Diversion to the downstream extent of the critical reach according to the Monitoring Plan (Chapter 6). When United is not engaged in other procedures under the Monitoring Plan, smolts will be bypassed through the diversion facility via a bypass pipe to the river downstream of the diversion during adult instream flow releases and during conditions when there is more than a projected 5-day window of functional downstream migratory connectivity to the estuary. Once the triggers are met, United biologists will engage the monitoring station, and relocation activities will commence until May 31 or until no *O. mykiss* has been observed in the trap for at least a week and no new precipitation is forecast, whichever comes last.

Fish Trap

The current fish trap will be used prior to renovation of the new fish passage facility. The trap is located at the downstream end of the fish screen bay and is constructed with 0.1875-inch mesh metal screen material. Surface flow from the fish screen bay enters the trap through a weir gate with an opening that directs fish and other aquatic species into the station. The station is situated to keep all fish immersed in at least 2 feet of flowing water.

CM 1.1.1 presents a description of the future fish monitoring and evaluation station; these will be used to trap fish under CM 1.2.5 upon completion of renovation.

Relocation Procedure

The relocation program will occur from January 1 to May 31 annually when the triggers are met and would continue until no *O. mykiss* has been observed in the trap for a week and no new precipitation is forecast. These curtailment criteria would be subject to adaptive management (see Chapter 6).

From March 15 to May 31, United would measure flows downstream of the diversion and near the downstream extent of the critical reach, with the objective to monitor instream flows, and to predict when instream flows will recede to the point of no functional connectivity to the estuary for downstream migrating steelhead (80 cfs initially subject to change under adaptive management). United will start 5 days before the river is predicted to decline below 80 cfs at the critical riffle. All river flow will be screened and released downstream (minus the 40 cfs critical diversion) during that 5-day period to allow downstream migrant fish that may be present in the river downstream of the diversion to make it safely through the critical reach.

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[5] In addition to relocating aquatic species for the purpose of this CM, United intends to operate the downstream migrant fish trap during periods other than those described above for monitoring purposes (see Chapter 6 Monitoring). When the trap is used for monitoring, then downstream migrant fish would not always be relocated.

Discussion

The tendency of the Santa Clara River downstream of the Freeman Diversion (i.e., affected reach) to become dry in the summer is a historically observed condition and was documented by early explorers in the 18th and 19th centuries (Beller et al. 2011).

As flows begin to decline below 80 cfs in the critical reach, habitat conditions and migration opportunities also decline. The critical reach provides little overhead cover and limited over-summering rearing habitat, greatly increasing the risks of predation for migrating fish, poaching, or death from physiological limitations (temperature and dissolved oxygen). As flows recede, the channel becomes increasingly braided, wide, and shallow, increasing the risks of stranding, predation, poaching, or death from physiological limitations. The combination of limited overhead cover and shallow depths contribute to elevated water temperatures, which further reduces habitat quality. Exposure to these conditions increases risk of stress or direct mortality for steelhead smolts.

Booth (2020) demonstrated that many steelhead smolts arrive at the Freeman Diversion after functional connectivity with the estuary is lost, even under conditions of no diversion of water at the Freeman Diversion. It is assumed that even if all water were bypassed through the Freeman Diversion, there would still be smolts, particularly later in the season, that would not make it safely to the estuary. CM 1.2.5 intends to provide safer passage for downstream migrants from the Freeman Diversion to the estuary when flows are insufficient to maintain a functional migration corridor through implementation of CM 1.2.2 and 1.2.4. Monitoring and relocating fish may potentially result in some minimal impact that is generally expected to be non-lethal. However, this measure will reduce the potential for unsuccessful downstream migration that results in mortality either due to water diversion (critical diversions) or “no diversion” conditions (not enough discharge in the river for functional migratory connectivity).

The downstream migration period for Pacific lamprey juveniles is unknown in the Santa Clara River. However, data collected from other drainages (Goodman et al. 2015) indicates migration occurs in response to storm peaks when many monitoring facilities are not in operation. Few lamprey juveniles or larvae (n=49) were collected in the downstream migrant trap at the Freeman Diversion from 1995 to 2006 (United Water 2010). Most of these fish likely migrated over the diversion structure or through the bypass channel during storm peaks when United turned water out to the river and was not diverting.

CONSERVATION MEASURE 1.2.6

CONSERVATION MEASURE 1.2.6

Minimize impacts to steelhead and lamprey through limitations on sediment management activities

United will optimize sediment management by implementing pre-emptive measures through opening the roller gate and sluicing accumulated sediment during times when pre-spawning adult steelhead are unlikely to actively swim in an upstream direction and ascend the fish ladder.

Development of Conservation Measure

The Santa Clara River carries high loads of suspended sediment and bedload (see Chapter 2 and Appendix E) particularly during and immediately after peak runoff following storm events. Removing accumulated sediment upstream of the Freeman headworks provides two benefits: (1) it keeps the river trained to the south bank and the facility itself so that the fish ladder, AWS and diversion can operate properly; and (2) scour to provide storage volume for future incoming bedload to accumulate when United operates the fish ladder and during water diversion.

Stillwater Sciences conducted a review of the best available scientific and commercial data with regard to suspended sediment effects to upstream migrating adult steelhead. Studies included peer review literature, industry data, regulatory white papers, and expert opinion including biological opinions by NMFS biologists (Appendix E). With the assumption that adult steelhead require at least 2 days to migrate from the ocean to the Freeman Diversion (i.e., exposure duration of 2 days), Stillwater Sciences used the best available science to infer the following:

1. Pre-spawning, migrating adult steelhead are "very likely" to actively swim in an upstream direction when SSC is below 40 mg/L.
2. Pre-spawning, migrating adult steelhead are "likely" to actively swim in an upstream direction when SSC is 40-500 mg/L.
3. Pre-spawning, migrating adult steelhead are "unlikely" to actively swim in an upstream direction when SSC is 500 mg/L-2,000 mg/L.
4. Pre-spawning, migrating adult steelhead are "very unlikely" to actively swim in an upstream direction when SSC is greater than 2,000 mg/L.

Typically, the peak of a storm will produce SSC in excess of 5,000 mg/L, which falls in the "very unlikely" range for active movement upstream. Additionally, United is often challenged to divert water because of high SSC greater than 4,000 – 7,000 mg/L, and will often turn the water out to the river during those times for to protect the facility. Therefore, sediment sluicing will be prioritized during the peaks in the hydrograph when the water is turned out of the facility and adult steelhead are "unlikely" to "very unlikely" to be actively swimming in an upstream direction.

Depending on the size of the storm, SSC can stay above approximately 1,800 mg/L for several days, which falls in the "unlikely" range for active movement upstream; however, United would be diverting and operating the fish ladder when SSC exceeds 1,800 mg/L. Adult, pre-spawning steelhead are "likely" to actively swim in an upstream direction when SSC is below 500 mg/L. Therefore, out of an abundance of caution and in anticipation of the SSC range that is most conducive to adult steelhead migration, United would conduct a pre-emptive sediment sluicing event that would start and end when SSC is above 1,800 mg/L. The purpose of this sluicing event is to prepare the scour zone so that sluicing would not be needed as often when conditions are most conducive to active migration by adult steelhead (500 mg/L and below). Short sluicing events at low SSC (conservatively <1,800 mg/L) would be minimized according to this strategy but would not be completely eliminated. Occasional sluicing at low SSC is still anticipated at an estimated frequency of 1-2 times/year with a duration of up to 2 hours. Sluicing at low SSC carries some risk to covered fish and is considered a covered activity. United proposes monitoring during the pre-emptive sluicing events and the low SSC sluicing events for which take and the impact of the taking is assessed in Chapter 7 - Effects Analysis.

Preemptive sluicing or sluicing at low SSC would not occur on the receding limb of the hydrograph if another storm is forecasted that will likely result in a turn-out in the next two weeks (i.e., another foreseeable opportunity for sluicing at high SSC exists).

Suspended Sediment Monitoring for the Sediment Management Strategy

Since 2017, United has operated a continuous optical turbidity sensor (Hach Solitax SC) at the Freeman Diversion headworks that measures turbidity and reports total suspended solids (a measure of SSC) based on a theoretical conversion calculation that is calibrated using lab samples (see Appendix F for details). The sensor provides continuous measurements of the SSC level in the Santa Clara River at five-minute intervals. The accuracy of the meter has been verified and continues to be verified by laboratory processed water samples collected at the location of the sensor. The renovated facility would include at least one similar sensor. The data from this sensor would be logged and processed through SCADA and would be made available through a web portal such as Ranch Systems. The meter would be calibrated according to the manufacturer's specifications and United would continue to collect lab samples to verify the sensor as part of the effectiveness monitoring program (see Chapter 6).

When conditions are safe in the river channel, supplemental monitoring of sediment accumulation would also be conducted using bathymetry surveys in the bypass channel approach and forebay. Surveyors would traverse fixed transects via boat or wading and collect depth measurements and the water surface relative to a known elevation (e.g., top of the wingwall). Data from repeated transects would be compiled to develop a dynamic bathymetry assessment and monitor the accumulation of sediment upstream of the facility. The District would continue to explore alternative methods or technologies in consultation with the Services that may provide a useful approach for monitoring sediment accumulation. This information would be used to inform sediment sluicing events so that they are conducted strategically and only when necessary to minimize take of steelhead and lamprey.

The proposed crest gates will be approximately 2 feet deeper than the concrete apron of the existing bypass channel. The new crest gates may prove to be more effective at sluicing sediment, creating a deeper scour pool upstream.

Pre-emptive Sediment Management Prior to Loss of Functional Downstream Migratory Connection to the Estuary

Under the SMP, when a functional migratory connection to the estuary would not be maintained in 5 days, then United would initiate ramp down of the smolt flows under the SMP. Prior to the start of ramp down and if the date is outside the adult steelhead primary migration season, then United may conduct a pre-emptive sediment sluicing event. When the roller gate is open to sluice sediment, then a pulse of water moves downstream. If this occurs when there is no connection to the estuary, risk to covered fish is much higher. This pre-emptive sediment sluicing event would serve to help move covered fish out of the critical reach and to the estuary prior to ramp down of the bypass flows and it would serve to avoid sediment sluicing after the instream flows are ramped down and there is no connection to the estuary. These sediment sluicing events are anticipated to happen once a year (50 times during the permit term).

During United's conservation releases, sediment sluicing may be needed outside of the primary migration seasons for both adult and juvenile steelhead when the flows in the river are disconnected to the estuary. During conservation releases, bed load can accumulate and if it is not sluiced, then it can overwhelm the infrastructure. If monitoring described above shows that the accumulated sands are close to overwhelming the existing infrastructure, then a sediment sluicing event would be conducted with a duration that does not allow flows to advance beyond the critical reach. United is exploring alternate sediment management methods (e.g., selective dredging), and if determined to be effective and protective of covered species, would potentially implement in conjunction with, or as an alternate to, sluicing events. A United biologist would be consulted prior to sediment sluicing allowing enough time for biologists to arrive on site to support Operations staff during the sluicing event. During the sluicing operation, biologists would be on site to survey upstream of the diversion during the sluicing event and then survey downstream of the diversion after the sluicing event. Biologists would implement rescue and relocation according to CM 2.1.4 for covered fish and record any other potential impacts to other covered species.

Improvement and refinement of the sediment management strategy will be subject to monitoring and adaptive management (Chapter 6), whereby United will consult with the Services each year to discuss each sluicing event, monitoring that year, any take of covered species, and how sluicing criteria can be adjusted if needed in the subsequent year.

5.2.3 CONSERVATION MEASURES UNDER GOAL 2, OBJECTIVE 2.1

CONSERVATION MEASURE 2.1.1

Conservation Measure 2.1.1
Best Management Practices
United will implement Best Management Practices (BMPs) for all covered activities.

Development of Conservation Measure

Best management practices (BMP) are measures included in the project description (covered activities) that are implemented as part of the project and are designed to avoid and minimize effects of covered activities on covered species. These measures are generally considered standard practice for industry-specific and for general development projects and are intended to provide a framework for good work practice aimed at environmental sensitivity. BMPs often include standard and general recommended avoidance or minimization measures outlined by an organization or agency, for example, the California Stormwater Quality Association (CASQA) or the CDFW. General site maintenance BMPs will be implemented during the pre-construction, renovation, operation, and maintenance phases of the project, and will include the following:

General

- Work boundaries are to be clearly marked, using stakes or other high visibility marking (e.g., flagging), prior to construction or other project activities involving ground or vegetation disturbance. No work will occur outside of marked work area unless first approved by the United environmental staff responsible for MSHCP compliance.
- At the end of project activities:
  - Remove all temporary flagging, fencing, barriers, project related structures, and associated materials (including BMPs)
  - Return work area to pre-project conditions
- Project activities will be conducted in a manner that prevents the introduction, transfer, and spread of invasive species, including plants, animals, and microbes; remove all visible soil/mud, plant materials, and animal remnants from all vehicles, tools, boots, and equipment.
- Clean up trash and other project debris daily; use fully covered trash receptacles with secure lids to contain all trash. Receptacles will be removed from the site and emptied at least weekly.
- Staging/storage and refueling/maintenance of equipment and materials will be outside of habitat areas. All staged equipment will have drip pans or similar containment placed underneath when not in use.
- No substances that could be hazardous to aquatic life will be allowed to contaminate the soil and/or enter or be placed where it may be washed by rainfall or runoff into waters of the State/U.S.
- Water will not be pumped from the channel and used for dust control or any other use in the project.
- No native vegetation with a diameter at breast height (DBH) of more than 3 inches will be removed or damaged without approval.
- Prior to construction, native tree protection fencing will be placed 5 feet outside the tree dripline

- When encroach within the tree dripline, measures to protect the trees (steel plates, pruning, etc.) will be used.
- Immediately remove cut vegetation from the construction area.

Schedule/Timing of Work

- The time of day for work activities will be limited to daylight hours to the maximum extent possible. When nighttime work must occur, lighting will be shielded and directed downward on the immediate work area to avoid or minimize light trespass on adjacent lands.
- To avoid or minimize impacts to steelhead and riparian habitat, covered activities involving the use of heavy equipment (e.g., excavation, grading, and contouring) in the Santa Clara River channel will be limited to the period between July 1 to October 31 of each year (dry season) to the extent practicable. Covered activities may begin prior to the dry season if the stream channel has been dry for a minimum of 30 days prior to initiating work. Covered activities will be limited to periods of low rainfall (less than 0.5 inch per 24-hour period and less than 40 percent chance of rain). Any work conducted within the river channel outside of the dry season will be subject to approval by NMFS, USFWS, and CDFW prior to performing the activity. Construction activities will cease 24 hours prior to a 40 percent or greater forecast of rain from the National Weather Service. Construction may continue 24 hours after the rain ceases and there is no precipitation in the 24-hour forecast.
- To avoid or minimize impacts to nesting birds, covered activities involving the use of heavy equipment (e.g., excavation, grading, and contouring) around riparian habitat occupied by covered species will be limited to the period between September 1 and January 31 (non-nesting season) to the extent practicable. Covered activities may be conducted within or near riparian habitat during the nesting season (February 1 through August 31) if pre-activity surveys have shown no nesting activity is occurring.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- When rainfall is predicted to exceed 0.5 inch in a 24-hour period, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.

Nesting Birds

- If an active nest is found, United environmental staff will establish a no-work buffer around the nest and monitor as needed.
- The breeding habitat/nest site will be fenced and/or flagged in all directions, and this area will not be disturbed until the nest becomes inactive (e.g., young have fledged and left the area or if the nest fails).
- Nest buffers will be 250 feet for all covered bird species, 50 feet for all other non-raptor species, and 300 feet for all raptor species:
    - Buffer distances may be adjusted up or down in distance from the nest by a United environmental staff person in coordination with USFWS and/or CDFW. Buffer distances may be increased if a subject bird is displaying any signs of stress due to covered activities. Buffer distances may be decreased if needed to adequately conduct covered activities and if the subject bird is not displaying any signs of stress due to covered activity.

Aquatic Species

- If vacuum trucks or pumps are used to dewater an area or to clean up any contamination, the hose will be protected on all sides by exclusionary screening with 3mm pore size to lower velocities and to prevent the uptake of covered species or other sensitive aquatic species.

Erosion Control

- Chemical dust suppression agents will not be used within 100 feet of wetlands or water bodies.
- Wind erosion control is required to be implemented at all construction sites greater than one acre by the Construction General Permit.
- After 14 days of inactivity, a stockpile is non-active. All stockpiles are required to be protected as non-active stockpiles immediately if they are not scheduled to be used within 14 days.
- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 feet.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 feet. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 feet. (a closer spacing is more effective).

Sediment Control

- Silt fence should be used in combination with erosion controls up-slope to provide the most effective sediment control.

Sanitary/ Septic Waste Management

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities will be secured to prevent overturning.

Concrete Waste Management

- Do not wash out concrete trucks into storm drains, open ditches, streets, streams or onto the ground. Trucks should always be washed out into designated facilities.
- Temporary concrete washout facilities will be located a minimum of 50 feet from storm drain inlets, open drainage facilities, and watercourses. Each facility will be located away from construction traffic or access areas to prevent disturbance or tracking.
- When temporary concrete washout facilities are no longer required for the work, the hardened concrete will be removed and properly disposed or recycled in accordance with federal, state, or local regulations. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and properly disposed or recycled in accordance with federal, state, or local regulations.

Waste Management and Materials Pollution Control

- All vehicles and equipment will be maintained in good working condition, free from leaks, and operating within normal parameters.
- Any vehicle or equipment fluid spills will be cleaned up immediately to ensure the work area is maintained clean and free of spills and contamination.
- The area where heavy equipment will operate is limited to the minimum footprint necessary and will be contained within straw waddles or similar material to prevent runoff from the work site. If access to areas outside of the delineated footprint is required it must be approved by a responsible United MSHCP administrator in coordination with the Services.
- The work site and general operations/maintenance areas will always be maintained free of trash. All trash will be deposited in closed-lid receptacles and will be removed from the site weekly.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater run-on and run-off and should be located at least 50 feet from downstream drainage facilities and watercourses.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- No pets or firearms will be permitted on the Freeman Diversion renovation project site or other United owned lands within the permit area.

Discussion

BMP implementation is effective at decreasing potential project impacts on covered species and their habitats by ensuring that project activities are less intrusive and better planned from the beginning. BMP implementation simultaneously increases awareness of sensitive resources on-site while ensuring that project activities are carried out as planned and in compliance with agency regulations.

Minimizing project impacts through the implementation of BMPs decreases the risk for direct and indirect harassment, harm, or take of covered species, particularly in sensitive habitats, and therefore contributes to the overall population health of covered species. The immediate ecosystem within and adjacent to the project area also benefits from BMP implementation, thereby ensuring covered species habitat does not become degraded due to project activities.

CONSERVATION MEASURE 2.1.2

Conservation Measure 2.1.2

Worker Environmental Awareness Training

A comprehensive worker environmental awareness training (WEAT) will be required and will be provided to all workers before they are allowed access to the work site.

Development of Conservation Measure

To ensure the MSHCP and all CMs under the MSHCP are followed, it is essential that personnel understand the content of the MSHCP, the scope of the covered activities, the general biology of the covered species, and the individual responsibilities of project personnel. The most effective approach to addressing personnel awareness is through a worker environmental awareness training (WEAT) program.

To ensure all personnel associated with the project are fully familiar with the MSHCP, the covered activities, the covered species, and the conservation measures, all personnel will attend a WEAT before conducting work on the project. The WEAT will provide details pertaining to approved covered activities and correct procedures to follow during work activities to ensure impacts to covered species are avoided and minimized to the extent possible. Other information provided in the WEAT will include identification of covered species, correct notification procedures, and action to take in in the event covered species are encountered, definitions of take, and penalties associated with non-compliance with the MSHCP.

Discussion

The WEAT will help ensure all on-site workers have full awareness of the identification and general behavior of sensitive biological resources and the necessary information to know what to do if they encounter sensitive biological resources. The WEAT will also facilitate an increased level of communication between field personnel, supervisors, United environmental staff, and agency staff regarding the presence of covered species in work areas and any risk for their take. Construction workers and maintenance and operations field personnel are generally the first individuals to encounter covered species and to notice when a risk of take occurs. A strong WEAT program increases worker awareness of biological resources on the site and helps workers avoid unknowingly harming covered species or contributing to take.

The WEAT program will involve several components to ensure all project personnel are properly trained:

- Before initiation of project activities, all United environmental specialists responsible for MSHCP compliance and any contract biologists hired for biological monitoring will be provided the WEAT material and will be thoroughly trained on the information and in how to teach the information.
- Before the start of any covered activities, United environmental staff will provide the WEAT to project personnel working on the site. Project personnel will attend the WEAT at a training facility designated by United.
- After the initial WEAT, any workers new to the project can be provided the WEAT by United environmental staff in a tail-gate format at the work site.
- WEAT handouts will always be available at the site when work is being performed to be handed out to workers during on-site trainings.
- A record of all trained personnel will be kept by the United environmental specialist responsible for MSHCP compliance

The WEAT will contain the following information:

- A list of phone numbers for United's environmental specialist personnel responsible for MSHCP compliance and relevant agency contacts will always be kept on site during work activities
- A list of all the BMPs, avoidance and minimization measures, and conservation measures for the project along with information on to which covered activity or covered species it relates
- Instruction on identification of covered species and where and when covered species are most likely to be found
- Instructions on correct techniques and procedures for working within the Santa Clara River channel and adjacent riparian vegetation community
- Instructions regarding the individual responsibilities under the Clean Water Act, the project Stormwater Pollution Protection Plan, site specific BMPs, and the location of Material Safety Data Sheets for the project

- Instruction regarding the importance of maintaining a clean construction site, including ensuring that all food scraps, wrappers, food containers, cans, bottles, and other trash from the project are deposited in closed trash containers.
- Instructions to notify the foreman and regional spill response coordinator in case of a hazardous materials spill or leak from equipment, or upon the discovery of soil or groundwater contamination
- Instruction on proper notification procedures in the event of take of covered species. The on-site foreman will be notified immediately followed directly by notification to the United environmental personnel responsible for MSHCP compliance. Within 12 hours of the incidence of take, notification will be provided to NMFS and USFWS. Written documentation of the incidence will be provided to agencies within 48 hours.
- Instruction that noncompliance with any laws, rules, regulations, or mitigation measures could result in a worker(s) being barred from participating in any remaining construction activities associated with the proposed project

CONSERVATION MEASURE 2.1.3

Conservation Measure 2.1.3

Pre-activity Surveys

United will conduct pre-activity surveys for covered species in suitable habitat prior to the start of any renovation or maintenance activities to verify the absence of covered species in the covered activity area. If covered species are present, one or more of the following conservation measures will be implemented, as appropriate:

CM 2.1.1 Best Management Practices
CM 2.1.4 Covered Species Capture and Relocation
CM 2.1.5 Noise Abatement
CM 2.1.7 Breeding Season and Nest Avoidance

Development of Conservation Measure

Prior to conducting any covered activities, it is essential to determine current site conditions and establish the appropriate course of action and CMs to be implemented based on time of year and presence/absence of covered species. Pre-activity surveys will be conducted prior to the start of any ground- or vegetation-disturbing activities to determine site conditions and potential presence of covered species. Conservation measures to be implemented will be determined upon completion of the pre-activity survey.

Covered Fish

United environmental staff will conduct pre-activity surveys for all sensitive aquatic species that could occur in the project area or could be impacted by the project. If any covered species is present, implementation of CM 2.1.1 will provide avoidance or minimization of impacts to covered species, and CM 2.1.4 will be implemented as necessary. United environmental staff will determine if instream flow conditions (i.e., flow, depth, stream continuity) are potentially suitable for the upstream or downstream migration of steelhead in the work area. When instream flow is present outside of the dry season (July 1 – October 31), steelhead will be presumed present and conservation measures will be implemented to avoid or minimize take. Surveys to determine instream flow conditions will occur prior to any ground/vegetation disturbance or covered renovation activities that require water diversion, work in flowing water, or work within 100 feet of flowing water in or adjacent to the Santa Clara River.

Covered Pond Turtle

United environmental staff will conduct pre-activity surveys for pond turtles prior to conducting any covered activities within or adjacent to suitable habitat. Such habitat includes aquatic and riparian habitats in the Santa Clara River, and upland nesting and overwintering habitats. Two surveys will be conducted: one the week before and one within 48 hours of implementation of a covered activity. If any covered species is present, CM 2.1.1 will be implementing as applicable, and CM 2.1.4 will be implemented, as necessary.

Covered Birds

United environmental staff will conduct pre-activity surveys for covered birds prior to conducting any covered activities with the potential to impact vegetation or to involve ground disturbance, and within or adjacent to suitable habitat for covered birds from February 1 to September 15. Suitable habitat is defined as dense or moderately dense southern cotton-willow riparian forest, southern riparian scrub, or mulefat scrub. United environmental staff will determine if nests of covered bird species are present in or within 250 feet of the work area. If nests are present, and no other avoidance and minimization measures are implemented (e.g., noise abatement, avoidance, buffer distance), the nest(s) will be monitored by United environmental staff with avian biologist experience while covered activities are conducted within 250 feet of the nest. In consultation with the USFWS, United environmental staff may reduce the nest buffer area.

Discussion

Pre-activity surveys provide the information necessary to conduct project activities according to the correct operational plan. This information establishes a reference point for understanding the specific biology of the work site, which helps inform how project activities can best be carried out with minimal impact to sensitive biological resources.

Identification of potential impacts through pre-activity surveys helps ensure that take is avoided or reduced to the maximum extent possible through early implementation of avoidance and minimization measures under CM 2.1.1. Pre-activity surveys provide updated information on the occurrence and distribution of covered species current with the onset of project activities. This up-to-date species information allows for best management of species conservation in response to data collected on species presence/absence and distribution and ensures effects of the project on covered species are reduced. In the event effects are unavoidable, pre-activity surveys facilitate the documentation of the level of take commensurate with the incidental take statement provided under the MSHCP.

CONSERVATION MEASURE 2.1.4

Conservation Measure 2.1.4

Covered Species Capture and Relocation Protocol

United will implement the Covered Species Capture and Relocation Protocol (CRP) for renovation-related activities and operations and maintenance-related activities that require relocation of covered fish or reptile species.

Development of Conservation Measure

To minimize impacts to covered species to the maximum extent practicable, the Capture and Relocation Protocol (CRP) will be implemented only as a last resort in the event impact to covered species cannot be avoided while undertaking covered activities. No bird covered species will be relocated because of the higher susceptibility of birds to stress and the difficulty involved in capture and transport of birds. The

CRP was developed using the best available approach, based on current professional literature, resource agency guidance, and expert experience, for capture, handling, and relocation of fish and reptiles.

The CRP includes protocols to safely capture and relocate covered species including steelhead, lamprey, and southwestern pond turtle encountered in work areas during certain covered activities. Prior to the start of any covered activity that would potentially require the capture and relocation of covered species, United environmental staff will conduct surveys of the given project area for the presence of covered species that could occur in or could be impacted by the project. If not already identified, the surveys will also identify suitable relocation sites based on physical essential habitat characteristics and species presence at relocation sites. Only United environmental staff or qualified biologists assigned by United's environmental staff and approved by resource agencies will conduct capture and relocation activities. All capture and relocation activities will be documented on hard-copy datasheets and in an electronic database.

During capture and relocation activities, it is anticipated that native non-target species not covered in this HCP (e.g., species other than covered species), will be incidentally encountered, and may require relocation to suitable habitats away from the project area. Relocation sites for native non-target species may be within the immediate area if return to the project site during covered activities is not expected. Capture and relocation will occur only as a last resort in the event covered species are in direct conflict with covered activities. Capture and relocation may also occur during sediment sluicing operations outlined in the sediment management plan.

Renovation, Operation, and Maintenance Activities Requiring Capture and Relocation

Renovation of Fish Passage Facility and Freeman Diversion

BMPs focused on excluding aquatic covered species from work areas (e.g., blocknets and flow re-route around the work area) are intended to avoid harmful effects to these species from covered activities. However, during any flow re-route activities, aquatic species could become stranded as flow recedes in the dewatered channel. Aquatic covered species that may become stranded will be captured using seines, dipnets, turtle traps, or other method specified by the Services, and relocated to suitable locations as approved by the Services.

Facility Operations and Maintenance

Periodically during operations and maintenance activities, certain areas of the Freeman Diversion facility will be dewatered (see Chapter 3). For example, the fish passage facility will be dewatered and the fish bay and impound upstream of the facility will be dewatered annually to facilitate routine maintenance activities. Also, areas upstream of the diversion will be dewatered during sediment sluicing operations and areas downstream may be watered and then dewatered following sediment sluicing operations. During dewatering activities, United biologists or contractors will enter the dewatered areas and survey for aquatic covered species (and other native species to the extent possible). Survey methods will include one or more biologists entering the dewatered area to capture and relocate any native species that may be present using methods appropriate to the site and conditions present at the time (e.g., may include but are not limited to dipnets, seines, electrofishing, and use of wildlife detection dogs).

Instream Flow Cessation Dewatering

During covered activities when the cessation of releases from the Freeman Diversion occur, much of the channel downstream of the diversion will become dry, especially within the critical reach of the river. To reduce the potential for stranding during and following cessation of bypass flows from the diversion, United biologists or contracted biologists will survey all portions of the river from the Freeman Diversion to the estuary where susceptibility to dewatering exists, with a more focused emphasis in the reach between the SR 118 (Los Angeles Avenue) bridge and the US-101 bridge. This is the reach with the highest percolation rates within the critical reach that tends to be void of riparian vegetation and has minimal holding pool habitats for aquatic species. When feasible, survey biologists will travel the critical reach with an all-terrain vehicle and conduct visual surveys for stranded aquatic covered species. When all-terrain vehicles are used, speed limits will be 10 miles per hour or less and only existing trails or roads will be used. When the use of an all-terrain vehicle is not feasible, survey biologists will walk segments of the critical reach, surveying for stranded aquatic species until the entire reach with the potential for stranding is surveyed. Survey biologists may also implement drone technology or specially trained wildlife detection dogs when feasible to increase detection probability. During walking surveys between the SR 118 bridge and US-101 bridge, a truck with aerated coolers will be nearby on the adjacent levee road to transfer aquatic species. Isolated aquatic habitats will be surveyed using seine nets, dip nets, or direct observation methods with mask and snorkel. Electrofishing will be used (following procedures approved by the Services) in habitats where water quality (turbidity, specific conductance) and habitat conditions make this technique most effective.

Aquatic Species Handling and Transport

All aquatic species will be identified and enumerated. All observations will be recorded on hard-copy datasheets and entered into an electronic database. United has developed a species identification photo book to assist in species identification. The following best practices will be implemented during the CRP:

- All equipment will be cleaned using the most current methodologies to avoid spreading diseases and invasive species.
- All fish and pond turtles will be transported using aerated containers.
- Transport containers used during relocation between sites will be aerated, insulated, and at least 100-quarts in size. Buckets (5-gallon) may be used to transport individual aquatic species from habitats to the 100-quart transport containers. Water temperature at the capture site and in the transport container will be measured prior to handling fish and monitored during transport.
- Whenever possible, fish will not be transported at temperatures above 20°C and transport activities will be performed in the morning to minimize thermal stress.
- No more than 25 smolts or lamprey juveniles will be placed in an individual 100-quart transport container. No more than one adult steelhead or kelt will be placed in an individual 100-quart transport container.
- The number of other native species placed in containers will depend on the life stages collected. Caution will be taken to not over-crowd containers.
- Fish handling, transfer between containers, and transport time will be minimized to the extent possible. Fish transport time is expected to be generally no more than one to two hours.
- Pond turtles will be transported in containers with approximately an inch of water and a damp towel to maintain a moist environment during transport.
- General fish condition will be assessed. For steelhead smolts, the general degree of smoltification or smolt condition (presmolt or full smolt) will be assessed based on silvery color, black tip fins, and scale loss. Steelhead smolts and kelts will be measured (fork length) to the nearest millimeter on a wet fish measuring board. Lamprey larvae and juveniles will be measured to total length from head to tail.
- All anadromous downstream migrant fish (steelhead smolts and kelts and lamprey juveniles) will be transported from the Freeman Diversion to the Santa Clara River Estuary/Lagoon.

When turtles are capture and held for relocation, data will be collected to document the size, sex, and condition of individuals. Data to be collected include:

- Carapace length, width, and height
- Bridge width
- Head length and width
- Fore and hind limb length
- Weight
- Sex
- General appearance (conditions)

The specific estuary relocation site will depend on the site-specific conditions. The estuary will be monitored weekly during the migration season to inform relocation activities. Generally, fish will be released to water upstream of the salt wedge (less salinity) in the estuary that has at least 1-foot depth and instream cover nearby. Areas of the estuary known to be low in oxygen will be avoided. Water quality parameters will be measured at the relocation sites with a multi-parameter water quality meter to prepare for acclimation.

Acclimation from a transport container to the relocation site will occur by periodically transferring water from the relocation site to the transport container using the time steps listed in Table 5-9.

Table 5-9 Stepped Acclimation Temperatures and Times

Temperature Differential (degrees)	Acclimation Time (minutes)
0-2	10
3-5	20
6-7	30

At the start of each water year (October 1), potential relocation sites will be identified, prioritized, and mapped for each covered species and will be submitted to the Services for approval. No response from the Services after 10 business days will be considered concurrence with the relocation sites.

Relocation sites will be located within the Santa Clara River watershed and contain habitat conditions suitable for the species in question (e.g., relocation sites may be different for resident rainbow trout, lamprey larvae, and pond turtle). Suitable relocation sites will also be identified for other native, non-anadromous fish and aquatic species (e.g., arroyo chub, prickly sculpin, threespine stickleback, native toads and frogs).

Non-native, invasive aquatic species will be euthanized or removed using standard practices (AFS 2014). These species include, but may not be limited to: largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), black bullhead (*Ameiurus melas*), fathead minnow (*Pimephales promelas*), Mississippi (inland) silverside (*Menidia audens*), threadfin shad (*Dorosoma petenense*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*) crappie (*Pomoxis* sp.), mosquitofish (*Gambusia affinis*), shimofuri goby (*Tridentiger bifasciatus*), African clawed frog (*Xenopus laevis*), American bullfrog (*Lithobates catesbeianus*), and red-eared slider (*Trachemys scripta elegans*).

United will consult with the agencies prior to covered activities to see if the agencies would like United staff or a partner to collect any scientific information (measurements, sex, scale samples, genetic sample, etc.), mark any captured animals, and/or tag any captured animals prior to relocation. United will report any information collected upon request and in an annual report (see Chapter 6 for details on reporting). Following submission of the annual report, United will consult with the agencies for any scientific information, marking, tagging requested in the subsequent water year.

Discussion

Relocation minimizes the potential for harm and injury to covered species as a result of implementation of certain covered activities and conservation measures, including BMPs related to renovation and operations and maintenance activities at the Freeman Diversion.

This conservation measure was developed to minimize effects from covered activities at the Freeman Diversion to covered species to the greatest extent practicable and using current professional literature (Dunham et al. 2009, Jacks et al. 2009, Nickum et al. 2004, Rose 2002), resource agency guidance (Flosi et al. 2010, Leitritz and Lewis 1980), and professional experience. Capture and relocation activities combined with collection of scientific data, marking, and/or tagging will provide an additional level of protectiveness to covered species from United's covered activities and will assist in the conservation and recovery of federally listed species.

CONSERVATION MEASURE 2.1.5

Conservation Measure 2.1.5

Noise Abatement Protocol

United will implement a noise abatement protocol to avoid or reduce the potential for noise impacts to covered species as a result of renovation, operations, maintenance, and conservation program activities.

Development of Conservation Measure

The noise abatement protocol was developed based on published scientific research and expert experience concerning the effects of noise on wildlife. The goal of the protocol is to serve as an avoidance or minimization approach to reduce the impact of noise from covered activities on covered species to the extent practicable.

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 the 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 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.

The noise abatement protocol will consist of protocols for minimizing the effects of noise on reptiles and nesting riparian birds, as well as the effects of underwater noise on covered fish species, particularly from impact pile–driving activities (Appendix G). The noise abatement protocol will be implemented during any covered activities that could generate noise levels above the threshold outlined in the MSHCP for each covered species.

To mitigate noise effects to sensitive species, 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 those shown in Table 5-10 should be evaluated relative to the noise abatement measures listed below. The mitigation strategies listed below will be assessed during the planning phase for appropriate integration into activities conducted by United personnel and contractors.

Table 5-10 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
Southern California steelhead	180 dB re 1µPa for > 2 hours	December through June (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			
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	No – nearest observation 1.5 northeast
Yellow-billed cuckoo	60 at nest	Mid-May to September	No

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

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

Discussion

Excessive noise due to project activities can be potentially harmful to covered species because of its tendency to harass and distress wildlife and interfere with natural behaviors, such as masking breeding and alarm calls. Planning project activities with an aim to abate noise, particularly during certain times of the year when species may be more sensitive (i.e., breeding season for birds), reduces the potential of covered species behaving erratically or abandoning the project area or adjacent habitat, which could have an overall negative effect on the population. Further details and specifics on the noise abatement protocol are provided in Appendix G.

CONSERVATION MEASURE 2.1.6

Conservation Measure 2.1.6
Biological Monitoring
United environmental staff will conduct biological monitoring during implementation of renovation and maintenance-related activities. During any ground disturbing covered activities, any covered activities that would trigger the noise abatement protocol (CM 2.1.5), or any covered activities that would trigger the CRP (CM 2.1.4), United environmental staff will be present at the work site to observed work and provide guidance on the avoidance and minimization of adverse effects to covered species.

Development of Conservation Measure

Biological monitoring is a generally accepted approach to providing oversight and support to project personnel while carrying out covered activities and maintaining compliance with the measures of the MSHCP. Several types of covered activities will require biological monitoring for each of the covered species. Not all covered activities would impact all covered species and biological monitoring my not be required to address all covered species at once. Biological monitoring should be conducted by an approved qualified biologist.

By providing a biological monitor, the focus of other project personnel can be directed toward technical and safety-related tasks. Biological monitor presence during renovation or maintenance activities ensures that worker response to sensitive biological resources in or near the project area is according to protocol. Biological monitors can also help other on-site personnel identify and avoid covered species and their habitat while carrying out covered activities. Biological monitors will possess expertise specific to covered species and therefore provide an extra level of oversight to covered project activities that helps to decrease overall project impacts.

Discussion

United environmental staff, or contracted biologists, will be approved as qualified biologists and biological monitors prior to conducting biological monitoring of covered activities. Generally, qualified biologists will be those persons who have the experience, education, and training necessary to perform the tasks described in this MSHCP. Qualified biologists assigned to biological monitoring will meet a minimum qualification, approved by resource agencies, prior to being assigned to monitoring tasks. At a minimum, qualified monitors will be able to demonstrate applied experience with covered species, including ability to identify the species, experience with the species' biological life history and behavior, experience with detection of the species in its natural habitat, and experience coordinating with construction personnel in avoidance of impacts to covered species. Experience with handling of covered species is not required for biological monitors; however, if such experience is lacking, the biological monitor shall not handle covered species. Handling of covered species for any reason shall only be by qualified biologists with demonstrated relevant experience.

The term "qualified biologist" is generally applied to a person with the experience, education, or trained to conduct a certain task with covered species. Qualified biologists may be qualified to work only with a single covered species or with multiple covered species. Experience, education, and training must be with the covered species or similar species approved by resource agencies. The process for agency approval of qualified biologists will be through submittal of a brief resumes for review. Resource agencies will review resumes for relevant experience, education, and/or training. If resources agencies find qualifications lacking, they may ask for further information or for another resume of a more qualified applicant.

United environmental staff, or a contracted approved biological monitor, will be present to monitor during all project activities occurring within or adjacent to sensitive or suitable habitat for covered species, or as directed under any other conservation measures, BMP, or Habitat Restoration and Management Plan. This includes monitoring a 500-foot buffer surrounding the active work area. The monitor's responsibilities include observing and documenting covered activities, and providing recommendations designed to (a) limit potential impacts to sensitive resources (i.e., covered species), (b) ensure compliance with the permit, and (c) document any incidence of take, if any occurs. The monitor will retain stop-work authority for instances when a covered species is observed to be at risk for direct harm or harassment due to the project activities. If a task does not have the potential to result in take of a covered species, United will be able to assign any otherwise trained personnel to conduct the given activity.

CONSERVATION MEASURE 2.1.7

Conservation Measure 2.1.7
Avoid Nests of Covered Birds and Other Bird Species During Nesting Bird Season
United will avoid nests and minimize impacts to covered bird and other bird species during the nesting bird season (February 1–September 30).

Development of Conservation Measure

The nest avoidance buffers and the conservation measure generally are consistent with standard agency protocols for avoiding or minimizing impacts to sensitive bird species. Riparian bird surveys will be conducted by permitted biologists before covered activities that involve ground disturbance or generate noise levels above 60dB occur to provide information of the presence of active nests. Any nests discovered will be avoided to the extent feasible with avoidance buffers, as described below.

Nest Avoidance – Covered Birds

During the covered bird nesting season (April 1 – September 30), United will avoid, to the extent feasible, impacts to covered bird's nests and breeding individuals and their territories. Covered activities that involve removing vegetation or conducting ground-disturbing activities will avoid nests of covered birds by a buffer distance of 300 feet.

If a nest is found within the avoidance buffer distance of a covered activity, a buffer will be established for the nest by United environmental staff using high visibility flagging or other similar material. Buffer distances will be determined by United environmental staff based on the level of disturbance of the associated covered activity (See CM 2.1.5) and the sensitivity of the species based on protocols established here for nest buffers. Covered activities may resume if approved by United environmental staff and with an avian monitor present during work. Appropriate noise abatement measures will be implemented (CM 2.1.5; Appendix G) while the nest remains active. United environmental staff will determine when the nest is no longer active and will communicate the status of the nest to United and the resources agencies. If at any time, based on observation of nesting/breeding bird behavior, it appears that the buffer distance established is insufficient to minimize disturbance to the bird, the buffer distance will be increased, or activities will be suspended, until further minimization measures can be established. Resource agencies will be consulted to coordinate further minimization measures.

Nest Avoidance – General Birds

During the general bird nesting season (February 1 – September 30), United will avoid impacts to bird's nests and breeding individuals. Covered activities that involve removing vegetation or conducting ground-disturbing activities will avoid nests by the following buffer distances:

- 150 from all non-raptor species (other than covered species)
- 300 feet from all raptor species

If a nest is found within the avoidance buffer distance of a covered activity, a buffer will be established for the nest by United environmental staff using high visibility flagging or other similar material. Buffer distances will be determined by United environmental staff based on the level of disturbance of the associated covered activity (See CM 2.1.5) and the sensitivity of the species based on protocols established here for nest buffers. Covered activities may resume if approved by United environmental staff and with an avian monitor present during work. Appropriate noise abatement measures will be implemented (CM 2.1.5; Appendix G) while the nest remains active. United environmental staff will determine when the nest is no longer active and will communicate the status of the nest to United and the resources agencies. If at any time, based on observation of nesting/breeding bird behavior, it appears that the buffer distance established is insufficient to minimize disturbance to the bird, the buffer distance will be increased, or activities will be suspended, until further minimization measures can be established. Resource agencies will be consulted to coordinate further minimization measures.

Nests of snowy plover (*Charadrius nivosus nivosus*) and least tern (*Sterna antillarum*) that may occur around the Santa Clara River estuary will be avoided. Prior to implementing any covered activities that may impact nesting habitat around the estuary, for example sediment sluicing events, United environmental staff will coordinate with State Parks staff at McGrath State Beach to identify any potential concern with plover or tern nest impacts. If potential impacts are identified, covered activities will be suspended, rescheduled, or reduced in degree such that no impacts to plover or tern nests occur.

Discussion

Avoidance of nesting birds ensures minimal project encroachment into bird nests and surrounding habitat. Encroachment onto bird nests can lead to a number of potentially harmful bird behaviors including nest flushing and abandonment. Establishing buffers around bird nests while project activities are occurring nearby prevents project activities from disturbing nesting birds and resulting in potential loss of the nests.

CONSERVATION MEASURE 2.1.8

Conservation Measure 2.1.8
Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
United will avoid impacts to western pond turtle during in-water work and any work that may impact riparian nesting habitat.

Development of Conservation Measure

Pond turtle will be avoided to the extent possible during construction, operations, and maintenance activities at the Freeman Diversion. This measure outlines the methods developed to detect the presence of the species prior to performing covered activities, and the approaches taken to avoid impacts to the pond turtle. Avoidance measures take the form of “no work zones” or avoidance buffers, as well as implementation of the capture and relocation plan.

Discussion

Surveys for western pond turtle will be conducted no less than 14 days prior to conducting any covered activities involving dewatering, excavation, construction, vegetation management, or invasive weed control. Any individuals or nests will be documented, and locations of nest will be marked in the field.

Prior to conducting any construction covered activities where pond turtle may be present, exclusion fencing will be installed around the work area to keep pond turtles from entering the work area. The fencing will be made of material that is not likely to be climbed by pond turtles and will include subterranean mechanisms (e.g., flashing, fence skirt) for preventing turtles from burrowing under the fence and entering the work area. Daily pre-activity sweeps will be conducted by United environmental staff to ensure no pond turtles are within the fenced exclusion area. If any pond turtles are found within the fenced exclusion area, United environmental staff will implement the capture and relocation protocol (CM 2.1.4) and will relocate the individuals to a safe location outside the fenced exclusion area. Following completion of construction, fencing will be removed.

To avoid pond turtles entering off-site facilities, such as the desilting basins, these facilities will be enclosed with permanent fencing that prevents entry by pond turtles. Such fencing may include standard chain-link security fencing with the bottom 24 inches fitted with finer mesh fencing or screening to prevent juvenile turtles from entering the fenced area. Fencing should be secured and maintained in a way that no pond turtles would be able to become entrapped in the fencing material.

Known locations of active turtle nests, as well as any additional active turtle nests found during preconstruction surveys, will be avoided by at least a 25-foot "no disturbance" buffer. Buffer limits may be marked with a high visibility material. No nests will be enclosed within the fenced exclusion area.

5.2.4 CONSERVATION MEASURES UNDER GOAL 2, OBJECTIVE 2.2

CONSERVATION MEASURE 2.2.1

Conservation Measure 2.2.1
Invasive Species Management
United will implement BMPs for invasive species management during all covered activities for the permit term.

Development of Conservation Measure

Increasingly there is concern for the spread of invasive species around California. Invasive species outcompete native species, are a significant contributor to the loss of native species, contribute to local population extirpation, and can interfere with agricultural operations. Measures to avoid or significantly reduce the spread on invasive species are frequently incorporated as standard operating procedures or best management practices for any project in California where invasive species spreading may be possible. These measures are often simple and easy to implement and can be highly effective to reduce the spread of invasive species.

During implementation of covered activities, BMPs will be in place to avoid and minimize the introduction and spread of invasive species. These BMPs include ensuring all vehicles, equipment, tools, and sediment and erosion control activities are free of invasive plant and animal species. Invasive species management protocols (e.g., CDFW 2016) will be implemented for all renovation related activities that occur within the Santa Clara River channel, riparian, and riverine habitat.

The following BMPs will be implemented during all covered activities:

- BMPs for invasive species management will be implemented when biological surveys are required (e.g., pre-activity surveys) in aquatic habitats suitable for covered species.
- Surveyors will remove all visible mud, algae, snails, and other debris from used nets, traps, boots, and other equipment between study sites to minimize the transfer of invasive aquatic species.

- All equipment will be washed off-site, at a location approved by United, before entering the permit area, to ensure equipment is free of mud, algae, snails, or other debris.
- All equipment will be inspected on site (i.e., Freeman Diversion), before leaving the site, to ensure equipment is free of mud or other debris that could contain invasive species.
- All soils, seed mix (e.g., for habitat restoration), or other material will be certified free of invasive species before being imported or exported to or from the permit area.

Invasive species will also be actively removed on an opportunistic basis during routine maintenance events and during monitoring events. During routine maintenance, invasive plant species (e.g., arundo, tamarisk) will be removed and disposed of off site in approved green waste facilities. Invasive wildlife species (e.g., common carp, American bullfrog) will be removed on an opportunistic basis during monitoring events for steelhead. Invasive wildlife would also be collected and removed during dewater events when stranded in receding pools. When invasive wildlife species are captured, they will be collected, humanly dispatched, and disposed of off site at approved waste management facilities.

Discussion

Renovation and maintenance-related covered activities can result in spread of non-native or invasive species in the project area due to the high presence of vehicles and personnel that have potential to carry non-native material to or away from the permit area thus transferring that non-native material from or to other ecosystems. This can result in large-scale changes to the ecosystem that pose increased risk to covered species and their habitat. Implementing invasive-free BMPs into covered activities minimizes the potential for this to occur, and therefore the overall impact to covered species and any adjacent species and habitat is reduced.

Conservation Measure 2.2.2

Conservation Measure 2.2.2

Avoid Riparian and Aquatic Habitat During Rainfall Events

United will avoid conducting covered activities within riparian or aquatic habitat during rainfall events with greater than 0.5 inch of precipitation or with 40 percent or more chance of precipitation predicted within 48 hours of the start of any activities.

Development of Conservation Measure

Activities occurring within riparian or aquatic habitat during a rain event or when water is present often are challenged to avoid impacts to covered species and can result in great impacts. Wetted channels are more susceptible to erosion, sedimentation, and reduced water quality and aquatic covered species are more likely to be present.

Activities occurring in riparian or aquatic habitat will be scheduled to avoid rainfall events and will occur during periods of no-flow or low-flow, to the extent feasible. If infeasible, United will implement additional CMs such as BMPs (CM 2.1.1), pre-activity surveys (CM 2.1.3), covered species relocation (CM 2.1.4), and renovation monitoring (CM 2.1.5), to ensure effects to covered species are avoided or minimized to the extent possible.

Discussion

During rain events of greater than 0.5 inch or with 40 percent or more chance predicted and at times when flow is present in the channel, species are more vulnerable to impacts from covered activities. Covered species may be more dispersed throughout the permit area during rain events and sediment runoff may be increased due to erosion when flows are present in the channel.

5.2.5 CONSERVATION MEASURES UNDER GOAL 2, OBJECTIVE 2.3

CONSERVATION MEASURE 2.3.1

Conservation Measure 2.3.1

Implement Habitat Restoration and Management

United will implement Habitat Restoration and Management to restore areas of temporary disturbance from covered activities.

Development of Conservation Measure

This Habitat Restoration and Monitoring measure provides a framework for the restoration of temporarily affected habitat areas associated with implementation of United's MSHCP. Restoration activities and monitoring will occur within the permit area where the renovation of the Freeman Diversion and fish passage is to occur. Monitoring will be implemented to ensure success criteria are achieved (see Chapter 6). The active restoration period is expected to last no more than 5 years, after which the temporary disturbance area should be successfully restored to pre-renovation conditions. Further monitoring or restoration activities in years 6-10 may be necessary if success criteria for restoration have not been met. In addition, on-going passive restoration (e.g., invasive species management) will occur in areas where covered maintenance activities result in the removal of riparian habitat adjacent to United's facilities but outside the existing right-of-way areas.

Discussion

United will implement the Habitat Restoration and Management to restore areas of temporary disturbance from covered activities.

All renovation activity that requires initial habitat restoration efforts (e.g. recontouring, erosion control installation, reseeding, etc.), or on-going restoration (e.g. recontouring, weeding) will be monitored in accordance with Conservation Measure 2.1.6 for on-site construction monitoring. In addition, pre-activity habitat surveys and short-term (0-5 years) restoration monitoring will be conducted to track and verify achievement of success criteria. Restoration conditions will be documented within annual reports.

Seeding efforts will be conducted in approximately October or early November of the year following the completion of renovation covered activities. The habitat restoration area will be prepared by decompacting the soil using hand tools such as hoes or picks to break up the soil surface. Straw wattles or sandbags will be installed to stabilize the soil and facilitate seed germination. Hydroseeding will be applied mechanically or by hand, followed by raking the seeds into the upper layer of soil. The habitat restoration area to be reseeded is approximately 1.95 acres, which requires approximately 273 bulk pounds of seed (60 pounds pure live seed). Seed for habitat restoration will be acquired from a reputable seed supplier and applied to the site by a qualified hydroseeding operator.

Methods

All restoration activities and monitoring will occur within the fish passage and Freeman Diversion renovation footprint (i.e., the restoration site or area). The restoration area therefore includes 2.83 acres of riparian, freshwater wetland, and aquatic habitat within the river at the Freeman Diversion. Figure C-1 shows the restoration area subset indicated by impact area types. The restoration area will not include the access roads into and out of the restoration site, as United previously developed, regularly uses, and maintains these roads. Restoration of this site will result in replacement of the pre-renovation habitat within the site and is expected to offset the biological value temporarily lost or impacted from renovation and maintenance activities.

Site Preparation

Habitat restoration will be coordinated with renovation activities, with consideration for the seasonal condition of the site at that time. If water is present in the riverbed within the restoration site, restoration activities may be postponed until no water is present, to reduce the need for further diversions and disruption of the channel. After renovations are completed, the site will be recontoured as needed. If considered necessary by a qualified restoration biologist, biodegradable erosion control will be installed along recontoured portions of the river within the restoration area to help stabilize unvegetated areas. Topsoil will be salvaged and redistributed, and the top layer of soil will be decompacted to encourage seeding success and natural recruitment of riparian habitat. BMPs for sediment and erosion control will be installed and maintained as needed. Restoration following any maintenance activities will be more passive in nature, as maintenance activities are expected to be infrequent (every year or less) and of low-impact. Therefore, site preparation for restoration post-maintenance will consist of recontouring of the area where impact occurred and will only involve installation of erosion control if considered necessary by the restoration biologist.

Site Revegetation

Seeding will be implemented within the restoration area to restore the riparian habitat present in the pre-renovation phase of the project. Seeding efforts will be conducted in approximately October or early November of the year following the completion of renovation activities. No seeding will occur within the low flow channel or open water areas. Given the dynamic nature of the Santa Clara River (and fluvial systems in general), revegetation through seeding within these areas would likely be unsuccessful. Dynamic fluvial processes are constantly washing away vegetation and disturbing the soil of the riverbed, allowing ruderal forbs and annual grasses to colonize quickly. Therefore, revegetation within the low flow channel will be accomplished by way of natural recruitment and management of invasive species.

Seeding outside the low flow channel will consist of spreading seed mixes via hand broadcasting in two initial applications following the site preparation activities. The seed mix will comprise in-kind species based on pre-activity surveys of the impact and adjacent area, and will be approved by the Services. The palette is expected to include a mix of the dominant native species. In particular, these species would include mule fat, arroyo willow, narrowleaf willow, red willow, Fremont’s cottonwood, California mugwort, southern cattail, and chairmaker’s bulrush. The seed mix will be tailored to the existing physical and hydrologic site conditions at the time of seeding (i.e., riparian or freshwater wetland).

Preparation of the area to be seeded will include tillage of the area with a rake to establish a receptive surface. The seed will then be spread by hand throughout the prepared area. Following seeding, the area will be raked again to help incorporate the seed, improve seed to soil contact, and improve the germination rate. Finally, if the seeded area is dry, the area will be watered using a mist sprayer so the ground is wet, but not inundated, to aid in germination. Hand broadcast seeding will only occur during conditions of low wind (0-3 mph).

To hand broadcast:

- Seed may be mixed with equal parts clean and damp sand in broadcasting
- Seed mix is applied in a two-step application, as follows
    - Step one consists of broadcasting one-half of the seed mix across the planting area in one direction (e.g., north to south)
    - Step two consists of broadcasting the remaining seed over the same area while moving in a perpendicular direction to step one

All seeding activities will be monitored by an approved restoration biologist. No seeding is expected to take place as part of on-going restoration efforts due to maintenance activities unless determined necessary based on the nature of the impact. These areas will be passively restored through invasive species management.

Invasive Species Management

Hand weeding will be employed throughout the 5-year active restoration period to control invasive non-native plants in the restoration area, after both fish passage renovation and maintenance activities. If determined necessary by the restoration biologist, mechanical weeding may be employed for large outbreaks of invasive species (e.g., arundo, tamarisk). In this circumstance, relevant conservation measures for species and habitat protection (e.g., monitoring, BMPs) will be employed. Maintenance activities that occur past the 5-year restoration period may merit additional weeding, if considered necessary by the restoration biologist. Control of invasive plants will be overseen by the restoration biologist. During monitoring visits, the site will be thoroughly examined for the presence of invasive, non-native plant species, particularly giant reed and tamarisk. Undesirable weed seeds, pollen, and biomass will be removed at the appropriate time of year to minimize spread by wind, water, animal, or other means.

When removing weeds by hand, care would be taken to avoid significantly disturbing on-site soils which could lead to increased erosion. All roots and stems would be completely dug out and, along with any flowers or seeds, would be disposed of off-site. Diligent and systematic control of weeds will be critical to restoration project success. The restoration biologist may revise treatment methods if weeds are not being adequately controlled.

Selective application of an approved herbicide (if necessary, and as approved by the restoration biologist and Services) would be limited to infestations that cannot be feasibly controlled by hand weeding, and where adverse effects to native plants and animals can be avoided. If herbicides are needed, only those which are approved for aquatic use shall be used. No herbicides shall be used on native vegetation. Herbicide shall not be applied if there has been a rain event within 24 hours and foliage is still wet, if rain is forecasted to occur within 48 hours, or if winds are in excess of 5 miles per hour.

The level of required weed removal will likely be higher in the first year and is expected to decrease in later years (years 2-5 or restoration) as native plant cover increases. Weeding will be conducted as needed to prevent displacement of native species, which may include treatment or removal several times per year. Specifically, weeding will be conducted at least three times annually (spring, summer, and fall), or until it is determined that the restoration site is not at risk from competition by invasive plants. Increased frequency of weeding may be required if deemed necessary by the restoration biologist.

Success Criteria

Restoration success will be measured relative to documented pre-renovation conditions based on the pre-activity assessment described below, with the exception that weeds should be fully eradicated within the 5-year active restoration period. The following criteria will be used to determine when restoration has been successfully achieved:

- Native vegetative plant cover equal to or more than the average total cover in the pre-activity site(s) after 5 years (Section 4.2, below)
- Species makeup and diversity equal to or more than the pre-activity site(s)
- Invasive weed density is no higher than the pre-activity reference sites after 5 years
- 100 percent eradication of identified arundo and tamarisk stands in restoration areas at end of five years

If a natural event outside of United's control, such as a flood, impacts the restoration area in such a way as to set restoration efforts back, the success criteria may be re-evaluated to create a more realistic goal. Similarly, because restoration success will be based on pre-renovation conditions, flood conditions prior to renovation may ultimately limit the required restoration acreage and species composition.

CONSERVATION MEASURE 2.3.2

Conservation Measure 2.3.2
Implement Invasive Brown-headed Cowbird Control
United will implement the Invasive Species Control Plan to mitigate for the taking of covered species from covered activities.

Development of Conservation Measure

United will implement the Invasive Brown-headed Cowbird Control Plan, which includes methods and success criteria related to removal of invasive brown-headed cowbirds.

Avoidance of impacts to covered birds may not be feasible and incidental take of covered birds may occur (see Chapter 7). United will mitigate the taking of covered birds through replacement of suitable nesting habitat (see Conservation Measure 2.3.1) and through invasive species management to reduce ecological pressures on the native species. Invasive species management will involve trapping and removal of the brown-headed cowbird (*Molothrus ater*), an invasive nest parasite species. For two years starting with the first year of renovation activities, a minimum of two cowbird traps will be installed in optimum locations in consultation with USFWS and CDFW based on the results of prior riparian bird surveys.

Discussion

Implementation of invasive species control will provide mitigation for impacts to covered bird species through reduction of ecological pressures imposed by invasive species and thereby facilitating recruitment and population recovery of covered bird species.

5.3 LITERATURE CITED

AECOM 2016. *Draft Freeman Diversion Fish Passage Hardened Ramp Design, 60% Hydraulic Basis of Design Report*. Prepared for United Water Conservation District. Prepared by AECOM, Alden, and R2 Resource Consultants. June 2016.

Amended Judgment dated December 1, 2018 in *Wishtoyo Foundation, et al. v. United Water Conservation District*, Central District of California Case No. 2:16-cv-03869-DOC-PLA (ECF No. 248).

American Fisheries Society (AFS). 2014. *Use of Fishes in Research Committee.* (Joint committee of the American Fisheries Society, the American Institute of Fishery Research Biologists, and the American Society of Ichthyologists and Herpetologists). Guidelines for the use of fishes in research. American Fisheries Society. Bethesda, Maryland.

Beller, E.E., R.M. Grossinger, M.N. Salomon, S.J. Dark, E.D. Stein, B.K. Orr, P.W. Downs, T.R. Longcore, G.C. Coffman, A.A. Whipple, R.A. Askevold, B. Stanford, and J.R. Beagle. 2011. *Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats*. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA.

Booth, Michael. 2020. Patterns and Potential Drivers of Steelhead Smolt Migration in Southern California. *North American Journal of Fisheries* Management. DOI: 10.1002/NAFM.10475

California Department of Fish and Wildlife (CDFW). 2009. Part XII Fish Passage Design and Implementation. Replacement of "Human Induced Obstructions, Fishways and Culverts" (pages VII-51 through VII-61) in the February 1998 version of the *California Salmonid Stream Habitat Restoration Manual*.

____. 2016. Aquatic Invasive Species Disinfection/Decontamination Protocols (Northern Region). Online: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=92821&inline.

____. 2017. Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California (CDFW-IFP-001). California Department of Fish and [Wildlife]. Insteam Flow Program. Sacramento, California. September 2017. Available online at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=57462. Retrieved July 2018.

California Stormwater Quality Association ®. 2019. https://www.casqa.org/

Dettman, D.H., and D.W. Kelley. 1986. *Assessment of the Carmel River steelhead resource. Volume 1: Biological investigations*. Report by D.W. Kelley & Associates to Monterey Peninsula Water Management District. Monterey, CA.

Dunham, J. B., A. E., Rosenberger, R. F. Thurow, C. A., Dolloff, and P. J. Howell. 2009. Coldwater fish in wadable streams. Pages 119-138 *in* S. A. Bonar, W. A. Hubert, and D. W. Willis, editors. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland.

Flosi, G, S. Downie, J. Hopelain, M. Bird, R. Coey, B. Collins. 2010. *California Salmonid Stream Habitat Restoration Manual, 4th Edition*. California Department of Fish and Game, Wildlife and Fisheries Division.

Goodman, D.H. and S.B. Reid. 2017. Climbing Above the Competition: Innovative Approaches and Recommendations for Improving Pacific Lamprey Passage at Fishways. *Ecological Engineering* 107: 224–232.

Goodman D.H., S.B. Reid, N.A. Som, and W.R. Poytress. 2015. The Punctuated Seaward Migration of Pacific lamprey (*Entosphenus tridentatus*): Environmental Cues and Implications for Streamflow Management. *Can. J. Fish. Aquat*. Sci. 72: 1–12

Goodman, D.H., S.B. Reid, R.C. Reyes, B.J. Wu, and B.B. Bridges. 2017. Screen efficiency and implications for losses of lamprey macrophthalmia at California's largest water diversions. *North American Journal of Fisheries Management* 37(1):30-40.

Jacks, S., S. Sharon, R. Kinnunen, D. K. Britton, D. Jensen, and S. S. Smith. 2009. Controlling the spread of invasive species while sampling. Pages 217-222 *in* S. A. Bonar, W. A. Hubert, and D. W. Willis, editors. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland.

Keefer, M.L., Daigle, W.R., Peery, C.A., Pennington, H.T., Lee, S.R., Moser, M.L. 2010. *Testing Adult Pacific Lamprey Performance at Structural Challenges in Fishways*. North American Journal Fisheries Management 30, 376-385.

Kelley, E. 2008. *Steelhead Trout Smolt Survival in the Santa Clara and Santa Ynez River Estuaries*. Prepared for the California Department of Fish and Game Fisheries Restoration Grant Program. 61 pp.

Kirk, M.A., Caudill, C.C., Tonina, D., Syms, J.C. 2016. Effects of Water Velocity, Turbulence and Obstacle Length on the Swimming Capabilities of Adult Pacific Lamprey. *Fisheries Management and Ecology 23*, 356-366.

Lang, M., M. Love, and W. Trush. 2004. Improving Stream Crossings for Fish Passage -- Final Report. NMFS contract number 50ABNF800082. 76 pp.

Leitritz, Earl. and Robert. C. Lewis. 1980. Trout and salmon culture (hatchery methods). California Fish Bulletin Number 164. University of California, Division of Agriculture and Natural Resources, Publication 4100.

Moser, M.L., M.L. Keefer, H.T. Pennington, D.A. Ogden, J.E. Simonson. 2011. Development of Pacific Lamprey Fishways at a Hydropower Dam. *Fish. Manage. Ecol*. 18: 190–200.

Moser, M.L., A.D. Jackson, M.C. Lucas, and R.P. Mueller. 2015. Behavior and potential threats to survival of migrating lamprey ammocoetes and macrophthalmia. *Reviews in Fish Biology and Fisheries* 25:103–116.

National Marine Fisheries Service (NMFS). 1997. *Southwest Region, Fish Screening Criteria for Anadromous Salmonids*. January 1997

____. 2011. *Northwest Region, Anadromous Salmonid Passage Facility Design.* NMFS, Northwest Region, Portland, Oregon. July 2011. http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_design_criteria.pdf. Accessed August 2018.

____. 2012. *Southern California Steelhead Recovery Plan*. Southwest Region, Protected Resources Division, Long Beach, California.

National Marine Fisheries Service (NMFS), Amicus Brief filed January 19, 2018 in *Wishtoyo Foundation, et al. v. United Water Conservation District*, Central District of California Case No. 2:16-cv-03869-DOC-PLA (ECF No. 179).

Nickum, J.G., Bart, H.L., Bowser, P.R. et al. 2004. Guidelines for the use of fishes in research. American Fisheries Society, Washington, DC.

PacifiCorp (2004). Klamath Hydroelectric Project. FERC Project No. 2082. Final Technical Report. February 2004.Petersen-Lewis, R.S. 2009. Yurok and Karuk traditional ecological knowledge: insights into Pacific Lamprey populations of the lower Klamath Basin. In: Brown, L.R., Chase, S.D., Mesa, M.G., Beamish, R.J., Moyle, P.B. (Eds.), Biology, Management, and Conservation of Lampreys in North America. American Fisheries Society Symposium Vol. 72, Maryland, pp. 1-39.

Powers, P.D., and J.F. Orsborn. 1985. An investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Part IV: Analysis of Barriers to Upstream Fish Migration -- Final Report. Prepared by Albrook Hydraulics Laboratory, Washington State University for Bonneville Power Administration, Portland, Oregon. 120 pp.

Puckett, L.K. and N.A. Villa. 1985. Lower Santa Clara River Steelhead Study, State of California Department of Fish and Game. Report Prepared under Interagency Agreement No. B54179 funded by the California Department of Water Resources. 31 pp.

R2 Resource Consultants 2014 Review of the TRPA (2005) – Adult Steelhead Passage in Lower Santa Clara River. Effects Analysis of the Freeman Diversion Dam on Steelhead Lamprey. Technical Memorandum, Project No 1936.04, January 8, 2014.Reinhardt, U.G., Eidietis, L., Friedl, S.E. Moser, M.L. 2008. Pacific Lamprey Climbing Behavior. *Canadian Journal of Zoology* 86, 1264-1272.

Rose, J.D., 2002. The Neurobehavioral nature of fishes and the question of awareness and pain. Rev. Fish. Sci. 10, 1–38.

Rose, B.P., and M.G. Mesa. 2012. Effectiveness of Common Fish Screen Materials to Protect Lamprey Ammocoetes. *North American Journal of Fisheries Management* 32:597–603.

Santa Inez River Technical Advisory Committee. 1999. Adult Steelhead Passage Flow Analysis for the Santa Ynez River. Prepared for Santa Ynez River Consensus Committee, Santa Barbara, California. 26 pp.

Snider, W.M. 1985. Instream Flow Requirements of Anadromous Salmonids, Brush Creek, Mendocino County, California. Stream Evaluation Report No. 85-1. California Department of Fish and Game, Sacramento, California.

Stillwater Sciences, and Kear Groundwater (Stillwater and Kear). 2012. *Santa Maria River Instream Flow Study: Flow Recommendations for Steelhead Passage Final Report*. Prepared for California Ocean Protection Council, Oakland, CA, and California Department of Fish and Game, Sacramento, CA. 139 pp.

Thomas R. Payne and Associates (TRPA). 2005. *Assessing Passage of Steelhead over Riffles in the Lower Santa Clara River*. Draft Final Report to the United Water Conservation District, Santa Paula California. 31 pp.

Thompson, K. 1972. *Determining Stream Flows for Fish Life*. Pacific Northwest River Basins Commission Instream Flow Requirement Workshop. March 15-16, 1972. 34 pp.

United Water Conservation District. 2010. Saticoy Recharge Mound Study. March.

____. 2016. Minimizing effects of river recession due to turn-in at the Freeman diversion. Open-File Report 2016-02, October 2016.

Vern Freeman Dam Fish Passage Panel. 2010. Vern Freeman Dam Fish Passage Conceptual Design Report. Final Report prepared for United Water Conservation District. 264 pp.

Zhu, Q., M. Moser, and P. Kemp. 2011. Numerical analysis of a unique mode of locomotion: vertical climbing by Pacific lamprey. *Bioinspiration and Biomimetics* 6(1), 016005.

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6 ADAPTIVE MANAGEMENT AND MONITORING

The monitoring and adaptive management program developed for this MSHCP is intended to document United's compliance with the ITP and the biological goals and objectives of the MSHCP, to evaluate the effects of the covered activities on covered species and their habitats and ecological processes, to evaluate the effectiveness of the conservation program, and to provide flexibility to adjust implementation actions to best achieve the biological goals and objectives while balancing water resource management to fulfill United's purpose and need.

6.1 ADAPTIVE MANAGEMENT

The NMFS and USFWS Five-Point Policy (65 FR 35242) defines adaptive management, as applied to HCPs, as "a method for examining alternative strategies for meeting measurable goals and objectives, and then, if necessary, adjusting future conservation management actions according to what is learned." Adaptive management also provides the means to address key uncertainties that can affect how a project operates. Consistent with these definitions, United has developed and incorporated an adaptive management framework in this MSHCP that does the following:

1. Identifies key *uncertainties* that relate to specific components of United's proposed CMs
2. Incorporates monitoring programs that will collect and use data to address the uncertainties
3. Identifies thresholds that when met/not met result in specific actions or additional consultations with agencies when specific actions are not clearly pre-defined

Adaptive management is only necessary when significant uncertainties exist, and therefore, the adaptive management strategy does not include all conservation measures. In this MSHCP, the primary focus of adaptive management actions pertains to the uncertainty regarding the effectiveness of certain plan elements or key assumptions related to specific CMs.

Per the Five-Point Policy (65 F.R. 35242), the types of uncertainty typically addressed include:

1. Significant lack of information about the ecology of a species or its habitat
2. Uncertainty about the effectiveness of habitat or species management techniques
3. Lack of knowledge on the degree of potential effects of the activity on the species

Adaptive management in an HCP allows the permittee to apply several different methods to achieve goals and objectives, rather than adhering to an inflexible list of prescriptions, and provides a process to identify and approve additional conservation measures. However, given the nature of the most substantial CMs in this MSHCP (instream flows and the fish passage facility), some significant limitations exist regarding the degree to which alternative methods for achieving goals can be applied. Many of these limitations concern the significant cost of capital improvements and the fact that United's essential function of diverting water for beneficial use is already constrained by the CMs. "No Surprises" (63 FR 8859 and 50 CFR parts 17 and 222) provides regulatory assurance to HCP permittees that, as long as they properly implement their HCP, the Services will not require them to provide additional conservation measures that would involve the commitment of land, water, or financial compensation, or add additional restrictions on the use of land, water, or other natural resources. At the same time, adaptive management is not a catchall for every uncertainty or a way to address issues that could not be resolved in negotiations of the HCP.

Adaptive management can take two forms: active and passive. Active adaptive management involves modeling and experimentation to compare the outcome of several possible alternatives. Passive management measures involve learning from the observed outcome of a single course of action. Both are considered acceptable approaches for HCPs depending on the specific situation (e.g., risk to the species or the scale and complexity of the HCP). The Five-Point Policy (65 FR 35242) emphasizes that experimentation is not required and that it is not practical to require all adaptive management strategies to incorporate an elaborate experimental design. For this MSHCP, the adaptive management program is based largely on passive management measures.

6.1.1 ADAPTIVE MANAGEMENT FRAMEWORK

United has established the following decision-making framework to guide the identification and implementation of potential modifications to the conservation program. The results of annual monitoring activities will inform management decisions. The following informs the development of alternative management actions in United's decision-making process and describes the details of its decision-making framework for determining what changes, if any, should be made to the conservation program.

The decision-making process will involve the analysis of monitoring data at the end of each annual reporting cycle or other decision periods, as outlined in the EMMs. United will meet annually with the Services to discuss the monitoring results and provide the opportunity to discuss whether modifications to the management actions prescribed in the conservation program are warranted. Any modifications to the MSHCP will be accomplished through the procedures identified in the implementing agreement.

Reporting

Table 6-1 summarizes reporting requirements related to components of the MSHCP's monitoring program. During the construction phase of the project, United will provide the Services with weekly email updates detailing construction progress, implementation of CMs, and any deviations from the CMs or construction plans that may be relevant to the covered species.

During the winter season (December 1 – May 31), United will provide the Services with written monthly status report for the first five years after issuance of the ITP. These will be submitted at the end of each month and will include a summary of findings from the monitoring activities of the preceding month.

United will submit a written annual status report to the resource agencies each year. The annual report will include findings from monitoring efforts of the preceding water year (October 1 – September 30), and include relevant statistical analyses and the interpretation of each study element to inform understanding of the overall effectiveness of the conservation program.

Annual Meetings

No later than October 15 of each year, United and the Services will meet (or have scheduled a meeting) or have agreed that no meeting is necessary to discuss the information presented in the annual report. These annual meetings will provide a collaborative framework to consider collectively the interpretation of monitoring data. Annual meetings will include the following:

- Summary of data analyses and results interpretations
- Consideration/discussion of results

The annual meetings will provide a structure during which to evaluate the content of the annual reports, determine if progress is being made towards meeting the biological goals of the MSHCP, and discuss any potential changes in management actions. This structure links implementation and monitoring of the conservation program to a decision-making framework that allows responses to new information and changing conditions and offers an opportunity to detect and reconcile issues with the management actions prescribed in the conservation program.

Table 6-1 Conservation Measures Implementation and Reporting Schedule

Conservation Measure (CM)	Permit Implementation Phase			Reporting Schedule			
	Pre-Construction	Construction	Post-Construction	Weekly Email Summary During Construction	Construction Completion Report	Monthly Report (Years 1-5 after issuance of ITP)	Annual Report (Years 1-50)
1.1.1 Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion	X	X	X	X	X	X	X
1.1.2 Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion	X	X	X	X	X	X	X
1.2.1 Instream Flow Commitment for Upstream Migration – Initial Operations (maximum instantaneous diversion of 375 cfs)	X	X - to extent feasible	X			X - until water right change	X - until water right change
1.2.2 Instream Flow Commitment downstream of Freeman Diversion for Downstream Migration– Interim Operations (maximum instantaneous diversion of 375 cfs)	X	X - to extent feasible	X			X - until water right change	X - until water right change
1.2.3 Instream Flow Commitment Downstream of Freeman Diversion for Upstream Migration - Future Operations (water right change to maximum instantaneous diversion rate – 750 cfs)			X - following water right change			X - following water right change	X - following water right change
1.2.4 Instream Flow Commitment Downstream of Freeman Diversion for Downstream Migration–Future Operations (Water Right Change to Maximum Instantaneous Diversion Rate – 750 cfs)			X - following water right change			X - following water right change	X - following water right change
1.2.5 Relocate Downstream Migrant Steelhead and Lamprey at Low Flows	X	X	X	X	X	X	X
1.2.6 Minimize Impacts to Steelhead and Lamprey Through Limitations on Sediment Management Activities						X	X
2.1.1 Best Management Practices	X	X	X	X	X	X	X
2.1.2 Worker Environmental Awareness Training	X	X	X	X		X	X
2.1.3 Pre-Activity Surveys	X	X	X	X	X	X	X
2.1.4 Covered Species Capture and Relocation Protocol	X	X	X	X	X	X	X
2.1.5 Noise Abatement Protocol	X	X	X	X	X	X	X
2.1.6 Biological Monitoring		X	X	X	X	X	X
2.1.7 Avoid Nests of Covered Species of Birds during Nesting Bird Season	X	X	X	X	X	X	X
2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones	X	X	X	X	X	X	X
2.2.1 Invasive Species Management	X	X	X	X	X	X	X
2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events	X	X	X	X	X	X	X
2.3.1 Implement the Habitat Restoration and Management Plan	X	X	X	X	X	X	X
2.3.2 Implement the Invasive Brown-headed Cowbird Control Plan		X				X	X

Following discussions at the annual meetings, United will prepare and submit their recommendations to the Services, which may accept United's recommendations and/or provide its own assessment, recommendations, and guidance on how to proceed. United's recommendations may include proposed changes to the CMs and monitoring and reporting requirements in support of the conservation program.

Adoption of Recommendations

Following the annual meeting and potential additional feedback from the Services, the next step in the annual decision-making process will depend on the nature of the recommendations United decides to pursue. Because it is difficult to anticipate the exact nature and types of recommendations that could be considered, the MSHCP does not provide specific steps for how the process would proceed. Although the adaptive management framework does not require additional land, water, or financial resources, United would have the option to commit additional land, water, or financial resources at the discretion of its Board of Directors, if the Services agree such action is warranted. Other actions that could be considered include modifications of patterns or timing of operations or flows that involve a combination of increases and decreases without overall decreases of United's average annual yield from the needed 71,800 acre-feet to remain a practicable project (see Chapter 10).

6.2 MONITORING

The role of the monitoring program under this MSHCP, as recommended by the HCP Handbook (USFWS and NMFS 2016), is to determine whether:

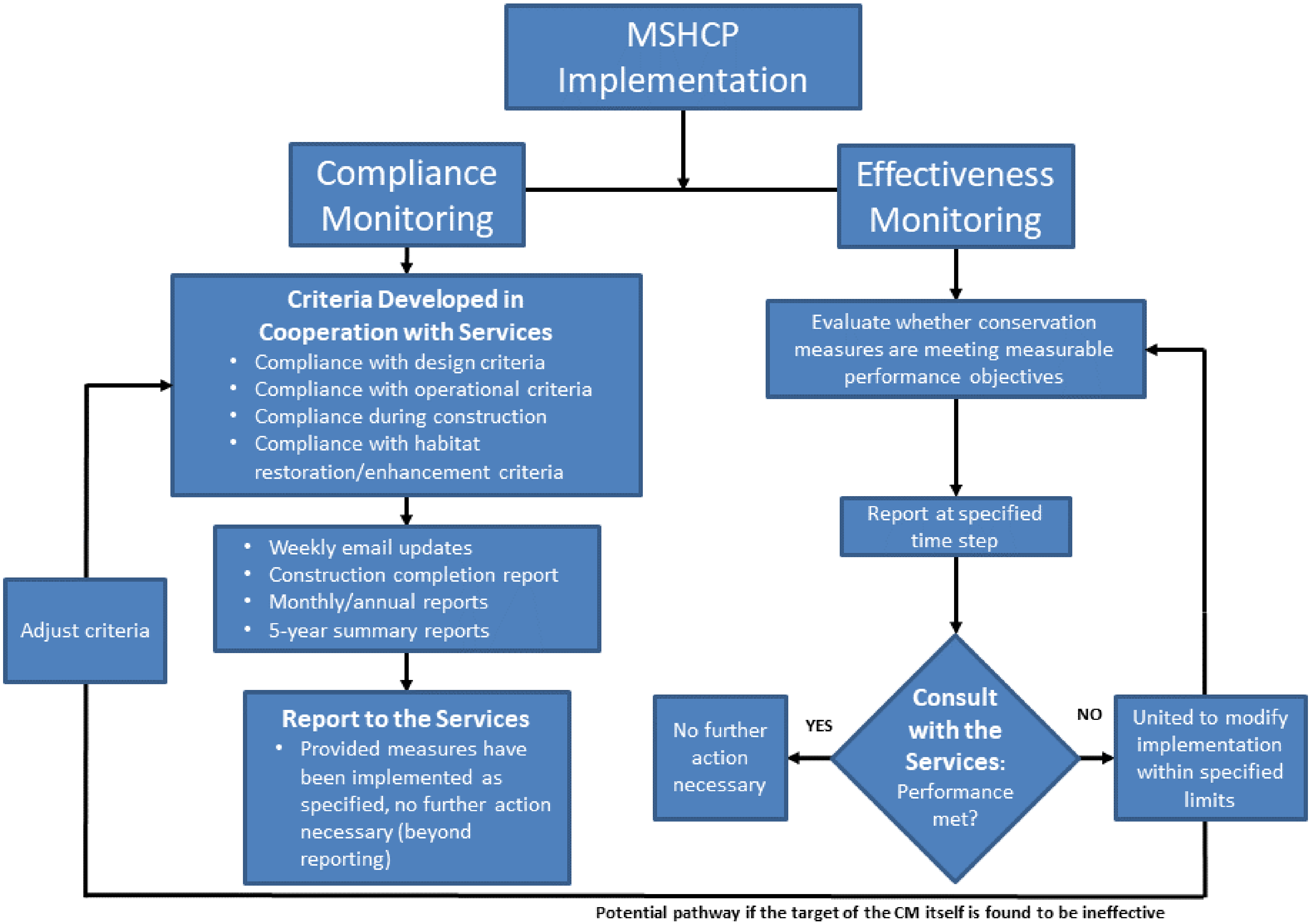
a) A permittee is in compliance with their incidental take permit and HCP
b) Progress is being made toward meeting an HCP's biological goals and objectives
c) The HCP's conservation program is effective at minimizing and/or mitigating impacts
d) There is a need for adjusting measures to improve the HCP's conservation strategy

The monitoring program outlined in this MSHCP (Figure 6-1) is divided into two groups:

- *Compliance monitoring* – designed to evaluate whether United is implementing the conservation program in accordance with the terms and conditions set forth in the ITP and MSHCP (items a and b above)
- *Effectiveness monitoring* – designed to provide feedback to improve performance and functionality of measures where United is responsible for ensuring results and for addressing areas of uncertainty (items c and d above)

In general, the two types of monitoring identified above will continue for varying durations. Some types of monitoring will continue for the duration of the ITP (such as most compliance monitoring). Other monitoring will continue until their respective success criteria and the commitments identified in the following sections are achieved and prior to ITP expiration. Section 6.4 presents a timetable for reporting. offers specific timetables for compliance monitoring. Effectiveness monitoring timetables and decision points are discussed in each effectiveness monitoring measure (EMM) described in Section 6.3.

Figure 6-1 Monitoring Program Overview



6.3 COMPLIANCE MONITORING

Compliance monitoring documents the implementation of activities outlined in this MSHCP (primarily covered activities and conservation program) to determine if United is fulfilling its commitment to implement those activities, according to the requirements set forth by the terms and conditions of the MSHCP and ITP. Any incidental take or specified impacts to habitat (as appropriate) that may occur while implementing the MSHCP is also documented through compliance monitoring.

All encounters with covered species during implementation of the MSHCP will be documented and reported to the Services, according to the reporting schedule (Table 6-1). Observed incidental take of any covered species during implementation of any portion of this MSHCP will be documented and reported to the Services according to the reporting schedule (Table 6-1). Any observed or suspected injury or death of covered species will be communicated to the Services within 24 hours by phone and 48 hours by email, in addition to regular reporting (Table 6-1). If the amount of authorized take is exceeded (e.g., number of individuals captured, injured or killed; extent of habitat affected), the Services shall be notified without delay (within 6 hours) by phone and email.

United will evaluate compliance with each CM and provide a take summary consistent with the MSHCP requirements through a combination of weekly summary emails during construction, monthly reports (December 1-August 31 for Year 1 through Year 5), a construction completion report, and annual reports (for the life of the ITP). Compliance evaluation for each CM and documentation of the amount, extent and cause of take for each covered species will be provided annually, and longer-term decision points (e.g., 5-year, 10-year) will be addressed in the appropriate annual reports. Report intervals can be adjusted at any time, in consultation with the Services and with the Services approval in writing. Table 6-2 presents a summary of the compliance monitoring actions associated with each conservation measure.

Table 6-2 Conservation Measures and Compliance Monitoring Actions

Conservation Measures	Compliance Monitoring Action
1.1.1 Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion	Document construction progress during onsite construction monitoring. Document any deviations from the facility design and specifications contained in Appendix C. Document if fish way facility operations perform according to the prescribed design criteria and comply with the protocols for prescribed flow splits. Evaluate hydraulic conditions and discharge through different pathways of the facility through a combination of installed devices (primarily non-contact radar), manual measurements, and evaluation of as-built plans and specifications. When the facility is not performing to design standards, assess the need for maintenance and repairs and completion of maintenance will be documented in addition to routine maintenance on the components required to meet fish passage design standards (e.g., crest gates, fish ladder gates, fish ladder screens). Construction compliance monitoring results will be reported in weekly email updates during the construction phase of the project and in the Construction Completion Report. Operations and maintenance compliance monitoring results will be reported for the life of the ITP and summarized at regular reporting intervals (Table 6-1).
1.1.2 Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion	Monitoring for CM 1.1.2 will be the same as CM 1.1.1 but for the lamprey fish passage system. Construction compliance monitoring results will be reported in weekly email updates during the construction phase of the project and in the Construction Completion Report. Operations and maintenance compliance monitoring results will be reported for the life of the ITP and summarized at regular reporting intervals (Table 6-1).
1.2.1 Instream Flow Commitment for Upstream Migration – Initial Operations (maximum instantaneous diversion of 375 cfs)	Monitoring implementation of the instream flow commitments contained in CMs 1.2.1-1.2.4 will involve a combination of continuous monitoring and manual flow measurements. Flows will be monitored continually at the Freeman Diversion and manually[1] downstream of the critical riffle, at a "compliance point." The compliance point is a non-specific location near the downstream end of the critical reach and upstream of the US-101 bridge. This general location was selected because it is downstream of any potential critical riffle locations that may shift from year to year in the critical reach. Any significant percolation will occur in the critical reach (upstream of the compliance point). For example, if 160 cfs is maintained at the compliance point, 160 cfs (or greater) will also be maintained at any other potential critical riffle location upstream. Each year, United will perform a reconnaissance survey to determine the specific location of the compliance point for that year and will document the location of the compliance point for that year in regular reporting (Table 6-1). The location of the compliance point may change during the year, for example when accurate manual measurements at the initially selected location are not possible due to low flow conditions and/or changed channel geometry. Continual monitoring at the Freeman Diversion will be conducted using a variety of flow and level measurement devices installed at the facility. Measurement devices that require calibration will be calibrated annually, if operational and hydrological conditions allow (conditions that may
1.2.2 Instream Flow Commitment downstream of Freeman Diversion for Downstream Migration– Interim Operations (maximum instantaneous diversion of 375 cfs)	
1.2.3 Instream Flow Commitment Downstream of Freeman Diversion for Upstream Migration - Future Operations (water right change to maximum instantaneous diversion rate – 750 cfs)	

Table 6-2 Conservation Measures and Compliance Monitoring Actions

Conservation Measures	Compliance Monitoring Action
1.2.4 Instream Flow Commitment Downstream of Freeman Diversion for Downstream Migration–Future Operations (Water Right Change to Maximum Instantaneous Diversion Rate – 750 cfs)	preclude calibration include year-round flows that prevent zero level calibration and lack of flows or certain flow ranges that prevent flow calibration). Water level measurement devices are calibrated by verifying zero levels and applying an offset as needed. Flows for level measurement devices are calculated using rating equations. Devices that can use accurate theoretical ratings do not need additional calibrations for flow. Any devices that use empirical rating curves (potentially applies to crest flow measurements) will be calibrated for flow by performing manual flow measurements as needed, typically when conditions change that affect the rating curve, and annually at minimum. Flow measurement devices will be calibrated according to manufacturer's requirements. In the case of area-velocity flow devices, this includes a level calibration; other devices may not require calibration. In order to verify instruments are working correctly, flow verification measurements will also be performed annually, if operational and hydrological conditions allow, and if devices can be isolated for flow measurements. Discharge immediately downstream of the Freeman Diversion will be calculated by combining measurements for all flow paths that release water below the Freeman Diversion. Discharge for each flow path will be obtained from devices integrated with United's SCADA system, either directly from the SCADA Historian database or via additional software (e.g., Ranch Systems or similar) capable of accessing data in the Historian database, calculating flows using rating curves, and calculating total river flow. Flows at the compliance point will be monitored using manual, direct discharge measurements (when stream wading can be done safely, or technological devices allow safe measurement of discharge). Discharge measurements are required at the compliance point to quantify percolation rates in the critical reach and will be conducted as needed. When the instream flow operations described in CMs 1.2.1 – 1.2.4, or as otherwise modified, have been triggered and conditions are safe, discharge measurements will be conducted at the compliance point, a minimum of once per day until a reliable and stable percolation rate can be established, or surface flows have stabilized. Compliance monitoring results for CMs 1.2.1-1.2.4 will be prepared for the Services monthly from December through May, for the first five years of project implementation, and annually for the life of the ITP. These reports shall include a synthesis of facility operations, discharge measurements, percolation rates, and other pertinent information in the context of the requirements and operational procedures set forth in CMs 1.2.1-1.2.4 and the terms and conditions of the MSHCP and ITP.
1.2.5 Relocate Downstream Migrant Steelhead and Lamprey at Low Flows	All fish trapping and relocating activities implemented for any portion of this MSHCP (e.g., CMs 1.2.5, EMM-03, EMM-04, EMM-05, EMM-06, EMM-07) will be documented and reported to the Services. Information recorded during trapping and relocating activities will include (but may not be limited to): • Start time and date of trap operations • Start time and date of trap check • End time and date of trap check • Trap check personnel • Water/atmospheric conditions at time of trap check • Species and life stage of individuals encountered • Number of individuals • Estimated fork length of steelhead and lamprey individuals • Sex if possible • Photographs of individuals (when appropriate) • Water quality conditions in transport container • Release location or disposition • Water quality conditions at release location • Acclimation schedule • Release time and date • Condition of individuals

Table 6-2 Conservation Measures and Compliance Monitoring Actions

Conservation Measures	Compliance Monitoring Action
1.2.6 Minimize Impacts to Steelhead and Lamprey Through Limitations on Sediment Management Activities	Data collected in real time through continuous monitoring at the Freeman Diversion will be available to the Services as discussed in CM 1.1.1. Sluicing events are evident in the shared data in real time as the flows begin to register in the bypass channel once the roller gate is opened. United will also document when a sluicing event occurred (start/end times); the conditions prior to the sluicing event, during the sluicing event, and after the sluicing event; any staff that surveyed upstream during the sluicing event and downstream after the event; and any covered species observed during the sluicing event. If any observed covered species required relocation under 1.2.5 or 2.1.4, then the data for those CMs will be collected and reported under those CMs. If injury or mortality of any covered species is observed, the Services will be contacted via phone within 24 hours and via email within 48 hours; injuries and mortalities of covered species will be documented in regular reporting (Table 6-1).
2.1.1 Best Management Practices	Confirm that BMP efforts are carried out prior to construction and maintenance activities, as appropriate, and during onsite monitoring. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.1.2 Worker Environmental Awareness Training	Document implementation of environmental awareness trainings and make training materials available to the Services. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.1.3 Pre-activity Surveys	Document methods and results of pre-activity surveys conducted as described in CM 2.1.3. Deliver results of pre-activity surveys to the resource agencies prior to initiating project activities, including special status species observations and proposed effects avoidance measures. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.1.4 Covered Species Capture and Relocation Protocol	All activities involving the handling and relocating of covered species implemented for any portion of this MSHCP (e.g., CMs 1.2.2, 1.2.4, EMM-03) will be documented and reported to the agencies at prescribed intervals (Table 6-1). Information recorded during trapping and relocating activities will include (but may not be limited to): • Start time and date of trap operations • Start time and date of trap check • End time and date of trap check • Trap check personnel • Water/Atmospheric conditions at time of trap check • Species and life stage of individuals encountered • Number of individuals • Sex when possible • Size (appropriate measure per species) • Photographs of individuals (when appropriate) • Water quality conditions in transport container (steelhead/lamprey) • Release location or disposition • Water quality conditions at release location (steelhead/lamprey) • Acclimation schedule (steelhead/lamprey) • Release time and date • Release conditions (e.g., dissolved oxygen, temperature, etc.) • Condition of individuals
2.1.5 Noise Abatement Protocol	Document implementation of noise abatement measures as described in Appendix G, including summaries of any monitoring efforts. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.1.6 Biological Monitoring	Document methods and results from all monitoring efforts, including but not limited to the items listed below. Report compliance monitoring results at prescribed intervals (Table 6-1). • Start time and date of monitoring • Name of individual conducting monitoring • Type and location of monitoring • End time and date of monitoring • General atmospheric conditions during monitoring • Activities that triggered the need for monitoring • Implementation of any impact avoidance measures • Avoidance/exclusionary buffers • Observations of any special-status species while monitoring • Construction or maintenance related impacts to sensitive species or habitats

Table 6-2 Conservation Measures and Compliance Monitoring Actions

Conservation Measures	Compliance Monitoring Action
2.1.7 Avoid Nests of Covered Species of Birds During Nesting Bird Season	Document implementation of all activities undertaken to avoid impacts to nesting birds during the nesting season, including results of pre-activity surveys, establishment and implementation of avoidance measures, and results of monitoring. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones	Document pre-activity surveys for pond turtles and pond turtle or pond turtle nest observations; the activities that required work in water; and any avoidance buffers that were implemented. If any pond turtles required relocation under CM 2.1.4, data will be collected in consultation with USFWS and recorded prior to relocation. The encounter location and the relocation site will be documented as well as the condition of the turtle at the time of release. Report compliance monitoring results at prescribed intervals (Table 6-1).
2.2.1 Invasive Species Management	Document implementation of invasive species management BMPs. Report compliance monitoring results at prescribed intervals (Table 6-1).

2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events	Document measures implemented in accordance with CMs 2.2.2, including but not limited to the items listed below. Report compliance monitoring results at prescribed intervals (Table 6-1).
	• Areas of sensitive habitat identified during pre-construction surveys or monitoring
	• Observations of special-status species
	• Implementation of avoidance measures
	• Minimization measures implemented when avoidance is infeasible
	• If unavoidable or unexpected impacts occur, characterize impacts:
	  ○ Classify impacted habitat(s)
	  ○ Quantify area impacted
	  ○ Classify type of impact(s)
	  ○ Identify implications of impact

2.3.1 Implement the Habitat Restoration and Management Plan	Document measures implemented in accordance with CM 2.3.1, including but not limited to the items listed below. Report compliance monitoring results at prescribed intervals (Table 6-1). • Pre-activity survey of impact areas to establish native plant palette and success criteria • Prepare restoration sites and employ BMPs • Revegetate sites through seeding and natural recruitment • Maintain and enhance sites through invasive species management • Implement CMs 2.1.1 - 2.1.7, as necessary, depending on restoration location, activity and seasonal timing • Monitor restoration sites over the short-term (0-5 years) and long-term (6-10 years) to verify achievement of success criteria or determine necessary remedial measures • Document monitoring and restoration success through monthly/quarterly memoranda and annual reporting
2.3.2 Implement the Invasive Brown-headed Cowbird Control Plan	Document implementation of brown-headed cowbird trapping, trap location(s), and trapping results. Report compliance monitoring results at prescribed intervals (Table 6-1).

[1] Continuous monitoring at the reach where the compliance point is located has been thoroughly evaluated and concluded to be infeasible by United and United States Geological Survey (Stuart Hill 2016); therefore, manual discharge measurements are required.

6.4 EFFECTIVENESS MONITORING

Effectiveness monitoring and adaptive management are activities intended to combine applied management with scientific research. They are used to address uncertainty about the response of natural ecosystems to ongoing management activities (USFWS and NMFS 2016). Under an adaptive management process, management actions are treated as a series of experiments (i.e., hypothesis testing); the results of these experiments are analyzed scientifically and used to guide future management actions.

Fundamentally, EMMs are used to evaluate whether conservation measures have achieved the specified resource objective. The desired outcome of effectiveness monitoring is to facilitate adaptations or adjustments to conservation measures if the original measures prove inadequate or are not supported by the hypotheses on which they were founded. Therefore, the effectiveness monitoring in the MSHCP includes only those conservation measures for which uncertainty exists regarding their outcomes and should therefore incorporate an adaptive management feedback loop.

United will implement the EMMs and summarize the results in specified reports (Table 6-1). The results of effectiveness monitoring will be reviewed in coordination with the Services on prescribed timescales depending on the measure, the project phase, and any feedback loops in the measure. Conservation measures found to be ineffective at meeting the associated objective will be modified within the limitations specified by the adaptive management framework (Section 6.5.1). If the Services find that a conservation measure about which there was some initial uncertainty is in fact effective at meeting the resource objective, then that conservation measure will continue to be implemented as described; in most cases the associated effectiveness monitoring will then be discontinued. It is possible United may need to alter the monitoring program or develop new monitoring measures, in consultation with the Services and through the adaptive management framework. Some possible reasons the monitoring program may be altered in consultation with the Services include changed or unforeseen circumstances, unexpected results revealed in monitoring data, or the conclusion that a proposed monitoring method has proven ineffective or technologically infeasible.

6.4.1 EFFECTIVENESS MONITORING MEASURE: EMM-01 – DISCHARGE VERSUS WIDTH AND DEPTH CRITERIA IN CRITICAL REACH

United will further evaluate the relationship between river discharge and width and depth criteria that form the basis of the instream flow commitments specified in CM 1.2.1 through CM 1.2.4 and assumptions regarding passage and migration in the related effects analysis (see Chapter 7). United will measure channel widths and depths relative to steelhead passage criteria at several discharges (between 30 and 200 cfs) and channel morphologies as well as longitudinal profiles upstream and downstream of the critical riffle to understand conditions upstream and downstream when flows at the critical riffle are considered "more than sufficient" for steelhead passage. The discharge range for this EMM was selected based on discharge well below the range considered to provide fish passage in the critical reach for juveniles as determined by previous data collection for the past decade and discharges in the upper limit of safe sampling in the river.

Uncertainties being addressed:

- Confirmation of relationship between river discharge and width and depth criteria within the critical reach.
- Address if relationship is consistent through different channel morphologies.
- Assess longitudinal profiles upstream and downstream of the critical riffle associated with width and depth criteria at critical riffle.

Methods

Semi-permanent, cross-channel transects will be established and surveyed in the critical reach (Figure 6-2) as well as upstream and downstream of the critical reach for 25 percent of the surveys. Reconnaissance surveys of the critical reach will be conducted to identify the location(s) of potential critical riffles to be evaluated with cross-channel transects. Reconnaissance surveys will identify one or more potential sites following the first storm of the season and following a channel-reshaping event. One or more transects will be placed at each selected site. Transect placement and measurement will generally follow the protocol for critical riffle analysis as specified by CDFW DFG-IFP-001: Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California (last updated in 2017). Critical passage sites in the lower Santa Clara River can be over 1,000 feet long and consist of multi-threaded braided channels for which the shallowest portion may be a sandy glide rather than a riffle crest. Therefore, United may utilize alternative equipment or technology (e.g., RTK GPS, laser-range finder) and gather additional data (e.g., multiple transects, longitudinal transects, aerial imagery) in an effort to best characterize and assess the complexity of sites in the lower Santa Clara River. Data analysis will follow the protocols specified in TRPA (2005) and in accordance with specified site-specific adult migration criteria as minimum depth ≥ 0.5 foot, within a ≥5-foot wide interval. Data analysis will also follow criteria specified in CDFW DFG-IFP-001 for smolts (≥0.4 foot), with the adoption of an alternative ≥5-foot wide interval consistent with site-specific analysis by TRPA (2005). Cross-section data will be plotted for visualization for the sampled flow conditions.

- Monitoring reports will include:
  - Location of critical riffle(s) surveyed
  - Synthesis of the collected data that includes individual transect results for each of the various flow periods during that reporting period
  - Discussion of the results relative to the criteria assumptions for instream flows
  - Whether criteria were met and appropriate recommended action if not
  - Recommendation regarding continued monitoring

Effectiveness Determination

This EMM has a minimum three-year monitoring period with relatively stable channel morphology conditions (i.e., no significant lateral migration of the thalweg and no peak flows exceeding 50,000 cfs). After three years of data collection and analysis, United will consult with the Services as to whether river discharge in the existing channel morphology has a predictable relationship to the width and depth criteria as applied to steelhead migration. Reset events for the three-year monitoring period are defined as major channel-reshaping events (e.g., lateral migration of the thalweg, peak flows exceeding 50,000 cfs, or change in location of the critical riffle) or changes to the instream flow operations implemented through adaptive management. This EMM could have several potential outcomes:

- The channel morphology is relatively stable as defined above, and the depth and width criteria are always met or exceeded under flows specified in the proposed instream flow operations. In this case, EMM–01 would be discontinued until the next reset event as defined above.
- A reset event occurs. This outcome initiates a new three-year monitoring period.
- The channel morphology has been altered by three channel-reshaping events, but the width and depth criteria are always met or exceeded consistently by the prescribed instream flows throughout the range of channel variability. In this case, EMM-01 would be discontinued. Note that this would be at least 9 years of monitoring total.

Figure 6-2 Relevant Locations in the Lower Santa Clara River for Effectiveness Monitoring Measure EMM-01

Imagery provided by Google and its licensors © 2018.
Hydrological data provided by County of Ventura, 2016.

Source: TRPA 2005.

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- United's instream flow commitments are greater than necessary or less than desirable to provide channel widths and depth criteria required for steelhead migration. United can use the collected data to inform a decision on whether to adjust instream flows consistent with the adaptive management framework. This outcome initiates a new three-year monitoring period.

Rationale

The lower Santa Clara River downstream of the Freeman Diversion includes a critical reach containing several shallow riffles (critical riffles) that migrating anadromous fish must pass. EMM-01 will evaluate the effectiveness of the instream flow CMs (1.2.1-1.2.4) at providing the target width and depth conditions aimed at supporting unimpeded migration of anadromous fish. It will also evaluate whether large storm events (i.e., channel reshaping events) may significantly alter the relationship of river discharge to width and depth criteria by altering channel morphology at the critical riffle sites.

Based largely on TRPA (2005), CM 1.2.1 and CM 1.2.3 assume adult migration baseflows of 160 cfs at the critical riffles provide for unimpeded adult steelhead migration through the critical reach and, therefore, through the affected reach (see Chapter 7; Section 7.2.5).

Upstream-migrating adult steelhead are large fish that require greater depths to facilitate unimpeded migration (compared to smolts and lamprey). Therefore, flows ≥120 cfs should also provide conditions suitable for the downstream migration of smolts. It is assumed, and United's preliminary data support, that 80 cfs is the discharge rate below which smolt migratory connectivity is lost in the critical reach. EMM – 01 evaluates the 80 cfs starting point by monitoring width and depth in the river over the range of flows specified under United's proposed operations; this allows United to propose adjustment of flow targets to minimize potential impacts to downstream migrating juvenile steelhead. EMM-06 assesses actual success of smolts migrating during low flows.

6.4.2 EFFECTIVENESS MONTORING MEASURE: EMM-02 – ADULT STEELHEAD PRIMARY MIGRATION PERIOD

United will evaluate the primary adult steelhead migration period for the Santa Clara River basin. The working hypothesis for this EMM is that the current proposed "primary migration season" (January 1 through May 31) provides adequate instream flows to approximate unimpeded migration for at least 95 percent of all adult steelhead that migrate or attempt to migrate in the Santa Clara River.

Uncertainties being addressed:

- 95% of adult steelhead enter the Santa Clara River from January 1 – May 31.

Methods

The evaluation of the adult steelhead primary migration window involves two components: a monitoring station at the Freeman Diversion fish passage facility as well as active monitoring for adult steelhead in the affected reach (including the estuary if possible) from November through June, a broader seasonal window than the primary migration window defined for instream flows in this MSHCP (January 1 through May 31).

Adult Steelhead Monitoring at the Freeman Diversion

United has experimented for about 30 years with fish monitoring techniques at and near the Freeman Diversion. A false weir with motion activated cameras has proven to be the most reliable method for detecting upstream migrating steelhead at the diversion in the Santa Clara River. Other passive fish monitoring techniques and technologies that do not involve trapping are vulnerable to issues of channel morphology, turbulence, and interference from suspended sediment. However, under court order, a false weir is prohibited as a monitoring approach at this time. United is undertaking a design process that will include assessment of an upstream monitoring option at the Freeman Diversion. In addition, a passive integrated transponder (PIT) antenna will be installed in the upstream fish passage to increase detection of adult returns, however not all adults would be anticipated to be detected via PIT tagging. Smolts will be tagged whenever they are trapped/rescued and relocated during the duration of the HCP as well as systematic studies of smolt biology explained in EMM-04. A PIT tag reader will also facilitate detection adult returns from other watersheds, assuming there are future PIT tagging efforts in other watersheds.

Monitoring for upstream moving steelhead will occur during the primary migration period, when instream flows are prescribed, and the fish ladder is operating. Monitoring outside the proposed primary migration period will be conducted at the Freeman Diversion when flow conditions permit (see CM 1.1.1 in Chapter 5). Level of effort and any potential bias in monitoring will be assessed and discussed when analyzing data.

Presence/Absence Assignment and Data Collection for Monitoring at the Freeman Diversion

Any day where the upstream fish passage facility was operating and no adult steelhead were observed will be assigned "absent" and a "0" recorded in the database and any day where the upstream fish passage facility was operating and adult steelhead were detected will be assigned "present" and a number based on the number of individuals observed (1, 2, 3, etc.) would be recorded in the database.

Adult Steelhead Monitoring Downstream of the Freeman Diversion

In addition to monitoring for adult steelhead that ascend the fish ladder, United will monitor for adult steelhead that enter the Santa Clara River, but do not reach the Freeman Diversion and for adult steelhead that reach the diversion but do not successfully ascend the fish ladder. Twenty-five percent of the potential sampling days from November through June (~60 days) will be randomly selected and represent an individual sampling event. Sampling locations will be the estuary (assuming permitting and access are feasible), the pool immediately downstream of the Freeman Diversion, and 25% of suitable holding pools for adult steelhead between the Freeman Diversion and the downstream end of the critical reach. Holding pool suitability will be determined by a qualified biologist using similar or improved methods used to identify holding habitat in Chapter 7 and will consider pool size, depth, complexity, and water quality.

Step 1

A biologist(s) will conduct a pre-survey assessment of the conditions in the sampling locations. If either of the following represent the existing conditions, then the conditions will be documented, and no further steps will be implemented for that sampling event:

- River discharge is too high for safe and effective sampling using the methods described in Step 3
- The lagoon estuary has not breached since before the start of the water year

In the first condition, flows are likely high enough to support adult steelhead migration to the Freeman Diversion anyway and upstream monitoring at the diversion will be relied upon for detecting steelhead. In the second condition, there would have been no new opportunity for adult steelhead to enter the river system. However, if discharge is low enough for safe and effective sampling and the lagoon estuary has breached at least once prior to the sampling event in that water year, then the monitoring team will proceed to Step 2 below.

Step 2

A qualified biologist would oversee all surveys. A biologist(s) will measure the water quality (DO, temperature, pH, etc.) and turbidity of each sampling location. If water quality allows for a visual survey method, then the location will be surveyed according to snorkel surveys described in Step 3. If water quality or habitat complexity does not allow for visual survey methods, then two non-visual surveys will be used including electrofishing or seining (see Step 3).

Step 3

One or more biologists will survey 25% of pool habitat and the estuary using one or more of the following methods ordered by decreasing detection efficiency (i.e., highest detection efficiency first), which generally corresponds to decreasing invasiveness. For example, electrofishing is the most efficient method proposed for detecting adult steelhead but also the most invasive method, whereas, in comparison, snorkel surveys are less invasive but also less efficient, especially in turbid environments. The most appropriate method for sampling will be determined by the survey results in Step 2.

a) Boat or backpack electrofishing surveys – boat electrofishing could be used in higher flow conditions and could cover more area with less disturbance. All fish captured during electrofishing would be enumerated, measured, sexed, PIT tagged or radiotagged. Once recovered, the fish would then be released where they were detected and incorporated into EMM-03, assuming conditions will not deteriorate soon (with regard to temperature, DO, flow recession, etc.) and there is still a functional migratory connection to Freeman Diversion or there likely would be connection soon (recent or forecasted precipitation event expected to result in increased river discharge). If conditions are expected to deteriorate soon or there is no functional migratory connection to Freeman Diversion, then the fish would be transported upstream of Freeman Diversion and released. PIT tagged fish would be used to assess kelt returns later in the year and could also be used for other studies in the watershed conducted by United or other entities (i.e., upstream migration studies in the tributaries).
b) Seining – sampling locations could be seined by hand and estuary by boat. All fish captured during seining would be treated the same way as described in electrofishing.
c) Snorkel surveys – Snorkeling is a noninvasive survey method used widely to survey for salmonids. Because snorkeling does not require an ITP, United has attempted to conduct several snorkel surveys with mixed results. The lower Santa Clara River is often turbid in the winter and can contain a lot of filamentous algae in warmer months, limiting the applicability of snorkeling. However, in the late spring when the water tends to be clearer and before the algae starts growing, snorkeling could be implemented effectively. Snorkeling would be implemented as outlined in Fish Bulletin 180. Multiple snorklers in established lanes would be used for larger sampling pools/survey areas.
d) Mobile DIDSON surveys (from a boat) – Mobile DIDSON surveys are noninvasive and have proved effective for detecting and distinguishing among fish species in California rivers (Stillwater Sciences & Wiyot Tribe 2017). The effectiveness of mobile DIDSON surveys for detecting adult steelhead in the Santa Clara River estuary and in holding pools below the Freeman Diversion will be evaluated. Anticipated challenges include distinguishing between similarly sized species (e.g., common carp and steelhead), high turbidity, and accessibility. United will explore whether morphometric traits (body size, fin placement) and swimming behavior can be used to distinguish among similarly sized species. In 2020, United initiated a pilot study to evaluate this approach.
e) eDNA analysis - Analysis of environmental DNA (eDNA) is a noninvasive survey method and an emerging tool for detecting species in aquatic environments, especially when species are rare or protected (Jerde 2019). Water samples collected in the estuary and holding pools in the Santa Clara River could be analyzed for the presence of *O. mykiss*. Using eDNA analysis will likely not

allow differentiation of age and life history strategy of *O. mykiss* but could be used to reduce uncertainty and to focus another paired survey method. These methods could be used to detect actively migrating or staging steelhead, as well as steelhead isolated in pools (see EMM-04 below). Prior to the use of eDNA as a monitoring tool, pilot studies would be needed to address eDNA uncertainties including the transfer of eDNA form upstream sources and degradation rates of eDNA in the Santa Clara River.

Presence/Absence Assignment and Data Collection for Monitoring Downstream of Freeman Diversion

If no adult steelhead are observed, then the sampling event would conclude absence of steelhead for that date and it would be assigned a "0." If adult steelhead are observed, then the sampling event would conclude that adult steelhead are "present" on that date and assigned a number according to how many adult steelhead individuals were observed (1, 2, 3, etc.).

If a sample location is assigned "present," then the steelhead observation and conditions of the pool will be communicated to NMFS within 48 hours via email.

Data Analysis

The data will be analyzed annually with a decision point under adaptive management once there are 40 adult steelhead detections **or** United has implemented EMM-02 for at least two years of each type of year (dry, medium, and wet years), whichever comes first. Survey dates will be converted to a continuous variable (day since beginning of water year) and the assigned present data will be summed for each day and the distribution plotted to test whether 95% of adults are observed under the primary migration window. Any potential distribution that captures 95 percent of the detections will be analyzed to see how detections are distributed across date and if the current primary migration period is consistent with the findings or if the prescribed season for instream flows should be adjusted under the adaptive management framework. In addition, a binomial general linear model will be applied to test potential drivers of adult presence (e.g., photoperiod, discharge, days since peak of storm, SSC, etc.).

Effectiveness Determination

Monitoring results will be discussed with NMFS to consider whether the existing migration period used to direct the timing of the proposed operations related to adult steelhead migration should remain January 1 – May 31, or whether some adjustment is warranted. The decision process will consider the number and the temporal distribution of detected upstream adult migrants (at any monitoring location) to determine whether the data support the hypothesis that 95 percent of adult steelhead migrations occur between January 1 and May 31 (the proposed primary migration window). It is recognized that the monitoring to determine the primary migration window for adult steelhead is influence by whether bypassed flows could have supported migration but for water. The analysis will include at least a qualitative assessment of these factors and may use models or apply a statistical correction for any lost opportunity to be considered through adaptive management.

There are several potential outcomes of this analysis listed below with example distributions in Figure 6-3):

- If monitoring supports the hypothesis that at least 95 percent adult upstream migrants are migrating during the window of January 1 to May 31 with reasonable effort outside of this window, then United would maintain its operational window for adult migration instream flows of January 1 to May 31 (Figure 6-4).
- If monitoring supports the alternative hypothesis that less than 95 percent of adult upstream migrants are detected during the window of January 1 to May 31, United will work with NMFS to

modify the operational window within the adaptive management framework (Section 6.5). Figure 6-5 displays one theoretical example where the window for providing adult migration flows could potentially shift to December 15 through April 30 within the adaptive management framework, recognizing there are several other potential distributions and sample sizes that may be observed.

- If all detections (100%) support a narrower migration window, then United could propose to narrow the operational window to that timeframe within the adaptive management framework. Figure 6-5 displays one theoretical example where the window for providing instream flows aimed at adult migration could potentially be narrowed to January 15 through May 25. In this outcome (narrowing of the migration window), EMM-02 would reinitiate (start over).

Figure 6-3 Example Distribution Illustrating No Change in Primary Migration Window

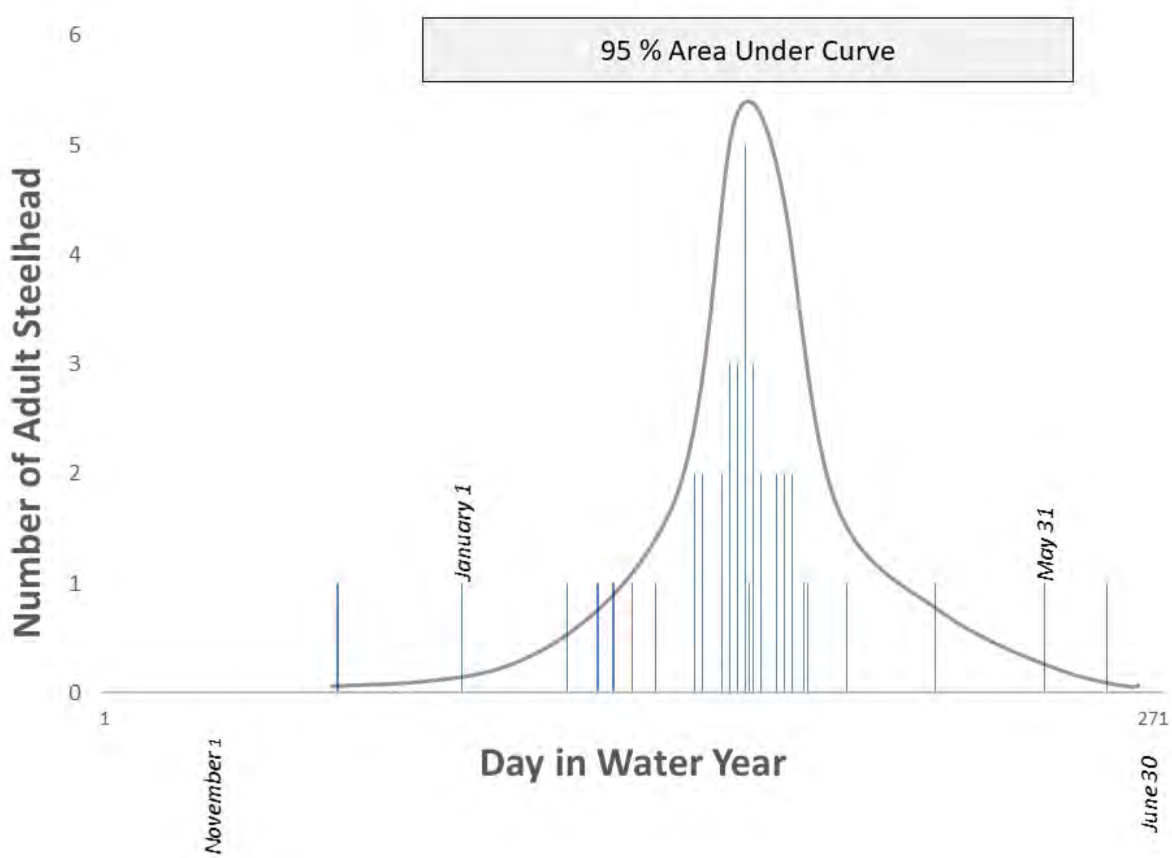


Figure 6-4 One Example Distribution to Support a Change in Timing of Instream Flows Aimed at Adult Migration

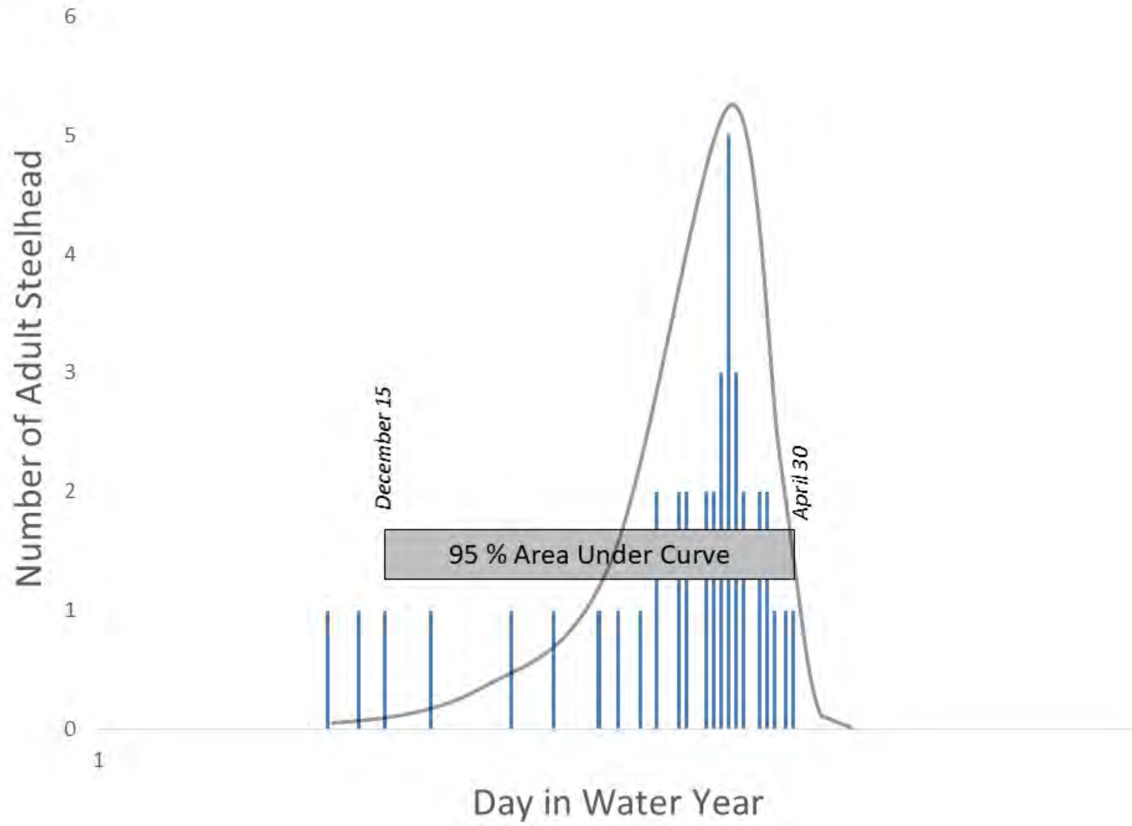
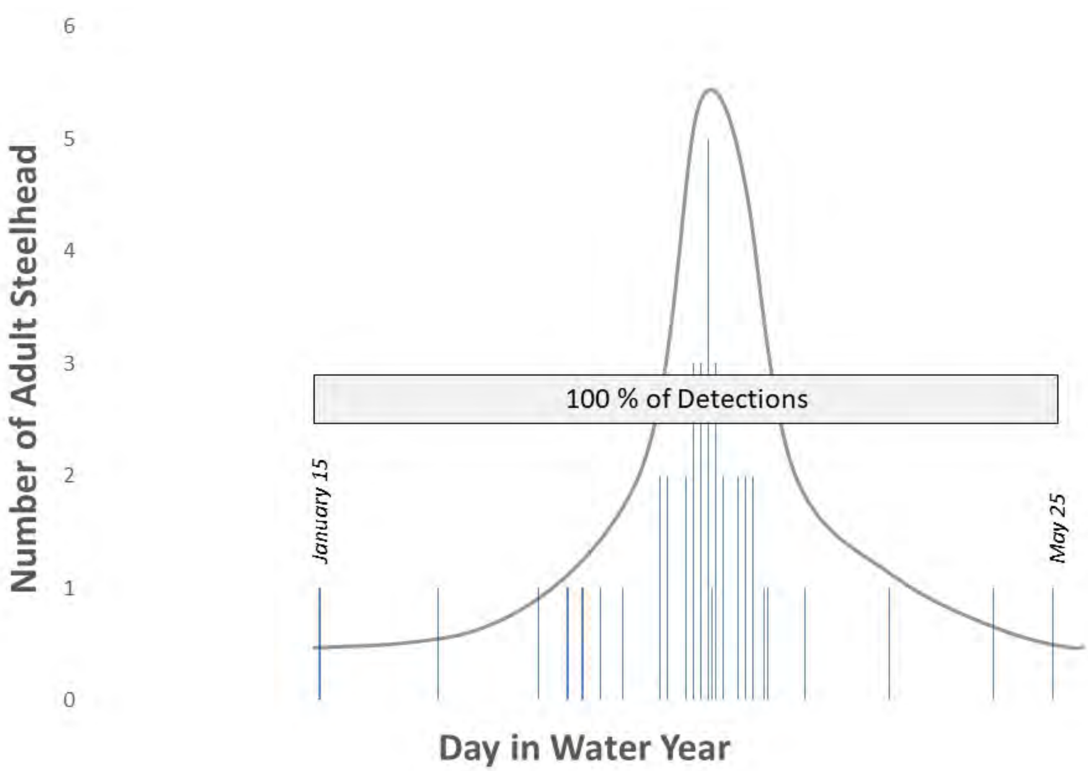


Figure 6-5 One Example Distribution to Support a Change to a Narrower Window for Adult Instream Flows



Rationale

The period of proposed operations assigned to adult steelhead migration (January 1–May 31) represents the period in which United would operate the fish passage facility and adhere to the instream flow schedules as described in CM 1.2.1 - CM 1.2.4. Instream flows may be provided outside of that window on an opportunistic basis, but diversions would be prioritized until the commitments contained in CMs 1.2.1 to 1.2.4 are triggered.

The rationale for selecting the window of proposed operations assigned to adult steelhead migration is provided in Chapter 5 (CM 1.2.1) and the effects are assessed in Chapter 7. This proposed operational window should occur when conditions suitable for migration during the period for which steelhead adults would be present and attempting to migrate. However, uncertainty exists in defining this window, especially in the context of climate change. Global climate models predict increased variability in precipitation (i.e., longer dry periods and shorter but more intense rainstorms), likelihood of flooding for any given rain event, and turbidity from more frequent wild-fire events (see Chapter 2). While these climate models do not explicitly predict a shift in the seasonality of rainfall events, the possibility exists that this will occur, which necessitates some flexibility in defining United's future operational windows. United understands the importance of defining the adult steelhead migration period in the Santa Clara River and is committed to implementing EMM-02, which will inform and allow consideration of operational adjustments within the limits of the adaptive management framework.

6.4.3 EFFECTIVENESS MONITORING MEASURE: EMM-03 – UPSTREAM MIGRATION BEHAVIOR MONITORING

United will evaluate adult steelhead migration behavior in the affected reach using radio telemetry to understand adult migration rates and habitat usage in the affected reach during a range of flows, temperatures, DO, and SSC. United will also conduct fine-scale radio tracking of tagged adults in the affected reach and in the Freeman Diversion tailrace to assess attraction efficiency and migration delay.

Uncertainties being addressed:

- What flows provide adult upstream passage through the affected reach?
- What is attraction efficiency and migration delay in the Freeman Diversion tailrace and fish ladder?

Methods

Adult steelhead will be captured either downstream of the Freeman Diversion using electrofishing or seining of adults (see EMM-02) will be collected from the fish ladder, which would require installation of a trap within or at the exit to the fish ladder. Adults will be tagged (either external radio, surgical internal, or PIT – to be determined based on consultations with NMFS and CDFW). Tagging, whether surgical, injection, or external tags, will be conducted by a qualified biologist and will follow standard protocols for the given method. Scale and fin tissue samples would be collected for age and genetic analysis, respectively. Tagged adults will be released downstream of the Freeman Diversion in a suitable holding pool (for fish collected from the fish ladder) or at the capture site (for fish captured downstream) after fish are allowed to recover. After release, movements of radio tagged fish will be monitored using fixed radio detection sites at strategic locations including:

- Downstream and upstream of the critical riffle (to assess passage),
- Downstream of the Freeman Diversion (to detect arrival at the Freeman Diversion and migration rate),

- The Freeman Diversion tailrace – e.g., one antenna at the fish ladder entrance and one antenna positioned to detect fish holding downstream (to detect attraction efficiency and delay)
- Within the fish ladder immediately downstream of the fish counting system
- The fish ladder exit (to determine passage efficiency and timing)

Additional manual tracking within the upstream mainstem and the tributaries (Santa Paula, Sespe, and Piru creeks) would be conducted bi-weekly following passage of radio tagged adults at the Freeman Diversion, but United would also explore locations for deployment of additional fixed detection sites within tributaries.

Effectiveness Evaluation

It is not expected that large sample sizes will be achievable for this EMM due to limited numbers of adult steelhead. However, even information collected from a few migrating adults will be informative for evaluating the effectiveness of CMs. A target sample size of five adult steelhead over the first 5 years of the permit term will be used to evaluate effectiveness based on the following thresholds:

- Upstream passage at critical riffle is provided at flows of 120 cfs
- Average delay in the tailrace < 6 hours
- Adult passage efficiency (APE) target at the Freeman Diversion is > 95%
- The infrastructure does not result in fallback

Data Analysis

Observed APE will be compared to the 95% APE target using a Bayesian approach to infer posterior probability distributions (posteriors) for observed APE. The posteriors are the source of Bayesian Credible Intervals (BCIs, aka Highest Density Intervals or HDIs), and form the basis of comparisons between observed APE and targets by inferring precision of posterior estimates based on 95% HDIs. After generating a 95% HDI, testing a hypothesis regarding threshold targets (i.e., comparing observed APE to target APE) at 5% alpha rate simply amounts to comparing the target value to the HDI range, and determining if the target falls within the HDI.

Evaluation of thresholds would result in the following outcomes:

- Effectiveness thresholds achieved – no action taken
- Critical riffle passage not provided at 120 cfs – increase river discharge to 160 cfs and re-evaluate with monitoring
- Tailrace delay > 6 hrs on average – increase attraction flows and re-evaluate with monitoring
- Adult passage efficiency <95% – increase attraction flows and re-evaluate with monitoring.
- If it is determined that reduced passage efficiency or tailrace delay is a result of fallback at the false weir, an alternative monitoring approach for upstream migration will be agreed to in consultation with NMFS.

Rationale

United recognizes that providing a functioning, freshwater migration corridor in the lower Santa Clara River is a critical element in conservation of southern California steelhead, and has developed specific CMs directed toward providing such a migration corridor. Adult steelhead migration is well-studied in the central and northern portion of the species range, where streams are characterized by perennial flows. Under these conditions, fish migration success is not often limited by water depth and velocity through critical riffles. Unlike northern streams, many of the regulated coastal rivers of the southern region are shallow, wide, and sandy, with intermittent sections depending on flow creating substantially different challenges for upstream migrating fish.

The limited historical research and monitoring of undisturbed steelhead populations forms a major challenge to understanding adult migratory behavior in the southern California steelhead DPS, a population in which unimpaired, "Core 1" populations do not exist currently. This situation makes it difficult to assess historical natural rates of migration in this region. Although assessments performed under impaired conditions may be unable to determine whether overall migration speed and behavior are degraded compared to natural rates, they can provide insights as to what components of the current system may restrict migration. Developing a basic understanding of how migration works under current conditions can better inform United's instream flow commitments and operational scenarios, as well as direct restoration and management efforts toward strategies that improve migration success.

United's proposed operations under CMs 1.2.2 and 1.2.4 specify a range of flows for maintaining migratory connectivity in and downstream of the critical reach and aims for greater than 160 cfs, which is estimated to provide more than sufficient passage conditions for adult steelhead at the critical riffle with sufficient passage estimated around 120 cfs. EMM – 03 evaluates this assumption by monitoring the movements of individual adults downstream of the Freeman Diversion under a variety of flows (above and below 120 cfs). The results obtained via EMM-03 will provide information useful for assessing the effectiveness of instream flow and timing of trapping protocols. The results obtained via EMM-03 will also expand the knowledge base relevant to protection, mitigation, and recovery actions beneficial to the southern California steelhead DPS.

In addition to the importance of instream flows supporting upstream migration in the affected reach, United recognizes the importance of providing safe and timely passage of upstream migrants at the Freeman Diversion. CM 1.1.1 describes how the Freeman Diversion will be designed and operated to maximize passage success while maintaining United's ability to fulfill their mission and purpose regarding water resources. Despite optimizing design and operation of the Freeman Diversion for upstream migration, it is important to evaluate the effectiveness of the passage system including the effectiveness of attraction flows for directing fish towards the fish ladder entrance and the efficiency and timing of adult passage through the fish ladder. EMM-03 will provide information on the behavior and timing of upstream migrating adults at the Freeman Diversion.

6.4.4 EFFECTIVENESS MONITORING MEASURE: EMM-04 – DOWNSTREAM PRIMARY MIGRATION PERIOD

United will evaluate the primary steelhead smolt migration period for the Santa Clara River basin. The working hypothesis for this EMM is that the current proposed "primary migration season" (March 15—May 31) provides adequate instream flows to approximate unimpeded migration for at least 95 percent of all steelhead smolts that migrate or attempt to migrate in the Santa Clara River with approximately 5 percent more smolts that will be transported to the estuary through CM 1.2.5 at low flows. To facilitate better data collection and analysis for this EMM, United will conduct a study to estimate trap efficiency of the downstream migrant trap under various flow conditions allowing for a statistical correction factor for trap efficiency.

Uncertainties being addressed:

- 95% of smolts migrate from March 15 – May 31.

Methods

Trap Efficiency Studies

An estimate of trap efficiency is needed to provide a correction factor for the total number of smolts moving downstream relative to the number of smolts detected in the fish trap per effort prior to data analysis for this EMM. To estimate trap efficiency, up to 500 smolts will be injected with PIT tags. Trapping, tagging, and sample collection will be overseen by a qualified biologist. Any trapped *O. mykiss* will be scanned for a PIT tag to make sure the fish is not already tagged and to record any *O. mykiss* that may have been tagged upstream of Freeman Diversion. If smolts are trapped that already have tags, then they will count toward the 500 and be incorporated into the trap efficiency study. Once their tag is scanned and recorded, the fish will be placed in the bypass and returned to the river. Standard operating procedures and best management practices will be followed for the selected technology. Only fish greater than 120 mm length will be tagged to reduce tag burden. PIT tags (12 mm) with unique individual codes will be injected allowing tracking of individual fish. After tag implantation, each fish will be placed in an aerated cooler at ambient river temperature to allow the fish to fully recover and ensure normal behavior (e.g., gills functioning, swimming upright) before they are released up to 30 yards upstream of the facility at night or near adequate cover to hide from predators.

Again, any trapped *O. mykiss* will be scanned for a PIT tag to also detect recaptures. If the fish is a recapture, then it will be released back to the river through the bypass pipe and may be incorporated into further downstream studies or may be transported to the estuary if flows are anticipated to be below 80 cfs in the next 5 days and the smolt is not needed for further study. Flow data will be collected continually at the Freeman Diversion and paired with smolt trapping and detection data to understand how flow influences downstream fish movements and trap efficiency. The proportion of tagged fish released upstream that are recaptured in the trap facility will be used to estimate trap efficiency and to correct total estimates of downstream moving smolts that will then be used to evaluate the SMP window.

As stated in EMM-02, A PIT antenna will also be installed in the fish ladder aimed at detecting upstream migrants, but it will also be evaluated for downstream moving fish to see if any smolts move downstream through the fish ladder and, if so, what is the proportion.

Fish Trapping Facility Monitoring

The new trapping and evaluation station will be used to monitor for steelhead smolts from January 1 through June 30. This monitoring will provide direct information regarding the timing and numbers of steelhead smolts and juveniles migrating downstream during these periods. Daily monitoring will occur whenever water is directed through the diversion or AWS bypasses (see CM 1.1.1 for flow splits and prioritization). Smolts will be trapped at the Freeman Diversion in an integrated downstream migrant fish trap. The trap will be operated and checked at least twice daily at approximately 12-hour intervals (+/- 1 hour or 11 to 13 hours after the previous trap check). For each *O. mykiss* detected in the trap, length and weight measurements will be taken and a caudal fin clip and scale sample will be taken for genetic and age analysis, respectively. Fish that exhibit at least some smolt characteristics (e.g., increased skin reflectance, larger heads, slimmer bodies, longer caudal peduncle, loss of parr marks, and darker margin of the dorsal fin) will be considered actively emigrating smolts and assigned presence/absence data for each day of trapping as follows. Any day where the fish trap was running and no steelhead smolts were observed will be assigned "absent" and a "0" recorded in the database and any day where the fish trap was running and steelhead smolts are detected will be assigned "present" and a number based on the number of individuals observed (1, 2, 3, etc.) would be recorded in the database. A correction factor will then be applied if needed based on the trap efficiency studies (see above).

Data Analysis

The data will be analyzed annually with a decision point under adaptive management at 5 years. Survey dates will be converted to a continuous variable (day since beginning of water year) and the assigned presence data will be summed for each day, corrected based on trap efficiency estimates, and the distribution plotted. Any potential distribution that captures 95 percent of the detections will be analyzed to see how detections are distributed across date and if the current primary migration period is consistent with the findings or if the prescribed season for instream flows should be adjusted under the adaptive management framework.

Effectiveness Determination

The fish trap monitoring component of EMM-04 will be conducted for at least 5 years. At the end of five years, the full data set collected will be analyzed and a decision made under the Adaptive Management framework as to whether the existing migration period applied by United for operations related to smolt migration (SMP) should remain March 15 to May 31, or whether some adjustment is warranted. The decision process will consider the temporal distribution of smolts arriving at the Freeman Diversion and/or detected at PIT tag readers and determine if the evidence supports the hypothesis that > 95 percent of smolt emigrations occur between March 15 and May 31. Possible outcomes include the following:

- If monitoring supports the hypothesis that 95 percent of downstream migrants are arriving at the Freeman Diversion from March 15 to May 31, then United would maintain its operational window of March 15 to May 31 for the SMP.
- If monitoring supports the alternative hypothesis that less than 95 percent of downstream migrants are migrating from March 15 to May 31, then United would work with NMFS to shift or expand the operational window within the adaptive management framework.
- If 100 percent of at least 300 steelhead smolts arrive in a narrower window of time between March 15 and May 31 across at least 5 years, then United would narrow the migration window to that timeframe within the adaptive management framework and EMM-04 would reinitiate for another 5 years but without the trapping efficiency study.

Rationale

United has proposed providing instream flows aimed at supporting smolt migration between March 15 and May 31 (CM 1.2.2 or 1.2.4). Outside of that period, United does not provide instream flows under the SMP, but other instream slows are provided under CMs 1.2.1 or 1.2.3 aimed at adult upstream migration when trigger criteria are met January 1 through May 31.

United has carefully considered data collected since the Freeman Diversion was built in 1991, and data collected to date support the March 15 through May 31 steelhead smolt migration period and United believes it realistically captures the major timeframe (>95 percent of smolts) during which downstream migration occurs (Booth 2016).

United understands the importance of defining the full extent of the steelhead smolt migration period, especially considering climate change and its effects on the Santa Clara River, as discussed in EMM-02. United is committed to implementing EMM-04 as a means to inform and adjust its operations under the adaptive management framework and to expand the base of information useful for the protection, mitigation, and recovery actions that benefit the DPS overall.

6.4.5 EFFECTIVENESS MONITORING MEASURE: EMM-05 STEELHEAD SMOLT PASSAGE THROUGH THE FACILITY

United will evaluate downstream migration timing and pathways of downstream migrants at the Freeman Diversion using radio telemetry under varying flows. The working hypothesis for this EMM is that downstream-migrating smolts can pass through the Freeman Diversion in a safe and timely manner under the operational framework proposed in CM 1.1.1.

Uncertainties being addressed:

- Smolts pass the Freeman Diversion in a safe and timely manner.

Methods

O. mykiss will be collected, processed, tagged, and released following similar tagging protocols discussed in EMM-04 except the use of surgically implanted radio tags will be used for EMM-05 instead of PIT tags. Up to 200 smolts will be tagged with radio transmitters. The radio tag sample size of 200 is based on a power analysis that supported a sample size of 100 (West 2010) and United factored in up to 100 more to account for potential tag failure or loss. Technology improvements at the time of permitting may decrease the number of tagged smolts needed to achieve equivalent statistical power. Radio tags will be surgically implanted and have unique frequencies allowing tracking of individual fish. The ratio of tag weight to steelhead weight in the air will be less than five percent to minimize physiological stress and ensure swimming performance will not be altered. Tagging and sample collection will be conducted by a qualified biologist. Standard operating procedures and best management practices will be followed for the selected technology. After tag implantation, each fish will be placed in an aerated cooler at ambient river temperature to allow the fish to fully recover and ensure normal behavior (e.g., gills functioning, swimming upright) before they are released upstream of the facility at night or near adequate cover to hide from predators.

After release, 5 or more fixed standard receiver-data-loggers (ATS R4500S or similar) will be used to monitor radio tagged smolts passage routes at the Freeman Diversion. Radio antennas can be deployed strategically to monitor different downstream migrant pathways at the Freeman Diversion, including 1) through the fish ladder; 2) through the screened fish bypasses (diversion and AWS); 3) through the bypass channel; 4) over the crest gates; and 5) over the diversion crest. Data will simultaneously be collected on flows and Freeman Diversion operations to relate to passage routes, timing of fish movements, and passage rates. Data collected from individual radio tagged fish may also be used to inform trap efficiency estimates (EMM-04) and the effects of flow on downstream migration in the affected reach (EMM-05).

Effectiveness Determination

EMM-05 will continue until United achieves 200 radio tagged individuals unless NMFS and United agree to curtail EMM-05 (e.g., if sample sizes cannot be met given sufficient effort or at NMFS discretion). Monitoring results will be summarized in annual reports with a full analysis at the end of the monitoring period. The information collected with this EMM will directly inform the adaptive management process, particularly uncertainties regarding downstream migration passage routes and timing and the effects of flow and operations of the Freeman Diversion. There are a variety of potential outcomes of this EMM that may include alterations to the operation of the Freeman Diversion, alterations to estimated trapping efficiency, or development of additional EMMs under the adaptive management framework. Preliminary results and data trend analysis will be discussed with the Services.

There are two main potential outcomes of this analysis:

- Monitoring results indicate that downstream-migrating smolts are passing the Freeman Diversion in a safe and timely manner under different operations and flows. In this case, the EMM would be discontinued and CM 1.1.1 would not be modified.
- Monitoring results indicate migration delay or injury in the facility. In this case, United would discuss options to adjust flow split priority orders or make physical adjustments to minimize delay and injury under the adaptive management framework.

Rationale

United recognizes the importance of providing safe and timely passage of downstream migrants at the Freeman Diversion. CM 1.1.1 describes how the Freeman Diversion will be designed and operated to maximize passage success while maintaining United's ability to fulfill their mission and purpose about water resources. Despite optimizing design and operation of the Freeman Diversion for downstream migration, it is important to evaluate the effectiveness of the passage system including the effectiveness of the bypasses for directing fish into the fish trap and how flow influences interactions and pathways smolts use to pass the Freeman Diversion.

Downstream migrants will have five potential routes through the Freeman Diversion, but only one pathway has been monitored in the past at the current facility (the downstream migrant trap in the diversion bypass). The potential pathways in the new facility include 1) through the fish ladder 2) through the screened fish bypasses (diversion and AWS); 3) through the bypass channel; 4) over the crest gates; and 5) over the diversion crest. Both screened fish bypasses have the option to engage a downstream trap. During low-flow years, nearly all flow will travel through the downstream migrant trap at the evaluation station, which likely allows for accurate estimates of downstream migrants. But during high flows, it is unknown what routes smolts use to pass the Freeman Diversion. Furthermore, it is unknown how Freeman Diversion operations, such as sediment sluicing affects smolt behavior and survival when they pass through the Freeman Diversion.

6.4.6 EFFECTIVENESS MONITORING MEASURE: EMM-06 - SMOLT MIGRATION WITHIN THE AFFECTED REACH

United will evaluate steelhead smolt migration behavior in the affected reach (Figure 6-2) to understand smolt migration rates and habitat usage in the affected reach during a range of flows, temperatures, DO, and SSC. United will conduct fine-scale tracking of individual smolt movement at the Freeman Diversion and in the affected reach using radio telemetry.

Uncertainties being addressed:

- 80 cfs is the lower limit for successful smolt downstream passage at the critical riffle

Methods

Fish will be collected, processed, tagged, and released as soon as possible following protocols discussed in EMM-04. After release, three or more fixed (ATS R4500S or similar) standard receiver-data-loggers will be used to monitor movements of radio tagged fish between the Freeman Diversion and the estuary. A mobile receiver will be used daily to document smolt presence or absence in all wetted habitat between the fixed receivers as well as in the estuary (if salinity levels are low enough for effective radio telemetry). All smolt identification and location data (GPS) collected during mobile tracking will be incorporated into a GIS database for further analysis. Every reasonable effort will be made to determine the final location of each radio-tagged smolt and whether mortality has occurred. The cause of mortality will be determined, if possible.

Flow data will be collected continually at the Freeman Diversion. Additional manual flow measurements will be collected frequently as part of the compliance monitoring program and EMM-01. If additional manual flow measurements are warranted for EMM-04, they will be collected using standard USGS methods. Smolt behavior will be monitored at a range of variable flows through the critical reach.

United will release tagged smolts across a wide variety of flows while implementing the instream flow plans outlined in CMs 1.2.1-1.2.4. Experimental flow releases at discharges <80 cfs may be conducted to evaluate whether flows of less than 80 cfs provide conditions suitable for successful downstream migration or use of downstream holding/rearing habitat in between storm events or over summer, respectively. United will develop a detailed experimental flow release plan in consultation with the Services, which may temporarily supersede the release schedules outlined in CMs 1.2.1 through 1.2.4. If it is obvious that a given flow rate is inadequate for fish passage or results in stranding, United will discontinue releases of flows equal to or less than the minimum flow where passage problems are observed and default to rescue and relocation protocols at Freeman Diversion to transfer downstream moving *O. mykiss* to the estuary or other habitat directed by NMFS. Water temperature will be recorded continuously at the receiver location sites below the Freeman Diversion as well as within the fish trap.

EMM-06 will be used to evaluate downstream migrant behavior and habitat usage, with special focus on migration rate, habitat features that limit or delay migration, the use of holding/rearing habitat, and probability of survival in the lower river and estuary. The following analyses will directly inform other EMMs and feed into the adaptive management process of the HCP:

- Smolt migration rates at different discharges
- Fish movement at different water quality variables (temperature, SSC, etc.)
- Migration variability among individuals
- Mortality, stranding, neutral movement locations (areas of holding/rearing and any associated mortality)
- Migration rate versus size, age, and degree of smolting characteristics
- Smolt survival in different areas of the lower river and estuary

The timing of this EMM would be however long it takes to trap and tag up 200 smolts across the flows of interest, estimating between 5-10 years.

Data analysis will include general linear modeling or general linear mixed effects modeling where tested independent variables tested in the model would be photoperiod, discharge at Freeman Diversion, discharge downstream of the critical riffle, temperature, SSC, and any other identified variable of interest tested against a binary dependent variable (successful passage through the critical reach assigned 1 for passage and 0 for failure to pass). An information criterion such as AIC will be used for model selection to determine the best fit and most parsimonious model that explains successful passage of smolts through the critical riffle.

Effectiveness Determination

EMM-06 will continue until there are 200 tagged individuals. Monitoring results will be summarized in annual reports with a full analysis at the end of the monitoring period. The information collected with this EMM will directly inform the adaptive management process, particularly uncertainties regarding downstream migration behavior and habitat suitability and usage. There are a variety of potential outcomes of this EMM that may include alterations to the instream flow plans, alterations to trapping and relocation of smolts under CM 1.2.5, or development of additional EMMs. Preliminary results and data trend analysis will be discussed with the Services.

There are several potential outcomes of this analysis, including:

- Monitoring results indicate that downstream-migrating smolts successfully pass into the estuary during channel conditions (width, depth, temperature) associated with discharge rates of 120 cfs or more, downstream of the critical reach provided by instream flow operations (CMs 1.2.2 and 1.2.4), and that smolts experience longer migration rates (delay), stranding, and/or higher predation rates during discharge rates less than 80 cfs downstream of the critical reach. If this is the case, the EMM would be discontinued and CMs 1.2.2, 1.2.4, and 1.2.5 would not be modified.
- Monitoring results indicate that downstream-migrating smolts do not successfully pass into the estuary with the channel conditions (width, depth, temperature) provided by instream flow operations (CMs 1.2.2 or 1.2.4). Utilizing the gathered dataset and in consultation with the Services, United will identify the likely cause(s) of unsuccessful out-migration and propose operational adjustments for improving out-migration success, consistent with the adaptive management framework. For example, United could increase the target width and depth criteria (CM 1.2.2 or CM 1.2.4) or adjust the trigger for the downstream migrant trap and relocate conservation measure (CM 1.2.5).
- Monitoring results indicate that downstream-migrating smolts successfully pass into the estuary at channel conditions (width, depth, temperature) significantly less than under conditions provided by instream flow operations (CMs 1.2.2 and 1.2.4). Utilizing the gathered dataset and in consultation with the Services, United could propose to decrease the target width and depth criteria.
- Monitoring results indicate that substantial numbers of smolts stop or "hold" at specific habitat features within the affected reach, but do not experience mortality. At this point, in consultation with the Services, United will develop additional EMMs to assess potential causes for the holding behavior and the potential for the affected reach to provide habitat functions other than being a migration corridor (i.e., rearing habitat).

Rationale

United recognizes that providing a functioning, freshwater migration corridor in the lower Santa Clara River is a critical element in conservation of southern California steelhead, and has developed specific CMs directed toward providing such a migration corridor. Maximizing the proportion of successful migrating smolts to the extent practicable is essential to providing adult steelhead returns. In much of the southern California population, adult steelhead returns are currently minimal or non-existent, which feeds back to reduced smolt production and a reliance on resident trout to maintain the anadromous life history strategy. Understanding what factors will maximize smolt to adult return ratios, given the potentially fewer anadromous offspring produced by resident trout, is a critical step for recovering steelhead populations in watersheds in the southern California steelhead population.

Steelhead smolt migration is well-studied in the central and northern portion of the species range, where streams are characterized by well-vegetated riparian corridors, relatively narrow, rocky channels, and cool water temperatures. Under these conditions, fish migration success is not often limited by water depth and velocity through critical riffles. Unlike northern streams, many of the regulated coastal rivers of the southern region are shallow, wide, and sandy, with minimal riparian canopy and seasonally high water temperatures, creating substantially different challenges for downstream migrating fish. In the affected reach of the Santa Clara River, steelhead smolts migrating downstream face numerous obstacles such as intermittent flows, shallow water, lack of cover, and high water temperatures.

Limited historical research and monitoring of undisturbed steelhead populations forms a major challenge to understanding smolt migratory behavior in the southern California steelhead DPS, a population in which unimpaired, "Core 1" populations do not exist currently. This situation makes it difficult to assess historical natural rates of migration in this region. Although assessments performed under impaired conditions may be unable to determine whether overall migration speed and behavior are degraded compared to natural rates, they can provide insights as to what components of the current system may restrict migration. Developing a basic understanding of how migration works under current conditions can better inform United's instream flow commitments and operational scenarios, as well as direct restoration and management efforts toward strategies that improve migration success.

United's proposed operations under CM 1.2.4 specify a range of flows for maintaining migratory connectivity in and downstream of the critical reach and aims for at least 120 cfs, with a lower threshold of ≥ 80 cfs. The lower flow (80 cfs) is assumed to be, and United's preliminary data support, the point where functional migratory connectivity for smolts is lost in the critical reach. Thus, as flows continue to recede below 80 cfs, both naturally and from United's operations, the probability of smolt stranding and isolation in pools increases and may result in increased smolt mortality. To prevent this, United's proposed operations (CM 1.2.2) include a conservation measure (CM 1.2.5) designed to trap all steelhead smolts (and Pacific lamprey macropthalmia) as effectively and safely as possible at the Freeman Diversion when flows at the critical riffle are predicted to recede below 80 cfs. United would relocate the smolts in a perennial segment of the lower Santa Clara River that maintains connectivity with the estuary or other location at the direction of NMFS. However, CM 1.2.5 triggering assumes that flows ≥ 80 cfs are sufficient to maintain riverine – estuary connectivity and therefore are suitable for the passage of smolts migrating downstream. EMM – 06 evaluates that assumption by monitoring the movements of individual smolts downstream of the Freeman Diversion under a wide variety of flows (above and below 80 cfs) and water quality conditions, particularly temperature. The results obtained via EMM-06 will provide information useful for assessing the effectiveness of instream flow and timing of trapping protocols. The results obtained via EMM-06 will also expand the knowledge base relevant to protection, mitigation, and recovery actions beneficial to the southern California steelhead DPS.

6.4.7 EFFECTIVENESS MONTORING MEASURE: EMM-07 – STRANDING POTENTIAL UNDER PROJECT OPERATIONS

United will evaluate the results of the ramp-down procedures in CMs 1.2.1 and 1.2.2, including potential for stranding covered species in the critical reach. This evaluation will be based on observation of dewatered areas of the critical reach during ramp-down procedures.

Uncertainties being addressed:

- Does ramp-down procedure cause stranding of covered fish and/or pond turtles?

Methods

EMM-07 triggers when a three-day ramp down period initiates under any of the various instream flow protocols. During these three days, United decreases instream flows by one-third per day. The intent of the one-third daily ramp down period is to gradually reduce instream flows such that any covered fish moving through the critical reach are not stranded in dewatered habitats or pools that become inhospitable (e.g., no cover with temperature rising and/or dissolved oxygen falling beyond suitable habitat limitations).

EMM-07 specifies once the transition to the one-third daily flow reduction process has begun, United will perform daily monitoring surveys along the critical reach throughout the three-day ramp-down process and one additional day after ramp down. The first survey will be conducted the day of the initial flow reduction; then two surveys will be conducted on each of the following two days (i.e., surveys will be conducted on the days that flows are transitioning to two-thirds, one-third, and zero). Finally, a fourth day of surveys will occur after the ramp down is complete. The surveys will be completed while travelling downstream through the critical reach; they will focus on inspecting the channel visually for the occurrence of any stranded covered fish or covered fish that may strand soon. Surveyors will also document any occurrence of pond turtles in areas that go dry soon. If pond turtles are observed in such areas, they will be relocated according to CM 2.1.4.

Any stranded fish will be identified by species, photographed if possible, and its location (GPS coordinates) recorded. Ancillary measurements of water temperature and dissolved oxygen will be measured. If any of the fish are thought to be covered species in habitats that will become unsuitable, United will immediately initiate rescue and relocation (CM 2.1.4). If covered species are detected in suitable lentic habitats, then they will be left undisturbed and United will monitor the temperature and dissolved oxygen with loggers checked weekly. If conditions deteriorate beyond suitable conditions, United will initiate rescue and relocation (CM 2.1.4).

Effectiveness Determination

EMM-07 has a minimum five-year monitoring period. The results of each year's monitoring will be presented in the annual report for that year. At the end of the five-year period, the full data set collected and analyzed will be reviewed and a decision made, in consultation with the Services, as to whether United's operations related to the one-third daily flow reduction are effective and do not result in excessive stranding of covered species. EMM-07 may also provide useful information for addressing uncertainties related to this measure. There are several potential outcomes of this analysis:

- If monitoring indicates no observed stranding occurs or trapping was not necessary over the five-year period, then EMM-07 will be curtailed and United will continue operations according to the conservation program. If a substantial increase of population size for covered species is observed during the life of the ITP (increasing the probability that some individuals will be stranded), United may reinitiate EMM-04 in consultation with the Services.
- If monitoring indicates that stranding of steelhead juveniles/smolts occurs during implementation of CM 1.2.2 and the one-third daily flow ramp-down procedure, then United could propose to adjust the initiation trigger of CM 1.2.5. Effectiveness monitoring would continue for one more year to evaluate the effectiveness of the approach, at which time EMM-07 would be curtailed if no stranding occurred or would continue if stranding were observed and trapping necessary. If stranding continues, United will make further adjustments to the trapping and relocation schedule and will continue with EMM-07 .
- If monitoring indicates that stranding of steelhead adults occurs during the one-third daily flow ramp-down period while implementing CM 1.2.1 or 1.2.2, United can propose adjustments to the flow ramp down rate and schedule in consultation with the Services and within the adaptive management framework.

Rationale

Storms dictate the migration flows in the Santa Clara River, the effects of which a wide range of conditions that can create short-duration, high-magnitude increases in flows with abrupt decline. One aspect of United's instream flow commitments (CMs 1.2.1 through 1.2.4) is to facilitate the gradual reduction of the remaining flows as flows cease. Operational protocols specify that once flows at the critical riffle cannot be maintained at 120 or 80 cfs (depending upon time of year and minus the 40 cfs critical diversion), United will gradually reduce the available flows by one-third each day over a three-day period until instream flows cease.

The three-day flow reduction process affords enough time for covered species to move into potential holding habitat, or for smolts/juveniles to move downstream out of the critical reach as the flows recede. However, there is concern that some steelhead (or other covered species) could be stranded in depression areas or perennial pools in the channel. Stranding fish in this way would result in direct mortality due to isolation in small depressions or potholes (in the worst case) in the channel plan-form that may be susceptible to dewatering and/or develop inhospitable water quality conditions over time. Fish stranded in these areas are more vulnerable to predation. Trapping may be required on a broader scale relative to isolation of the species in pools and short segments of river as flows decrease and surface connectivity is lost.

EMM-07 is designed to evaluate the potential for the step-down process in flow reduction that marks the cessation of flows into the critical reach to result in stranding of covered species. This EMM will monitor the proposed process involving one-third daily flow reductions, and depending on results, refinements may be made to better protect covered species. The results obtained via EMM-07 will also expand the overall knowledge base relevant to protection, mitigation, and recovery actions beneficial to the southern California steelhead DPS.

6.4.8 EFFECTIVENESS MONITORING MEASURE: EMM-08 – SUSPENDED SEDIMENT RELATIONSHIP WITH COVERED FISH MOVEMENT

United will evaluate correlations between migration of adult steelhead and lamprey and concentrations of suspended sediment in the Santa Clara River. The uncertainty of these effects will be evaluated by measuring the SSC at the Freeman Diversion through automated continuous monitoring, grab sampling at river transects, and collection of additional grab samples for verification and calibration purposes.

Methods

United routinely monitors SSC at the Freeman Diversion and has observed that no upstream-migrant steelhead are documented during times of elevated SSC. United seeks to collect additional information to better determine the upper SSC range in which steelhead and lamprey are likely to actively swim upstream or move downstream in the Santa Clara River. Monitoring for EMM-08 will consist of the following components:

- Continuous monitoring of SSC concentrations at the Freeman Diversion headworks using a turbidity sensor, with site-specific calibrations to translate the raw optical signal to SSC
- Collection of grab samples from within the Freeman Diversion facility and the river channel near the diversion as needed to verify the continuous monitoring results, and when samples are needed during turn-out, as the suspended sediment sensor may underestimate SSC at that time because the sensor would be placed behind the trash rack
- Sampling of sediment to determine lateral SSC gradients at several transects in the affected reach
  - Samples collected during at least three events when SSC concentrations are expected to range between 500 and 3,000 mg/l
  - At least three transects measured and sampled, as variable channel geometries may affect SSC gradients (e.g., one straight channel with uniform depth, one location with shallow water near the bank, one location with vegetation near the bank)
  - Turbidity measurements taken with a hand-held probe at high frequency, at least 10 measurements per transect (e.g., every 6 inches from bank to 2 feet out, and then six more measurements to mid-channel or maximum wading depth)
  - Additional grab samples collected for laboratory analysis from the location closest to the bank and from two additional locations from each transect during the first sampling event to confirm a correlation between turbidity and SSC measurements (if a good correlation cannot be established, SSC samples will be collected during two additional sampling events)
- Radio and/or PIT telemetry studies to monitor movements of juvenile steelhead relative to flow and SSC.

The sampling conducted as part of EMM-08 is intended to address the following questions:

- Do lateral SSC gradients exist in the Santa Clara River? If so, can they provide a possible migration route even when high SSC may inhibit fish migration through mid-channel?
  - This will be determined by analyzing lateral SSC profiles in the Santa Clara River across a range of stream morphologies and stream flows (see Appendix E for more context).
- Does high SSC reduce or inhibit fish migration? If so, what is the highest SSC observed during adult passage through the fish ladder?
  - This will be determined by comparing migration monitoring data from EMM-02 with SSC concentrations, considering the potential confounding effects of varied flow velocities, hydrological conditions, and steelhead population size. Because field observations will be used instead of controlled lab experiments, it may be difficult to identify multiple effective concentrations defining the exposure-response curve. Therefore, the primary metric of interest will be the 100 percent effective concentration (EC_{100}) (i.e., the SSC exposure concentration at which no adult or juvenile steelhead movement is observed). This analysis can only occur if enough adult upstream migrants have been observed (e.g., at least 20 detections at a range of sediment concentrations).
- Is the fish passage facility operational when SSC is conducive to steelhead and lamprey movement?
  - This will be determined by analyzing SSC concentrations obtained by the sensor and grab samples just before initiating operation of the upstream fish passage facility. SSC concentrations at the initiation of the upstream fish passage facility are anticipated to be higher than the EC_{100} (see CM 1.1.1 in Chapter 5).

Effectiveness Determination

SSC monitoring at the Freeman Diversion is needed as part of United's diversion operations and will be conducted for the life of the ITP. SSC monitoring to determine lateral concentration gradient is expected to be completed within one to two years of monitoring. The results of each year's monitoring, as related to the three monitoring questions above, will be presented in the annual reports. At the end of the first five years of monitoring, the full dataset collected and analyzed will be reviewed and a decision made, in consultation with the Services. Reporting will only continue after the first five years if there are any outstanding questions. Several potential outcomes from this analysis include:

- SSC is not at levels associated with steelhead migration inhibition near the river margins for all stream morphologies (e.g., due to low velocities), but SSC concentrations in the river channel are at levels that may inhibit steelhead migration. United will incorporate these "edge effects" when analyzing the inhibitory effects of SSC on fish migration.

- No consistent pattern of lower SSC concentrations exists near the margins for all stream morphologies. Grab samples and continuous monitoring at the Freeman Diversion headworks are adequate for determining exposure of steelhead to SSC downstream.

- SSC observed when river flows are within the operational range of the fish passage facility prevent adult steelhead migration (i.e., EC_{100} occurs at river flows < 6,000 cfs). United will investigate changes to the fish ladder operations schedule and proposed operations. If reduced instream flows are proposed at higher river flows (e.g., > 500 cfs), United will aim to provide more instream flows at lower river flow, with the goal of being yield-neutral, but with net benefits to steelhead migration. Any adjustments to fish ladder operations schedule and proposed instream flow operations will occur in consultation with the Services and within the adaptive management framework.

- The fish passage facility is operational when SSC is conducive to fish migration. No changes are required to fish ladder operation.
- The fish passage facility is not always operational when SSC concentrations are conducive to fish migration. United will identify the window during which the fish ladder should be operational, using a relationship between stream flow and SSC based on United's observations in the Santa Clara River at the Freeman Diversion. United will investigate potential changes to the fish ladder operations schedule, in consultation with the Services and within the adaptive management framework.

Rationale

Behavioral and physiological effects of suspended sediment on salmonids are well-documented and discussed in detail in Appendix E. However, applying laboratory results to ecological processes is often confounded by the complexity of natural systems. Reliable scientific data to support postulations that southern California steelhead have developed physiological or behavioral adaptations to aid their migrations through sediment-laden systems of southern California are sparse. Based on anecdotal observation in other systems, NMFS has suggested that steelhead have developed avoidance behavior to utilize stream margins during periods of elevated sediment load. While preliminary data do not support this hypothesis, United understands the importance of determining effects that suspended sediment on migration behavior. United also seeks to adjust its operations, within limits, in a way that expands the overall base of information useful to the protection, mitigation, and recovery actions that benefit the southern California steelhead DPS.

6.4.9 EFFECTIVENESS MONITORING MEASURE: EMM-09 – ON-SITE HABITAT RESTORATION

United will monitor the ongoing success of on-site habitat restoration of temporarily disturbed areas once revegetation has been completed per CM 2.3.1 (Chapter 5, Section 5.2.5). Regular monitoring and maintenance of the habitat restoration area will be conducted to ensure that invasive plant species are removed, and that native plant species are becoming established. Maintenance of the habitat restoration area will include regular removal of non-native plants and implementation of standard corrective measures identified during monitoring, such as minor repairs of BMPs (e.g., erosion control with straw wattles and/or burlap bags), additional weeding, and/or herbicide treatment.

Short-term (one to five years) and long-term (six to ten years) restoration monitoring will be implemented to verify that restoration areas achieve success criteria. Quantitative monitoring will be conducted in early spring (February or March depending on seasonal rains) and will consist of collecting data for percent cover of native and non-native vegetation, and height of shrub/tree species using protocol Relevé sampling. Specific quantitative data collection techniques and timing will be determined by a restoration ecologist approved by USFWS.

Monitoring in years one to five will consist of quarterly qualitative and quantitative monitoring and, if deemed appropriate and necessary based on success criteria (Chapter 5, Section 5.2.5, CM 2.3.1), monitoring may continue in years six to ten. Monitoring in years six to ten would consist of semi-annual qualitative and quantitative monitoring. Monitoring will be conducted using quantitative and qualitative methods. Focused vegetation assessment pre-activity condition surveys will be conducted in the habitat restoration area and directly adjacent to determine the average cover, height class, species richness and diversity, and condition of the vegetation. Surveys will be conducted using the line-point intercept method. The plant community compositions within the habitat restoration area will be assessed for meeting success criteria. Assessment of the site's ability to support wildlife species will be noted and management actions will be assessed if needed. Photographs will be taken to document conditions for ongoing habitat restoration management.

United will conduct weed removal throughout the habitat restoration area three times per year in April, May, and June. Monitoring throughout the year will include careful inspection of the habitat restoration area and documentation of on-site conditions, restoration progress, and any issues that may be preventing the sites from meeting performance criteria. Any straw wattles that have deteriorated to the point of non-functionality will be repaired or replaced when necessary.

6.4.10 EFFECTIVENESS MONITORING MEASURE: EMM-10 – POND TURTLE POPULATION MONITORING MEASURE

There is limited information on the ecology, natural history, and life history of the pond turtle (Germano et al. 2012). To gather detailed information on the population demographics of pond turtle around the Freeman Diversion and to gain an understanding of natural and life histories of individuals within the population upstream and downstream of the Freeman Diversion, United will implement a monitoring program for pond turtles. The monitoring program will not only provide information for the adaptive management of the pond turtle population around the Freeman Diversion but will also provide invaluable information on the species as a whole and will contribute to the scientific knowledge of the species. The monitoring program will involve three approaches to monitoring pond turtles:

1. A focused pond turtle trapping mark and recapture study,
2. A telemetry study, and
3. Capture, mark, and relocation of pond turtle on an incidental basis during implementation of the capture and relocation plan (CM 2.1.4) aim at removing individuals out of harm's way in areas where covered activities will occur.

All United environmental staff or contracted biologists responsible for trapping and handling of pond turtles will be trained and experienced in safe trapping and handling techniques and will be approved by agencies to conduct that work.

Focused Trapping, Mark and Recapture Study

United will implement pond turtle trapping at locations upstream and downstream of the Freeman Diversion facility using standard trap design for pond turtles (Iverson 1979) and standard methods for trapping and handling pond turtles. Traps will be placed in areas of identified suitable habitat for pond turtles. The specific locations of traps and frequency and duration of trapping will be established in consultation with the resource agencies. Any captured turtles will be removed from traps by hand and data will be collected before marking and release. Date collected may include weight, carapace length, plastron length, sex, age, and general condition. Age of individuals will be assessed according to Bury and Germano (1998) and Germano and Bury (1998). Individuals will be marked (possible marking techniques may include scute notches [Cagle 1939; Bury 1972], or PIT tags) before releasing them to the same location of capture, assuming no potential exists for impacts from covered activities.

Information gathered during the mark and recapture study will inform United on the population dynamics upstream and downstream of the Freeman Diversion facility and will provide United with valuable information for population management during implementation of the capture and relocation plan and for adaptive management. Data collected will provide invaluable information for the scientific community on the ecology and life history of pond turtles and contribute towards the conservation of the species.

Telemetry Study

United will conduct a telemetry study on a subset of trapped individuals to gather data on movement patterns and population interactions. A subset of individuals trapped upstream and downstream of the Freeman Diversion will be fitted with radio transponders according to currently acceptable methods (Reese and Welch 1997; Rathbun et al. 2002). Individuals will be tracked over the course of several seasons to document their movement patters and determined their habitat use and potential nesting locations. Once initial data has been collected and transponders have been fitted, individuals will not be handled to reduced stress and enable natural behavior.

Capture and Relocation Plan

Data will be collected on pond turtles incidentally captured during implementation of the capture and relocation plan (CM 2.1.4; e.g., to move individual pond turtles out of harm's way). Additionally, these individuals will be checked to determine if they have been previously trapped or marked, and unmarked individuals may be marked. Individuals captured under this CM may be good candidates for radio telemetry transponders because the telemetry study will provide information on how well pond turtles survive and what their habitat use is after relocation. The general approach will be to release the individual back to where it was originally captured, if safe to do so. However, as part of an adaptive management approach, empirical evidence gathered through mark recapture and telemetry will be assessed to determine if release at another location is justified. For example, if monitoring indicates that the Freeman facility poses a barrier to certain movement patterns (e.g., turtles can move in a downstream direction through the facility but not back upstream), United will refine the relocation strategy to better facilitate natural movement patterns. In this way, United hopes to maintain population genetic diversity that facilitate natural gene flow throughout the metapopulation.

6.4.11 ADDITIONAL DATA COLLECTION

United estimates that >4,000 smolts will be collected during downstream migrant trap operations and stranding surveys. Of these, it is proposed that 500 will be tagged with PIT tags under EMM-04 and 200 will be tagged with radio tags under EMM-05-06. United will also PIT tag all other collected smolt and juvenile *O. mykiss* that are of appropriate size over the duration of the permit term. These tagged fish could be used to inform a number of questions about life history patterns, migration behavior, passage efficiency, and even adult ocean return rates of *O. mykiss* in the Santa Clara River. For example, tagged *O. mykiss* relocated to closed and open estuaries, as well as upstream of the Freeman could be used to compare behavior of those fish given detections of fish at the Freeman Diversion or during surveys. Tagged *O. mykiss* released downstream might, under some situations, migrate back upstream through the fish ladder, and detection of these fish would inform life history patterns in the Santa Clara River. Data from tagged fish could also be used to address questions that have not yet been considered under the current HCP.

6.5 LITERATURE CITED

Booth, M.T. 2016. Fish passage monitoring at the Freeman Diversion 1993-2014. United Water Conservation District. Santa Paula, CA. 13 pp.

Bury, R.B. 1972a. Habits and home range of the Pacific pond turtle, *Clemmys marmorata*, in a stream community [dissertation]. Berkeley, CA: University of California. 205 p.

Bury, R.B. and D.J. Germano. 1998. Annual deposition of scute rings in the Western Pond Turtle, Clemmys marmorata. Chelonian Conservation and Biology 3: 108-109.

Cagle, F.R. 1939. A system of marking turtles for future identification. Copeia 1939:170-172

California Department of Fish and Wildlife (CDFW). 2017. Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California. CDFW-IFP-001. Instream Flow Program, Sacramento, California. September 2017. Available online: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=150377. Accessed April 2019.

Germano, D.J. and R.B. Bury. 1998. Age determination in turtles: Evidence of annual deposition of scute rings. Chelonian Conservation and Biology 3: 123-132.

Germano, D.J., R.B. Bury, and H.H. Welsh, Jr. 2012. Future research and management actions. Pp. 81-92 in Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management. Bury, R.B., H.H. Welsh, Jr., D.J. Germano, and D.T. Ashton (eds.). Northwest Fauna 7.

Iverson J. B. 1979. Another inexpensive turtle trap. Herpetological Review 10:55.

Jerde, C.L., 2019. Can we manage fisheries with the inherent uncertainty from eDNA?. Journal of fish biology. 25 November 2019.

Rathbun, G.B, N.J. Scott Jr, and T.G. Murphey. 2002. Terrestrial habitat use by Pacific Pond Turtles in a Mediterranean climate. Southwestern Naturalist 47:225-235.

Reese, D.A. and H.H. Welsh JR. 1997. Use of terrestrial habitat by Western Pond Turtles, *Clemmys marmorata*: Implications for management. In: van Abbema J, editor. Proceedings: Conservation, restoration, and management of tortoises and turtles. An international conference. New York, NY: Wildlife Conservation Society Turtle Recovery Program and the New York Turtle and Tortoise Society. p 352-357. http:/ /www.treesearch.fs.fed.us/pubs/ 3652. Accessed 28 July 2012.

Stillwater Sciences and Wiyot Tribe Natural Resources Department. 2017. Status, distribution, and population of origin of green sturgeon in the Eel River: results of 2014–2016 studies. Prepared by Stillwater Sciences, Arcata, California and Wiyot Tribe, Natural Resources Department, Loleta, California, for National Oceanic and Atmospheric Administration, Fisheries Species Recovery Grants to Tribes, Silver Springs, Maryland.

Thomas R. Payne and Associates (TRPA). 2005. *Assessing Passage of Steelhead over Riffles in the Lower Santa Clara River*. Draft Final Report to the United Water Conservation District, Santa Paula California. 31 pp.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 2016. Draft Habitat Conservation Planning Handbook. U.S Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Washington, DC. Available online: https://www.fws.gov/endangered/improving_ESA/hcp-handbook.html. Accessed August 2018.

Western Ecosystems Technology (West). 2010. Power and Sample Size for a Steelhead Migration Rate Repeated Measures Study. 12 pp.

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7 EFFECTS ANALYSIS

7.1 REGULATORY SETTING

Both Section 7 and Section 10 of the ESA require project proponents to estimate the amount of incidental take reasonably certain to occur from a given activity in order to obtain an incidental take statement (pursuant to ESA Section 7) or an incidental take permit (pursuant to ESA Section 10). The ESA defines take as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Harm is defined as "any act that kills or injures the species, including significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 Code of Federal Regulations [CFR] 17.3).

Section 7(a)(2) of the ESA requires federal agencies to ensure their actions (to authorize, fund, or otherwise carry out) are not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its designated critical habitat. The most recent updates to ESA Section 7 were issued with a joint notice (84 Federal Register 44976) of a final rule on August 27, 2019 (Revised Rule) by the U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA). The regulatory revisions address several aspects of Section 7 consultation, including changing some key definitions and providing new ones. The following two definitions relevant to this MSHCP are discussed here: (1) effects of the action and (2) environmental baseline.

Effects of the action are defined as follows:

> All consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

Environmental baseline is defined as follows:

> The condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

According to the Revised Rule, USFWS and NOAA revised the definition of environmental baseline to distinguish clearly between the concepts of environmental baseline and the effects of the action. The Revised Rule clarifies that the purpose of the environmental baseline is to enable a comparison between the conditions of species and critical habitat in the action area with and without the effects of the action, with the difference amounting to the effects. Furthermore, the Revised Rule includes a statement that this approach would "answer the question as to whether ongoing consequences of past or ongoing activities or facilities should be attributed to the environmental baseline or the effects of the action under consultation when the agency has no discretion to modify either those activities or facilities."

Section 10(a)(2)(B) of the ESA requires a similar jeopardy determination (see criterion 4 below) in the context of the following permit issuance criteria: (1) the taking will be incidental to otherwise lawful activities; (2) the applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking; (3) the applicant will ensure that adequate funding for the plan will be provided; (4) the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and (5) the measures, if any, required by the Secretary as being necessary and appropriate for purposes of the plan.

The most recent policy and guidance on ESA Section 10(a)(1)(B) permits were issued with a revised joint *Habitat Conservation Planning and Incidental Take Permit Processing* handbook in December 2016 by both USFWS, and the National Marine Fisheries Service (NMFS). While the amount of take must be included on any 10(a)(1)(B) permit issued by either USFWS or NMFS, the handbook clarifies that the "primary purpose for quantifying take in the HCP is to provide a foundation for conducting the impact analysis."

The amount of take and the impact of the take must be described in the HCP to receive an incidental take permit pursuant to Section 10(a)(1)(B) of the ESA. [1] The amount of take is calculated in sections 7.1-7.7 and the summary of take, impact of the taking, and offsets of the taking are discussed in Section 7.8. In order to determine the impact of the taking, the HCP must first identify and consider all components of the proposed covered activities in order to assess which activities result in stressors that would trigger a negative response in one or more individuals of the covered species, if exposed to the stressor. All negative impacts that rise to the level of take are then aggregated to determine the amount of take reasonably certain to occur from each covered activity. The amount and type of take is then evaluated to determine the impact of the taking on the covered species. One important distinction between the amount of take and the impact of the taking is that take occurs on the individual level, while the impact of the taking occurs at a level above individuals, such as to a local population or the species as a whole. This chapter provides an account of the type and amount of take and concludes with the impact of the taking pursuant to ESA Section 10(a)(1)(B) for all covered species.

To evaluate the operational effects to covered species, four analytical scenarios constituting four different flow conditions are used as points of comparison in order to account for the full range of potential effects of United's operations on covered species and the resulting impact of the taking.

1. **No Diversion** represents the instream flow conditions in the Santa Clara River as they would have been prior to construction of the facility and prior to the listing of steelhead. This scenario provides a theoretical context by which to measure the level of take associated with the new facility (i.e., effects of its physical presence as a passage barrier and effects of its operations that modify instream flows) as proposed in the MSHCP. NMFS has also requested this scenario as a comparison point.
2. **Initial Operations** represent the instream flow conditions and diversions (up to a maximum 375 cubic feet per second [cfs]) proposed under the MSHCP Conservation Program (Chapter 5), starting with permit issuance (Year 1) through Year 10. This scenario includes construction and operation of a new fish passage facility, with an expanded operational flow range, improved attraction flow to the upstream fish passage facility, better monitoring capabilities, a new screening system, and other design components aimed at protecting steelhead and lamprey that pass through the facility (see CM 1.1.1 in Chapter 5 for details of components).
3. **Future Operations** represent the instream flow conditions and diversions (up to a maximum 750 cfs) after United receives a modified water right permit (Year 11 through Year 50) with the same facility improvements discussed in the Initial Operations Scenario. This would be an increase in instantaneous diversion rate but maintains the same requirements for instream flows under the

[1] ESA section 10(a)(2)(A)(i), 50 CFR 17.22(b)(1)(iii)(A), 50 CFR 17.32(b)(1)(iii)(C)(1) for USFWS and 50 CFR 222.307(b)(5)(i) for NMFS.

conservation program (i.e., United diverts at a higher rate at high flows, when doing so would be less impactful to covered fish compared to low flows).

4. **Current Water Rights Operations** represent flow conditions as they would exist if United was exercising its entire, current water rights (up to a maximum instantaneous diversion rate of 375 cfs) with instream flow requirement of 40 cfs from February 15 through May 15, each time the flow upstream subsides to 415 cfs. The flow would be bypassed through the fish ladder for 48 hours and bypassed water shall not exceed 500 acre-feet on a 10-year average (see Chapter 2). United operated with these instream flow requirements from 1987 to 2016 with voluntary interim modifications aimed at promoting steelhead migration. The water rights operations represent a reasonable operational scenario in the absence of the MSHCP. This scenario provides context to measure benefits of the proposed MSHCP as a comparison point. This scenario is also useful to measure the cost of the MSHCP to United because it represents the most water that could be diverted in the absence of listed species and limitations imposed by the MSHCP.

Although assessed in supporting technical documents (R2 Resources 2016, Stillwater Sciences 2016a, Stillwater Sciences 2016b), current operations are not included in the effects analysis. Since 2016, United has been operating at greatly reduced diversion rates consistent with the NMFS 2008 Final Biological Opinion (2008 BO).[2] In 2018, a federal court imposed the same operational regime but with allowance for continued use of the Sespe trigger for instream flows as temporary, interim operations in order to minimize the risk of take of steelhead while United prepares an HCP.

Interim operations under the 2008 BO were intended to be replaced by flow measures meeting ESA Section 10 permit issuance criteria. The unsustainably low level of current diversions (modeled average is 50,000 acre-feet per year, but diversions have been much less than modeled in the last 5 years averaging 15,500 acre-feet) was never intended to continue indefinitely, as the low diversion levels cannot meet United's need to divert an average of 71,800 acre-feet per year at the Freeman Diversion, thus allowing maintenance of the coastal aquifer at levels sufficient to minimize saltwater intrusion and adequately address water quality issues such as nitrate concentrations.[3] Alternatives that include current operations (i.e., flows consistent with 2008 BO) are considered in Chapter 10, Alternatives to Take, where two alternatives that consider the 2008 BO include one with the proposed vertical slot passage facility (Alternative B) and one with the hardened ramp passage facility (Alternative C).

The use of multiple analytical scenarios in the MSHCP helps inform the amount of take reasonably certain to occur from the proposed covered activities and to reflect the benefits of the MSHCP's conservation strategy. Determining the amount of take reasonably certain to occur is necessary to conduct an impact assessment and to determine whether the proposed mitigation fully offsets the impact of the taking or can be demonstrated to represent the maximum extent practicable. The use of a no diversion scenario is only meant as a theoretical evaluation point and does not establish the environmental baseline or the status of the species within the action area. The 2008 BO operations are not an appropriate evaluation point because they were not intended to be applied for longer than it took United to prepare an MSHCP. The proposed HCP operations were intended to replace the current, interim water operations. Therefore, the impact of the taking (Section 7.6) compares the proposed project (expanded and improved fish passage facility in conjunction with proposed operations) to the current fish passage facility (Denil fish ladder) and the diversion/instream flow operations

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[2] This 2008 BO was never adopted because the federal agency consulting with NMFS (U.S. Bureau of Reclamation) withdrew its proposed action. Despite this, the courts determined that the operational parameters of the 2008 BO represented interim flows that best minimized the risk of take of steelhead while United Water prepared the HCP to provide long-term take authorization under a different flow regime.

[3] The 2008 BO required no more than diversion of 20 percent or 30 percent of river discharge when total discharge is < 635 cfs or between 635 cfs and 750 cfs, respectively.

under United's existing water rights demonstrating that the proposed project provides a much improved condition for covered species compared to the existing fish passage facility operated under United's water rights.

Populations Considered and Population Growth Assumptions for Covered Fish

For each assessment of the impact of the taking, the population unit for each species to be assessed needs to be defined. Consistent with NMFS (2012), the Southern California Steelhead Distinct Population Segment (DPS) is used as the population for the analysis of impacts of the taking of steelhead in the Santa Clara River watershed. At this time, Pacific lamprey are considered one population with no DPSs identified. Therefore, as a species, Pacific lamprey is considered the focal population. For the purposes of the effects analysis, the Los Angeles-Ventura phylogeographic unit of tidewater goby was considered. For the purposes of the effects analysis in this MSHCP, the meaningful population of pond turtles is defined as the population contained within the contiguous lower Santa Clara River watershed, from roughly five miles upstream at the confluence with Santa Paula Creek to the estuary. The focal populations of covered birds are defined as the populations contained in the lower Santa Clara River watershed from the confluence with Piru Creek to the estuary, including tributaries to the Santa Clara River in that area.

To estimate the amount of take, some understanding of the population size of southern California steelhead in the Santa Clara River is needed. However, because there are no reliable estimates of abundance of steelhead in the Santa Clara River watershed under current conditions, the abundance during the 50-year permit term was inferred from the best available data. The data come from monitoring conducted by United at the Freeman Diversion using stranding surveys within the facility (fish screen bay, fish ladder, canal), an upstream fish trap, a false weir with motion activated camera within the fish ladder, and a downstream migrant trap at the downstream end of the fish screen bay. These monitoring data are summarized by Booth (2016) and Dagit et al. (2020) for the period from 1993 through 2014. Two adult steelhead detected in 2020 via the false weir and motion camera are also considered in this analysis (United unpublished data). Booth (2016) and Dagit et al. (2020) reported a total of 16 adult steelhead observed at the Freeman Diversion from 1993 to 2014, typically 2 or less per year, with most years having no fish observed. The most adult steelhead that have been observed migrating upstream in the Santa Clara River in any recent year is 2 adults (Booth 2016, Dagit et al. 2020; United unpublished data). However, this is potentially an underestimate as fish could migrate through the facility without being detected, enter the Santa Clara River but fail to reach the Freeman Diversion, or reach the Freeman Diversion but fail to successfully ascend the fish ladder. Therefore, for the purposes of estimating take, it is assumed that during the first ten years of the permit term, an average of four adult steelhead would enter the Santa Clara River and attempt to migrate upstream. This is twice the maximum adult steelhead observed in any one year based on existing data and is intended to account for potential detection bias.

In summarizing adult steelhead observations within the southern California DPS (see Chapter 4), the highest counts of observed adult steelhead in recent history (within the last 20 years) were reported in the Ventura River in 2008 (10 adults; CMWD 2008), and in the Santa Ynez River in 2008 (16 adults; Dagit et al. 2020). Assuming low detection-probability noted by Booth (2016) and a population in the future approaching and then exceeding (by double) the maximum counts observed in the Ventura River, the HCP assumes that during the permit term counts will increase and then average slightly more than the maximum observed in the Santa Inez within 20 years, and that up to 20 adults might migrate annually because of improvements to the fish passage facility at Freeman Diversion and other restoration efforts in the watershed (i.e., Harvey Diversion fish passage improvement and other barrier removal projects in the watershed)(Table 7-1). The assumed potential increase in adult abundance is an informed estimate. Predictions in abundance for the first 10 to 20 years are based on observations under existing conditions, and predictions further into the future are increasingly speculative. Based on these assumptions, a total of 550 adult steelhead would enter the Santa Clara River and attempt to migrate upstream during the permit term (Table 7-1).

Unlike other Pacific salmon species, steelhead are iteroparous and capable of repeat spawning. Once an adult steelhead has spawned and survived, it can become a kelt. Based on past kelt detections (Booth 2016), most downstream migrating kelts are anticipated during March and April, but presumably could occur anytime following adult upstream migration. During adult migrant monitoring from 1993–2014 (Booth 2016), 16 upstream migrating adult steelhead and three downstream migrating kelts were observed. These observations are potentially limited due to downstream passage routes that are not monitored: the fish ladder, bypass channel, and diversion crest. However, based on this data, it is assumed that around 19 percent of steelhead adults in the Santa Clara River will exhibit a kelt life history (Table 7-1).

Table 7-1 Assumed Potential Annual Adult Steelhead Population Increase in Santa Clara River

	Years 1-10	Years 11-20	Years 21-30	Years 31-40	Years 41-50	Total
Average annual population of migrating adults, by time period	4	6	10	15	20	11
Total population of migrating adults, by time period	40	60	100	150	200	***550***
Percent of adults observed as kelts	19%	19%	19%	19%	19%	**19%**
Total population of migrating kelts, by time period	8	11	19	29	38	105

To assess the number of steelhead smolts vulnerable to take, the abundance of adult steelhead within the Santa Clara River watershed during the 50-year permit term was predicted. The most steelhead smolts recently observed at the Freeman Diversion is 839 in 2000 (Booth 2020). However, during wet years, fish may take several pathways (i.e., fish ladder, diversion crest, bypass channel) that avoid detection, leading to underestimates of fish numbers. There is no estimate of detection probability and detection is likely variable depending on the proportion of flow that was directed through the fish bypass into the downstream trap Booth (2020). If detection probability were 5 percent, the actual peak number of smolts that migrated in 2000 would be over 1,700. Assuming low detection and a larger population in the future, up to 1,500 smolts could migrate annually initially, with up to 10,000 annually following improvements to the fish passage facility at Freeman Diversion and other restoration efforts in the watershed (Table 7-2). The assumed potential increase in smolt abundance is an informed estimate. Predictions for production during the first 10 to 20 years are based on observations under existing conditions, and predictions further into the future are increasingly speculative.

Based on these assumptions, there might be a total of 175,000 steelhead smolts that migrate downstream within the Santa Clara River during the permit term (Table 7-2). There are limited data on smolt-to-adult (SAR) ratios for steelhead in California. In Scott Creek (Central California Coast DPS), SAR was estimated from 2002 to 2007 based on PIT tagging of 2,144 smolts, 52 of which returned as adults; adult return rates for estuary rearing juveniles and for direct ocean migrants was 4.3 percent and 0.6 percent, respectively. In the Santa Clara River, most smolt production is assumed to be the result of direct ocean migration, and if a similar SAR of 0.6 percent were to occur, the average annual adult returns would be around 21 adults annually. Assuming that the SAR from Scott Creek could be similar in the Santa Clara River, this estimate of adult returns is slightly higher than estimated total adult returns presented above (Table 7-2), suggesting that either the estimate of smolt production is slightly high, or the estimate of adult production is slightly low.

In addition to smolts, steelhead fry and other *O. mykiss* juveniles (not fry or smolts) also move downstream and are observed at the Freeman Diversion (Booth 2016). Although observations fluctuate annually, an average 86.7 percent of the juvenile *O. mykiss* observed at the Freeman Diversion are smolts, 8.6 percent are fry, and 4.7 percent are other *O. mykiss* juveniles. Assuming similar proportions of each life stage during the permit term, in addition to smolts, there might be a total of 17,359 steelhead fry, and 9,487 steelhead juveniles that also migrate downstream within the Santa Clara River during the permit term (Table 7-2).

Table 7-2 Assumed Potential Steelhead Production Increase in Santa Clara River

	Years 1-10	Years 11-20	Years 21-30	Years 31-40	Years 41-50	Total	Annual Average
Avg. annual population of migrating smolts (86.7% of migrants)	1,500	2,500	3,500	4,500	5,500	175,000	3,500
Avg. annual population of migrating fry (8.6% of migrants)	149	248	347	446	546	17,359	347
Avg. annual population of migrating juveniles (4.7% of migrants)	81	136	190	244	298	9,487	190

To assess the number of adult Pacific lamprey vulnerable to take, the abundance of adult Pacific lamprey within the Santa Clara River watershed during the 50-year permit term was predicted. There are no consistent reliable estimates of abundance of Pacific lamprey in Santa Clara River watershed under current conditions. The best available data is from monitoring conducted by United Water at the Freeman Diversion using stranding surveys within the facility (fish screen bay, fish ladder, canal), an upstream fish trap and counting tubes within the fish ladder, and a downstream migrant trap at the downstream end of the fish screen bay; the results of which are summarized by Chase (2001), Swift & Howard (2009), and Booth (2016) for the period 1991 through 2014. Over 2,600 adult Pacific lamprey have been observed at the Freeman Diversion from 1991 to 2014. The number of Pacific lamprey has been extremely variable among years when Pacific lamprey were observed at the Freeman Diversion ranging from 2 in 1999 to 1,185 in 1994 (Booth 2016). However, this is likely an underestimate, since fish could migrate through the facility without being detected or could have entered the Santa Clara River and failed to reach the facility.

To predict abundance of adult Pacific lamprey in the Santa Clara River, observation data from similar rivers within the region were also considered. In summarizing recent (within last 10 years) observations of adult Pacific lamprey in southern California (see Chapter 4), there have only been a few adult observations in San Luis Obispo creek, Ventura River, Santa Clara River and Santa Ana River. Few observations within the Southern California region makes it challenging to estimate expected abundance of Pacific lamprey following improvements to the Freeman Diversion. Instead, it is assumed that the numbers of fish observed at the Freeman Diversion from 1991 – 2001 are representative of the expected population numbers. Based on these observations, and for the purposes of estimating take, it is assumed that during the first ten years of HCP permit term, on average 20 adult Pacific lamprey would enter the Santa Clara River and attempt to migrate upstream each year (Table 7-3). This is approximately 1.6% of the most fish observed in any one year and 10 times the fewest fish observed in any one year (excluding years with zero observations) based on existing data described above. It is further assumed that recovery of the population will follow an exponential growth until an average annual population size of 374 adult Pacific lamprey enter the Santa Clara River by the end of the 50-year permit term with a total of 6,740 adult Pacific lamprey entering the Santa Clara River over the 50-year permit term (Table 7-3). The average population size estimate of 374 is based on the average observed Pacific lamprey at the Freeman Diversion from 1991 to 2014 excluding years with zero observations. The predicted initial abundance and rate of increase in abundance are informed guesses. Unlike steelhead, Pacific lamprey do not return to natal rivers at high rates, rather they are opportunistic and enter rivers with suitable conditions (Moyle 2009). This creates non-genetically discrete populations (Goodman et al. 2008; Spice 2012) and thus, production of Pacific lamprey in the Santa Clara River is strongly influenced by regional

(Southern California or more broadly) population dynamics. Thus, increases in abundance of Pacific lamprey may not be observed following operational improvements to the Freeman Diversion or could be observed sooner than estimated due to regional factors affecting Pacific lamprey. Pacific lampreys are generally considered semelparous and are not capable of repeat spawning (Moyle 2009), therefore detection of dead or dying lampreys that appear to have spawned previously (i.e., displaying abrasions and suction marks) during covered activities is not considered "take" for the purposes of this effects analysis.

Table 7-3 Assumed Potential Annual Adult Pacific Lamprey Population Increase in Santa Clara River

	Years 1-10	Years 11-20	Years 21-30	Years 31-40	Years 41-50	Total
Average annual population of migrating adults, by time period	20	40	80	160	374	~135
Total population of migrating adults, by time period	200	400	800	1,600	3,740	6,740

To assess the number of juvenile Pacific lamprey vulnerable to take, the abundance of juveniles within the Santa Clara River watershed during the 50-year permit term was predicted. The most juveniles that have ever been observed migrating downstream in the Santa Clara River recently is 113 at the Freeman Diversion facility in 1995 (Swift and Howard 2009). These fish were observed in the fish ladder of the Freeman Diversion. However, fish may take several pathways (i.e., fish ladder, dam crest, bypass channel) that avoid detection, leading to underestimates of fish numbers. There is no estimate of detection probability, and as noted by Booth (2016) it is likely low. For example, if detection probability were 5%, the actual peak number of juveniles that migrated in 1995 would be over 2,000. Assuming low detection and a larger population in the future, optimistically during the permit term up to 450 juveniles might migrate annually initially, with up 7,000 annually following improvements to Freeman Diversion fish passage, improved operations, and other restoration efforts in the watershed (Table 7-4). These estimates for annual downstream migrating juvenile abundance following improvements to the Freeman Diversion are similar to abundance estimates from a stream system on the Oregon coast (n = 3,592 – 6,569; Van de Wetering 1998). While the stream in Van de Wetering (1998) is located within a much smaller watershed than the Santa Clara River, Sespe Creek if thought to be the primary spawning location for Pacific Lamprey in the Santa Clara River watershed, and thus is of similar size in terms of suitable habitat to the stream evaluated in Van de Wetering 1998. However, streams on the coast of Oregon likely have more suitable stream conditions and habitat per unit stream area in addition to having continuous access to and from the ocean, and therefore should be expected to produce more migrating juveniles per stream area compared to the Santa Clara River (or Sespe Creek). Thus, predicted abundance for the Santa Clara River is likely an overestimate. The assumed potential increase in juvenile Pacific lamprey abundance is an informed guess due to very little information available on juvenile Pacific lamprey in the Santa Clara River and similar rivers at the southern extent of Pacific lamprey. Furthermore, unlike steelhead, Pacific lamprey do not return to natal rivers at high rates, rather they are opportunistic and enter rivers with suitable conditions (Moyle 2009). This creates non-genetically discrete populations and thus, production of Pacific lamprey in the Santa Clara River is strongly influenced by regional population dynamics. Thus, recovery of Pacific lamprey may not be observed following operational improvements to the Freeman Diversion or could be observed sooner than estimated due to regional factors affecting Pacific lamprey. Acknowledging these uncertainties, United estimates a total of 135,750 juvenile Pacific lamprey that migrate downstream within the Santa Clara River during the 50-year permit term.

Table 7-4 Assumed Potential Macrophthalmia Pacific Lamprey Production Increase in Santa Clara River						
	Years 1-10	Years 11-20	Years 21-30	Years 31-40	Years 41-50	Total
Avg. annual population of migrating juvenile Pacific lamprey	450	875	1,750	3,500	7,000	2,715
Total population of migrating juvenile Pacific lamprey, by time period	4,500	8,750	17,500	35,000	70,000	135,750

Habitat Considered

General habitat impacts are considered for covered species in the form of impacts to migratory corridors, rearing habitat, foraging habitat, and breeding habitat, as well as designated critical habitat, which incorporates all forms of habitat by defining physical or biological features (PBFs).

The Santa Clara River channel is a migratory corridor for steelhead and lamprey. Steelhead and lamprey may use the mainstem Santa Clara River for rearing, but the extent of rearing in the mainstem is unknown. Foraging habitat was not considered separately from rearing for covered fish.

Pond turtles are not considered a migratory species. Pond turtles nest in terrestrial habitat and forage, breed, and rear in aquatic habitat. The mosaic of upland and aquatic features is critical to the species life history.

Covered birds nest in terrestrial habitat and forage over aquatic habitat and within terrestrial habitat. Covered birds also migrate and likely use riparian habitat for cover, forage, and resting during migration. Impacts from covered activities on migratory habitat (2.83 acres) for covered birds are considered negligible here compared to the total amount of riparian habitat available to covered birds in the Santa Clara River channel at the Freeman Diversion. Further, the covered activities do not present a barrier to bird migration and so are not addressed further. Because the covered birds generally occupy the same types of habitat, we expect habitat impacts will be the same for all the covered birds and so treat impacts to habitat similarly throughout.

Impacts to foraging and breeding habitat are expected to occur on a temporary basis (no permanent impacts to habitat are expected) and are discussed for each covered activity below. Foraging and breeding habitat are defined for each covered species as follows in Table 7-5 (Note: acreages for aquatic and terrestrial habitat provided in Table 7-5.)

Table 7-5 Potentially Impacted Habitat Categories for Covered Species				
Covered Species	**Migratory Corridor**	**Spawning/Breeding/Nesting**	**Rearing**	**Foraging**
Southern California Steelhead	Aquatic (Riverine and Estuarine)	NA	Aquatic (Riverine and Estuarine)*	NA
Pacific Lamprey	Aquatic (Riverine and Estuarine)	NA	NA	NA
Tidewater Goby	NA	Estuarine	Estuarine	Estuarine
Western Pond Turtle	NA	Terrestrial	Aquatic	Aquatic
Least Bell's Vireo	NA	Terrestrial	Terrestrial	Aquatic and Terrestrial
Southwestern Willow Flycatcher	NA	Terrestrial	Terrestrial	Aquatic and Terrestrial
Yellow-billed Cuckoo	NA	Terrestrial	Terrestrial	Aquatic and Terrestrial
*Whether and the extent to which steelhead rear in the lower river and the estuary remains unknown but is possible and evaluated in the effects analysis.				

When considering critical habitat, the Services define PBFs considered essential to support one or more life history stage(s) of listed species (50 CFR 424.12b, 50 CFR 226). Critical habitat occurs in the permit area for three covered species: steelhead and flycatcher. For steelhead, NMFS has identified five PBFs consisting of (1) freshwater spawning sites; (2) freshwater rearing sites for juveniles; (3) freshwater migration corridors; (4) estuarine areas; and (5) marine areas. United's operations may affect PBFs 2 through 4, and, therefore, these PBFs are considered in the effects analysis. United's covered activities in the MSHCP will not affect spawning habitat or marine areas used by steelhead and therefore these PBFs are not considered.

For tidewater goby, UWFWS has identified five PBFs consisting of (1) saline aquatic habitat, (2) water depth, velocity, and temperature (3) freshwater habitat, (4) sandbars, (5) food, (6) cover or shelter, (7) sites for breeding, reproduction, or rearing (or development) of offspring, and (8) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species. Primary constituent elements have been further defined for tidewater goby consisting of: (1) persistent, shallow still-to-slow-moving lagoons, estuaries, and coastal streams with salinity up to 12 ppt, which provide adequate space for normal behavior and individual and population growth that contain of or more of the following: (a) Substrates (e.g., sand, silt, mud) suitable for the construction of burrows for reproduction; (b) Submerged and emergent aquatic vegetation that provides protection from predators and high flow events; or (c) Presence of a sandbar(s) across the mouth of a lagoon or estuary during the late spring, summer, and fall that closes or partially closes the lagoon or estuary, thereby providing relatively stable water levels and salinity.

For southwestern willow flycatcher, USFWS has identified six PBFs consisting of (1) space for individual and population growth and for normal behavior, (2) food, (3) water, (4) sites for germination or seed dispersal of willow or other key woody riparian vegetation, (5) cover or shelter, and (6) sites for breeding, reproduction, or rearing (or development) of offspring. United's operation may temporarily affect PBFs 1, 2, 4, and 5 and therefore these PBFs are considered in this analysis.

7.2 RENOVATION EFFECTS

To assess renovation effects, disturbance areas and associated disturbed habitat were mapped (Figure 7-1) and quantified (Table 7-6). Unless renovation takes place during exceptionally dry years, preparation for renovation activities will include dewatering, flow rerouting, and some disturbance to riparian vegetation. The aquatic and riparian habitat in and around the construction and staging area provide habitat for covered species to migrate, forage, shelter, breed, and nest. Renovation activities associated with improving migratory conditions for steelhead and lamprey through construction of updated fish passage facilities will affect this habitat. These effects and any take reasonably certain to occur from these effects are described in this section.

United is under court order to complete all construction on the improved fish passage facility within 2 years of permit issuance, which likely necessitates some work in channel when flows are in the river and during nesting season. Therefore, for the purposes of estimating effects, take, and the impact of the taking, it was assumed that renovation activities will occur for 2 full years, which would be 2 full migration seasons for the two covered fish and 2 full nesting seasons for the three covered birds, recognizing that the start date will be determined by the timing of ITP issuance as well as all other associated permits and required environmental review.

Table 7-6 Acreage and Specific Locations of Temporary Effects to Covered Species' Habitat at the Freeman Diversion*

	Acreage of Specific Habitat Affected by Type		
Location of Effect with Respect to Freeman Diversion*	**Aquatic**	**Terrestrial****	**Total Acreage**
Upstream	0.45	0.64	1.09
Downstream	0.38	1.36	1.69
Total Acreage	0.83	2.0	2.83

* See Chapter 3 for detailed discussion of covered activities.

** Terrestrial habitat consists of arroyo willow (including early successional) and eucalyptus vegetation communities, as well as unvegetated sandbar

7.2.1 RENOVATION - EFFECTS TO AND TAKE OF STEELHEAD

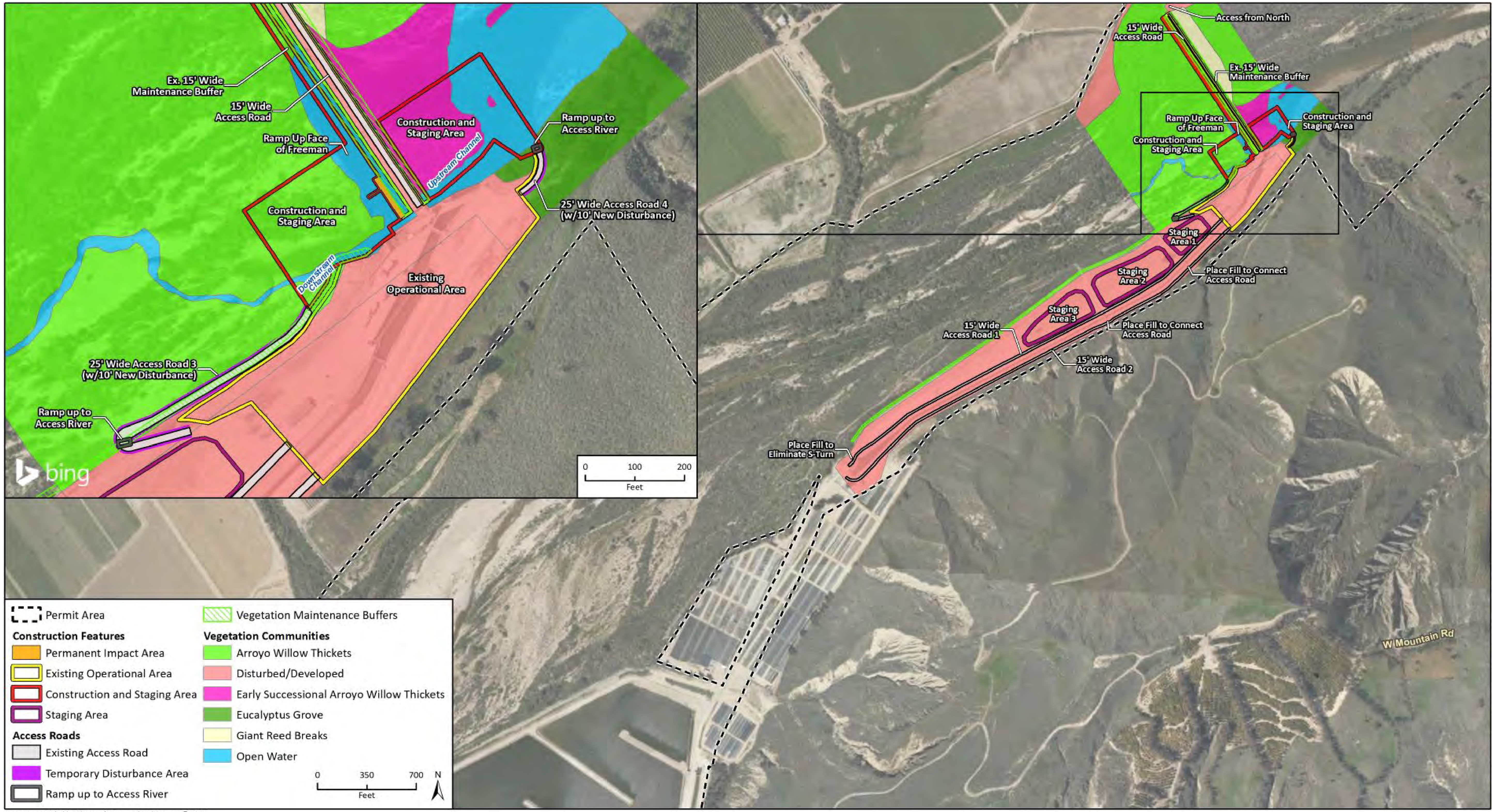
For the purposes of estimating take, it is assumed that during the 2 years of renovation, an average of 4 adult steelhead per year (total of 8 adult steelhead) would enter the Santa Clara River and attempt to migrate upstream (Table 7-1). This is twice the maximum adult steelhead observed in any one year based on existing data and is intended to account for potential detection bias.

It is anticipated that the Denil fish ladder would still be in operation during the first year of construction and a temporary fish ladder or a trap and haul option would be operated during the second year of construction. Considering a worst-case scenario, where both options cause migration delay, it is anticipated that 4 adult steelhead may successfully detect and pass the temporary fish ladder with little delay and 4 adult steelhead would be subject to potential harm from migration delay during renovation activities. To reduce the risk of harm, EMM-02, EMM-03, and/or CM 2.1.4 would be implemented in an attempt to detect these adult steelhead in the lower river and then tag them for effectiveness monitoring and/or relocate them upstream. In so doing, it is estimated that 3 of the 4 adult steelhead would be detected and subject to trapping, tagging, and release/relocation, while it is anticipated that 1 would remain harmed because it was not detected.

During renovation, United would be implementing diversion operations outlined in Chapters 3 and 5 when possible, otherwise flows would be bypassed when diversions are not possible potentially resulting in more instream flows downstream of the diversion than the instream flow commitments outlined in CM 1.2.1 and 1.2.2. Therefore, effects and take to juvenile steelhead would be the same or less to those discussed in Section 7.2.3 and an additional 10 smolts, 5 juveniles and 5 fry could be trapped and relocated out of harm's way during the initial preparations for construction including dewatering and flow rerouting with assumed up to 5 percent injury and 2 percent mortality. Juvenile *O. mykiss* of any kind that are large enough would also be PIT tagged prior to release and relocation.

No effects to tidewater goby were identified, given the location of the construction area relative to the estuary.

Figure 7-1 Covered Species Habitat



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7.2.2 RENOVATION - EFFECTS TO AND TAKE OF LAMPREY

Estimated Take of Pacific Lamprey

The construction and staging area is considered to primarily be a migration corridor for Pacific lamprey immigrating adults and emigrating macrothalmia (juveniles)(Puckett and Villa 1985). Although ammocoetes (larvae) have been observed historically in very small numbers at the diversion, it is likely that these individuals washed downstream in high flow and were not resident and rearing in the construction and staging area.

Based on the estimated annual numbers, United anticipates no more than 20 adult lamprey attempting to migrate during the two-year renovation period. These lamprey would be provided temporary passage during renovation, therefore it is anticipated that they would experience minor passage delay during the migration season but may be subject to trapping and relocation during certain times (i.e., flow rerouting during initiation for construction if it were to occur between mid-December and May). CMs 2.1.1, 2.1.2, 2.1.3, and 2.2.2 would minimize the need to capture/trap and relocate individuals under CM 2.1.4, however given the two-year duration of construction, complete avoidance may not be feasible.

United anticipates no more than 40 lamprey juveniles (double the adults) migrating downstream would be subject to capture and relocation with no more than 5 percent injury and 2 percent mortality from handling during relocation efforts.

United anticipates no more than 20 larvae being washed into the construction and staging area and subject to capture and relocation with no more than 5 percent injury and 2 percent mortality from handling during relocation efforts.

7.2.3 RENOVATION - EFFECTS TO AND TAKE OF POND TURTLES

Pond turtles are observed year-round both upstream and downstream of the Freeman Diversion. Pond turtles, ranging in size, and therefore age, regularly occur around the facility with up to approximately 20 individuals observed at any time (Chapter 4; United unpublished data). This is consistent with studies that show pond turtle density in suitable habitat averages approximately 20 individuals per acre (e.g., Holland 1994; Rathburn et al. 2002).

During renovation of the Freeman Diversion, take of pond turtles could occur from equipment strikes, destruction of turtle nests, destruction of or displacement from refugia, and disturbance to or removal of occupied habitat such that foraging, breeding, basking, or sheltering behavior is disrupted. Renovation would temporarily disturb a total of 2.83 acres of aquatic and terrestrial habitat (Table 7-5) and the effects analysis assumes that covered activities, including the capture and relocation plan to relocate pond turtles out of the construction and staging area, would make this area temporarily unavailable to pond turtles for two years. Temporary removal of 0.83 acres of suitable aquatic (foraging, sheltering) habitat and 2 acres of suitable terrestrial (nesting, sheltering) habitat may lead to temporary disruption of nesting, foraging, basking, and sheltering behavior resulting in temporary impacts to individuals.

The use of heavy equipment in the river channel during renovation could harm pond turtles through equipment strikes, crushing of turtle nests, crushing/removal of refugia, and general habitat disturbance or removal. Dewatering or rerouting of the channel could result in loss of aquatic habitat and reduced habitat complexity for foraging and sheltering making pond turtles more susceptible to predators or resulting in overcrowding. United would attempt to capture and relocate all pond turtles out of the construction and staging area prior to and during construction. Implementation of the capture and relocation protocol is aimed to prevent harm of pond turtles, but will result in take of pond turtles through capture and associated stress from handling, displacement, and increased stress from higher densities at relocation sites.

Based on historically documented population densities throughout the species range, numbers of individuals documented at the Freeman Diversion, and implementation of the CMs, United expects that no more than 10 pond turtle individuals and up to nest (11 eggs; Earnst and Barbour 1972) would be taken due to mortality during renovation of the fish passage and Freeman Diversion.

During renovation of the fish passage and Freeman Diversion, United expects that up to 56 individual pond turtles (assuming 20 individuals per acre) could be taken because of capture and relocation during temporary removal of 2.83 acres of suitable aquatic and terrestrial habitat.

7.2.4 RENOVATION - EFFECTS TO AND TAKE OF COVERED BIRDS

Take of covered birds includes potential take of individuals as well as potential adverse modification of critical habitat for flycatcher. Take of individuals in the form of mortality is not expected given implementation of the conservation program. Take in the form of mortality of eggs or chicks may occur is nests are incidentally destroyed during vegetation clearing activities or if disturbance from covered activities results in adults abandoning a nest. Potential adverse modification to flycatcher critical habitat would occur to 2.83 acres within mapped critical habitat.

Individuals

Least Bell's vireos have been observed immediately upstream and downstream of the Freeman Diversion every year during their nesting season since 2012. The most recent protocol-level surveys in 2019, resulted in the detection of 87 territorial males within 1.5 miles of the Freeman Diversion, of which all were determined to be paired. A total of 47 nests were incidentally observed; 12 nests within 500 feet of the facility (both upstream and downstream; Griffith Wildlife Biology 2019). Southwestern willow flycatchers were observed nesting approximately 1.5 miles west of the Freeman Diversion in 2016 and 2017 but have not been observed since 2017, despite annual protocol surveys and no observed decreases in riparian habitat. Yellow-billed cuckoo have not been observed during surveys of the Freeman Diversion during annual protocol-level surveys initiated in 2012 but have been observed within 5 miles east of the Freeman Diversion in recent years (Hall et al. 2020). The action area and area within 500 feet (Figure 7-1) is currently considered occupied by vireo but unoccupied by flycatcher and cuckoo. Considering cuckoo and flycatcher have not been documented within a 500-foot buffer of renovation disturbance footprint, direct effects to individuals are not reasonably certain to occur. Suitable foraging habitat may exist around the Freeman Diversion for flycatcher and cuckoo (e.g., see habitat suitability modeling results presented in Hall et al. 2020) and potential effects are considered here as effects to potentially suitable habitat as a surrogate for take.

Renovation of the Freeman Diversion would result in the temporary removal of 2.83 acres of suitable foraging habitat for cuckoo and flycatcher and suitable foraging and breeding habitat for vireo (Table 7-6). No take of individual covered birds due to direct mortality is expected. Nests detected during pre-construction surveys (CM 2.1.3) would be avoided during renovation activities to the extent practicable and direct strikes on covered birds are not expected because of implementation of BMPs (CM 2.1.1). Take in the form of harm of covered birds may occur from the destruction of nesting habitat resulting in the temporary loss of nesting opportunities for 2 years.

Project activities and use of equipment during renovation will generate noise and dust that have the potential to disrupt nesting or foraging activities within a 500-foot buffer around the disturbance footprint. Generated noise and dust have the potential to result in loss of fecundity and nesting opportunity due to disruption of breeding and nesting activity. Implementation of CM 2.1.1, CM 2.1.2, CM 2.1.3, CM 2.1.5, CM 2.1.6, and CM 2.1.7 is intended to reduce the potential for noise and dust related effects to occur.

Take of vireo is estimated from known numbers of breeding territories and breeding pairs of individuals based on observations over the 8-year period (2012 to 2019) when protocol surveys and nest monitoring were conducted (Chapter 4). During that timeframe, 436 pairs (average 55 per year) of vireo and 292 nests (average 37 per year) were observed and monitored within the 1.5 miles survey area upstream and downstream of the Freeman Diversion (note: the survey area increased in 2016 accounting for higher numbers of observations consistent with the average density of pairs over the study area). Vireo nests have been documented within the renovation disturbance footprint and 500-foot buffer as recently as 2019 (Figure 7-2). Within a 500-foot buffer of the renovation disturbance footprint, approximately 30 nesting pairs have been documented upstream and approximately 25 nesting pairs have been documented downstream within the past 8 years. In 2019, a total of 12 nesting pairs (5 upstream and 6 downstream) were detected in the renovation footprint and 500-foot buffer. For the purposes of estimating take of vireo, it is assumed up to 30 individuals (15 pairs) could be present and attempting to nest any given year within the renovation footprint and 500-foot buffer. These 30 individuals would be subject to take due to harm from increased energetic stress, behavioral modification resulting in reduced foraging and lost nesting opportunities. Loss of nesting opportunities is expected to result in loss of up to 15 nests, which translates to 50 offspring (based on average of 3.4 young per nest; Griffith Wildlife Biology 2019).

Based on no observations during recent protocol-level surveys in the construction and staging area and the 500-foot buffer, no flycatchers or cuckoos are expected to be present during renovation; therefore, no take of flycatcher or cuckoo individuals is reasonably certain to occur during renovation.

Critical Habitat

Renovation of the fish passage facility and Freeman Diversion could temporarily adversely affect 2.83 acres within the boundaries of designated critical habitat for southwestern willow flycatcher (see Figure 7-1). The construction and staging areas do not meet the definition of PBFs for flycatcher critical habitat given the patchy quality of the riparian community (Chapter 4). However, abundant intact large patches of riparian community occur adjacent upstream and downstream of the Freeman Diversion and provide suitable critical habitat for flycatcher. Effects to mapped flycatcher critical habitat from covered activities are negligible with respect to the species critical habitat overall (approximately 11,006 acres in the Santa Clara watershed) and would be temporary, coincidental with planned habitat restoration (CM 2.3.1).

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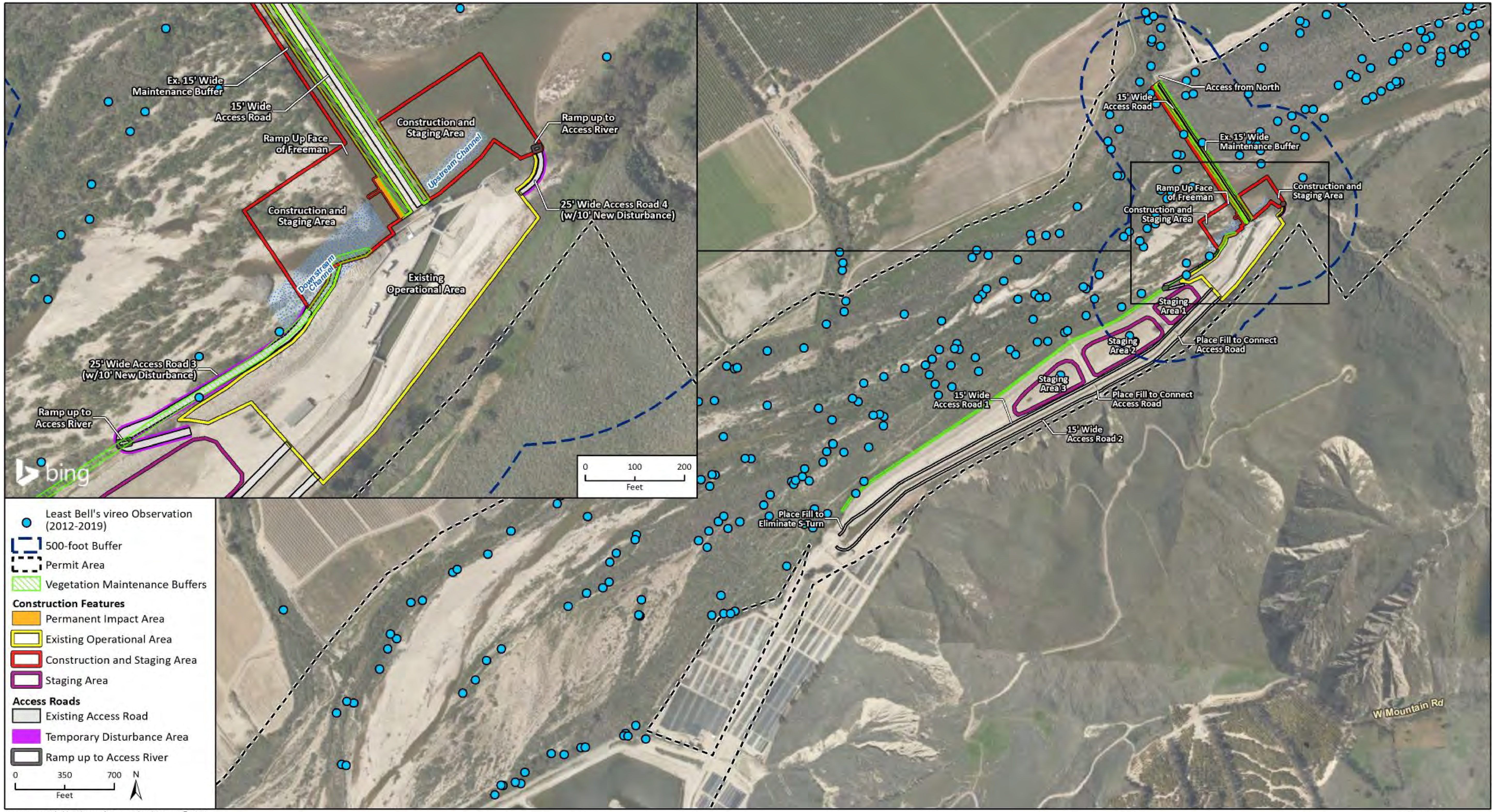
Figure 7-2 Nest Observations in the Action Area



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7.3 WATER DIVERSION AND INSTREAM FLOW OPERATIONS EFFECTS

United diverts surface water from the Santa Clara River to recharge groundwater aquifers and provide surface water deliveries in lieu of pumping in the areas of the aquifers most subject to water quality issues, particularly saltwater intrusion. The timing and extent of these water withdrawals alters the hydrology in the downstream reach of the Santa Clara River from Freeman Diversion through the estuary (affected reach). The lower river is a critical part of the migratory corridor for anadromous species in the Santa Clara River. Steelhead and lamprey must efficiently navigate the affected reach and the Freeman Diversion fish passage facility during both upstream and downstream migration. Hydrologic alterations from water diversion can affect aquatic habitat and riparian habitat that the covered species rely on and some of these effects could rise to the level of take as defined by the ESA. This section analyzes the potential effects of the water diversion operations to covered species and critical habitat, identifies where effects rise to the level of take, and quantifies take based on estimated population sizes with assumptions based on the best available scientific information or logical inferences from the best available scientific information.

7.3.1 FLOW DATA AND MODELING

Daily mean flows were modeled using United's Hydrologic Operations Simulation System (HOSS) developed by United and peer reviewed by R2 Resource Consultants (2015). The model simulates flows for every day between October 1, 1943 and September 30, 2014, or water years 1944–2014. Flows were modeled at two locations: (1) immediately downstream of Freeman Diversion; and (2) near the downstream end of the critical riffle (i.e., near the US 101 bridge).

The HOSS model output is mean daily flow (discharge) in cfs. There are some limitations on the types of analyses that can be conducted using daily means, particularly in regard to passage delay of anadromous fish. Therefore, when analyses were conducted on finer timescales (e.g., hours or less), then actual measured flow data collected over the last 4 years was used. These data were obtained from flow measurement devices placed in every pathway of the Freeman Diversion facility starting in 2016 through present day. Measurement devices are regularly calibrated and verified, as described in Chapter 6, Section 6.2-Compliance Monitoring. Flow or level measurement device data are collected approximately every second and are processed and stored through a supervisory control and data acquisition (SCADA) system and Historian database. Instantaneous calculation of total river flow is performed using Ranch Systems software, which copies data from the Historian database and performs calculations every five minutes. Flow measurements from the devices at the Freeman Diversion were summed to calculate total river flow upstream of the Freeman Diversion. The last 4 water years are a good representation of the variation in rainfall, runoff, and types of storm events experienced in the Santa Clara River. Water year 2017 represents a wet year following a drought period, and water year 2018 a moderately dry year. Water years 2019 and 2020 represent wet to moderate years, respectively, with increasing amounts of baseflows.

7.3.2 ESTUARY WATER BALANCE MODEL

For effects analyses that involve the estuary, United used an analytical water balance model combined with relationships between estuary hydraulic/hydrologic characteristics and species-specific estuary habitat conditions (Stillwater Sciences 2011a, Stillwater Sciences 2016).

The analysis assumed that estuary habitat conditions are driven primarily by local hydrologic and associated hydraulic conditions, in particular the estuary stage and the inundated area. For example, the availability and quality of potential steelhead rearing habitat is expected to be maximized when an estuary is full inundating an extensive area. The timing and frequency of river-mouth breaching, and the associated effects on stage and water-depth dynamics, also influence habitat conditions.

A conceptual model was developed that analyzed the conditions when the estuary was “open” or “closed.” Whenever the estuary-mouth is reported as “open,” steelhead and lamprey movement from the ocean into the affected reach and vice versa is assumed feasible. Breaching of the beach berm is controlled by a range of factors, including berm morphology, antecedent estuary-lagoon stage, river discharge, ocean wave climate and anthropogenic breaching due to human activities. Breaching of the beach berm was modeled based on empirical observations of river discharge and estuary-lagoon stage preceding breach events (Stillwater Sciences 2016). Recognizing that the stability of open-mouth conditions reflects a balance of riverine energy and the opposing ocean wave energy at the mouth breach (Behrens et al. 2013), mouth closure was modeled based on a combination of tidal range and river discharge.

An analysis using stage and mouth-breaching observations from water years 2010 – 2011 determined that the estuary berm breaches tended to occur at two different estuary-lagoon stages depending on antecedent wave and discharge conditions between storm and non-storm (quiescent) periods. For a given representative water year, quiescent conditions were assumed in absence of rainfall in the watershed as indicated when flows in the lower river are less than 300 cfs, whereas storm conditions were assumed when flows in the lower river are greater than 300 cfs. During non-storm, low-river conditions, the berm was found to breach at approximately 10.7 feet NAVD88, while at storm, high-river conditions, the berm was found to breach at 13.5 feet NAVD88. While the analysis identified average estuary-lagoon stages that corresponded to berm breaching under either condition, the average stage at which breaching occurs varies due to inter-annual variations in berm morphology.

A conceptual model was developed initially (Figure 7-3) that focused on the hydraulic/hydrologic functioning of the affected reach and estuary. The conceptual model considered the relative magnitude of seasonal river flow volume into the estuary (and resulting estuary stage and inundation characteristics) and anticipated seasonal river-mouth breaching dynamics with and without flow diversion. Based on this, the water balance model was developed and calibrated for hydro-geomorphic conditions present in water years 2010–2011 to simulate Santa Clara River hydrologic/hydraulic conditions under six representative water years (two low flow years, three moderate flow years, and one high flow year) for the four instream flow operational scenarios. The six representative water years modeled were:

- Low Flow WY #1 (based on WY 1990 conditions)
- Low Flow WY #2 (based on WY 2002 conditions)
- Moderate WY #1 (based on WY 2000 conditions)
- Moderate WY #2 (based on WY 2009 conditions)
- Moderate WY #3 (based on WY 2011 conditions)
- High Flow WY #1 (based on WY 1998 conditions)

The modeling approach treats the water years as representative water-year types that presumably will occur in the future, and therefore should provide a reasonable basis for comparison of operational effects. Unlike the riverine effects, where all 71 years of data were considered, data for the estuary are lacking regarding stage and berm-breaching relationships (among other data) and it is not possible to accurately duplicate the hydrological and estuarine processes known to have occurred in any given year. The mechanisms for river-mouth breaching can be anthropogenic, the effects of which cannot be integrated realistically into the model.

Further details of the water balance modeling efforts can be found in the estuary effects analysis report (Stillwater 2016).

Estuary Breaching Analysis

Daily visual observations conducted by staff from the Ventura Water Reclamation Facility since 1984 indicate that the estuary mouth at the beach berm opens shortly after rainfall runoff events, coinciding with continuous flow between the estuary and the Freeman Diversion. Whenever the estuary was open, the Ventura Water Reclamation Facility observations included visual estimates of widths, depths, and velocities of river outflow and tidal inflows. These observations indicated that when the river-mouth at the beach was open, water depths through the eroded berm were generally sufficient to allow adult steelhead and lamprey access from the ocean into the estuary lagoon. Observations from water years 1985 through 2016 revealed that the median open-mouth wetted width was 25 feet (ranging from less than 1 foot to 600 feet), and the median water depth was 2 feet (ranging from less than 1 foot to about 10 feet). Most of the time water depths at the beach berm were greater than 1 foot deep indicating access to the estuary from the ocean would be possible (see Stillwater Sciences 2011a and 2018 for additional details) as well as juvenile access to the ocean from the estuary. Usually, this corresponds to water depths in the open-mouth greater than one foot deep, so fish passage is feasible (Figure 7-3, left panel)(Figure 7-4). Rarely, the breach through the beach berm is shallower, a condition associated with artificial breaches or low flows in the river, particularly during the limited duration of a low tide (Figure 7-3, right panel). This pattern of beach berm regulated estuaries temporarily closing during low tides is commonly reported even in watersheds farther north without significant flow modifications (e.g., Williams and Stacey 2016).

Figure 7-3 Conceptual Framework of the Santa Clara River Estuary Water Balance Model, Applied to the Effects Analysis

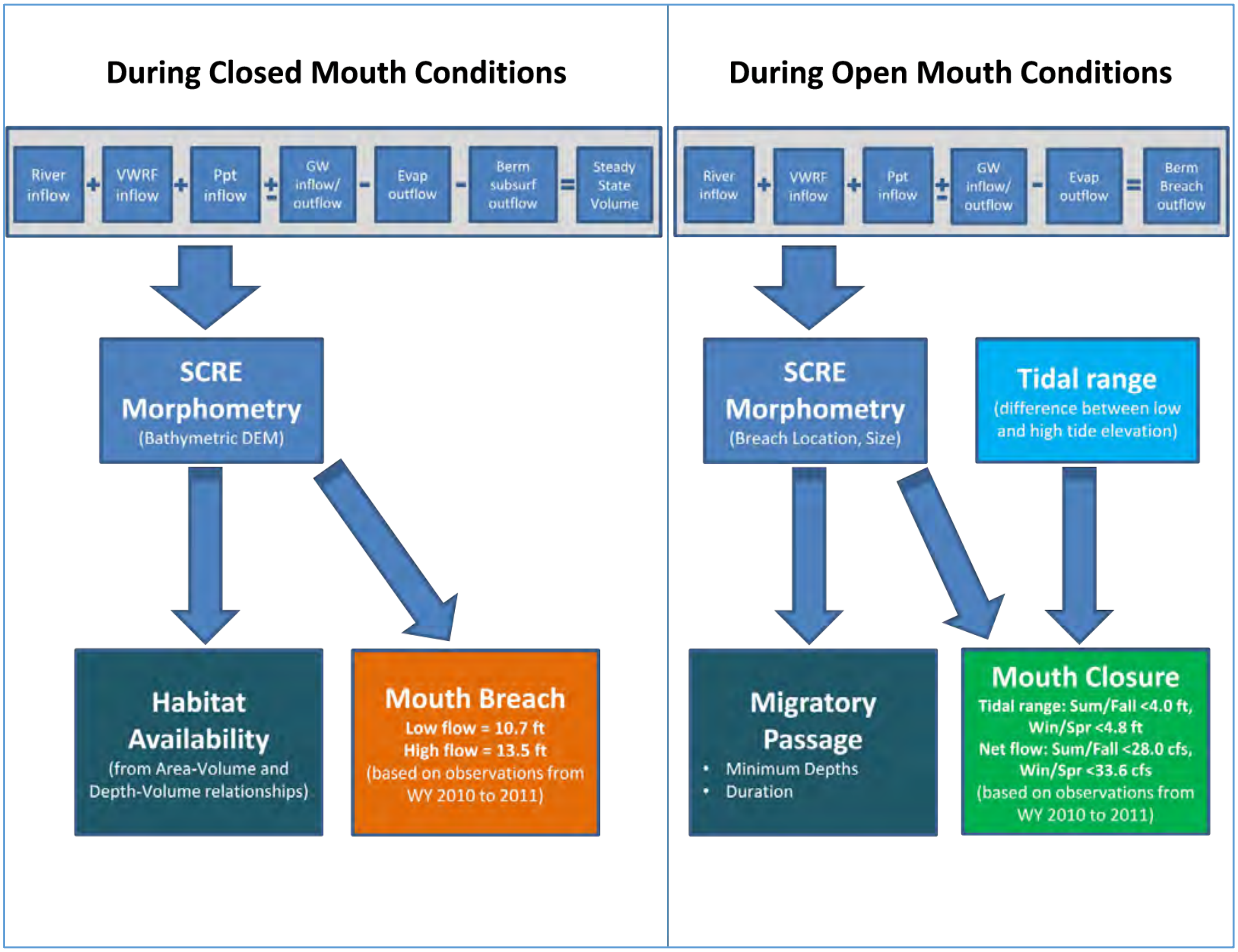


Figure 7-4 Views of an Open Estuary Mouth between Santa Clara Estuary Lagoon and Ocean during Median Water Depth Conditions (~2 ft) (a), and Shallow (<1.0 ft) (b)

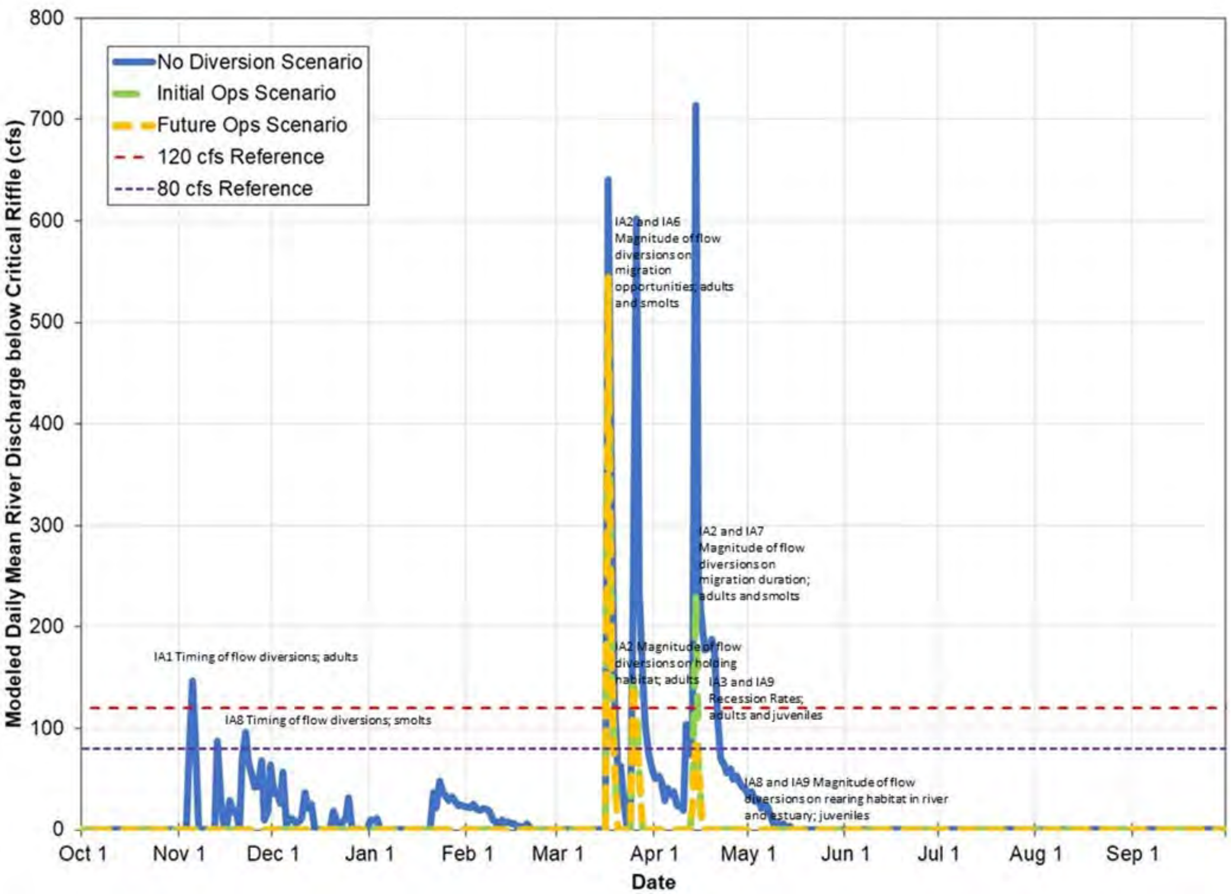
(photos: Stillwater Sciences)

7.3.3 WATER DIVERSION – EFFECTS TO AND TAKE OF STEELHEAD

Take assessed in this section, and conclusions regarding the impact of taking, includes potential take that would be "ongoing" from the current Freeman Diversion facility and existing operations, as well as any potential additional take from the proposed project (covered activities, conservation program, and monitoring program), for a sum total of the take for the proposed operations in the context of a proposed improved fish passage facility. To identify and estimate potential take, all metrics for the impact assessments are compared between a "no diversion" condition and the proposed operations as requested by NMFS. Therefore, statements of comparison in this section (Section 7.2.3) are between no diversion and proposed operations. However, the no diversion condition is not the existing condition, nor was "no diversion" the condition at the time steelhead were listed, and the no diversion condition should not be considered relative to the proposed diversion operations for the jeopardy analysis under Section 7 or similar assessment under Section 10 issuance criteria. A comparison of alterations to steelhead habitat and their deviations from no diversion as well as improvements compared to the water rights operations is presented in Section 7.2.4.

Because of the complexity of the proposed operations and the consequential effects to steelhead, this section (7.2.3) is divided into individual "impact assessments" to identify potential effects of the water diversion regarding alterations to the hydrograph and to estimate the level of take compared to no diversion. Figure 7-5 illustrates water year 2012 as an example to illustrate the portion of the hydrograph each impact assessment is focused on addressing.

Figure 7-5 Santa Clara River Example Hydrograph from 2012 Illustrating Individual Impact Assessments from Modeled Data below the Critical Riffle



Flow Criteria Assumptions

In some of the impact assessments, the HOSS is used to evaluate passage conditions at the critical reach for adult steelhead. The critical reach contains a series of critical riffles identified and measured by TRPA in 2004 and 2005 to determine "sufficient" (as defined in TRPA 2005 and 2005) adult steelhead passage conditions. The flow criterion downstream of the critical riffle considered throughout this effects analysis to provide "sufficient" passage through the critical reach is 120 cfs. This infers that adult steelhead can swim through the critical reach at 120 cfs, which is less than the adult migration flow prescribed in the proposed operations (>160 cfs). The higher flow prescribed by the proposed operations includes a buffer to conservatively ensure passage criteria are met (i.e., flows are "more than sufficient" to support passage of adults through the critical riffle). Using the lower number, 120 cfs, in the effects analysis prevents United from underestimating the effects of the proposed operations, since United provides 160 cfs in the proposed operations.

Similarly, the assumed smolt passage flow (>80 cfs) applied in the effects analysis is the lower limit assumed for United's proposed operations that is expected to provide downstream passage for steelhead ("sufficient passage"); under operational rules, higher flows for steelhead outmigration of 120 cfs ("more than sufficient") are maintained, if possible, minus United's 40 cfs critical diversion. United would provide 120 cfs ("more than sufficient passage") at the critical reach while diverting 40 cfs in the proposed operations as long as possible. United would maintain the 40 cfs diversions and provide as much flow as possible from 120 down to 80 cfs (maintained for at least 5 days) as the river recedes. When the river recedes to the point that 80 cfs ("sufficient passage") cannot be maintained for five days, despite bypassing the total river flow (less 40 cfs critical diversions), then a ramp down would be initiated aimed at preventing smolt stranding in the critical reach. Eighty cfs is the assumed threshold for safe passage through the critical reach for downstream migrating steelhead (see Chapter 5; CM 1.2.2 and CM 1.2.4).

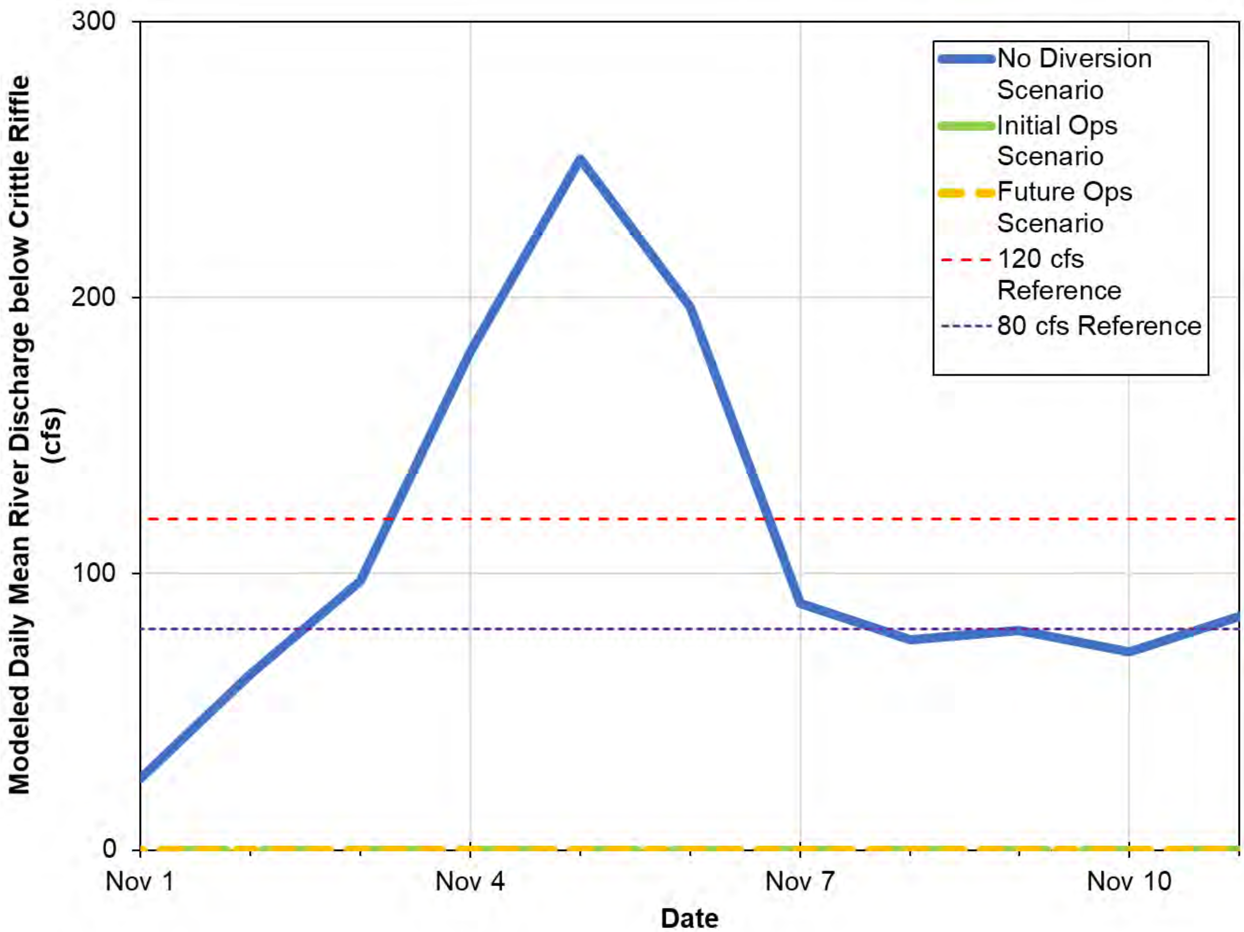
Impact Assessment 1: Timing of Flow Diversions Effects to Steelhead Adult Upstream Migration Timing

The primary migration window for adult upstream migrating steelhead in the Santa Clara River is January 1 through May 31. However, it is possible that adult steelhead could migrate earlier in the season if suitable flow events occurred. During November and December, the proposed diversion operations are expected to reduce river flows to levels that would not support upstream steelhead migration (less than 120 cfs). Impact Assessment 1 (IA 1,Figure 7-6) describes the consequences of this potential impact on adult upstream migrating steelhead.

For this assessment, 3 days is assumed to be the number of days a steelhead adult requires to enter the estuary and migrate upstream to the Freeman Diversion. Although data are limited regarding migration rates of adult steelhead in the Santa Clara River, available observations from 2012 (Booth 2016) and 2020 (United unpublished data) indicate that it takes adult steelhead approximately 2 to 3 days to migrate approximately 10 miles, enter, and pass the current Freeman Diversion fish ladder. This equates to migration rates of approximately 3 to 5 miles per day for adult steelhead. In a study of over 4,000 radio tagged adult steelhead, Keefer et al. (2004) observed much faster upstream migration rates averaging 11 to 13 miles per day in the lower Snake River, suggesting using a 3-day passage window provides for a conservative assumption that may overestimate effects and, therefore, take.

Figure 7-6 provides one example of the effects of the proposed operations on a flow event that occurred in November of 2011. Without flow diversions, the magnitude and duration of the flow event would be suitable to provide an upstream adult steelhead migration opportunity for around four days if adult steelhead were present during that time. However, in this example, modeled flows under proposed operations would reduce flows to less than 120 cfs through the critical riffle compared to no diversion. If adult steelhead were migrating upstream during this time they might: be prevented from migrating upstream of the estuary; become stranded within the riverine habitat and perish; spawn in poor quality habitat; locate suitable habitat within the river or the estuary to hold and wait for a subsequent suitable migration flow event with enough instream flows to complete migration through the affected reach; migrate downstream and out of the Santa Clara River to wait in the ocean for another opportunity or locate an alternative watershed for their spawning migration.

Figure 7-6 Water Year 2011 Santa Clara River Hydrograph Illustrating Impact Assessment 1 Based on Modeled Flows at the Downstream End of the Critical Riffle



To assess this impact the HOSS Model was run for the 71-year record to determine how often would there have been enough water (>120 cfs) at the critical riffle for at least three consecutive days during November and December for adult steelhead to migrate upstream under both a no diversion scenario, and under initial and future operations. Under a no diversion scenario, flow conditions within the Santa Clara River greater than 120 cfs for at least three consecutive days occur in November or December 6 percent of the years, compared with around 0.5 percent of years under initial and future operations. This equates to around 3 years during the permit term that would have suitable migration during November or December under no diversion that would not under proposed operations.

The criterion that the bypass flow trigger must occur after January 1 creates an imposed constraint on supporting migration for flow events starting before January and extending into January. The HOSS model estimates that 13.8 percent of years have flow events that start in December and extend into January, which would be approximately 7 years during the permit term. Thirty percent of the years that have flow events that run over into January (30 percent of the 7 years) would not be followed by another rainfall event that would trigger bypass flows. Therefore, out of the 3 years that during the permit term that would have suitable migration in November and December but for the proposed operations, it is estimated that 2 of those years would not be followed by a flow event to support adult upstream migration. The other 5 years when flow events carry over into January or the other 1 year that had a 3-day flow event prior to January, are estimated to be followed by another flow event that would trigger upstream bypass flows (CM 1.2.1 or 1.2.4).

For flow diversion timing to cause take, adult steelhead would need to be present to migrate, and flow conditions would need to be suitable to support migration for at least 3 days (as discussed above) but for United's operations. The migration timing of steelhead adults relative to storm events is important in rivers with highly dynamic hydrologic regimes such as the Santa Clara River. The Santa Clara River steelhead is a winter-run population, which are typically ocean-maturing as described by McEwan (2001). Because of their reliance on intermittent storm events, the upstream migration by adult steelhead is opportunistic (Moyle et al. 2008), although photoperiod may also play a role in migration timing. Even in more northern watersheds, very few (less than 10 percent of all observations) adult steelhead are observed migrating prior to January 1. The HCP makes a conservative assumption that if the beach berm were open, and flows through the critical riffle were suitable, up to 5 percent of the adult migrants would ascend the Santa Clara River during those years. If 5 percent of returning adults were available to migrate prior to January 1, then during years with suitable flow conditions at most one adult would have migrated upstream without United flow diversions in November and December (assuming five percent of a maximum 20 adults per year is one fish). Based on the 3years with migration opportunity in the early winter under no diversion that would not be provided under proposed operations, it is predicted that up to 4 adults would attempt to migrate and would be effected over the 50 year permit term. It is estimated that 3 of the 4 adults would be delayed until after bypass flows are triggered following January 1 and 1 of the 4 adults would have no subsequent migration opportunity for the entire migration season. It is predicted that up to 4 adults could be precluded from migrating in November or December during the permit term. However, it is most likely 3 of these fish would only experience a delay in migration until after January 1. Waiting for a subsequent flow event could result in harm through exhaustion or stranding mortality within the riverine habitat and/or spawning in poor quality habitat. Alternatively, these adults could locate suitable habitat within the river, estuary, or ocean to hold, as discussed in more detail in IA3. The consequence of a short delay in migration could be minor and not rise to the level of take. A moderate delay could influence the reproductive effort/fitness of eventual spawning or, under a worst-case scenario, a migrant delayed from moving upstream could become stranded within the mainstem Santa Clara River, and perish. Delays in migration can mean that adults arrive at spawning grounds with less energy for reproduction (Caudill et al. 2007), possibly reducing fecundity and survival to emergence of eggs. Upstream migration delays could also reduce the window of opportunity for post-spawning adults (kelts) to migrate downstream and contribute to future reproductive efforts, as was observed for iteroparous American shad (*Alosa sapidissima*) in the Connecticut River. On the other hand, in an evaluation of fish passage at dams, McLaughlin et al. (2013) cite growing theoretical justification and empirical evidence to suggest that fish passage delays are potentially important to Darwinian fitness and population dynamics but note that additional research explicitly measuring these consequences is required.

Alternatively, adult steelhead could migrate downstream and out of the Santa Clara River to wait in the ocean for another migration opportunity, or these fish may migrate upstream in a different watershed within the DPS (discussed in more detail below). The 1 adult with no subsequent migration opportunity may also wait in the ocean for another opportunity or migrate up a different watershed. Holding in the ocean or selecting an alternative watershed for migration could increase the risk of exposure to predation, or exhaustion, potentially resulting in eventual mortality. These effects would result in reduced reproductive success and increased risk of mortality or injury. Over time this may also reduce the diversity in the timing of migration by selecting against adults that may tend to migrate sooner than the general population.

However, unlike winter-run steelhead in coastal Pacific Northwest rivers, where perennially open river-mouths maintain passage potential regardless of instream flow conditions (Margolis and Groot 1991), episodic loss of passage through bar-built estuaries is common throughout the range of steelhead in California south of San Francisco Bay. Natural riverine geomorphic features can also limit migration during low-flow conditions in this climate, regardless of season. Steelhead have adapted to these environments by responding rapidly and opportunistically to high-flow events that simultaneously breach coastal beach berms and support suitable passage conditions in upstream riverine reaches (Shapovalov and Taft 1954; Moyle 2002; NMFS 2014; Stillwater and Kear 2012). This pattern is observed as far north as San Mateo County (e.g., Smith 1990; Osterback et al. 2018), and the proposed operations will not alter this dynamic (estuary habitat discussed in more detail in IA11). Indeed, during many years, adult migration must occur within relatively short windows that allow passage from the ocean to spawning tributaries and these passage windows may occur only a few times within the primary migration window from January through May. As discussed in more detail in IM3, suitable holding habitat is available within the lower Santa Clara River, and would presumably be critical to provide refuge habitat for migrating steelhead even without United's diversion operations.

Additionally, the earliest storms of the season result in flows with higher levels of suspended sediment on average. Therefore, earlier storms in a water year may be naturally prohibitive or limiting to migration of adult steelhead even without United's diversions (see Appendix E).

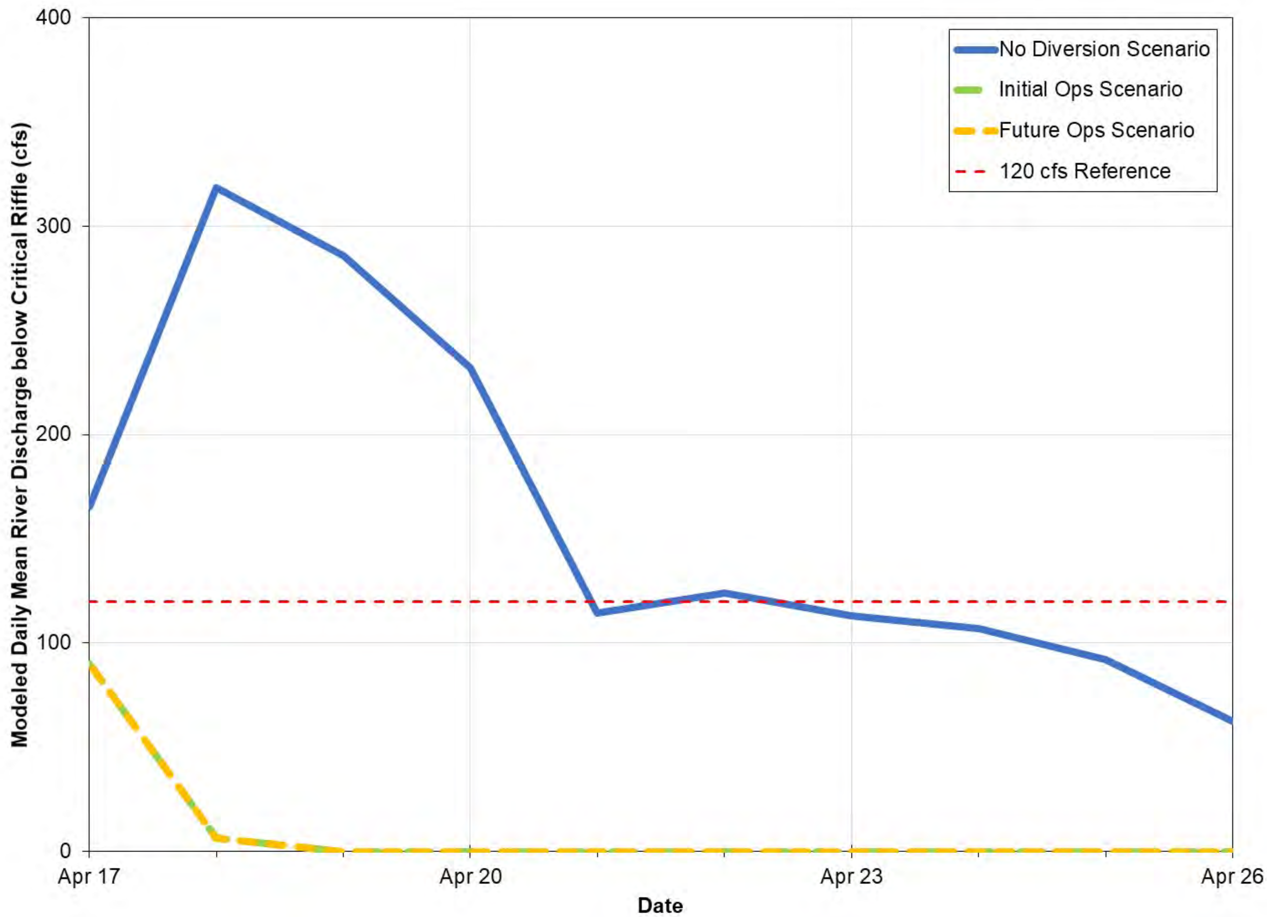
Therefore, the effect associated with alteration to the timing of migration opportunities has the potential to cause harm through reduced reproductive success, increased risk of mortality or injury, and reduced diversity of migration timing for up to 4 adults during an estimated 4 years over the 50-year permit term.

This take would be measured by monitoring the occurrence of United flow diversions during November and December and storm events that start before January 1 and carry through January 1, resulting in a reduction in flows to less than 120 cfs for three days compared to no diversion. In addition, per EMM-02, United will evaluate new data related to the adult steelhead migration period for the Santa Clara River and will track time of arrival at the Freeman Diversion of any upstream-migrating steelhead throughout the life of the ITP. EMM-02 also includes monitoring for adult steelhead that enter the lower river, but do not ascend the fish ladder, including monitoring outside the defined primary migration window in an attempt to detect adult steelhead that may be harmed and are stranded in the river because of the timing of bypass flows. Therefore, assuming a detection rate of 25 percent through EMM-02, 1 of the 4 adult steelhead would be captured, tagged, and released or relocated instead of harmed.

Impact Assessment 2: Magnitude of Flow Diversions Affecting Steelhead Adult Migration Opportunities

Adult steelhead potentially migrate upstream within the lower Santa Clara River whenever flow conditions are suitable, which is assumed to be at flows greater than 120 cfs and less than 6,000 cfs at the critical riffle. Operation of the Freeman Diversion results in diversion of flows within the primary adult steelhead migration window (January 1 through May 31). Impact Assessment 2 (IA 2, Figure 7-7) describes the consequences of reduced frequency of migration opportunities for adult migrating steelhead because of water diversions (note that IA 3 below addresses reduced duration of migratory opportunities). Figure 7-7 illustrates a flow event occurring in April 2006. Without diversions, the duration of the flow event would be around 4 days, and presumably adult steelhead could migrate up the lower Santa Clara River and past Freeman diversion to suitable spawning habitat. However, in this example, diversion operations result in flows of less than 100 cfs, preventing adult steelhead from migrating upstream through the critical riffle. If this were to occur, adult steelhead would be prevented from migrating upstream of the estuary, they could be stranded within the riverine habitat and perish, spawn in poor quality habitat, or they could locate suitable habitat within the river or the estuary to hold and wait for a subsequent suitable migration flow event, they could migrate downstream and out of the Santa Clara River to wait in the ocean for another opportunity, or locate an alternative watershed.

Figure 7-7 Water Year 2006 Santa Clara River Hydrograph Illustrating Impact Assessment 2 Based on Modeled Flows at the Downstream End of the Critical Riffle



To assess this impact, the HOSS Model was run for the 71-year record to determine how often would there have been enough water (>120 cfs) at the critical riffle but less than 6,000 cfs for at least three consecutive days (discussed in IA 1) during the primary adult steelhead migration window to migrate upstream under both no diversion and initial and future operations.

This analysis assumes that under any scenario adult steelhead would not actively swim in an upstream direction at flows greater than 6,000 cfs, which is 1,500 cfs higher than 4,500 cfs. 4,500 cfs is the average discharge in the lower Santa Clara River where it was determined it is “very unlikely” that adult steelhead actively swim in an upstream direction due to exposure to high concentrations and durations of suspended sediment (Appendix E). The extra buffer provided by an upper limit of 6,000 cfs compared to 4,500 cfs allows the effects analysis to provide a conservative estimate of the threshold where adult steelhead would be “very unlikely” to actively swim in an upstream direction. For this reason, 6,000 cfs was assumed to be the upper limit for upstream movement under no diversion. Additionally, the capacity of the proposed fishway is 6,000 cfs with 10 percent attraction flow; therefore, 6,000 cfs was assumed to be the upper limit for upstream movement during adult migration for the proposed operations as well. Based on the 71-year record, under no diversion there would be around 28 years (~56 percent of years) when 6,000 cfs would be exceeded for at least a day during the adult migratory period (averaging around 2.7 days per year) during the permit term, whereas under the proposed operations there would be the same number of years when 6,000 cfs would be exceeded for at least a day, but slightly fewer days (averaging around 2.3 days per year) during the permit term.

Per EMM-06, United will evaluate the correlation of suspended sediment concentration (SSC) and migration of adult steelhead in the Santa Clara River. The uncertainty of these effects will be evaluated by measuring the SSC at the Freeman Diversion through automated continuous monitoring, grab sampling at river transects, and collection of additional grab samples for verification and calibration purposes. Per EMM-02, United will track time of arrival at the Freeman Diversion of any upstream-migrating steelhead throughout the life of the ITP as well as additional downstream monitoring under EMM-02 and EMM-04. Therefore, the migration of steelhead at the Freeman Diversion or further downstream can be compared to SSC.

Assumptions in the effects analysis and minor model limitations overestimate the number of potentially biologically relevant passage days lost in the proposed operations. Assuming a three-day travel time from the estuary to the Freeman Diversion (as discussed above), these short storm events may not provide enough time for steelhead to make it to the Freeman Diversion or to make it to the upstream tributaries even if they make it past the diversion under no diversion. Other lost passage days occurred when there was a long storm event or multiple storm events and the proposed operations decreased flows following 18 to 30 days of migration opportunity, while the no diversion scenario continued to provide passage days beyond the already long window of opportunity that had been provided in the proposed operations. Finally, other lost passage days reflect the use of average daily values in the model versus hourly data. There are times when the Sespe Creek trigger would have been met when considering hourly data, but these triggering events were lost when using the average daily data of the model. In these cases, passage opportunity would have been provided in a real-world scenario, but this was not captured because of model limitations, resulting in an overestimate of effects.

The frequency of migration opportunities resulting in take of adult steelhead under the MSHCP is estimated to be up to seven years with no adult migration opportunities during the 50-year permit term because of the covered activities. This estimate is based on the modeled estimate of 37 percent of years (19 years) providing flows that are too low to provide three days of adult upstream passage through the critical riffle and Freeman Diversion under future operations (more opportunities under initial operations), compared with 23 percent of years (12 years) under no diversion (during the period of record, Table 7-7); for an average of 14 percent fewer migration opportunities under the proposed operations compared to no diversion. The difference of these two estimates results in a prediction of seven years during the permit term with no migration opportunities because of initial and future operations. Based on the assumptions described above, this has the potential to harm a total of 77 adults by not providing migration opportunity that would otherwise exist under no diversion during seven years of the 50-year permit term (Figure 7-5). No additional take is anticipated for kelts because of the assumption that during years of no migration opportunity, no kelts would occur in the watershed to be affected.

Table 7-7 Assumed Effect of Reduced Migration Opportunities under Future Operations

	Years 1-10	Years 11-20	Years 21-30	Years 31-40	Years 41-50	Total
Avg. annual population of migrating adults, by period	4	6	10	15	20	~550
Percent increase in lost migration opportunities compared to no diversion	14%	14%	14%	14%	14%	--
Estimated number of years with no migration opportunities during period	1.4	1.4	1.4	1.4	1.4	7
Total number adults denied migration during period	5.6	8.4	14	21	28	77

It is also possible that flows could be high enough during initial and future operations to provide adult steelhead river entry access from the ocean but then diversions reduce flow below 120 cfs, before the three-day window is complete, potentially precluding upstream migration all the way to the diversion. In this scenario, steelhead that entered the river during high flow could hold in the lower river or estuary if they were not able to exit to the ocean. These fish would have to hold until flows were suitable for migration. Holding adults would experience delayed migration with impacts described in IA1. Additional information on stranding potential is discussed in IA4.

In summary, an estimated 77 adult steelhead across 50 years may experience take through harm via migration delay that results in increased risk of mortality and increased risk of reduced reproductive success compared to no diversion. Overall, most are expected to remain in the population by two distinct pathways, either 1) migrating up another river system within the DPS, 2) returning to the ocean and migrating up the Santa Clara River in a subsequent year.

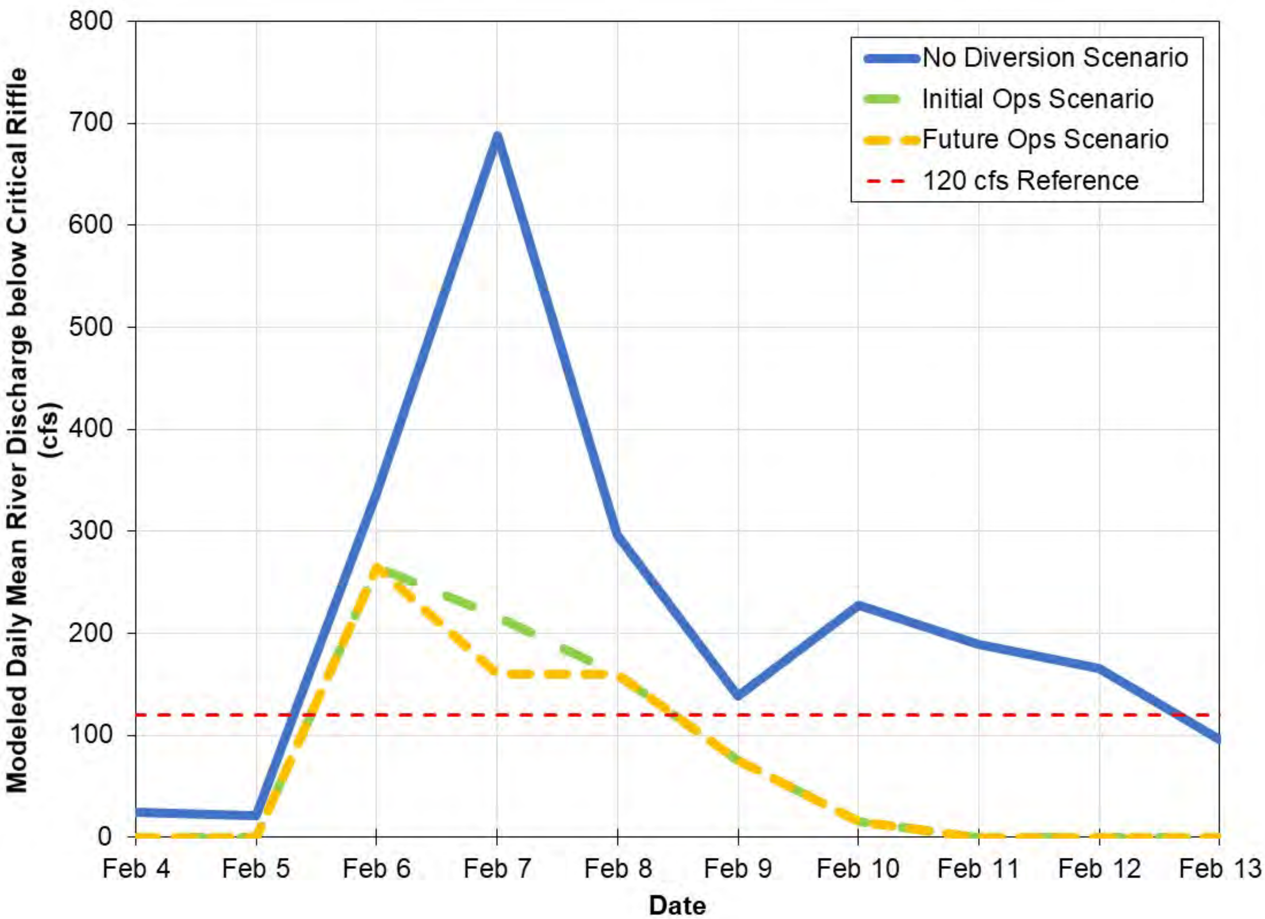
This take would be measured by monitoring the occurrence of United flow diversions during the migratory season resulting in no migratory opportunities defined as at least three days with flows greater than 120 cfs that would have been available under no diversion. Per EMM-02, United will evaluate new data related to the adult steelhead migration period for the Santa Clara River basin in addition to the information that factors into the adult instream flow commitment specified in CM 1.2.1 and CM 1.2.3. United will track time of arrival at the Freeman Diversion and in the lower river of upstream-migrating steelhead. Further, stranding potential will be monitored under EMM-04, and rescue initiated under CM 2.1.4 if conditions are deemed unsuitable for steelhead in holding locations. Therefore, assuming a detection rate of 25 percent through EMM-02, 19 of the 77 adult steelhead would be captured, tagged, and released or relocated instead of harmed.

Monitoring the occurrence of stranded adults will aid evaluation of conservation measures specified in CM 1.2.1 and CM 1.2.3 under an adaptive management framework.

Impact Assessment 3: Magnitude of Flow Diversions Affecting Steelhead Adult Migration Duration

United proposes to divert flows at the Freeman Diversion within the primary adult steelhead migration window (January 1 through May 31), resulting in reduced frequency of adult migration opportunities (as described in IA2 above), as well as reduced duration of migratory opportunities compared to no diversion. Impact Assessment 3 (IA 3, Figure 7-8) describes the consequences of reduced duration of migration opportunities on adult upstream migrating steelhead. Figure 7-8 illustrates a flow event occurring in February 2009. Without flow diversions, adult steelhead would have around eight days to migrate up the lower Santa Clara River and past Freeman Diversion to suitable spawning habitat. However, in this example, diversion operations result in a reduction in duration of the flow event, and adult steelhead would instead have around 3 days to migrate upstream past Freeman Diversion. Although 3 days is considered the minimum required duration to support suitable migration up the lower Santa Clara River, if adults were to enter on the second or third day of the flow event, the reduced duration of migration could result in similar effects to lost migratory opportunities described for IA2. To assess IA 3, the HOSS Model was run for the 71-year record to determine how many days per year there would have been enough water (>120 cfs) at the critical riffle and less than 6,000 cfs during the primary adult steelhead migration window to migrate upstream under both no diversion and proposed operations.

Figure 7-8 Water Year 2009 Santa Clara River Hydrograph Illustrating Impact Assessment 3 Based on Modeled Flows at the Downstream End of the Critical Riffle



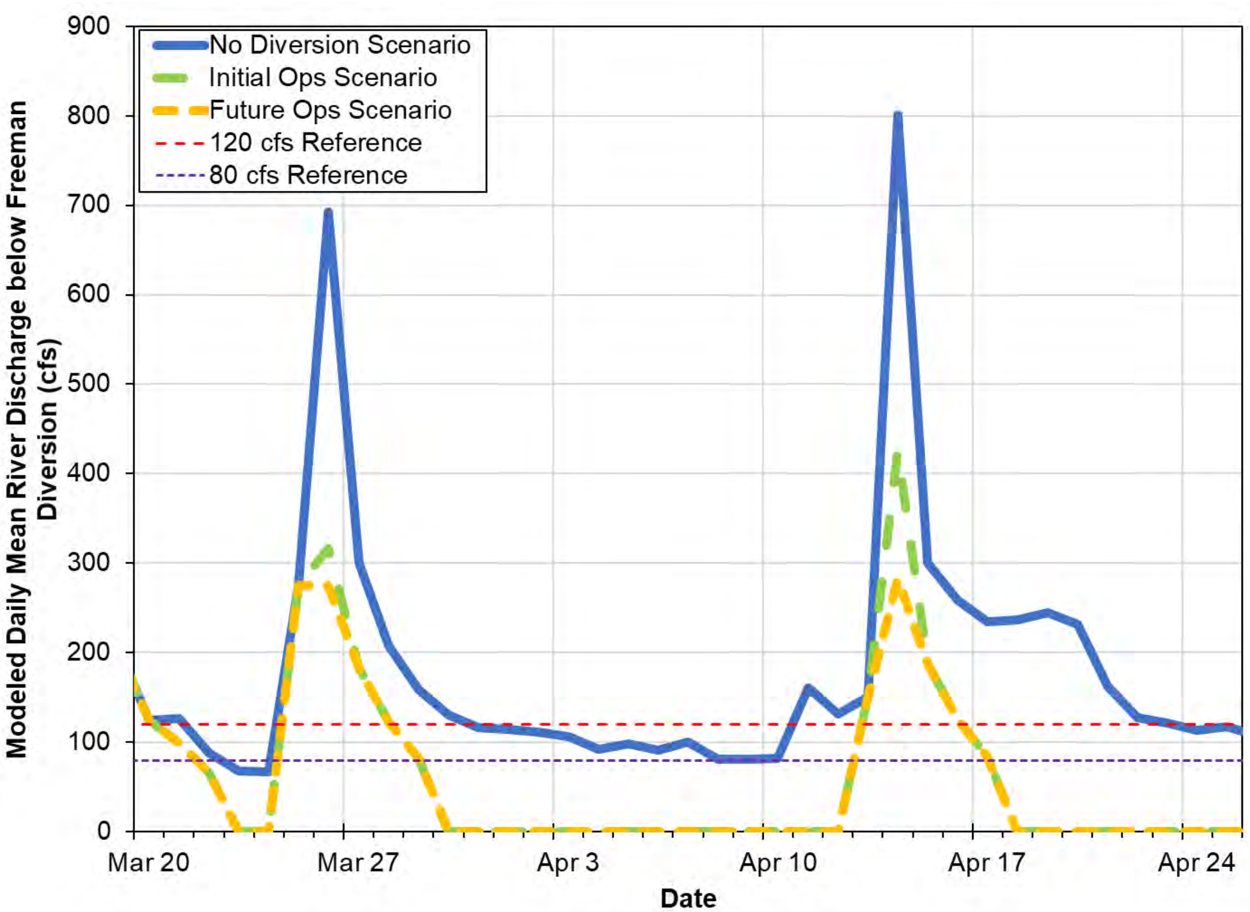
The proposed operations would reduce the duration of adult migration opportunities by up to 8 days per year on average compared to no diversion for a total estimated reduction of 400 days during the permit term. During years in which migration is possible, steelhead have the potential to migrate for an average of 34 days per year under no diversion, and 23 days per year under proposed operations, a 32 percent reduction in the number of available migration days per year compared to no diversion.

The number of adult migrating steelhead potentially affected by reduced duration flows supporting migration would depend on their occurrence during flow events and when an adult steelhead initiates migration. Based on the predicted increase in the steelhead population in the Santa Clara River, all of the average 11 adults per year would be subject to reduced duration in migration opportunity compared to no diversion.

Flows required to provide safe downstream passage of kelts through the critical riffle have not been identified, and it is assumed that the >120 cfs threshold identified for upstream migrants in the critical riffle applies equally to downstream migrating kelts. Therefore, the 8 days per year with no adult migration opportunities would also result in take of kelts from reduced migratory opportunities. Based on the assumptions described above for adult upstream migrants, there might be an estimated 2 kelts per year during the permit term experiencing reduced migratory opportunities (Table 7-1).

Reduced duration of flows greater than 120 cfs at the critical riffle also results in consequences for adult steelhead on the falling limb of hydrographs. For example, in Figure 7-9, under proposed operations, the flows are approximately 0 cfs at the critical reach on March 30, 2012, and any fish that attempted to migrate up the Santa Clara River on that day would have been prevented from migrating upstream, with the consequence of reduced migratory opportunities discussed in IA 2 above. However, also as illustrated in Figure 7-9, it is hypothetically possible that under proposed operations adult upstream migrating steelhead that enter the Santa Clara River on the March 28 or March 29, and then are located within the 10 miles of riverine habitat downstream of Freeman Diversion on March 30 when flows drop to less than 120 cfs and passage is no longer supported. Under the no diversion, baseflows continue to exceed 80 cfs downstream of Freeman Diversion, presumably providing enough flows for holding until a second high flow event providing suitable passage opportunity occurs on April 11, whereas under the proposed operations baseflows are reduced to zero, and so the second flow event is not an opportunity for passage for any fish that may be holding within the affected reach. If this were to occur under proposed operations, adult steelhead could be subjected to the effects of reduced migratory opportunities described in IA2 compared to no diversion.

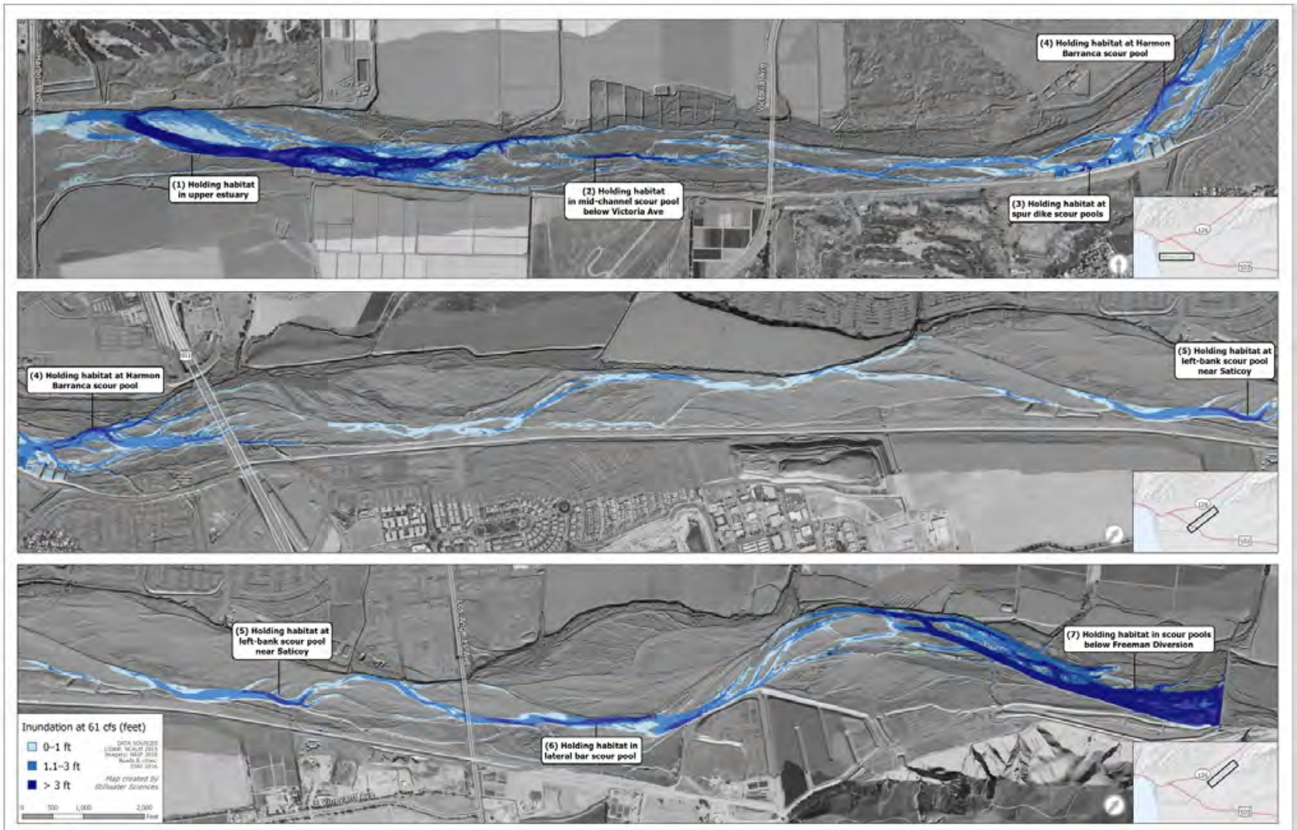
Figure 7-9 Water Year 2012 Santa Clara River Hydrograph Illustrating Impact Assessment 4



For simplicity, it should be noted that this assessment does not take into account percolation in the critical reach. To assess the effect of reduced baseflows on holding habitat downstream of Freeman Diversion, holding habitat suitability was evaluated in the 10-mile reach from Freeman Diversion downstream through the estuary. TRPA (2005) estimated that flows of greater than 70 cfs would maintain pools with depths of greater than 1 ft depth suitable for holding (following criteria in Thompson 1972), and that at flows less than 70 cfs very little suitable holding pools would be available. However, and as acknowledged in the TRPA (2005) report, there is little existing data to support these holding depths for steelhead in southern California. Most existing information on holding patterns of adult steelhead focus on summer-run populations that over-summer (i.e., hold) in pool habitats in rivers prior to spawning. These studies consistently identify holding depths of approximately 3 feet or greater (e.g., Nakamoto 1994; Baigún, C.R., 2003), but it should be noted that greater holding pool depths may be required for steelhead holding during the summer months compared to the winter months as would be relevant to Santa Clara River. Steelhead holding in summer months may need the extra depth to ensure a thermocline remains intact to provide a thermal refuge. For this analysis it is assumed that 1 foot could be considered a minimal depth for short-term holding (hours to a few days), but depths >3 feet would be required for steelhead holding for longer-periods of time (such as between storm events that can last days to weeks, as illustrated in Figure 7-10).

Figure 7-10 illustrates potential holding pools with depths greater than 3 ft based on 2015 LIDAR data at 61 cfs, which is a flow for which transect measurements are available to establish water surface. Since there are several potential holding pools apparent at 61 cfs, this analysis assumes that 80 cfs would reliably provide suitable holding habitat within holding pools in the reach downstream of Freeman. Pool numbers 2, 4, 5, and 6 are likely to be transient depending on the channel conditions and may no longer exist under current conditions. The most consistent holding habitats include the lagoon (pool number 1, discussed below) and the pool immediately below the Freeman Diversion (pool number 7).

Figure 7-10 Holding Pools in Santa Clara River Downstream of Freeman Diversion at 61 cfs in 2015.



Note: Channel morphology based on 2015 LIDAR and water surface measurements at 61 cfs at the Montalvo Gage (USGS 11114000).

Steelhead presumably migrate quickly (~3 days) through the lower Santa Clara River, and thus any steelhead holding below the Freeman Diversion are likely individuals that were not able to pass the Freeman Diversion. Based on the assumption that any steelhead holding downstream of the Freeman Diversion are those that were unable to pass the Freeman Diversion, it follows that the pool below the Freeman Diversion would be the most likely location to encounter ‘holding’ steelhead following a flow event. The pool downstream of Freeman Diversion has existed for at least the period of 2010 through 2019, with suitable depths (> 3 ft) during most of the winter period following at least one flow event at the diversion. However, it has been observed in the past that at times this pool becomes full of sediment and dry for months at a time before high flow events re-establish it.

To assess the effect of flow diversions on baseflows following migration opportunities under Proposed Operations, the HOSS Model was run for the 71-year record to determine the median number of days per year having flows 80–120 cfs under the no diversion scenario that would reduce to <80 cfs under the Initial and future operations scenarios. Based on this analysis, the median number of days per year having flows 80–120 cfs under the no diversion scenario that would reduce to <80 cfs under the initial and future operations scenarios would be 41 days (and 51 on average). Most (median of 37) of these days (and 47 days on average) would be within a week of a flow event high enough (> 120 cfs) to support adult steelhead migration far enough up the Santa Clara River to be holding within the lower Santa Clara River and in a potentially vulnerable position when flows recede to less than 80 cfs.

Proposed operations are predicted to result in a reduction in baseflows capable of providing suitable holding habitat on average 47 days per year. However, as described above, there are very few suitable holding pools within the lower Santa Clara River. The Santa Clara River Estuary (pool number 1 in Figure 7-4) is the most likely highly suitable holding habitat for adult steelhead in the lower Santa Clara River. This is consistent with estuary/lagoons throughout the range of winter-run steelhead, which are commonly observed to support adult steelhead staging prior to migrating upstream to spawning habitat. Holding habitat within the estuary is not sensitive to flow diversions per se, and rather is directly influenced by the sand-bar being either open or closed. When the Santa Clara Estuary sand-bar is open the estuary drains to a minimum pool, which can vary based on conditions but tends to continue to provide extensive holding habitat. For example, during the 2014–2016 period the lagoon deep (> 3 ft), open water area ranged from approximately 4 to 50 acres when the sand-bar was open (Stillwater Sciences 2018). When the estuary mouth berm is closed the estuary tends to fill rapidly toward achieving an equilibrium state, and extensive (around 100 acres) of deep (> 3 ft) open water habitat suitable for steelhead holding is provided (Stillwater Sciences 2018). Based on an assessment of beneficial uses in the estuary (Stillwater Sciences 2018), this habitat is not only suitable in terms of water depth and velocity for rearing, based upon recommended ranges in reviews by Boughton et al (2015), it also has suitable temperature (<29ºC annual maximum) and dissolved oxygen (DO; >6 mg/L) to support steelhead rearing/holding under closed-mouth conditions. Additionally, salinity is temporally variable, with levels during closed-mouth periods typical of freshwater or oligohaline brackish environments, and periods of higher salinity driven by tidal exchange during open-mouth conditions. During the period that adult steelhead holding would be most likely (January through May) conditions are generally highly suitable for adult steelhead within the estuary.

While flows suitable for holding downstream of Freeman Diversion are predicted to be reduced because of operations, adult steelhead are not expected to holdover in the lower mainstem for extended periods of time as is common for northern stocks in mainstem rivers (Hockersmith et al. 1995, Hooton and Lirette 1986), but instead are expected to utilize the lower mainstem as a migration corridor (Moore 1980, Puckett and Villa 1985, NMFS 2002) and continue their migration upstream closer to their ultimate spawning area in upstream tributaries. There is a paucity of research on migration behavior of winter-run steelhead in Southern or Central California. Despite the lack of evidence, it is reasonable to assume that steelhead would not hold for long durations in lower sections of the Santa Clara River under natural conditions. This assumption is based on the risks associated with holding in areas of rivers with variable (or no) flow. Low flows, even under no diversion, would expose fish to sub-optimal conditions (low dissolved oxygen, high temperatures and increased predation risk). There is also uncertainty as to the timing of migration opportunities (i.e., rain events) in these rivers, which could occur days to weeks to months apart. Hence, in theory, steelhead holding behaviors in intermittent river sections would not be favored by natural selection.

The effect associated with fewer migration and holding days for upstream migrating adults and downstream migrating kelts is increased risk of mortality and reduction of anadromous life history production in the Santa Clara River. The migration timing of steelhead adults relative to storm events is likely critical in rivers with highly dynamic hydrologic regimes such as the Santa Clara River. The Santa Clara River steelhead is a winter-run population that are typically ocean-maturing as described by McEwan (2001). Because of their reliance on intermittent storm events, the upstream migration by adult steelhead is opportunistic (Moyle et al. 2008). Lang and Love (2014) highlighted the relatively short duration of migration opportunities in the DPS relative to more northern populations, suggesting that any reductions in duration of fish migration opportunities over the already brief migratory opportunities would have a disproportionate impact on southern populations. This may be an even more pronounced effect for the kelt life history, which relies on downstream migration opportunities to be prolonged enough to migrate upstream, spawn, and then successfully migrate downstream to the ocean; often during the later portion of the migration season in March and April. Natural riverine geomorphic features can also limit migration during low-flow conditions in this climate, regardless of season. Steelhead have adapted to these environments by responding rapidly and opportunistically to high-flow events that simultaneously breach coastal beach berms and support suitable passage conditions in upstream riverine reaches (Shapovalov and Taft 1954, Moyle 2002, NMFS 2014, Stillwater and Kear 2012). This pattern is observed as far north as San Mateo County (e.g., Smith 1990, Osterback et al. 2018), and the proposed operations will not alter this dynamic. Indeed, during most years, adult migration in unimpaired southern California DPS watersheds must occur within relatively short windows that allow passage from the ocean to spawning tributaries and these passage windows may occur only a few times within the broader migration window from January through May. In the absence of diversions, adult steelhead that are unable to migrate would presumably hold within suitable pools in the lower Santa Clara River until subsequent opportunities occur. Proposed operations are predicted to reduce baseflows, resulting in fewer holding opportunities for migrating adults. The result is that adult steelhead that are unable to migrate past the Freeman Diversion during reduced flow events would have to fall back to the estuary, could become stranded and die, may attempt to spawn in poor quality habitat, or become exposed to predation or poaching. Aside from staging in the estuary to await additional migration opportunities, the outcome would be increased risk of mortality and reduced anadromous production of steelhead. Fewer migration days may also reduce the diversity in the timing of migration and reduce the resiliency of the population to disturbance.

The effects associated with alteration to the duration of migratory opportunities compared to no diversion is 8 fewer days per year of adult steelhead migration opportunity. Although all 11 adults migrating per year are subject to 8 fewer days to migrate per year compared to no diversion, it is unknown if this effect rises to the level of take for these individuals.

Additionally, the effects associated with alteration to the duration of migratory opportunities compared to no diversion is 47 days per year reduced suitable holding conditions following a suitable passage flow during the 50-year permit term. However, adults are not anticipated to hold in the affected reach so no take is reasonably certain to occur.

This take would be measured by monitoring the occurrence (days) of United flow diversions during the migratory season resulting in no adult migratory opportunities when flows would have exceeded 120 cfs under no diversion. Detection of adults holding in pools will be evaluated in EMM-02. Stranding potential because of reduced duration of migratory opportunities will be monitored under EMM-04, and rescue initiated under CM 2.1.4 if conditions are deemed unsuitable for steelhead in holding locations. Monitoring the occurrence of stranded adults will aid evaluation of conservation measures specified in CM 1.2.1 and CM 1.2.3 under an adaptive management framework.

Impact Assessment 4: Flow Recession Rates Affecting Adult Migration

Components of the proposed operations can result in alterations of the no diversion hydrograph recession rates. Operations that potentially result in recession rate alterations (sometimes faster and sometimes slower) are initiating diversions (also known as a “turn-in”); transitioning between the Variable Flow Protocol and the Base Flow Protocol; the hourly “step-down” in instream flows prescribed in the Variable Flow Protocol; the pulse of flow and subsequent decrease in the Pulse Protocol; the pulse of flow and subsequent decrease during sediment sluicing operations. The effects of the Pulse Protocol and the sediment sluicing operations are described in other sections of the Effects Analysis (IA5 and Section 7.3.1 respectively). Impact Assessment 4 (IA 4, Figure 7-11) evaluates the impacts of the other diversion and instream flow operational protocols other than the Pulse Protocol that may affect recession rates and describes the potential consequences of altered recession rates from proposed operations on adult upstream migrating steelhead.

Figure 7-11 illustrates a flow event occurring in January 2017. As United initiates diversions, the model predicts there would be a notable divergence in recession rates between no diversion and proposed operations when flows drop from about 700 cfs to around 450 cfs. Under no diversion, this drop takes around 13 hours, with a rate of decline of around 0.4 inches per hour; whereas under the proposed operations the same drop in flows takes around 4 hours, with a rate of decline of around 1.4 inches per hour. Under proposed operations, the rate of recession is faster than under no diversion. A similar divergence occurs on the January 26, when United would be transitioning between the Variable Flow Protocol and the Base flow Protocol. Proposed operations include measures to minimize increased recession rates, through implementation of the Turn-In-Rate Protocol and the Transition Protocol, as described in CM 1.2.1 in Chapter 5. Figure 7-12 illustrates that there are small differences in recession rates resulting from proposed operations, especially at flows less than 2,500 cfs. At flows greater than 2,500 cfs there is a slight increase in recession rates under the proposed operations, relative to upstream (i.e., unaltered) river flows. Flows greater than 2,500 cfs are not common in lower Santa Clara River, occurring on average during the primary steelhead migration period around 4 days per year under initial operations and 3 days per year under future operations.

Figure 7-11 Water Year 2017 Santa Clara River Hydrograph Illustrating Impact Assessment 4 Based on 15-Minute Data and Modeled Flows Immediately Downstream of Freeman Diversion

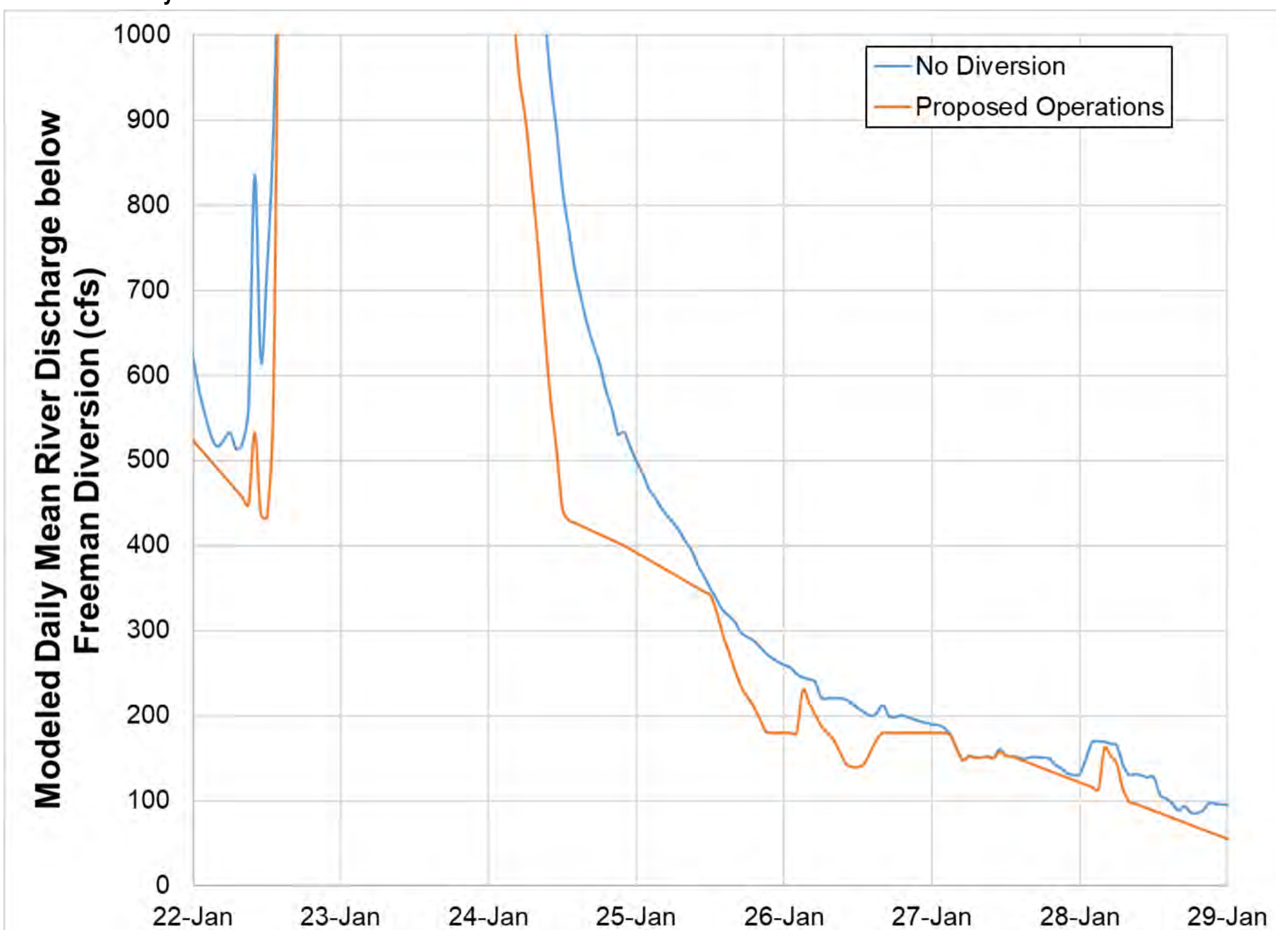
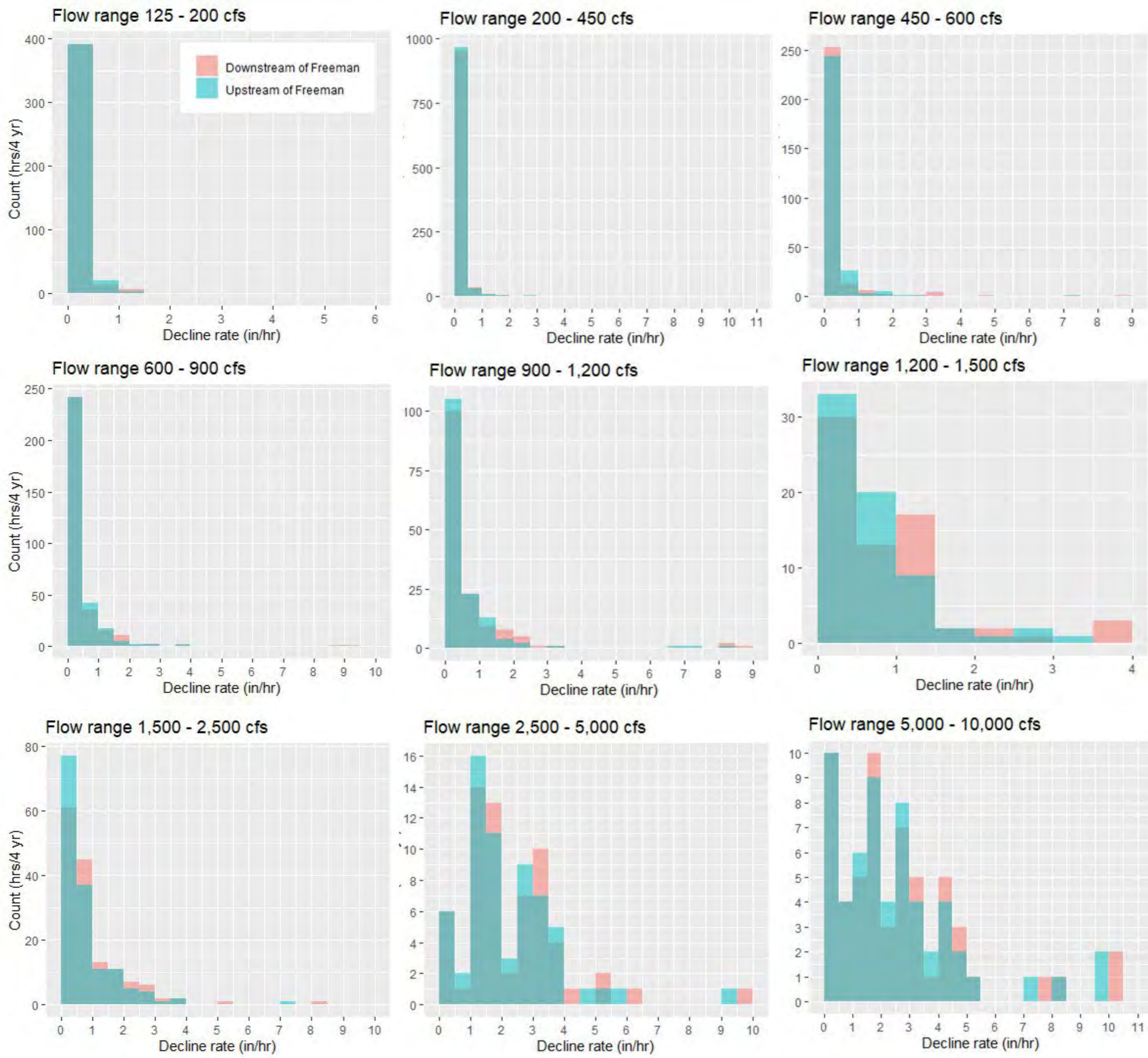
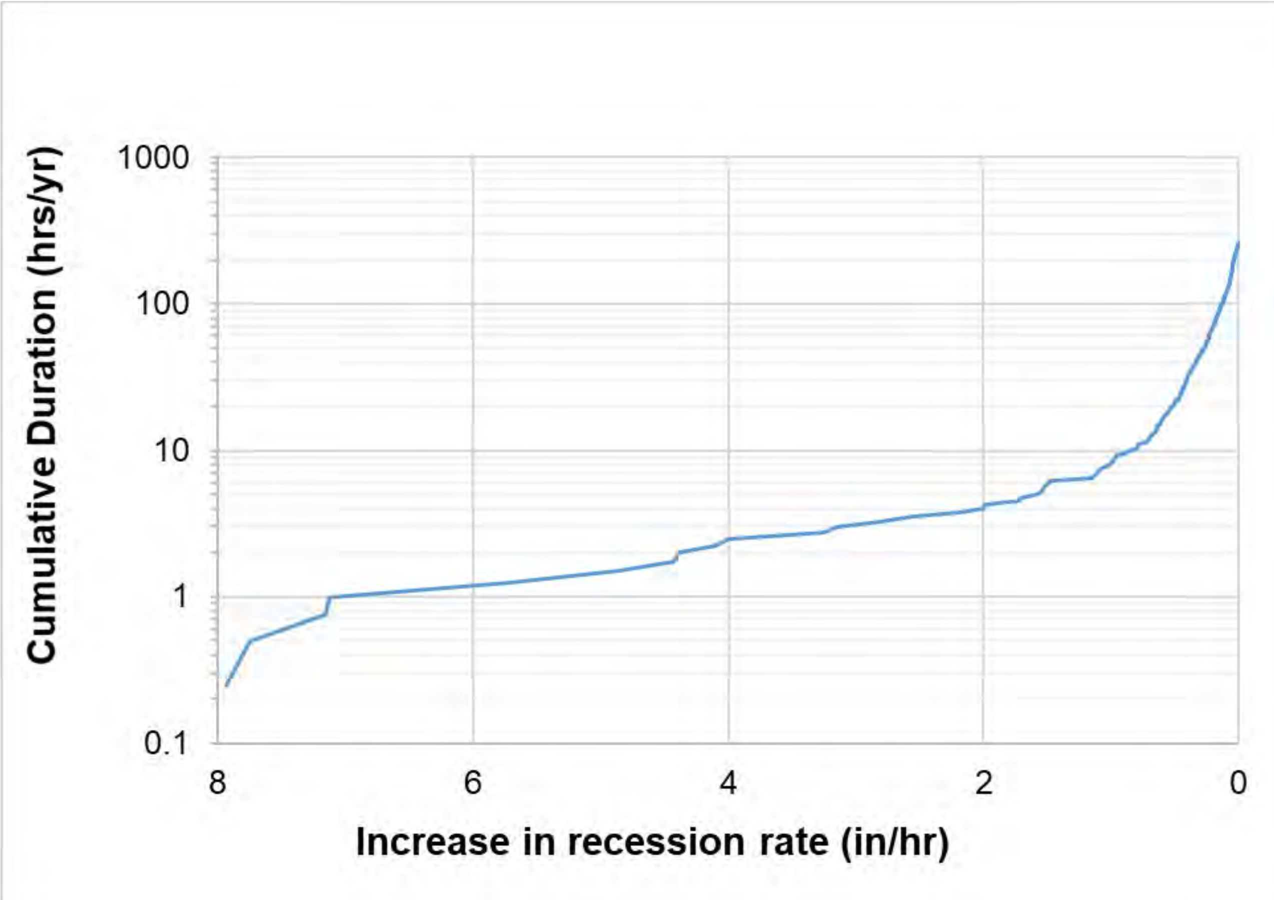


Figure 7-12 Recession Rates (Total Hours During Four-Year Record) in Santa Clara River Upstream (observed) and Downstream (modeled proposed operations) of Freeman Diversion, Based on 15-minute Data from December 1, 2016 to May 10, 2020



Minor increases in flow recession rates at the higher range of flows (>2,500 cfs) in theory may have adverse effects on migrating adult steelhead, but these effects are not expected to result in substantial changes in essential behavior patterns, which is the threshold that defines take in the form of "harm." This is in large part due to the low duration of occurrence of "sudden" drops in flows. For example, based on the 15-minute data from 2017 through 2020, there are around four hours per year when the proposed operations (including all operations resulting in increased recession) result in increased rate in recession greater than 2 inches/hour (Figure 7-13). Although the 15-minute data is only available for 4 years of operations, these years are a good representation of the variation in rainfall, runoff, and type of storm events experienced in the Santa Clara River. Water year 2017 represents a wet year following a drought period, and water year 2018 a moderately dry year. Water years 2019 and 2020 represent wet to moderate years, respectively, with increasing amounts of baseflows.

Figure 7-13 Observed Increased Recession Rates as a Result of Proposed Observations (Cumulative Per Year) in Santa Clara River Downstream of Freeman Diversion, Based on 15-minute Data from December 1, 2016 to May 10, 2020



Migrating adult steelhead are routinely subjected to varying streamflow and conditions as they migrate upstream in a natural river environment, but unless physically thwarted by a barrier, waterfall or channel structure where water depths are too shallow or velocities too high, they will generally continue to migrate. Freshets (short duration high rainfall events) have been cited and widely accepted as a cue to upstream migration for a variety of salmonids (Vadas 2000; Quinn 2005) including southern California steelhead (NMFS 2008). In a study involving direct observations of numerous adult steelhead migrating upstream through critical riffles in the Eel River, CA, under varying stream flows, VTN (1982) reported that steelhead tended to hold when flows were stable and migrate during changes in flow increasing or decreasing (IA5 addresses effects of stable flows on migration). Lang et al. (2004) PIT tagged 45 adult steelhead and monitored upstream migration through a culvert. They observed that adults tended to migrate upstream through the culvert (fish passage obstacle) on the falling limb of the hydrograph, during the recession flows. Shapovalov and Taft (1954) report that adult migrating steelhead ascend both on the rising and falling limb of the hydrograph but cease movement during peak floods. It was observed that steelhead migrating in Waddell Creek during a storm or series of storms would stop migrating as a result of a sudden drop in flows. These fish remained "holed up" until even a small increase in flows resulted in fish either ascending the stream or spawning within the holding pool. Shapovalov and Taft (1954) noted that steelhead appeared less exacting than coho salmon in regard to the flows conditions under which they would migrate.

Because of the relatively minor change in recession rates during the portion of the hydrograph in which adult steelhead typically migrate and the flexibility in migration behavior of steelhead in response to recession rates, there is no take of adult migrants associated with increased recession rate anticipated under the proposed operations. However, EMM-02 and EMM-04 both include monitoring for adult steelhead stranded in the affected reach or isolated in pools. If any adults are detected during these EMMs in the lower river and they are at risk of mortality, then United would implement CM 1.2.5 to rescue and relocate the fish and United would consult with NMFS on potential adjustments to the conservation strategy under the adaptive management framework (see Chapter 6).

Impact Assessment 5: Reduced Magnitude and Fluctuations of Flows Affecting Steelhead Adult Migration Behavior

Under the Initial and Future operations United may divert flows up 375 cfs during the adult steelhead migration season (January 1 through May 31), provided that flows within the critical riffle are greater than 160 cfs. Therefore, within a Santa Clara River flow range of 160 to 535 (i.e., 375 cfs diverted flow plus 160 cfs migration flow) under Initial Operations, and 160 to 910 cfs (i.e., 750 cfs diverted flow plus 160 cfs) under Future Operations, the magnitude of flows downstream of Freeman Diversion will not substantially exceed 160 cfs. IA 5 describes two consequences of this reduction in flows during potential adult upstream migration downstream of Freeman Diversion, including 1) reduced water depth available for migration, and 2) reduced fluctuations in flows (Figure 7-14).

Figure 7-14 Water Year 2009 Hydrograph Illustrating Impact Assessment 5 Based on Modeled Flows at the Downstream End of the Critical Riffle

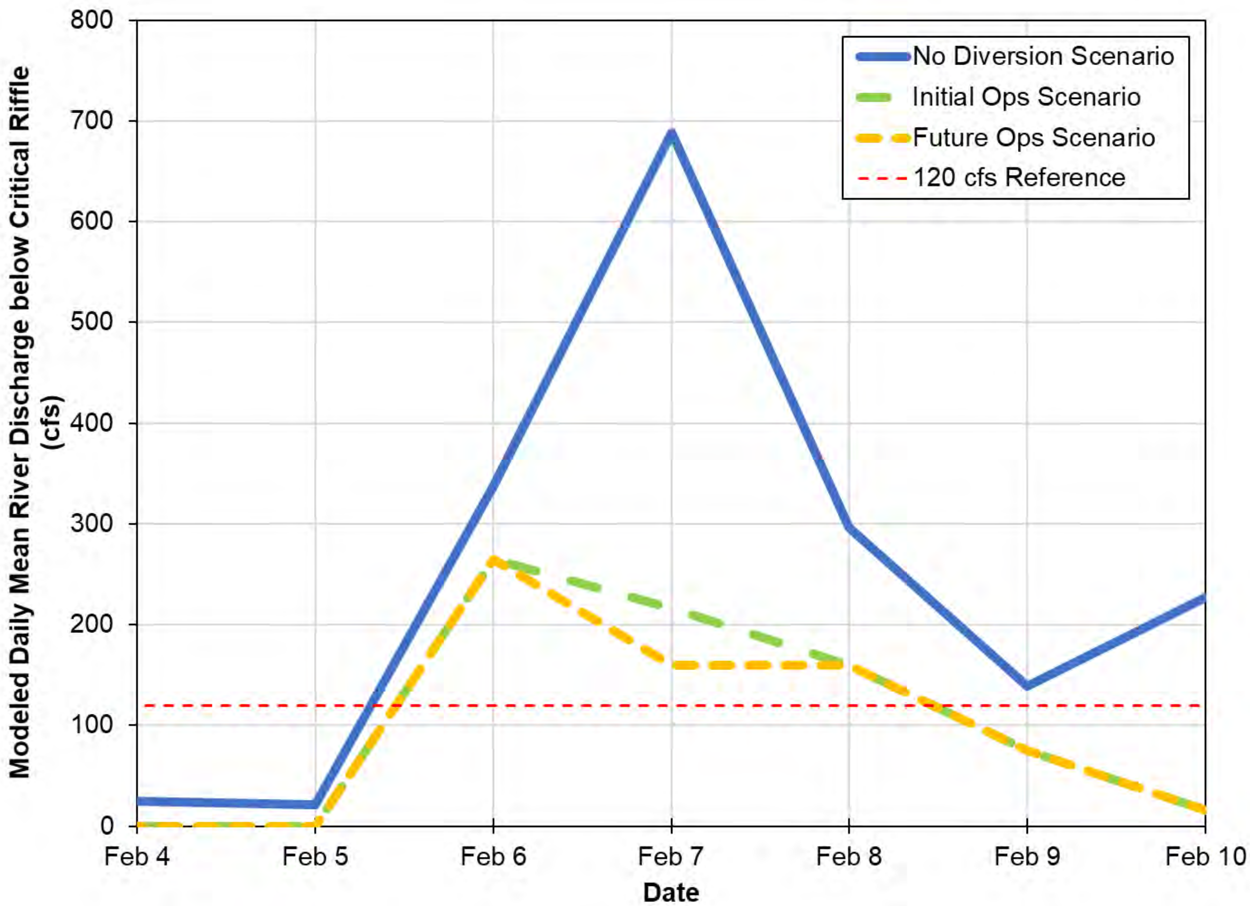
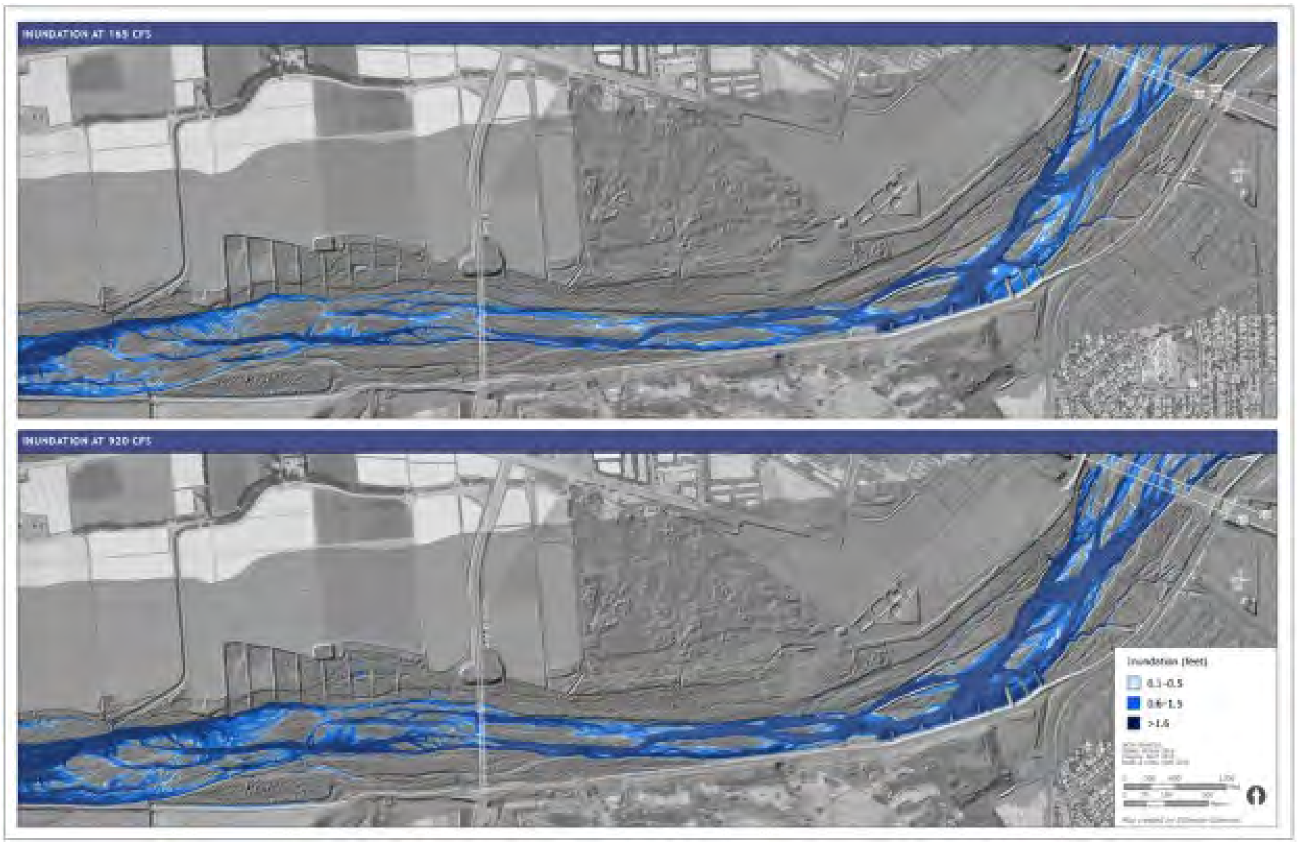


Figure 7-14 illustrates a flow event occurring on February 5, 2009. Without flow diversion operations flows peak near 700 cfs and exceed 500 cfs for over a day. Under the initial and future operations flows peak at less than 300 cfs and are closer to 200 cfs for most of the flow event. Under proposed operations, migrating fish have less water depth and a narrower river channel for migration than would occur without flow diversions (Figure 7-15). Once flows in the Santa Clara River exceed 535 cfs (under Initial Operations), or 910 cfs (under Future Operations), this effect is ameliorated, and high magnitude of flows will occur downstream of Freeman Diversion. To assess IA 5, the HOSS Model was run for the 71-year record to determine how many days per year there would have been reduced flow magnitude to 160 cfs at the critical riffle during the primary adult steelhead migration window for at least three days (a migration event) under no diversion and proposed operations.

Figure 7-15 Water Depth and Inundated Surface Area within the Santa Clara River Downstream of Freeman Diversion Dam at 165 cfs and 920 cfs



Note: Channel Morphology Based on 2015 LIDAR; Water Surface Measurements Based on Measurements at Montalvo Gage (USGS 11114000) at 165 cfs and 920 cfs.

Under Initial and Future operations there are a median of 14 days per year when peak flows are “dampened” by diversions during potential migration events, which is around 60 percent of the suitable passage days per year. For these 14 days per year, take of adult migrating steelhead could occur because of reduced migration habitat. Although minimum fish passage requirements through the critical riffle are achieved at 120 cfs, and the proposed operational minimum of 160 cfs provides an additional buffer to provide passage, presumably there is an additional benefit to fish migration that occurs when flows exceed 160 cfs. As illustrated in Figure 7-15, water depths are sufficient (>0.6 ft) through riffles to provide adult upstream passage. However, as flows increase (in this example from 165 cfs to 920 cfs) there is increased channel width providing improved passage opportunities, increased water depth through shallow riffles, and access to inundated side channels that may provide temporary holding or passage habitat. It is also apparent in Figure 7-15 that, despite an increase in flow of over 755 cfs (similar to proposed future operations), the apparent increases in water depth and additional inundated surface area are not substantial. There is uncertainty in the science as to whether less migratory habitat would rise to the level of take compared to no diversion, however it is possible that less migratory habitat may slow migration (for example, possible three days to reach Freeman Diversion instead of two under no diversion).

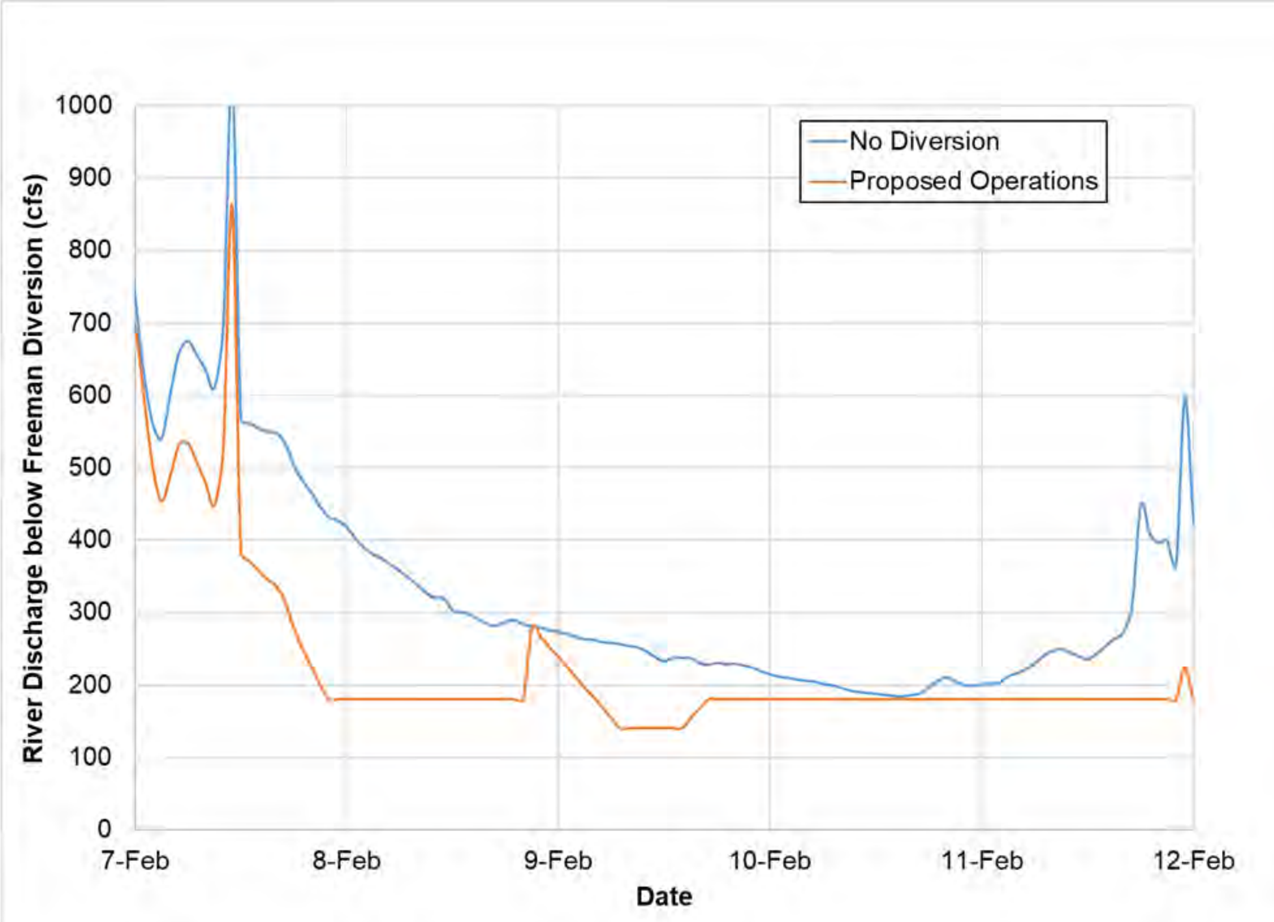
The consequence of a slower migration rate is that, under some flow events, adult steelhead would have fewer migration opportunities. For example, if suitable flows to support migration were available for 2 or 2.5 days and with highly suitable migration conditions adult steelhead could reach and pass Freeman Diversion, whereas at a slightly slower migration rate perhaps three days would be required for migration (three days of migration is assumed for all reported analysis here). If this were to occur, fewer migration opportunities would have similar effects to those described for IA2. In addition, if adults were to migrate slower at the reduced flows, there would be an effect similar to a shorter duration of migration opportunity, coincident with similar effects as described for IA3.

There is less certainty in quantifying or monitoring this effect. However, stranding could result from shorter duration migrations as described in IA3, and thus the same monitoring as described for IA3 will be applied (i.e., EMM-04), and rescue initiated under CM 2.1.4 if conditions are deemed unsuitable for steelhead in holding locations. Given future improvements in recruitment for adult steelhead, radio telemetry could be considered as an approach under EMM-02 to monitor movement patterns in response to flows below the Freeman Diversion. Monitoring the occurrence of stranded adults will aid evaluation of conservation measures specified in CM 1.2.1 and CM 1.2.3 under an adaptive management framework.

In addition, the potential effect of reduced magnitude of flows during migration, fluctuations in flows may also be reduced by proposed operations. Under the initial and future operations, United would divert flows up 375 cfs during the adult steelhead migration season, provided that flows within the critical riffle are greater than 160 cfs. Therefore, within a Santa Clara River flow range of 160 to 535 (i.e., 375 cfs diversion plus the 160 cfs for passage) under initial operations, and 160 to 910 cfs (i.e., 750 cfs for operations in the addition the 160 cfs) under future operations, flows through the critical riffle could be relatively "stable" at around 160 cfs. However, as described in CM 1.2.1, the proposed operations include the Pulse Protocol, designed to increase flow fluctuations based on a set of criteria presented in CM 1.2.1 in Chapter 5. Impact Assessment 5 (IA5, Figure 7-16) evaluates the consequences of reduced fluctuations in flow on adult migrating steelhead.

Figure 7-16 illustrates hypothetical flows from February 8 to 11, 2017. During this period, under no diversion, flows would fluctuate from around 400 cfs to around 180 cfs, and, under the proposed operations, flows would fluctuate from around 280 to 140 cfs. Adult steelhead migrating upstream during this period would have enough flows to support passage through the critical riffle, and fluctuating flows intended to stimulate movement of holding adults. Under proposed operations, flows would continue to fluctuate during this period, albeit to a lesser degree than under no diversion. To assess this impact, the HOSS Model was run for the 71-year record to determine how often flows would be within this "stable" range under initial and future operations. For this analysis it was assumed that if flows do not fluctuate for at least three days they would be considered "stable," and thus have the potential for effects on adult steelhead migration behavior. Under initial or future operations, stable flows would occur for a median of 14 days per year. Therefore, the operations described in CM 1.2.1 would be implemented to address and reduce stable flows for a median of 14 days per year.

Figure 7-16 Water Year 2017 Hydrograph Illustrating Proposed Operations to Reduce "Stable" Flows



Steelhead respond to a variety of environmental cues during their reproductive migrations including chemical odors (e.g., natal olfactory cues, odors from conspecifics), temperature, photoperiod, geomagnetic fields, water quality, and flow (Dittman & Quinn 1996, Thorstad et al. 2008, Bett & Hinch 2016). Increased flow, such as freshets (short duration high rainfall events), have been cited and widely accepted as a cue to upstream migration for a variety of salmonids, including steelhead (NMFS 2008), once they enter freshwater (Jonsson 1991, Vadas 2000, Quinn 2005). It has been postulated that historical flow patterns provided important selective pressure associated with species- and population-specific adaptations in morphology and migration behavior, such as river entry timing (Quinn 2005).

Steelhead in southern California evolved in river systems characterized by highly variable flows. Steelhead enter these rivers in the winter and spring when storms create short pulses of high flows that breach sandbars causing rivers mouths to connect with the ocean. Periods of low flows can occur between flow pulses in these rivers with sections of rivers becoming dry in some locations. In the summer and fall 'dry' season, large sections of rivers can be completely dry limiting migration opportunities. Due to the risks associated with migrating in 'flashy' rivers, flow is thought to be a critical cue for upstream migrations of steelhead in southern California (NMFS 2008).

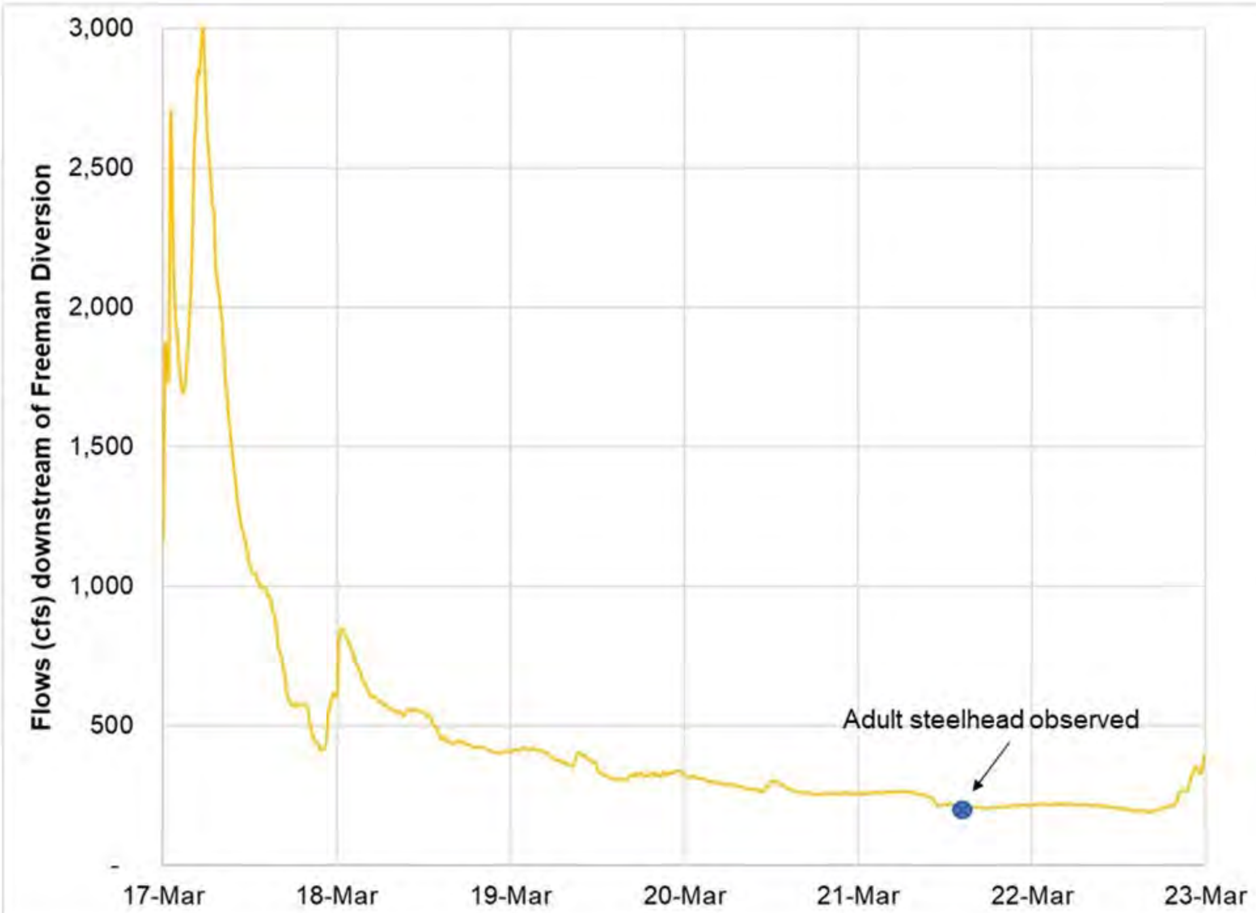
Flow provides a directional cue for upstream migration because adult salmon display positive rheotaxis, and salmon rely on olfactory cues transported within river flow to navigate to natal waters for reproduction (termed 'homing') (Quinn & Dittman 1990, Thorstad et al. 2008). It is perhaps not surprising then that upstream migrations of salmon have been associated with increased flow in many studies [see reviews by

Banks (1969), Jonsson (1991), Thorstad et al. (2008), and Taylor & Cooke (2012)]. However, high flows can impede migration or result in migration delay due to increases in locomotor activity required during periods of high flows (Cocherell et al. 2010, Peterson et al. 2017). Migration can also be impeded when flows are low due to exposure of barriers, reduction in connectivity, and changes in water properties (e.g., higher temperatures and lower dissolved oxygen) (Thorstad & Heggbert 1998).

As discussed in IA4, it is generally thought that adult steelhead in southern California migrate upstream during the falling limb, and to a lesser extent, the rising limb of a storm hydrograph, and that migration does not occur at high flows due to high water velocities, high suspended sediment concentrations, and/or high debris loads associated with peaks in the hydrograph. In spring 2020, an adult steelhead was observed at the Freeman Diversion facility migrating upstream following around 2 days of relatively stable flows (Figure 7-17).

Operations are proposed to reduce the period of time during which flows downstream of Freeman Diversion would be stable. In regulated rivers, pulsed flows have been used to stimulate river entry of fish holding in estuaries (Huntsman 1948, Hunter 1959) and flow is used to attract fish to and facilitate movement within fish ladders and traps at dams (Thorstad & Heggberget 1998, Thorstad 2003, Keefer et al. 2006). Although many studies have shown elevated river flow is associated with increased upstream migration of salmonids (Hunter 1959, Erkinaro et al. 1999, Keefer et al. 2006, Hasler et al. 2014, Jones & Petreman 2015, Vehanen et al. 2019), positive relationships between flow and upstream migration have not been consistently observed within and among studies (Thorstad & Heggberget 1998, Erkinaro et al. 1999, Thorstad 2003, Salinger & Anderson 2006, Strange 2007, Hasler et al. 2014, Jones & Petreman 2015, Peterson et al. 2017). For example, summer-run Chinook salmon (*O. tshawytscha*) showed increased upstream migration rates in response to three out of 11 experimental pulse flow events with no clear indications as to why migration rates increased only during certain flow pulses (Hasler et al. 2014). In another study, fall-run Chinook salmon passage increased only briefly immediately following flow pulses and passage rates did not increase after flow reached some threshold value (Peterson et al. 2017). Other researchers have observed upstream migration increases with both increasing and decreasing flow (Shapovalov & Taft 1954). Few studies have examined how the rate of flow change influences migration, but it has been acknowledged as potentially contributing to observed behaviors (Jones & Petreman 2015).

Figure 7-17 Adult Steelhead Observation and Flows Downstream of Freeman Diversion in Water Year 2020



With the implementation of the Pulse Protocol, stable flows are not anticipated to occur for long enough periods of time to reduce migration rate of steelhead, and therefore no take is predicted. However, due to the uncertainty in the effectiveness of the flow pulses promoting steelhead migration, United will track time of arrival at the Freeman Diversion of any upstream-migrating steelhead throughout the life of the ITP under EMM-02 and can compare arrival time with flow abundance and rate of change. Downstream monitoring under EMM-02 and EMM-04 could provide additional information on the relationships of flow change and movement patterns of adult steelhead. Information collected through these monitoring activities will be used to inform adult instream flow commitment specified in CM 1.2.1 and CM 1.2.3 under the adaptive management framework.

Impact Assessment 6: Magnitude of Flow Diversions Affecting Frequency of Steelhead Smolt Migration Opportunities

Steelhead smolts, fry, and juveniles generally migrate from the Freeman Diversion to the estuary during the primary migration window (driven by median day length) following flow events that connect key tributaries (e.g., Sespe and Santa Paula creeks) to the mainstem, and when instream flows are suitable in the lower Santa Clara River (Booth 2020). Although, the minimum flow to support migration from upstream tributaries to the Freeman Diversion has not been rigorously studied, the lowest flow at which fish have been detected at the facility is 6 cfs; therefore, it was conservatively assumed that flows greater than 6 cfs support downstream migration within the lower Santa Clara River at the Freeman Diversion.

The proposed operations would sometimes result in flows less than the 80 cfs required to support migration through the critical reach (Figure 7-18) during the primary migration window (March 15 – May 31; impacts on smolts migrating outside of the primary smolt migration window is assessed in IA8). Per Conservation Measure 1.2.2, United will implement a Smolt Migration Protocol (SMP) to facilitate downstream migration of steelhead juveniles in the Santa Clara River downstream of the Freeman Diversion through the affected reach and into the estuary. When flows at the critical reach cannot be sustained above 80 cfs for 5 days, then CM 1.2.5 will be implemented to trap downstream migrating steelhead at the Freeman Diversion and transport them to the estuary or other appropriate release site directed by NMFS.

Figure 7-18 Water Year 2010 Hydrograph Illustrating Impact Assessment 6 Based on Modeled Flows at the Downstream End of the Critical Riffle

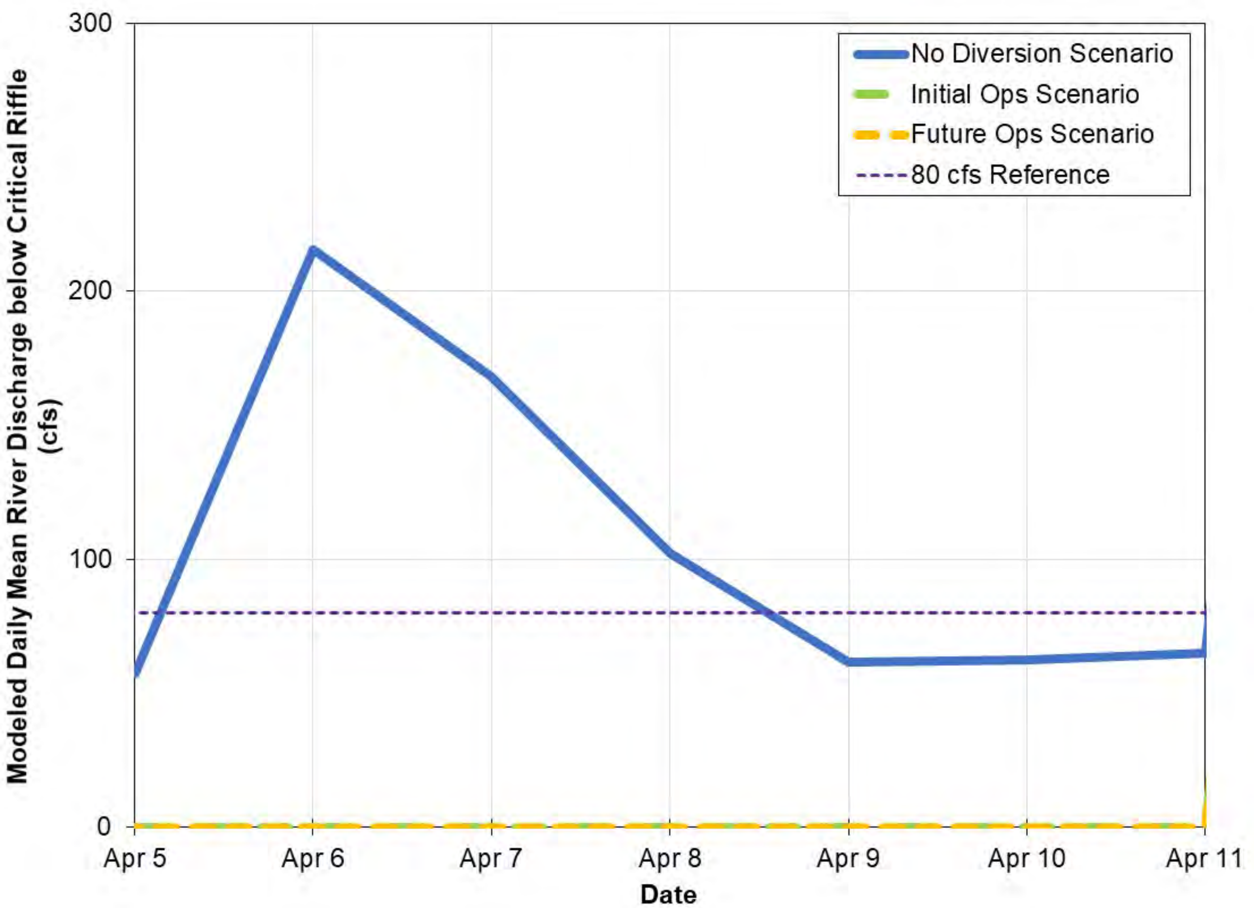


Figure 7-18 illustrates a flow event occurring April 5 through April 8 that, without flow diversions, would have been over 80 cfs (supporting downstream migration through the critical riffle) for over three days, whereas, under proposed operations, no instream flows would have been released because 80 cfs could not be maintained for 5 days and downstream migrating steelhead would be trapped and transported downstream.

When flows recede to the point that 80 cfs cannot be provided (accounting for the 40 cfs critical diversions) downstream of the critical riffle within the following 5 days, then United would initiate a ramp down procedure outlined in the SMP. Water would be redirected through screened pathways during the ramp down, promoting movement of juveniles already in the downstream reach to continue down to the downstream gaining reach or the estuary, while preventing further juveniles from traveling past the Freeman Diversion down into the affected reach prior to cessation of flows. During the ramp down, a downstream migrant trap would be engaged at the evaluation station. Any smolts, fry, and juvenile steelhead trapped during the ramp down would be transported to the most appropriate location in coordination with NMFS (likely the downstream gaining reach or the estuary if the estuary it open or to an appropriate upstream location if the estuary is closed). Prior to transport, standard data would be collected, and appropriately sized fish would be PIT tagged for individual identification.

Per EMM-03, United will evaluate downstream migration behavior in the affected reach to understand migration rates and habitat usage in the affected reach during a range of flows, temperatures, and SSC. United will conduct fine-scale tracking of individual smolt and juvenile movement in the affected reach using radio telemetry. A combination of stationary radio antennas and mobile tracking will allow estimates of downstream migration rates, holding habitat, and fate of radio tagged smolts. Experimental flow releases or tagging and release during ramp down can be used to test whether alternative flows are suitable for downstream migration. Smolt migration monitoring under EMM-03 combined with stranding surveys under EMM-04 could provide additional information on the relationships of flow and movement patterns of smolts. Information collected through these monitoring activities will be used to inform the SMP specified in CM 1.2.2 and CM 1.2.4 under the adaptive management framework.

Impact Assessment 7: Magnitude of Flow Diversions Affecting Steelhead Smolt Migration Duration

Diversion operations can result in reduced frequency of migration opportunities (as described above) as well as reduced duration (described here, Figure 7-19) compared to no diversion during the primary migration window (March 15 – May 31; impacts on smolts migrating outside of the primary smolt migration window is assessed in IA 8). Per Conservation Measures 1.2.2 and CM 1.2.5, United will implement the SMP to promote smolts migrating to the estuary of their own volition as well as CM 1.2.5 at low flows to facilitate downstream migration of steelhead smolts and safe relocation of fry and juveniles in the Santa Clara River.

Figure 7-19 Water Year 2012 Hydrograph Illustrating Impact Assessment 7 Based on Modeled Flows at the Downstream End of the Critical Riffle

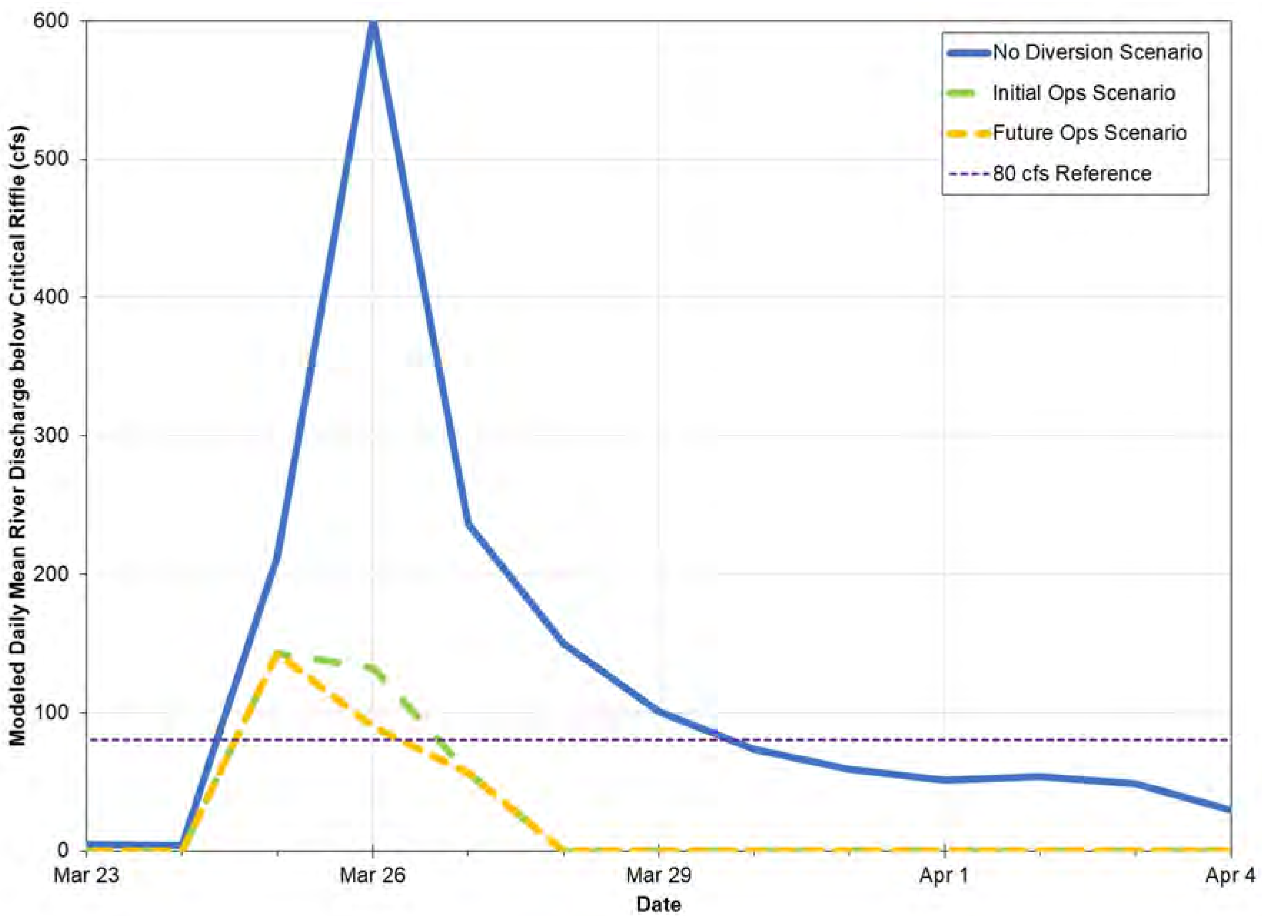


Figure 7-19 illustrates a spring flow event that, under no diversion, would have resulted in flows greater than 80 cfs from March 24 through March 30; a duration of six days supporting downstream fish migration. Under the proposed operations, migration would be supported from March 24 to 26 (two days). When United operations reduce the magnitude of instream flows to less than 80 cfs through the critical riffle, there is the potential to reduce the number of days per year that downstream steelhead migration may occur each year. However, when flows are insufficient, United would trap and relocate smolts downstream (CM 1.2.5) providing reliable passage downstream to the estuary. To assess IA 7, the HOSS Model (described in Section 7.2.1 [Methods for Evaluating Operation Effects] Flow Modeling and Metric Estimation) was run for the 71-year record to determine how often and for how many days there would have been enough water (> 80 cfs) for enough duration (>3 days) under no diversion, that, as a result of initial and future operations, would be reduced to insufficient duration to support migration (< 3 days) during and outside the primary steelhead smolt migration window.

The result of reduced migration days is that downstream migrants that would be unable to complete the migration from Freeman Diversion to the estuary are transported following CM 1.2.5. Under no diversion, there are many days each year when smolts would become stranded, resulting in mortality, but under proposed operations would be safely transported (Booth 2020).

The proposed operations would have more potential passage days for smolts in the river than under the no diversion during some years (around 2 years during the permit term) (R2 2016). During these years, diversions would cause artificial mounding to occur beneath the percolation ponds. Under these artificial circumstances, the losing reach of the lower river can become a gaining reach temporarily and in combination with instream flow releases results in higher flows near the critical riffle than would be produced under a no diversion scenario with no artificial mounding.

In addition to lost migration days, as illustrated in Figure 7-19, under proposed operations, spring flows are “dampened” by diversion during a potential migration event, in this example from 600 cfs down to around 150 cfs. For example, based on the HOSS Model and the 71-year record, there is an average of 4.7 days per year when flows would have been greater than 100 cfs during the smolt migration period under no diversion, that under proposed operations are less than 100 cfs. Although minimum fish passage requirements through the critical riffle are sufficiently achieved even at 80 cfs, presumably there is an additional benefit to fish migration that occurs when flows exceed 80 cfs.

As discussed for adult migration in detail in IA5, as flows increase there is increased channel width providing improved passage opportunities, increased water depth through shallow riffles, and access to inundated side channels that may provide temporary refuge or passage opportunity. Little is known about the migration rates of steelhead juveniles/smolts in the Santa Clara River. Kelley (2008) acoustically tagged and successfully tracked two steelhead smolts in the Santa Inez River and recorded rates ranging from 6.4 miles/day to 9.5 miles/day between release in Salsipuedes Creek to the first time they were recorded at the river mouth. A smolt tracking study by Sandstrom et al. (2012) in the Napa River observed riverine movement rates ranging from 3.9 to 9.6 miles per day. Assuming around 3.3 miles/day is a slow (conservative) rate, it is assumed that, within the Santa Clara River, smolts require at least three days to traverse the reach from upstream of the Freeman Diversion to the estuary.

It is not feasible to quantify the effect of reduced migration habitat, but presumably downstream migrating steelhead could experience reduced migration rate (for example, possibly 3 days to reach the estuary from Freeman Diversion instead of 2). The impact associated with a potentially slower migration rate (i.e., impact of the taking) is that, theoretically under some flow events smolts would effectively have fewer migration opportunities. For example, if suitable flows to support migration were available for 2 or 2.5 days and with suitable migration conditions smolts could reach the estuary, whereas at a slightly slower migration rate perhaps 3 days would be required for migration (3 days of migration is assumed for all reported analysis here). If this were to occur, fewer migration opportunities would have similar impacts to those described for IA6. In addition, if smolts were to migrate slower under the reduced flows, there would be an increased risk of mortality from stranding as described in IA9.

Per EMM-03, United will evaluate downstream migration behavior in the affected reach to understand migration rates and habitat usage in the affected reach during a range of flows, temperatures, and SSC. United will conduct fine-scale tracking of individual smolt and juvenile movement in the affected reach using radio telemetry. A combination of stationary radio antennas and mobile tracking will allow estimates of downstream migration rates, holding habitat, and fate of radio tagged smolts. Experimental flow releases of < 80 cfs can be used to test whether lower flows are suitable for downstream migration. Smolt migration monitoring under EMM-03 combined with stranding surveys under EMM-04 could provide additional information on the relationships of flow and movement patterns of smolts. Information collected through these monitoring activities will be used to inform the SMP specified in CM 1.2.2 and CM 1.2.4 under the adaptive management framework.

Impact Assessment 8: Flow Diversions Affecting Steelhead Smolt Migration Timing

Per Conservation Measure 1.2.2 United will implement the SMP to facilitate downstream migration of steelhead smolts and juveniles in the Santa Clara River below the Freeman Diversion through the affected reach and into the estuary from March 15–May 31. CM 1.2.5 (trap and transport) will be implemented January 1 through May 31 when flows are below 80 cfs at the critical riffle and outside this window (earlier than January 1 and later than May 31) when conditions are favorable for downstream migration. As described in Section 4.2, 95 percent of downstream migrants in the Santa Clara River are observed at the Freeman Diversion between March 15 and May 31 (Booth 2020), but 5 percent are observed prior to March 15th during some years, and as late as mid-July (Booth 2020). United operations during these periods outside of the primary smolt migration period would be managed to divert flows within the mainstem Santa Clara River, nominally to 375 cfs under Initial Operations and 750 cfs under Future Operations. Therefore, there could be periods when mainstem river flows are reduced to levels too low (< 80 cfs) to support downstream migration, when adult migration flows are not triggered, and when the SMP would not be implemented.

Figure 7-20 illustrates a flow event in late spring 2006 that, under no diversion, would support migration (>80 cfs) through mid-June, whereas under proposed operations flows to support migration end by June 1. For take to occur because of United flow operational timing, flow conditions would need to be suitable to support migration for at least three days, and steelhead smolts, fry, or juveniles would need to be present to migrate. Assuming downstream migrating steelhead require at least three days of suitable passage conditions to be considered a migratory opportunity, based on the 71-year historical record around 23 percent of the time there would be sufficient flow to support migration downstream of Freeman Diversion during the period November through March 15, under no diversion, compared with 13 percent of the time under the proposed operations. For the period of time from June 1 through July, around 8 percent of the time there would be sufficient flow to support migration downstream under no diversion, compared with 0.7 percent under the proposed operations. Therefore, there is a 10 percent reduction in suitability of downstream passage conditions for smolts prior to March 15, and around a 7 percent reduction after May 31.

Figure 7-20 Water Year 2006 Hydrograph Illustrating Impact Assessment 8 Based on Modeled Flows at the Downstream End of the Critical Riffle

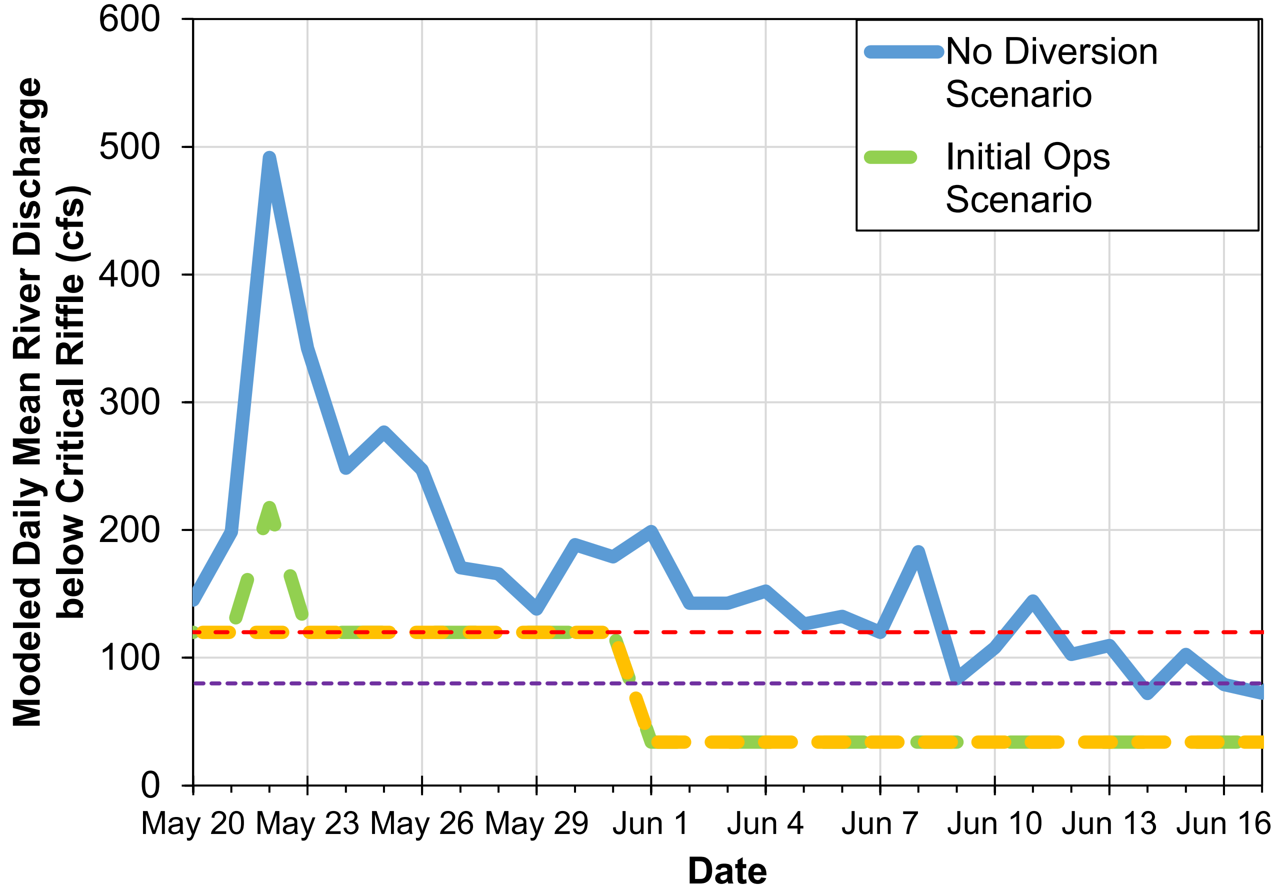


Figure 7-20 summarizes smolt observations at Freeman Diversion. By normalizing the distribution of smolt observations, it is apparent that based on available data around 3.66 percent would migrate prior to March 15, and 1.01 percent migrate after May 31 (Figure 7-21), for a total of around 4.67 percent that would migrate outside the primary migration period. Based on observations of Booth (2016), presumably similar percentages of fry and juveniles would migrate outside the primary migration period as well. Although data reported by Booth (2016) include observations in the forebay that could be double counted, and would be biased based on period of trap operations, in general the downstream migrant trap was operated consistently during at least January through June, and this data remains the best source of information available on smolt timing in the Santa Clara River (Figure 7-22). Also, Booth (2020) accounted for sampling bias through an assessment of effort and an assessment of trapping patterns in more common species of fish and concluded that the primary migration window of March 15 through May 31 is still supported with approximately 95 percent of smolts being detected in this window even after accounting for sampling bias to the extent feasible given the dataset. Trapping was still limited by high flow events, however high flow events trigger adult migration flows, therefore smolts would be afforded approximately unimpeded migration during those times and there would be negligible effects of operations on migration timing.

Figure 7-21 Cumulative Smolt Observations at Freeman Diversion 1993 to 2014 Fitted to a Normal Distribution

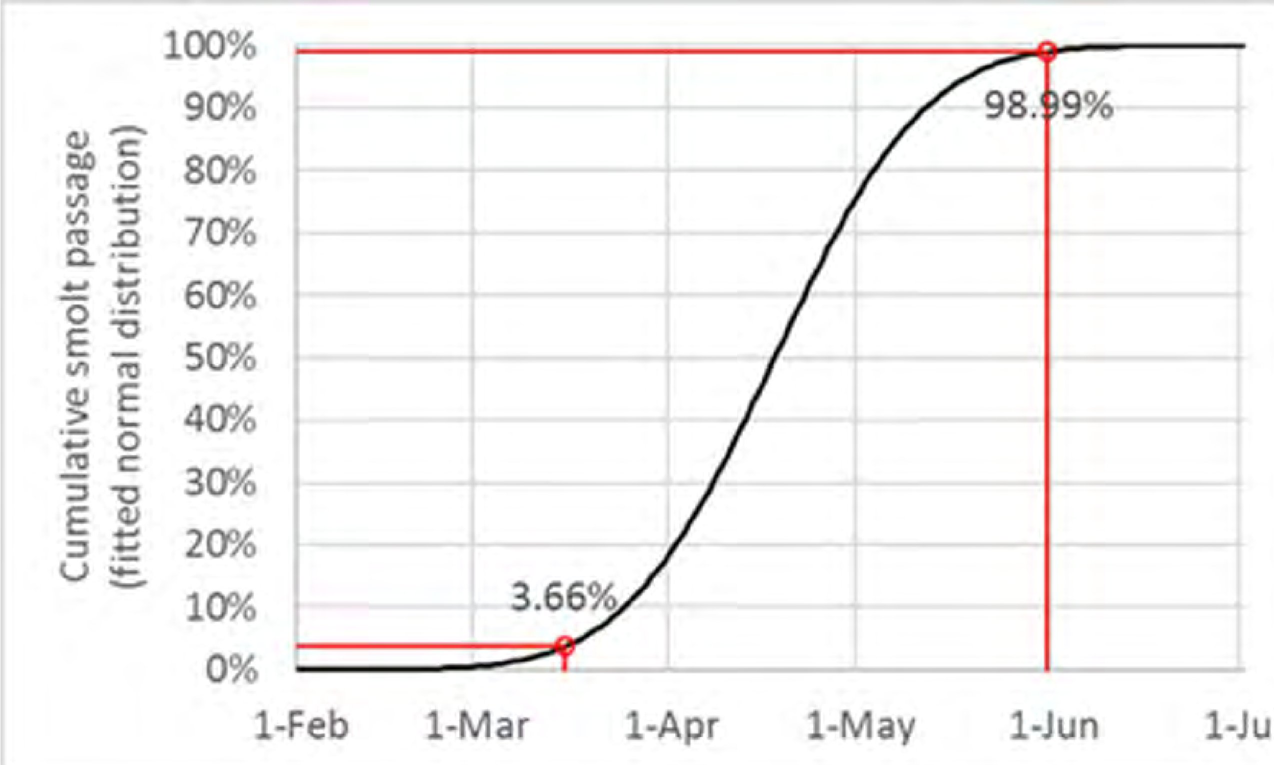
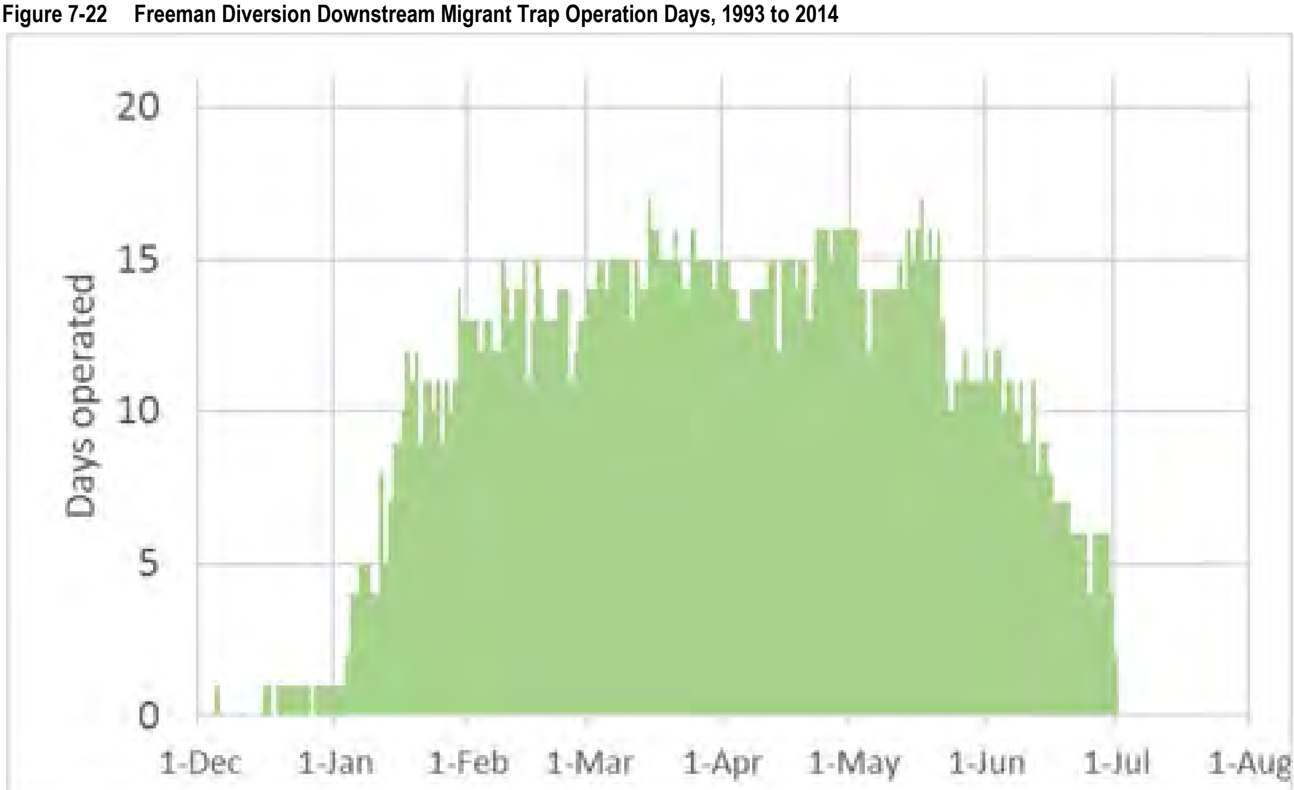


Figure 7-22 Freeman Diversion Downstream Migrant Trap Operation Days, 1993 to 2014



If 3.66 percent of migrants were available to migrate prior to March 15, then, during years with suitable flow conditions, on average 128 smolts would migrate prior to March 15, assuming an average of 3,500 smolts per year (Table 7-7). Under no diversion, 80 percent of years in the historical 71-year record had suitable passage conditions prior to March 15, compared with 73 percent under proposed operations. Therefore, the proposed operations would result in a 7 percent decrease in years with passage opportunities prior to March 15. However, it is unlikely that steelhead would migrate downstream the mainstem Santa Clara River prior to March 15 during years with insufficient flows. Smolts migrating downstream prior to March 15 are observed during flow conditions coincident with tributary connection to the mainstem Santa Clara River (Booth 2020), and under such conditions smolts would have sufficient flows to migrate to the estuary, especially since adult flows are triggered in January, regardless of the SMP operating window. Any smolts that do not migrate volitionally prior to March 15th would experience generally suitable rearing conditions prior to the provision of the SMP in mid-March or would be trapped and relocated downstream under CM 1.2.5. Therefore, no impacts are anticipated for smolts migrating downstream earlier than the primary smolt migration window.

In addition to potential for early migration, an estimated 39 smolts would migrate after May 31 (1.1 percent) assuming an average of 3,500 smolts per year (Table 7-7). Under no diversion, 18 percent of years in the historical 71-year record had suitable passage conditions after Mary 31; compared with 15 percent under proposed operations. Therefore, the proposed operations would result in a 3 percent decrease in years with passage opportunities after May 31. Within a 50-year permit term, this could result in 1 years (3 percent) when downstream passage conditions would not be provided after May 31. An average of 39 smolts for each of the years could be denied volitional downstream migration opportunity (Table 7-7). The downstream migration of these smolts would be provided by the trap and transport program described in CM 1.2.5. Estimates for fry and juveniles are similarly estimated in Table 7-21.

In addition, based on flows greater than 80 cfs for at least 3 days within the 71-year record, the duration of migration opportunities outside the primary smolt migration window would be reduced under the proposed operations by an average of 57 percent (14 days) in each of the 37 years that suitable passage conditions would occur prior to March 15 (Table 7-7). Therefore, assuming approximately equal numbers of smolts migrate each day of suitable flow conditions, an additional 2,728 smolts, 277 fry, and 149 juveniles, would be affected by the reduced number of days of suitable passage conditions (Table 7-5). A taking of up to a total of up to 3,151 smolts (1.8 percent of total production) 320 fry (1.6 percent of total production), and 172 juveniles (1.8 percent of total production) exposed to reduced volitional migration opportunities is estimated during the permit term, resulting in trap and transport, as described in IA12 below.

The migration timing of steelhead smolts relative to storm events is likely critical in rivers with highly dynamic hydrologic regimes such as the Santa Clara River. Unlike winter-run steelhead in coastal Pacific Northwest rivers, where perennially open river-mouths maintain migration regardless of instream flow conditions (Margolis and Groot 1991), episodic loss of passage through bar-built estuaries is common throughout the range of steelhead in California south of San Francisco Bay. Lang and Love (2014) highlighted the relatively short duration of migration opportunities in southern California steelhead relative to more northern populations, suggesting that any reductions in duration of fish migration opportunities over the already brief migratory opportunities would have a disproportionate impact on southern populations; however this publication was focused on smaller watersheds than the Santa Clara River drainage. Fewer migration days may also reduce the diversity in the timing of migration and reduce the resiliency of the population to disturbance. The provision of bypass flows during the primary migration window, and the provision of trap and transport for downstream migrants, is anticipated to support steelhead anadromous smolt migration in the Santa Clara River during the naturally relative short migration opportunities in the watershed.

Table 7-8 Estimated Effects of Smolt Migration Outside Primary Migration Window (March 15th to May 31st) During Permit Term

	Passage Opportunities No Diversion		Passage Opportunities Initial and Future Operations	
	Prior to March 15th	After May 31st	Prior to March 15th	After May 31st
Years with migration opportunities	40 years	9 years	37 years	8 years
Increase in years with no volitional migration opportunity	–	–	3 years	1 years
Average Duration (Days)	32 days	9 days	18 days	1 day
Percent days lost compared to No Diversion	–	–	57%	9%
Average smolts present annually	128	39	128	39
Average fry present annually	13	4	13	4
Average juveniles present annually	7	2	7	2
Total smolts migrating in years with migration	5,120	351	4,736	312
Total fry migrating in years with migration	520	36	481	32
Total juveniles migrating in years with migration	280	18	259	16
Total smolts effected by reduced *frequency* of volitional migration	–	–	384	39
Total fry effected by reduced *frequency* of volitional migration	–	–	39	4
Total juveniles affected by reduced *frequency* of volitional migration	–	–	21	2
Total smolts affected by reduced *duration* of volitional migration	–	–	2,700	28
Total fry affected by reduced *duration* of volitional migration	–	–	274	3
Total juveniles affected by reduced *duration* of volitional migration	–	–	148	1
Total smolts affected	–	–	**3,084**	**67**
Total fry affected	–	–	**313**	**7**
Total juveniles affected	–	–	**169**	**3**

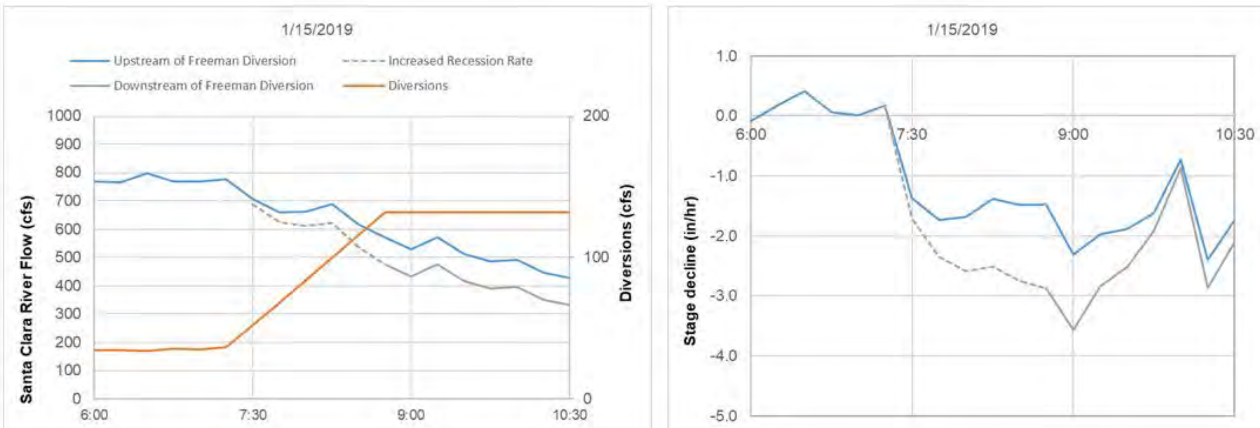
Per EMM-05, United will evaluate the steelhead smolt migration period used for the SMP. This evaluation will be based on tracking the dates downstream migrating smolts arrive at the Freeman Diversion over the life of the ITP and used to inform the SMP specified in CM 1.2.2 and CM 1.2.4 under the adaptive management framework.

Impact Assessment 9: Flow Recession Affecting Potential for Juvenile Stranding

Components of the proposed operations can result in alterations of the no diversion hydrograph recession rates. Operations that potentially result in recession rate alterations (sometimes faster and sometimes slower) are initiating diversions (also known as a "turn-in"); transitioning between the Variable Flow Protocol and the Base Flow Protocol; the daily "step-down" in instream flows prescribed in the Variable Flow Protocol; the pulse of flow and subsequent decrease in the Pulse Protocol; the pulse of flow and subsequent decrease during sediment sluicing operations. The effects of the Pulse Protocol and the sediment sluicing operations are described in other sections of the Effects Analysis (Section 7.3.2 and IA5 respectively). Impact Assessment 9

(IA 9, Figure 7-23) evaluates the impacts of the other diversion and instream flow operational protocols other than the Pulse Protocol that may affect recession rates and describes the potential consequences of altered recession rates from proposed operations on juvenile, fry, and smolt steelhead occurring within the lower Santa Clara River downstream and upstream of the Freeman Diversion.

Figure 7-23 Santa Clara River Flows on January 15, 2019 Illustrating Impact Assessment 9



As one example of proposed operations increasing recession rates, Figure 7-23 illustrates a "turn-in" event occurring on January 15, 2019 under the proposed operations. At around 7:30 am, Santa Clara River flows are "turned in" to the diversion canal and diversions are initiated resulting in a reduction in flows downstream of the diversion. During the 1.5 hours required to complete the turn-in, proposed operations resulted in a stage decline of 1 to 3 inches per hour downstream of Freeman Diversion, whereas under no diversion (upstream of Freeman Diversion) the recession rate during the same time would have been 1 to 2 inches per hour.

Steelhead life stages presumed to be at risk of stranding include migrating smolts, rearing juveniles, and fry. Based on 14 years of observations at Freeman Diversion analyzed by Booth (2020), it appears that steelhead smolts and other young life stages arrive at Freeman Diversion during times of most rapidly increasing day length (mid-March) and following connection of flows from tributaries to the mainstem. Often detections of migrants at the Freeman Diversion occur months following flows that connected tributaries, suggesting the potential for rearing of smolts, juveniles, and fry in the lower Santa Clara River during downstream migration, and the potential for stranding rearing juveniles if flows and stage drop too quickly. In general, observations suggest that migration through the lower Santa Clara River occurs on the receding limb of the hydrograph, and not during the peak or high flows (greater than around 1,000 cfs).

In general, the faster the rate of decline in water surface elevation, the more likely fish are to be stranded (Phinney 1974, Bauersfeld 1978, Halleraker et al. 2003), and fluctuations within natural river environments are typically less than 2 in/hr (Hunter 1992). In the Santa Clara River, recession rates under no diversion are often greater than 2 inches/hour, especially during high flow events (> 1,000 cfs; Figure 7-12 from IA4). However, increased recession rates as a result of proposed operations occur for a short duration each year. For example, based on 15-minute data from January 2017 to May 2020, the annual duration of increased recession rates greater than 2 inches per hour was around four hours per year (Figure 7-12 from IA4). Notably, under no diversion there would be over 50 hours per year of recession rates greater than 2 inches/hour (Figure 7-12); far more than would occur as a result of the proposed operations.

In addition to increased rate of recession, there are also operations during the final step of ramp down that result in 0 bypassed flows, which always occurs at the end of the year when flows recede below 80 cfs at the critical riffle for the last time of the water year or after May 31, whichever comes first. In addition to that, flows are ramped down to 0 cfs any time that there is not enough flow in the river to support the baseflow protocol or the SMP depending on time of year. This is estimated to occur approximately 0.6 time per year based on the 71-year record. When this occurs, any rearing steelhead downstream of Freeman Diversion would become stranded within isolated pools if they have not made it to the estuary. The number of *O. mykiss* potentially exposed is dependent on the outmigration abundance, which fluctuates annually (as described in IA6). Based on the estimates discussed in IA6, up to approximately 10 smolts, 5 fry, and 5 juveniles are assumed to be potentially vulnerable to stranding per event for a total of 16 smolts, 8 fry, and 8 juveniles per year (number expected time 1.6 events per year). For the permit term, this would total 800 smolts, 400 fry, and 400 juveniles.

There is potential for smolt, fry, or juvenile steelhead migrating downstream of Freeman Diversion to become stranded within the alluvial gravel-bar habitat on the falling limb of the hydrograph as flows recede. This risk is related to the natural channel morphology downstream of Freeman Diversion. As illustrated in Figure 7-25 and Figure 7-26, the river-flow depth profile illustrates that within the natural morphology (in this example a long sandy glide), as flows recede (in this example from 328 cfs), side channels and pockets will become exposed potentially stranding or trapping fish for eventual desiccation or predation, unless a subsequent flow re-inundates the habitat. Based on natural hydrographs and channel morphology, this is a risk that would occur under both no diversion conditions and under the proposed operations; but is potentially exacerbated by operations that increase the rate of flow recession (discussed above).

Figure 7-24 Recession rate observed in Santa Clara River upstream of the Freeman Diversion, Based on 15-minute data from December 1, 2016 to May 10, 2020

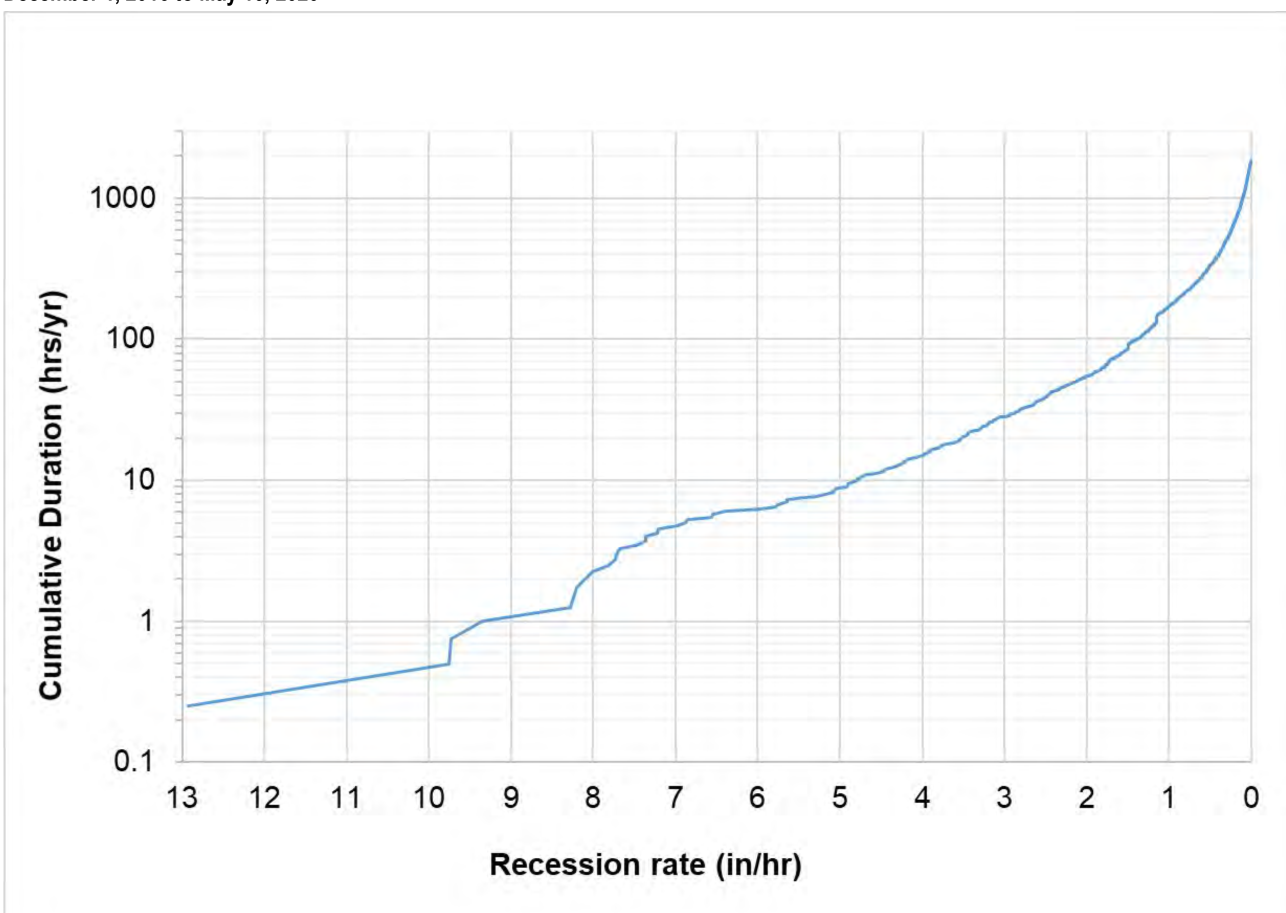


Figure 7-25 Riverflow-Depth Profile on April 7, 2011 at 328 cfs, 0.5 Miles Upstream of the Highway 101 Bridge

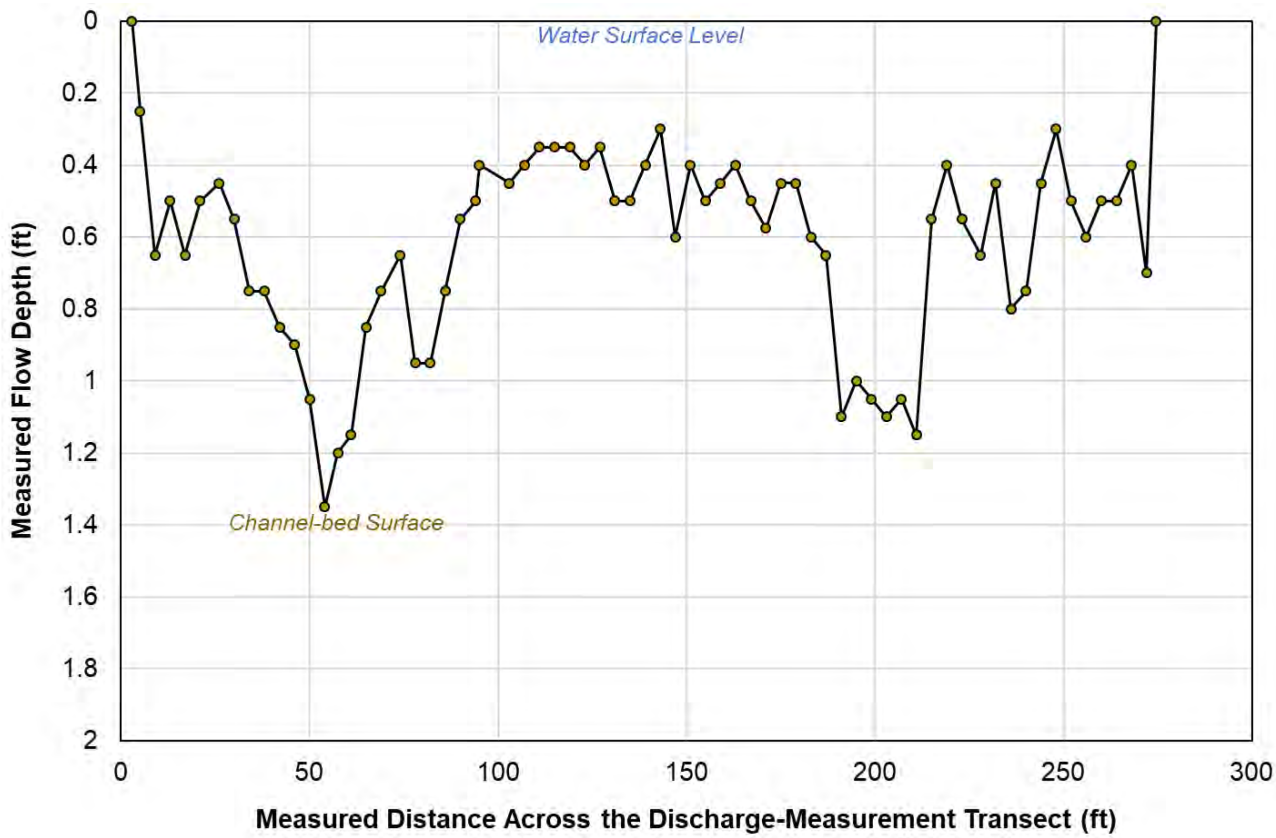


Figure 7-26 Sandy Alluvial Channel, 0.5 Miles Upstream from 101 Bridge

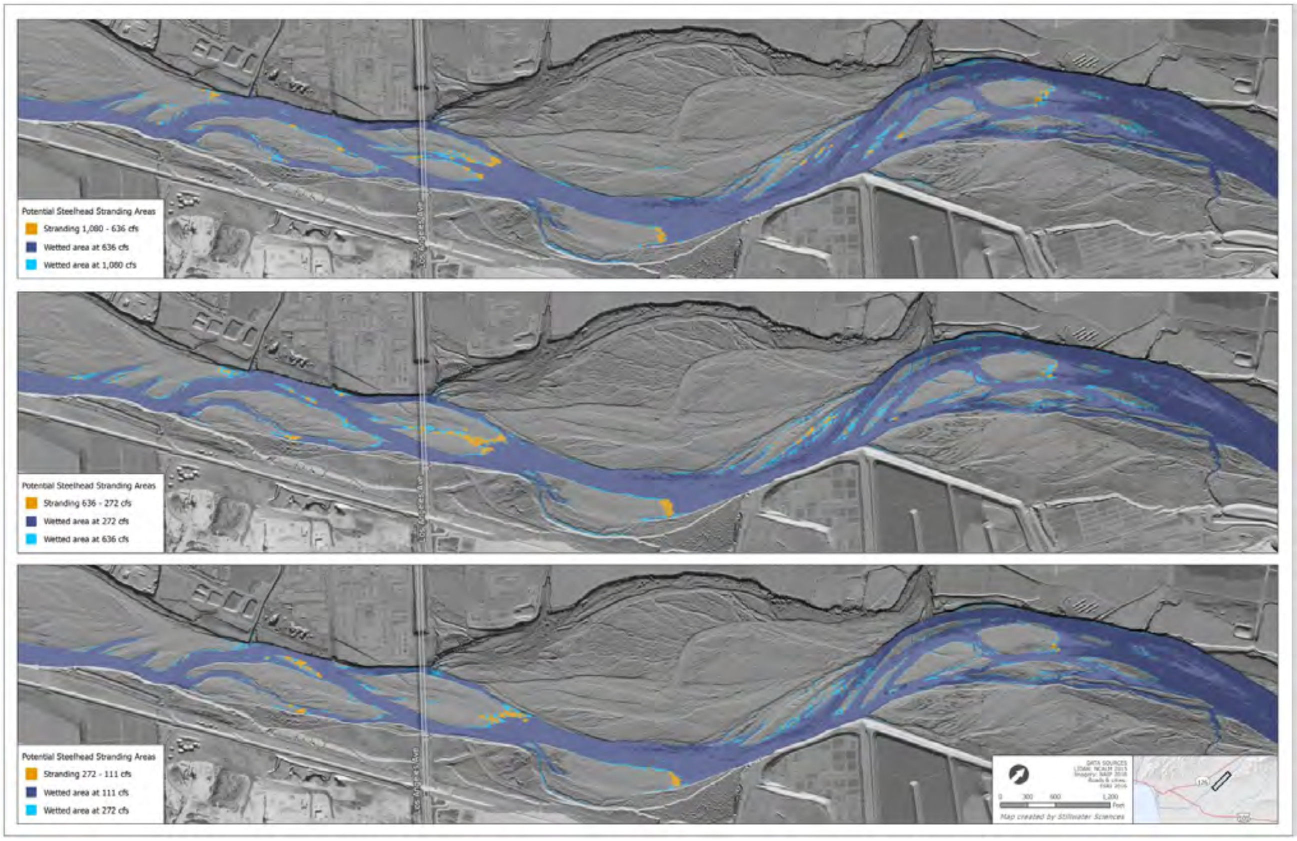
The river channel downstream of Freeman Diversion overall supports substantial amounts of potential rearing habitat. For example, as summarized in Table 7-9, at 1,080 cfs there is over 25,000,000 square feet of inundated habitat. As flows recede there is the potential to strand migrating smolts or rearing juvenile or fry steelhead resulting in mortality. Under certain circumstances, flow fluctuations may also result in indirect effects on fish, such as temporary loss of habitat from dewatering, and behavioral responses that could reduce survival or growth (Hunter 1992). Although areas with a high risk for stranding (less than or equal to 1 percent slope) do occur downstream of Freeman Diversion, these areas are a small percentage of the total inundated habitat. For example, as flows recede from 1,080 cfs to 111 cfs there is less than 1 percent of the total wetted habitat that presents a risk of stranding (Table 7-9). Overall, areas with stranding risk are focused in a few places, and at flow ranges less than 1,000 cfs do not appear to cover a substantial area (Table 7-9, Figure 7-27).

Table 7-9 Wetted (>0.01 ft) Habitat and Stranding Risk (Slopes Equal to or less than 1%) in the Santa Clara River Downstream of Freeman Diversion to the Estuary as Flows Recede

From Flow (cfs)	To Flow (cfs)	Wetted Habitat (ft^2)	Stranding Risk (ft^2)	Wetted Area with Stranding Risk (%)
25,000	10,800	47,071,743	269,033	0.57%
25,000	5,230	47,071,743	582,801	1.24%
10,800	5,230	38,777,891	304,285	0.78%
10,800	3,330	38,777,891	418,253	1.08%
5,230	3,330	33,167,139	107,790	0.32%
5,230	636	33,167,139	356,748	1.08%
3,330	1,080	30,363,883	172,847	0.57%
3,330	272	30,363,883	319,376	1.05%
1,080	636	25,126,347	59,040	0.23%
1,080	111	25,126,347	194,256	0.77%
636	272	23,314,253	70,827	0.30%
272	111	21,047,697	49,611	0.24%

Note: Channel Morphology Based on 2015 LIDAR; Water Surface Measurements Based on Measurements at Montalvo Gage (USGS 11114000) at Reported Flow Ranges

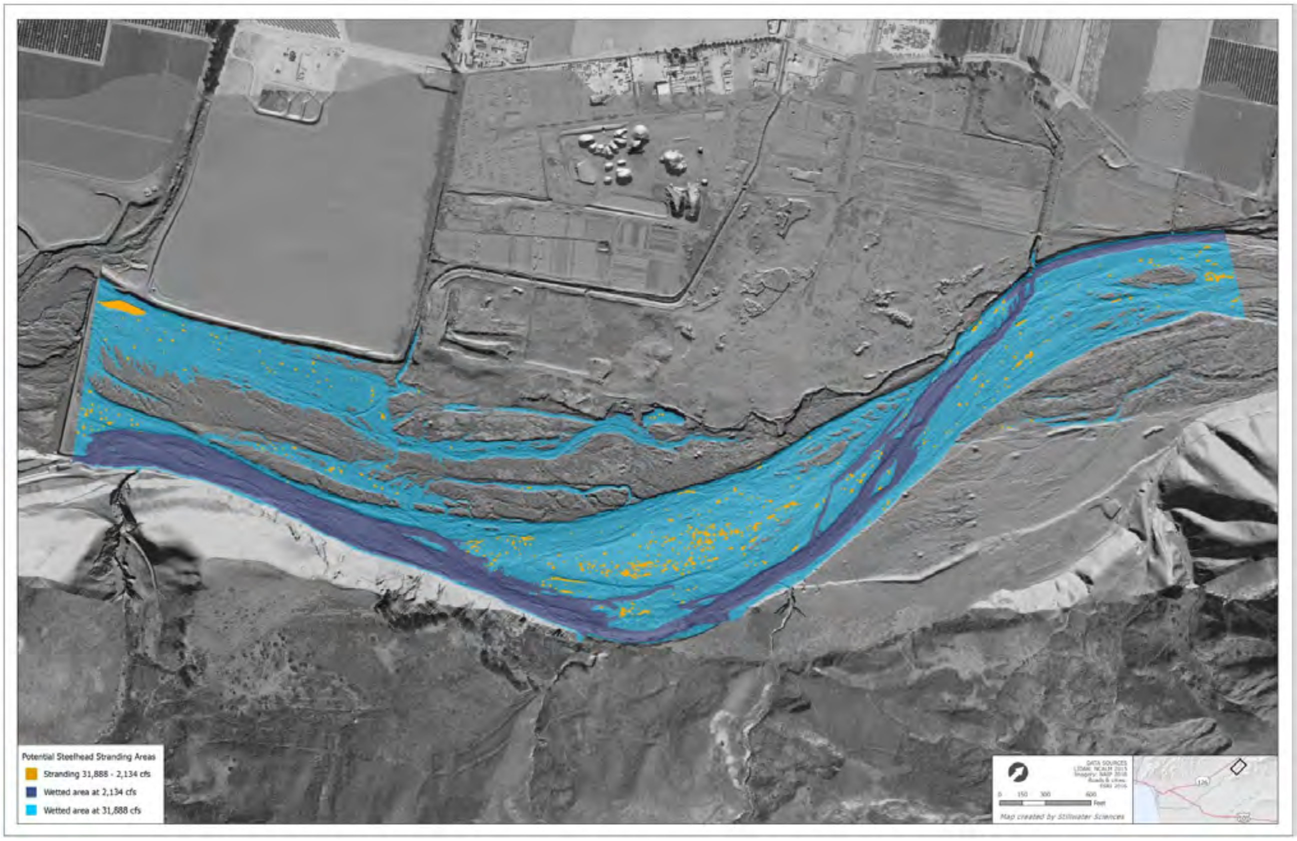
Figure 7-27 Stranding Risk (Habitat with Slopes Equal to or Less than 1%) Downstream of Freeman Diversion



Note: Channel morphology based on 2015 LIDAR; water surface measurements based on measurements at Montalvo Gage (USGS 11114000) at specified flows.

There is also potential for smolt, fry, or juvenile steelhead migrating or rearing upstream of Freeman Diversion to become stranded within the alluvial gravel-bar habitat on the falling limb of the hydrograph as flows recede. This risk is related to the natural channel morphology upstream of Freeman Diversion. The channel upstream of the diversion is relatively confined at flows less than around 2,000 cfs (Figure 7-28), whereas at flows greater than around 2,000 cfs alluvial bars become inundated and there are a few areas with stranding risk. Based on the low frequency of flows greater than 2,000 cfs, and the limited rearing duration expected at higher flows, it appears that the risk of fish stranding upstream of Freeman Diversion is negligible.

Figure 7-28 Stranding Risk (Habitat with Slopes Equal to or less than 1%) Upstream of Freeman Diversion



Note: Channel Morphology Based on 2015 LIDAR; Water Surface Measurements Based on Measurements at the Freeman Diversion Intake

Stranding risk to juveniles as a consequence of the proposed diversion/instream flow operations is anticipated to be negligible, with the exception of up to 800 smolts, 400 fry, and 400 juveniles that may become stranded in isolated pools during the permit term due to the last "step down" in flows to 0 cfs 1.6 times per year. However, per EMM-03, United will evaluate smolt migration behavior in the affected reach (Figure 7-2), to understand smolt migration rates and habitat usage in the affected reach during a range of flows, temperatures, and SSC. United will conduct fine-scale tracking of individual smolt movement in the affected reach using radio telemetry. Per EMM-04, United will evaluate the results of the ramp-down procedures in CMs 1.2.1 and 1.2.2, including potential for stranding covered species in the critical reach. This evaluation will be based on observation of dewatered areas of the critical reach during ramp-down procedures.

Impact Assessment 10: Magnitude of Flow Diversions Affecting Steelhead Rearing Habitat Area in Lower Santa Clara River

As described in Section 5.2.2, under initial and future operations involving the variable flow plan, the recession limb of the hydrograph will be truncated as a result of "turning-in," resulting in a reduction in flows downstream of Freeman Diversion (Figure 7-29).

Figure 7-29 Water Year 2006 Illustrating Impact Assessment 10 Based on Modeled Flows Immediately Downstream of Freeman Diversion

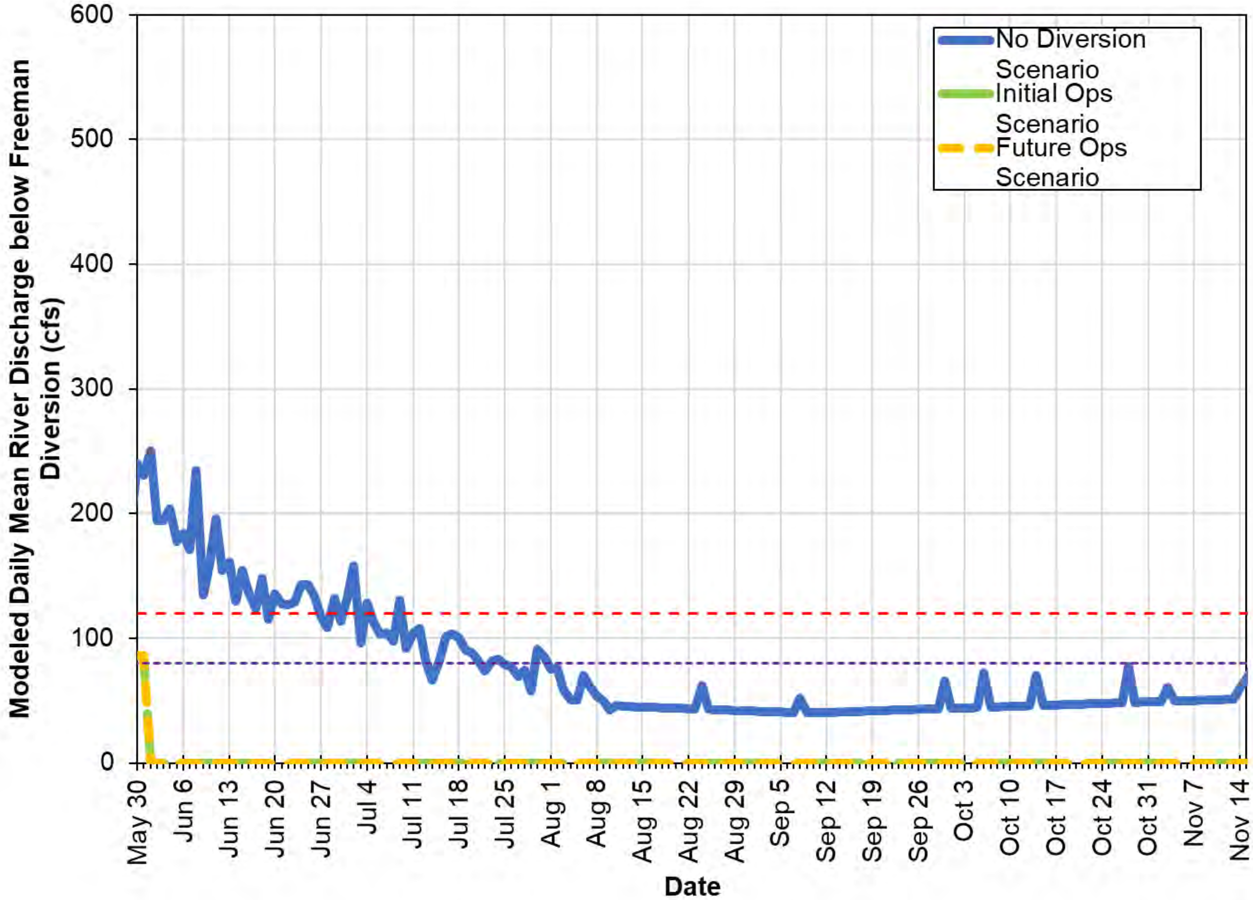


Figure 7-29 illustrates that in Water Year 2006, under no diversion, flows to support potential rearing would have continued through spring and summer into fall for at least the stable reach downstream of Freeman Diversion, before natural percolation would result in complete loss of flows in the critical reach. Under the proposed operations, no surface flows to support rearing occur after June 1, but underflow through buried pipes under the diversion maintains a perennial downstream pool. Potential take associated with a truncated hydrograph could include alteration of rearing habitat in the 10-mile reach downstream of Freeman Diversion. Rearing habitats for fluvial-anadromous steelhead primarily consist of tributaries to the Santa Clara River containing suitable water quality, water depths, water velocities, and cover where juveniles can feed and grow within a relatively protected environment. Juveniles (parr or fry) are also observed moving or drifting downstream in the Santa Clara River and have been detected at the Freeman Diversion Facility (Booth 2016). These fish moved out of the tributaries or were carried downstream to the Freeman Diversion. If conditions within those areas are suitable, they can either continue to rear and grow until they become smolts and then migrate downstream to the estuary and ocean, or they may move further downstream into the estuary for rearing.

Conceptually, rearing habitats just upstream of the estuary would seem to be influenced by flow operations as long as surface flows maintain connectivity. However, the reach just upstream of the estuary is a gaining reach that is supported by agricultural and municipal return flows, therefore residual pool areas can be maintained even without upstream surface flows so that little difference in habitats would occur between proposed operations and no diversion, even when there is no flow at the critical riffle.

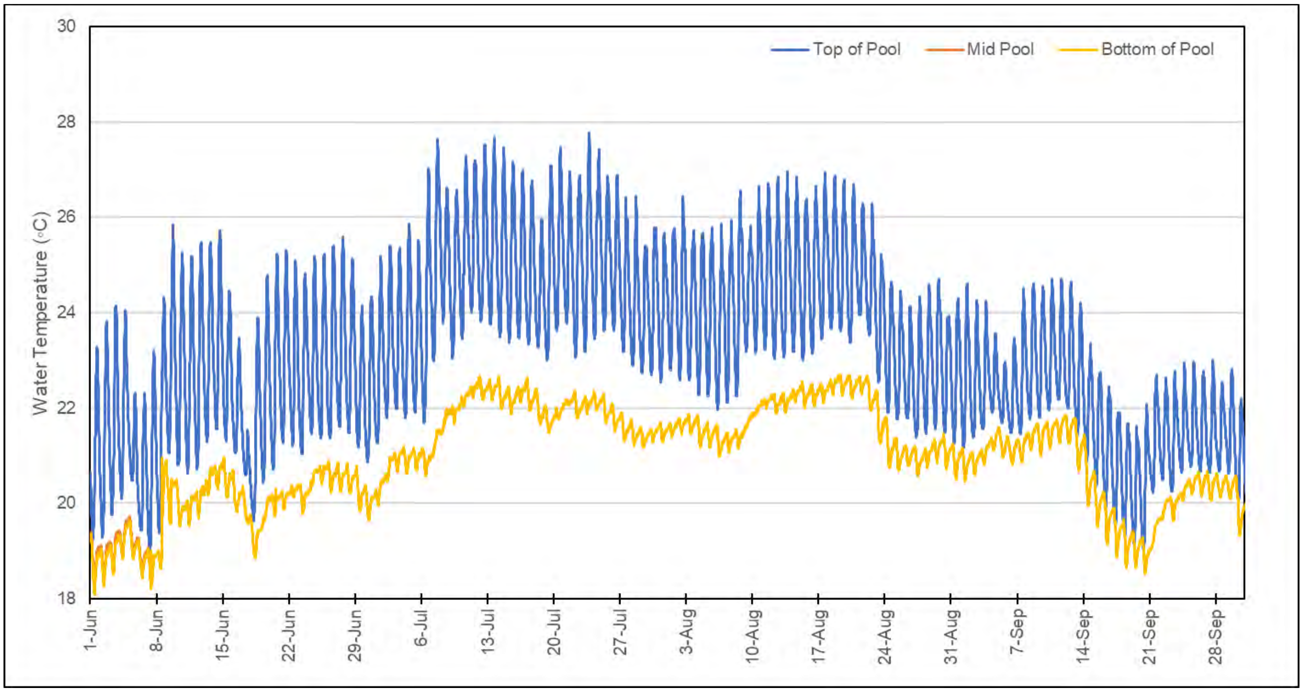
Underground, underflow pipes built into the Freeman Diversion also convey water underground from upstream to downstream supporting a pool immediately downstream of the Freeman Diversion that has been perennial over the last 10 years as shown on Google Earth images.

The proposed operations do at times artificially result in a surplus in groundwater that can create mounding in the aquifer resulting in groundwater inflow to the river that would not otherwise exist but for United's diversions and groundwater recharge activities. In this case, the amount of potential rearing habitat during low flow periods may not differ that much and could theoretically be greater with the proposed operations compared to no diversion.

Overall, there would be periods when more flows would have been available under no diversion during late spring and early summer compared to the proposed operations, resulting in modification of potential rearing habitat. The total amount of rearing habitat affected would depend on the flows that would have occurred, the duration that the flows would be provided, and percolation loss in the reach downstream of Freeman Diversion. Under no diversion there would be around 28 days per year with flows greater than 50 cfs between June 1 and November 1 downstream of Freeman (often in June and July), whereas under the proposed operations there would never be flows greater than 50 cfs during this period.

The SMP is intended to ensure smolts are provided safe downstream passage to the estuary, either through instream flows or trap and relocate operations. There is a potential for occasional juvenile rearing to occur in habitat downstream of Freeman Diversion, although there is no evidence that steelhead rearing occurs in the lower Santa Clara River. Boughton and Goslin (2006) classified the lower Santa Clara River as naturally having a "low potential" for steelhead rearing, based on intrinsically intermittent flows during summer. The most recent information was collected by United during two qualitative opportunistic surveys within the river between Hwy 101 and Hwy 118 bridges in which fish observations were made in April 2017 and January 2018. No steelhead were observed in either survey. Water temperature during summer may limit rearing habitat suitability in the lower Santa Clara River. Laboratory studies have shown reduced growth in steelhead exposed to temperatures above 25°C for extended periods (Kammerer and Heppel 2013), and temperatures at 27.5°C have been found to be lethal for steelhead (Myrick 1998). Bell (1986) defines the "upper lethal threshold" for steelhead as 23.9°C. For steelhead acclimated to 19°C, 21.0°C was found to be a lethal threshold by Coutant (1970, as cited in USEPA 1999). Regarding juvenile rearing and growth, USEPA (1999) considered 22-24° C to be the "range which totally eliminates salmonids from an area, limiting their distribution." Water temperature data is limited downstream of Freeman Diversion. Water temperatures were monitored in a deep (> 6 ft) pool downstream of Freeman Diversion during the summer of 2018. Data loggers at the water surface in a pool downstream of Freeman Diversion showed water temperatures too warm to support steelhead rearing, while loggers at the pool bottom recorded temperatures within a potentially suitable range (Figure 7-30), suggesting that there may be areas within the lower Santa Clara River that could potentially provide suitable rearing conditions in at least some locations during some years. Note that this deep pool that was observed in summer 2018 was filled in with alluvial sediment in winter 2019 and no longer occurs. Summer rearing conditions downstream of Freeman are further challenged by several invasive fish species, including documented predators on juvenile steelhead such as black bullhead (*Ameiurus melas*) and green sunfish (*Lepomis cyanellus*) (Stoecker and Kelley 2005), which are considered a "very high threat" to the steelhead population there (NMFS 2012).

Figure 7-30 Water Temperature Monitoring in a Deep Pool Downstream of Freeman Diversion During Summer 2018. "Top of Pool," and "Bottom of Pool" Loggers were Active from June 1st through 28 September 2018, whereas the "Mid-Pool" logger was active from June 1st to June 7th



Due to the intrinsic low quality of rearing habitat within this reach, no Impact on rearing habitat is associated with the truncated hydrograph. Even in the absence of water diversions, the affected reach would be unlikely to provide steelhead rearing habitat during summer. Per EMM-03, United will evaluate smolt migration behavior in the affected reach, to understand smolt migration rates and habitat usage in the affected reach during a range of flows, temperatures, and SSC. United will conduct fine-scale tracking of individual smolt movement in the affected reach using radio telemetry. A combination of stationary radio antennas and mobile tracking will allow estimates of downstream migration rates, holding habitat, and fate of radio tagged smolts. Under, EMM-04, stranding surveys will also be conducted in holding locations downstream and initiation of CM 2.1.4 will be considered depending on conditions. Smolt migration monitoring under EMM-03 combined with stranding surveys under EMM-04 could provide additional information on the relationships of flow and timing of smolt migration. Information collected through these monitoring activities will be used to inform the SMP specified in CM 1.2.2 and CM 1.2.4 under the adaptive management framework.

Impact Assessment 11: Magnitude of Flow Diversions Affecting Estuary Rearing Habitat for Juveniles

United operations have the potential to alter instream flows entering the Santa Clara River estuary. However, the habitat-based analysis of the estuary (Section 7.2.4) indicated little if any adverse effects of the proposed operation on the quantity and quality of steelhead juvenile rearing habitat. On the contrary, the analysis conclude that the proposed operations would increase the quantity of rearing habitat in the estuary. Rapid dewatering of the estuary or lagoon during otherwise stable conditions of summer is a potential threat to steelhead rearing. Under all operational scenarios, few berm-breaches are predicted to occur during summer (see Section 7.2.4 for details). Notably, under all scenarios, more summer breach events are predicted to occur during low-flow and moderate water years than high-flow years. This is because the accumulation of inflow during low-flow years will eventually lead to a breach. In a low-flow year, the accumulation is lower and thus the breach, if any, would occur later in the year (i.e., summer rather than winter or spring) due to a lack of storms earlier in the season. In a high-flow year, the accumulation is greater and typically the mouth will open earlier in the season (i.e., winter or spring) and remain open longer, sometimes persisting well through spring and summer.

Out-of-season breach events during summer (May through September) can reduce the quality of steelhead rearing habitat (Smith 1990; Bond et al. 2008) by causing unstable fluctuations in DO, salinity, and water temperature (Sloan 2006; Atkinson 2010), and, in some lagoons, can be significant enough to result in fish kills (e.g., Pescadero Creek [Sloan 2006]). Breach events during the summer are a documented source of steelhead mortality in the estuary (see Chapter 4). Under the proposed operations, breach events during summer are predicted to be uncommon (see Section 7.2.4 for more details) and should therefore provide more stable water levels and juvenile rearing habitats than would occur during and after a breach. However, unauthorized breaching unrelated to proposed operations may occur due to human disturbance of the beach berm and can have deleterious effects on steelhead due to rapid dewatering and stranding of fish, as well as changes in water quality.

The results of the analysis indicate that there will be no take associated with the proposed operation on the quantity and quality of steelhead juvenile rearing habitat in the estuary-lagoon. However, data are still lacking regarding the extent to which estuary-lagoon rearing by steelhead actually occurs in the Santa Clara River estuary. No steelhead have been documented in routine seining surveys conducted by the City of Ventura (e.g., Nautilus Environmental 2009; Stillwater Sciences 2018), although several stranded steelhead in the size range of 10–12 inches were identified following an artificial breaching event in October 2010 (Cardno/Entrix 2010). However, this stranding event directly followed the relocation of juvenile steelhead from the river into the estuary associated with a fish rescue effort from the Freeman Diversion. Thus, it is not known whether volitional rearing by juvenile steelhead occurs in the estuary. Nevertheless, the analysis of habitats and observations of the stranded fish suggest the estuary should be able to sustain juvenile steelhead for at least short periods of time, but the overall extent, suitability, and use of rearing habitat is unknown. To verify the assumptions associated with this analysis, United will be assessing rearing behavior downstream of the Freeman Diversion and in the estuary as part of the smolt radio tagging study (EMM-03) and will consider the use of eDNA analysis for detecting smolts rearing in the estuary.

Impact Assessment 12: Relocate Smolts Downstream during Low Flows

The proposed operations include a conservation measure (CM 1.2.5) that results in the trapping and relocation of smolts when flow conditions below the critical riffle become too low to afford safe passage. Based on past experience and United's critical riffle surveys to date, this is estimated to occur at approximately 80 cfs at the critical riffle and 80 cfs is the assumed threshold for functional migratory connection through the critical riffle for downstream moving steelhead. Trapping downstream moving steelhead would occur under CM 1.2.5 upon initiation of ramp down procedures under the proposed operations (CM 1.2.1-CM 1.2.4) January 1 through May 31, as well as outside that window when conditions are favorable for downstream migration. Smolts trapped through CM 1.2.5 will overlap with the Monitoring Program (see Section 7.7-Monitoring Program).

The take associated with trapping and transporting downstream moving O. mykiss is considered a covered activity when steelhead could travel downstream but for United's critical diversions and is considered a conservation measure when steelhead are thought to not be able to safely traverse the critical reach even if all the river flow was bypassed downstream. Either way, the trapping and relocation of steelhead is considered take and calculated below, with the impact of the taking being at least partially offset by the transport of steelhead to safer habitat during low flows.

From 1996 to 2009, United recorded smolt observations on a daily basis at the Freeman Diversion in the downstream fish trap and the fish bay (Table 7-10). When United is not diverting the total river flow, smolts would pass the diversion undetected through the bypass channel, fish ladder or over the spillway; therefore, the recorded observations represent only a portion of the smolts that have passed through the facility. However, smolts that were not counted historically because they passed the facility in the bypass flows would have additional flows in the proposed operations, therefore there should be little to no effect on the historically undetected smolts in this analysis from water diversion and no take of smolts was assumed in this context.

The smolts that are most likely to be affected by the operations were the smolts that were observed in the fish trap and the fish bay, because those smolts went into the diversion infrastructure. In order to estimate the potential effects on the observed smolts, the initial operations generated by the HOSS was overlaid with the smolt observations from 1996 to 2009. A total of 1,789 smolts were observed at the Diversion during this 14-year period. In the smolt migration plan (SMP) detailed in CM 1.2.2, United proposes to maintain 120 cfs down to 80 cfs (while maintaining the 40 cfs critical diversions) until May 31 or until 80 cfs can no longer be maintained below the critical riffle within 5 days. Results from the HOSS model compared when flows were predicted to be greater than or equal to 80 cfs to when actual smolts arrived at the diversion from 1996 to 2009. Of the 1,789 smolts counted at the Freeman Diversion, a total of 746 smolts would have passed on their own volition in flows greater than 80 cfs under the proposed smolt migration plan. The remaining 1,043 would be collected at the fish evaluation station for data collection, PIT tagging, and relocation due to the poor migration conditions below the diversion.

Even with all flows bypassed at the diversion, an average of 70 smolts per year would have arrived at the critical riffle (Table 7-10) (assuming they continued to migrate downstream from the diversion) under poor passage conditions. Under the proposed operations, 5 additional smolts per year (75 per year total average) would arrive at the critical riffle in poor passage conditions. Therefore, while all 75 smolts per year (3,750 total during the permit term) would be taken due to trapping, 70 smolts per year (3,500 total during the permit term) would be provided passage to the estuary through CM 1.2.5 that would have otherwise not had passage to the estuary under no diversion, while 5 smolts per year (250 total during the permit term) would be subjected to trap and relocate that would have otherwise been able to migrate downstream of their own volition.

A similar evaluation was done with the no diversion scenario. United's diversions for groundwater recharge artificially raise water levels in the Santa Clara River overlying the Oxnard Forebay. During some years, artificial recharge will raise water levels to a point that will reduce the expected percolation rates in the river downstream of the diversion. The increase in water levels is normally at a maximum during the smolt migration season due to the groundwater recharge generated by the winter storms. As a result, the river in the no diversion scenario during the smolt migration period is expected to, at times, experience higher percolation rates due to the absence of artificial recharge of the groundwater levels. Some of the years in the analysis are expected to provide fewer days of flows greater than 80 cfs under the no diversion scenario. On other years, when the groundwater recharge has less of an influence on the water levels under the river, the 40 cfs diverted in the proposed operations will reduce the amount of days greater than 80 cfs. In summary the no diversion scenario would have provided flows at or above 80 cfs at the critical riffle for 804 of the 1,789 smolts observed from 1996 to 2009. An additional 58 smolts or 7 percent more smolts would have migrated with flows greater than 80 cfs under the no diversion scenario compared to the initial operations.

United is proposing minimization measures that will allow safe passage for the remaining 58 smolts that will include the construction and operation of a fish evaluation station to allow for trapping, data collection, PIT tagging, and transport of the smolts that would have made it through the critical reach but for United's operations.

United is also proposing a mitigation measure through CM 1.2.5 that would allow for safe passage of the estimated 70 smolts per year that would not have arrived at the critical reach in good migrating conditions even if there were no diversions. This mitigation measure is expected to have a significant positive impact on the proposed success of steelhead migrating safely to the estuary and ocean. As demonstrated in the discussion below this mitigation effort will provide passage for all smolts that arrive at the Freeman Diversion. During some years, no flows over 80 cfs are expected to occur with or without diversions during the migration season. Without the relocation program at the Freeman Diversion smolts that arrive at the diversion in those years would have no opportunity for outmigration.

Table 7-10 Number of Smolts Counted at the Freeman Diversion when Flows at the Critical Riffle are above or below 80 cfs

	Total Smolts Observed/ Trapped	No Diversion		Proposed Operations	
		Flow ≥ 80 cfs (Could Have Made It)	Flow < 80 cfs (Would Not Have Made It)	Flow ≥ 80 cfs (Could Have Made It)	Flow < 80 cfs (Would Not Have Made It)
1996	98	70	28	98	0
1997	413	73	340	116	297
1998	2	2	0	2	0
1999	3	3	0	3	0
2000	791	499	292	351	440
2001	119	97	22	108	11
2002	3	0	3	0	3
2003	41	5	36	4	37
2004	2	0	2	0	2
2005	0	0	0	0	0
2006	13	13	0	13	0
2007	12	0	12	0	12
2008	133	39	94	51	82
2009	159	3	156	0	159
Total	**1,789**	**804**	**985**	**746**	**1,043**
Average	**128**	**58**	**70**	**53**	**75**

Steelhead mortality in drying riverbeds in the lower reaches of mainstems has been well documented in southern California. Before Lake Cachuma was built on the Santa Ynez, steelhead were rescued each summer by the California Department of Fish and Game due to low water levels in the main steam of the river. The fish were then relocated to the upper part of the Santa Ynez and other nearby watersheds such as the Santa Clara River. Shapovalov stated "undoubtedly large numbers migrated downstream prior to the start of rescue operations, and many others perished in various tributaries," (Shapovalov 1944). Booth (2020) confirmed that many smolts arrive at the Freeman Diversion after functional migratory connectivity through the critical riffle is lost even under no diversion and they too would likely perish if not for a trapping and relocation program at Freeman Diversion like CM 1.2.5.

A review by Lusardi and Moyle (2017) note that juvenile salmonids transported downstream are observed to experience delayed mortality, reduced growth rates, and increased predation; with steelhead being apparently less sensitive to handling than other salmonids. However, because of CM 1.2.5, steelhead would not be exposed to the likely higher potential for delayed mortality and increased predation associated with traversing the critical reach in low flows or attempting to hold/rear during rapid river recession. Based on the anticipated effects of the downstream relocation described above, take associated with transporting fry, juveniles, and smolts downstream is not anticipated to exceed 5 percent injury or 2 percent mortality.

The impact associated with take of less than 2 percent mortality and less than 5 percent injury of steelhead migrants is anticipated to result in less anadromous production compared to no diversion. However, under natural fish passage conditions some level of injury and mortality from predation, stranding, disease, and other sources of mortality would be expected to occur and some of this mortality would be offset by affording passage to steelhead that would not otherwise have passage to the estuary even under no diversion. This take would be measured by biological monitoring of fish transported downstream using methods described in EMM-03.

Summary of Take from Water Diversion Compared to the No Diversion Condition

Table 7-11 summarizes the estimated take for each of the water diversion impact assessments.

Table 7-11 Summary of Potential Effects, Anticipated Total Take, and Estimated Impact of the Taking of Proposed Operations

Impact Assessment (IA)	Anticipated Total Take during 50-year permit term Compared to No Diversion
IA 1: Timing of Flow Diversions Affecting Steelhead Adult Upstream Migration Timing.	Up to 4 adults potentially harmed through migration delay with 1 detected, captured, tagged, and released/relocated
IA 2: Magnitude of Flow Diversions Affecting Steelhead Adult Migration Opportunities	Up to 77 adults potentially harmed through migration delay with 19 detected, captured, tagged, and released/relocated
IA 3: Magnitude of Flow Diversions Affecting Steelhead Adult Migration Duration	Up to an average of 8 days per year or 400 days over the permit term where United's operations reduce the duration of a migration window by decreasing the average daily flow at the critical riffle below 120 cfs compared to no diversion when flows below the critical riffle would be above 120 for at least 3 consecutive days
IA 4: Flow Recession Rates Affecting Adult Migration	Relatively minor change in recession rates; no take is reasonably certain to occur
IA 5: Reduced Magnitude and Fluctuation of Flows Affecting Steelhead Adult Migration Behavior	Pulse Protocol results in less stable flows, no take is reasonably certain to occur
IA 6: Magnitude of Flow Diversions Affecting Frequency and Duration of Steelhead Smolt Migration Opportunities	Take accounted for in IA12 trap and relocate; no other take is reasonably certain to occur.
IA 7: Magnitude of Flow Diversions Affecting Steelhead Smolt Migration Duration	Take accounted for in IA 12 trap and relocate; no other take is reasonably certain to occur
IA 8: Flow Diversions Affecting Steelhead Smolt Migration Timing	Take accounted for in IA 12 trap and relocate; no other take is reasonably certain to occur
IA 9: Flow Recession Rates Affecting Potential for Juvenile Stranding	Less than 1.5% of wetted habitat at risk of stranding. 800 smolts, 400 fry, 400 juveniles stranded in pools subject to rescue and relocation with 5 percent injury and 2 percent mortality
IA 10: Magnitude of Flow Diversions Affecting Steelhead Rearing Habitat	Take not reasonably certain to occur
IA 11: Magnitude of Flow Diversions Affecting Estuary Rearing Habitat for Juveniles	Take not reasonably certain to occur
IA 12: Transporting Steelhead Downstream	3,750 smolts Up to 5% injury for all life stages relocated Up to 2% mortality for all life stages relocated

7.3.4 WATER DIVERSION - COMPARATIVE ASSESSMENT OF EFFECTS TO STEELHEAD HABITAT

The effects analysis also focused on how water diversion and instream flow operations would affect the freshwater migration corridor and the dynamics of the estuary that regulate access to the corridor, as well as potential juvenile steelhead rearing habitat in the estuary.

Because there are losing and gaining segments within the affected reach, the quantity of flow at any given location can be quite variable. In terms of the provision of a functional migration corridor, the critical reach is a losing segment and has been throughout history, therefore the critical reach is a bottleneck in the steelhead migration corridor in the lower river. This is because the interplay of the amount of flow entering the reach and its channel characteristics essentially control the provision of suitable migration conditions for adult steelhead for the entire affected reach. Thus, critically, if suitable conditions afford passage through the critical reach then those same conditions afford migration through the lower river up to the Freeman Diversion. The same is true at the Freeman Diversion, in that passage through the diversion fish passage facility is the other critical bottleneck in the migration corridor. In other words, unimpeded migration is approximated when steelhead have efficient passage through the critical reach and the fish passage facility. Alternatively, although conditions may be suitable in other segments of the river, if they do not afford efficient passage through the critical reach, then approximating unimpeded migration is not possible through the lower river.

The critical reach contains a series of critical riffles identified and measured by TRPA in 2004 and 2005 to determine sufficient adult steelhead passage conditions. Thus, this component of the effects assessment was centered first around the provision of flows within the critical reach that afford "sufficient" (>120 cfs) passage conditions for adult steelhead to swim through the critical reach and therefore unimpeded migration through the affected reach is conservatively inferred at 120 cfs. It is important to note that the "sufficient passage" comparison point (>120 cfs) applied in the effects analysis is less than the adult migration flow prescribed in the proposed operations (> 160 cfs). The higher flow targeted by operations includes a buffer to conservatively ensure passage criteria are met (i.e., are "more than sufficient" for passage).

The HOSS model was used to assess four biological metrics:

- **Total days of potential passage opportunity for steelhead adults through the critical reach –** This metric estimates the number of potential passage days per water year, defined as days within the primary migration window with flows that allow passage of steelhead adults through the critical reach. For this analysis, suitable passage conditions are assumed at flows > 120 cfs at the critical riffle, with a migration window of January 1 through May 31.
- **Total days of potential passage opportunities for steelhead smolts through the critical reach –** This metric estimates the number of potential passage opportunity days per water year, defined as days within the assumed migration window with flows that allow passage for steelhead smolts through the critical reach. For the effects analysis, suitable passage conditions are assumed to be provided at flows >80 cfs, with a migration window of February 15 through June 30. Note that the migration window applied for the effects analysis differs from the primary migration season identified for operational criteria in the SMP (March 15 – May 31).

In addition to passage through the critical reach, adult steelhead must also pass over the Freeman Diversion (via upstream fish passage facilities) to reach spawning habitats in the upper Santa Clara River watershed. NMFS' assessment of the current Denil fish ladder concluded that passage of adult steelhead is ineffective at river discharges over 500 cfs (NMFS 2008). Adult steelhead may be able to pass through the existing structure when total river flow is greater than 500 cfs, but the probability of successful passage may decrease as flow increases. Thus, the effects analysis herein conservatively treats 500 cfs as a strict upper limit under the water rights operations and assumes the diversion structure to be a complete barrier to upstream migration at flows above this level. The proposed operations include the construction and operation of a new fish passage with approximated unimpeded passage up to flows of 6,000 cfs. The effects analysis for adult steelhead therefore applies this additional metric:

Total days of potential unimpeded passage opportunities for steelhead adults through the critical reach and the Freeman Diversion from January 1 through May 31 – This metric is similar to potential steelhead adult passage days except that unimpeded passage over the Freeman Diversion is also considered. For this metric, suitable passage conditions are assumed at flows > 120 cfs at the critical riffle but only when Santa Clara River flows are lower than the unimpeded passage threshold at the Freeman Diversion fishway. Approximated unimpeded passage through the Freeman Diversion is assumed when total Santa Clara River flows entering the fish passage facility are ≤ 500 cfs for water rights and ≤ 6,000 cfs for proposed operations. There was no applied maximum for unimpeded passage under the no diversion scenario providing a more conservative comparison between the operational scenarios and no diversion, which likely overestimates effects of the proposed operations.

Passage metrics for each flow scenario were calculated on an annual basis (water year), and summary statistics included the minimum, maximum, mean, and median for each of the water year types (low, moderate, and high flow) and all 71 years of the available hydrologic record. The analysis for a given metric in this Section was based on median values. This is because the annual metrics have skewed distributions reflective of the highly variable precipitation and flow patterns in the Santa Clara River. Most years are relatively dry, with modest opportunities for steelhead migration, but there are a few years in the 71-year record with high flow during the entire migration season and ample migration opportunities. When comparing operations, although the full range of potential effects is important to consider, the primary focus should be on the most likely effect in any given year. In statistical terms, this most likely effect is the "expectation." When distributions are approximately normally distributed, the sample mean, or average, is the best estimate of expectation. The median (i.e., the value which is exceeded 50 percent of the time) in this case, will be very similar to the average, and could also be used as an estimate of expectation. With positive skewed distributions, as with the annual metrics in the effects analysis, the sample mean is a biased estimate of the expectation – it is higher than the most likely result in any given year. For example, if a distribution contains 10 zeros and two 20s, the average of these is 3.3, but the most likely result of a random selection is obviously zero. With a biased distribution, the median is an unbiased estimate of the expectation – the most likely result. Therefore, the median was used as a central statistic for most of the effects analysis comparisons in the MSHCP. However, mean results for every year are provided in the detailed effects analysis reports (R2 2016).

In terms of providing an estimate of take, or changes in the hydrograph conditions that can affect biologically relevant metrics, the no diversion scenario for the biological resources was assumed to represent a best-case scenario for steelhead and lamprey migration flows in the lower Santa Clara River. The determination of potential effects, characterized for purposes of the analysis only as take, first involves defining the extent to which the proposed operations improve conditions over what would otherwise occur under United's legally permitted water right prior to the ESA listing of SC DPS steelhead. Those conditions are represented by the water rights operations, which includes the Freeman Diversion and all other prior environmental perturbations in the Santa Clara River watershed. Thus, the water rights operations represent the overall level of take/harm from which the conservation plan has been developed to recover.

The relative improvement from water rights operations to proposed operations was estimated as:

$$\frac{(\text{Proposed Operations Metric} - \text{Water Rights Operations Metric})}{(\text{No Diversion Metric} - \text{Water Rights Operations Metric})}$$

The remaining or residual potential effects of the proposed operations relative to no diversions was estimated as:

$$\frac{(\text{No Diversion Metric} - \text{Proposed Operations Metric})}{(\text{No Diversion Metric})}$$

These ratios were calculated on an annual basis and summarized over the period of record by the median, for an overall estimate of the effects of the proposed operations compared to no diversion and percent recovery from the water rights.

Finally, although little is known regarding juvenile steelhead rearing within the estuary, an analysis of potential habitat was completed for each of the six representative years (October 1 to September 30) applied in the estuary model that resulted in the computation of mean habitat in acres, for each of the four operations. The analysis computed rearing habitat as a function of water depth and distance to cover. The criterion applied was a minimum water depth of 3 feet to avoid avian predation, unless cover was available from vegetation or woody debris. An additional analysis was completed that focused on the frequency of breach events during the summer months. Such events can occur during drier months—May through September—and may reduce the quality of steelhead rearing habitat (Smith 1990; Bond et al. 2008) by causing unstable fluctuations in dissolved oxygen, salinity, and water temperature (Sloan 2006; Atkinson 2010), and, in some lagoons, can be significant enough to result in fish mortality (e.g., Pescadero Creek [Sloan 2006]). Breach events during summer are a documented source of juvenile steelhead stranding in the estuary (see Section 4.2.1, Cardno/Entrix 2010).

Potential Diversion and Instream Flow Operations Effects to Adult Steelhead Habitat – Upstream Migration

The migration corridor for adult steelhead attempting to spawn in upstream tributaries is open for upstream migration when the river mouth is open, flow through the critical riffle of the affected reach is sufficient for adult steelhead to navigate efficiently, and the flows exiting the Freeman Diversion are not too high for the fish to locate and use the fish passage facility and migrate through the diversion structure. Effects of proposed operations on the adult upstream migration corridor are discussed here in two main sections. First, passage through the critical riffle and through the Freeman Diversion for the 71-year period of record is assessed. Then the effects to the entire migration corridor through the lower river are described by adding the river-mouth breaching component for the six representative water years in the estuary model.

Migration through the Critical Reach

This section summarizes the potential migration opportunities for adult steelhead through the critical reach under the four flow scenarios over the 71-year period of record. In addition to the median result and the median difference from the passage days available under no diversion across years, the number of years with no passage days, and the number of years with three or fewer passage days are summarized to provide two levels of years with poor passage potential. Finally, the results for the three diversion operations (initial, future, and water rights operations) are summarized as relative percent reductions from no diversion, and the proposed operations are summarized in terms of relative percent recovery from the water rights operations.

Metric: total days of potential passage for steelhead adults during the migration window (January 1 – May 31) – This metric represents the total overall days of passage opportunity for steelhead adults that meet the sufficient passage criteria of 120 cfs.

Under proposed operations for the period of record, the median annual days of potential passage is 23, with 10 out of 71 (14 percent) years having zero passage potential, and 23 out of 71 (32 percent) of years having 3 or fewer potential passage days (Table 7-12). This represents a median annual loss of 17 percent of potential passage opportunities for upstream migration compared to no diversion (median annual difference of five days). Under water rights operations for the period of record, the median annual days of potential passage is 6, with 17 out of 71 (24 percent) years having zero passage potential, and 29 out of 71 (40 percent) of years having three or fewer potential passage days (Table 7-12). This represents a median annual loss of 72 percent of potential passage opportunities for upstream migration in the water rights operations compared to no diversion. The proposed operations represent a median annual recovery of 67 percent of the potential passage days not available under the water rights operations.

Based on the HOSS model results for the 71-year period of record with no diversion, annual potential for upstream migration of adult steelhead through the critical riffle is highly variable even under the no diversion scenario (Figure 7-33). The distribution of annual passage opportunities is skewed, with 50 percent of years having less than 34 days of passage (median), but a few years with passage throughout the entire inferred migration window (151 days total possible days in leap years).

Out of 71 years, six years (8 percent) had no passage opportunities at all under no diversion (Table 7-12). There was an extended dry period from 1945–1966 during which nine of 22 years (41 percent) would have three or fewer potential passage opportunities without diversions, but for the entire period of record, 23 percent of years (16 out of 71) had three or fewer potential passage days.

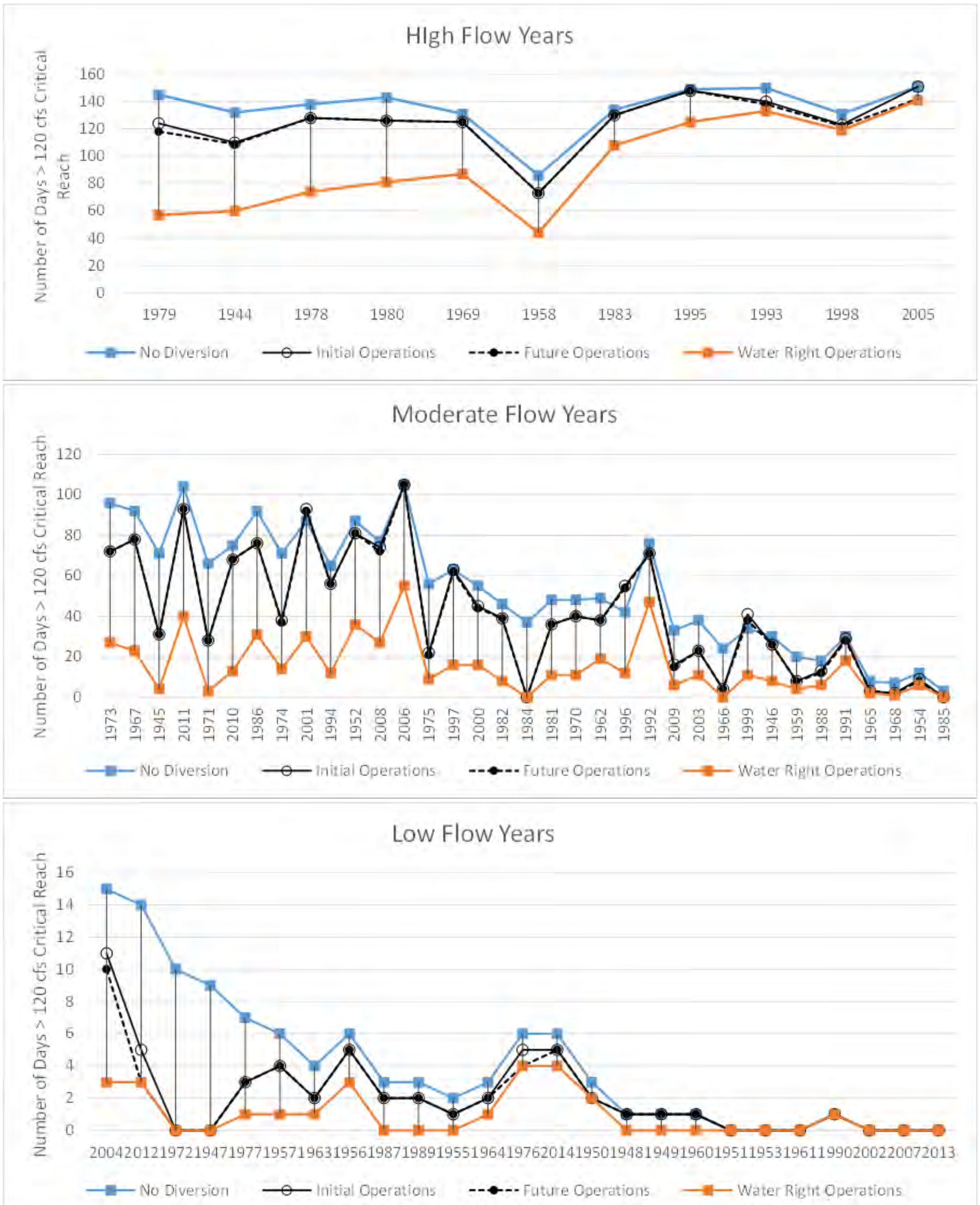
Table 7-12 Comparison of Selected Statistics for Adult Steelhead Passage through the Critical Riffle among Four Operations Based on 120 cfs Flow Passage Criteria from January 1 – May 31

Adult Passage through Critical Riffle	No Diversion	Initial Operations	Future Operations	Water Rights
Years with 0 Passage Days (%)	8%	14%	14%	24%
Years with 3 or fewer Passage Days (%)	23%	32%	32%	40%
Median # Passage Days	34	23	23	6
Median Passage Days Less than No Diversion	NA	5	5	22
Median Annual Percent Loss from No Diversion	NA	17%	17%	72%
Median annual Percent Recovery from Water Rights	NA	67%	67%	NA

The proposed operations provide substantially greater passage opportunities through the critical riffle than water rights operations, which is particularly important because passage opportunities under water rights operations are generally few (median of 6 days).

The plots in Figure 7-31 show annual comparisons in adult steelhead critical riffle potential passage days among the four operations, with years divided into high, moderate and low-flow years. In high flow years, initial operations represent a median annual recovery of 76 percent of the potential passage opportunities not available under water rights operations, with a median residual annual deficit of 7 percent of passage opportunities under no diversion (median difference of 10 days per year). In moderate flow years, a median of 74 percent of the adult passage potential not available under water rights operations are recovered under proposed operations, with a median residual annual deficit of 18 percent of passage opportunities under no diversion (median difference of eight days per year). In low-flow years, an annual median of 50 percent of the passage days unavailable under water rights operations are recovered with the proposed operations, with a median residual annual deficit of 33 percent of passage potential with no diversion (median difference of one day per year).

Figure 7-31 Comparison in Annual Steelhead Upstream Passage Days among Four Scenarios, Plotted by Water Year Type (high, moderate, and low flow years) and in Order of Magnitude of Difference for Given Years between Water Rights Operations and No Diversion



Adult Steelhead Migration through the Critical Reach and Freeman Diversion

For estimation purposes, adult steelhead are expected to migrate through the critical reach and the Freeman Diversion within the same day. To qualify as an upstream passage day through the Freeman Diversion, flow through the critical reach must be at least sufficient to meet adult passage criteria and total river flow cannot exceed levels above which adult steelhead may not be able to migrate through the fish passage facilities at the Freeman Diversion. An upper flow limit of 6,000 cfs was imposed on the no diversion and proposed operations scenarios. An upper flow limit of 500 cfs was imposed on the water rights operations.

When considering passage through the critical reach and the Freeman Diversion (Table 7-13), the number of passage days with water diversion operations is lower in most years. For water rights operations, the median annual loss is 100 percent of the adult upstream passage potential available under no diversion. With the new passage facility combined with instream flow conservation measures (CM 1.2.1-1.2.4), the proposed operations have a median recovery of 88 percent from that lost passage potential under water rights, which is higher than the recovery rate for critical reach passage alone (67 percent recovery; Table 7-12).

Table 7-13 Comparison of Selected Statistics for Adult Steelhead Passage through the Critical Riffle and the Freeman Diversion among Four Scenarios based on 120 cfs Passage Criteria from January 1– May 31

Adult Passage through Critical Riffle and Freeman Diversion	No Diversion	Initial Operations	Future Operations	Water Rights
Years with 0 Passage Days (%)	8%	14%	14%	83%
Years with 3 or fewer Passage Days (%)	23%	32%	34%	92%
Median # Passage Days	34	23	23	0
Median Days Lost from No Diversion	NA	4	4	34
Median Annual % Loss from No Diversion	NA	12%	12%	100%
Median Annual % Recovery from Water Rights	NA	88%	88%	NA

Diversion and Instream Flow Operations Effects to Juvenile Steelhead Habitat – Downstream Migration

The downstream migration of steelhead smolts through the affected reach commences once they pass over the Freeman Diversion using any of several pathways including the vertical slot fishway, fish bypass system, bypass channel, crest gates, and diversion crest. Once below the Freeman Diversion, the steelhead smolts must migrate downstream through the critical reach and the lower Santa Clara River to, and through, the estuary to reach the ocean. Effects of proposed operations to the steelhead smolt downstream migration corridor are discussed here in two main sections: (1) passage through the critical riffle, and (2) passage from above the Freeman Diversion to the ocean.

Downstream Migration through the Critical Reach

This section summarizes the potential migration opportunities for steelhead smolts through the critical reach under the four flow scenarios over the 71-year period of record. In addition to the median result and the median difference from the passage days available under no diversion across years, the number of years with no passage days, and the number of years with three or fewer passage days are summarized to provide two levels of years with poor passage potential (Table 7-14). Finally, the results for the three diversion operations (initial, future, and water rights operations) are summarized as relative percent reductions from no diversion, and the proposed operations are summarized in terms of relative percent recovery from the water rights operations.

Metric: total days of potential passage for smolts during the migration window (Feb 15 – June 30) – This metric represents the total overall days of passage opportunity for steelhead smolt/juveniles that meet the criterion of 80 cfs for smolt/juvenile passage at the critical riffle.

Table 7-14 Comparison of Selected Statistics for Steelhead Smolt Passage through the Critical Riffle among Four Scenarios Based on 80 cfs Passage Criteria from February 15 to June 30

Smolt Passage Through Critical Riffle	No Diversion	Initial Operations	Future Operations	Water Rights
Years with 0 Passage Days (%)	11%	18%	18%	35%
Years with 3 or fewer Passage Days (%)	28%	35%	35%	48%
Median # Passage Days	42	25	25	4
Median Days Lost from ND	NA	9	10	24
Median Annual % Loss from ND	NA	24%	24%	82%
Median annual % Recovery from WR	NA	56%	54%	NA

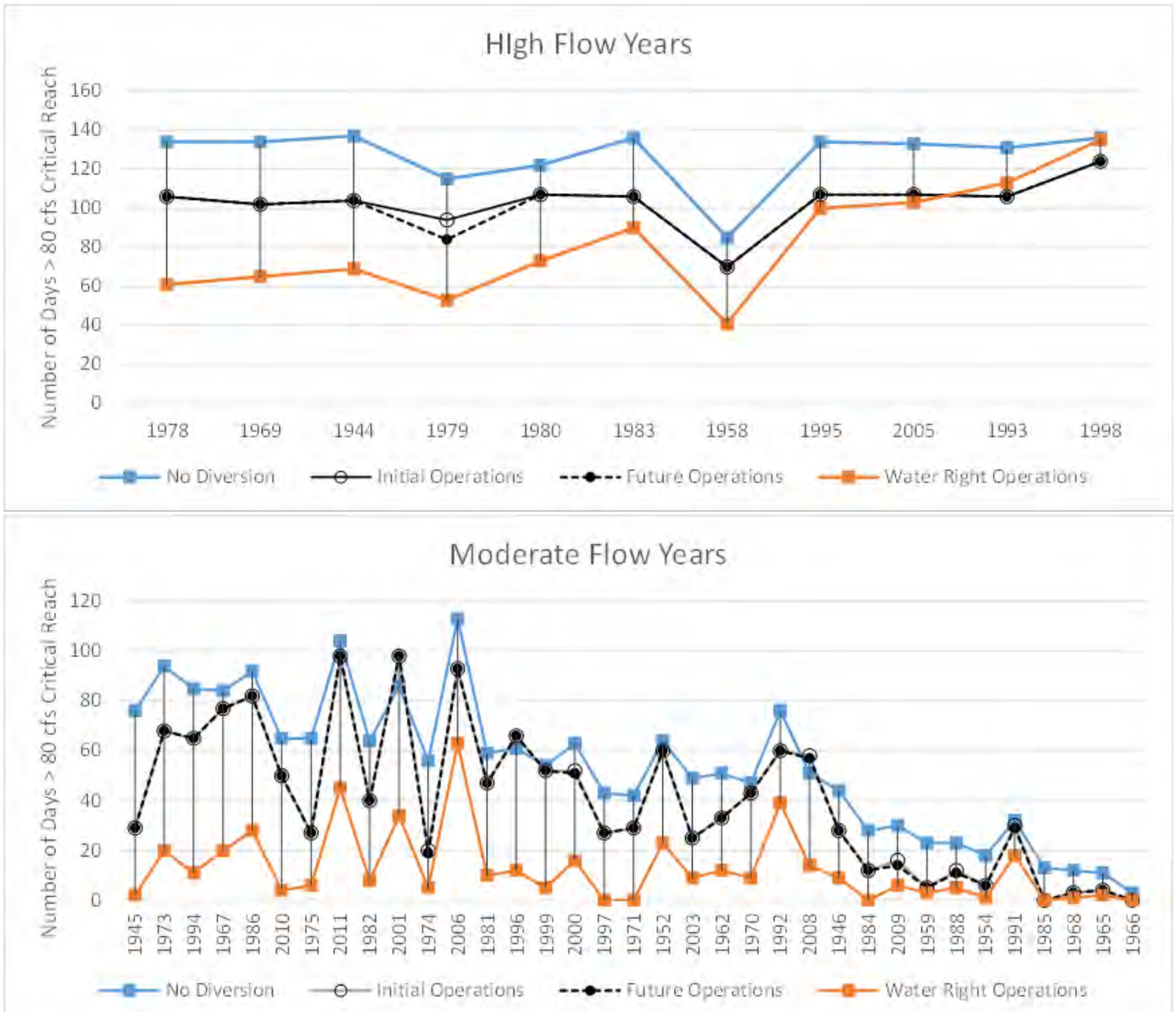
Based on the HOSS model results for the 71-year period of record, annual potential for migration of smolts through the critical riffle is highly variable with no diversion (Figure 7-35). The distribution of annual passage opportunities is skewed, with 50 percent of years having less than 42 days of passage (median), but a few years having passage opportunities throughout the primary migration window (137 total possible days in leap years). Out of 71 years, eight of the annual hydrographs (11 percent) provided no passage opportunities with no diversion. There was an extended dry period from 1945–1966 during which 11 out of 22 (50 percent) years would have had 3 or fewer potential passage days with no diversion, but for the entire period of record, 28 percent of years (20 out of 71) had 3 or fewer potential passage days.

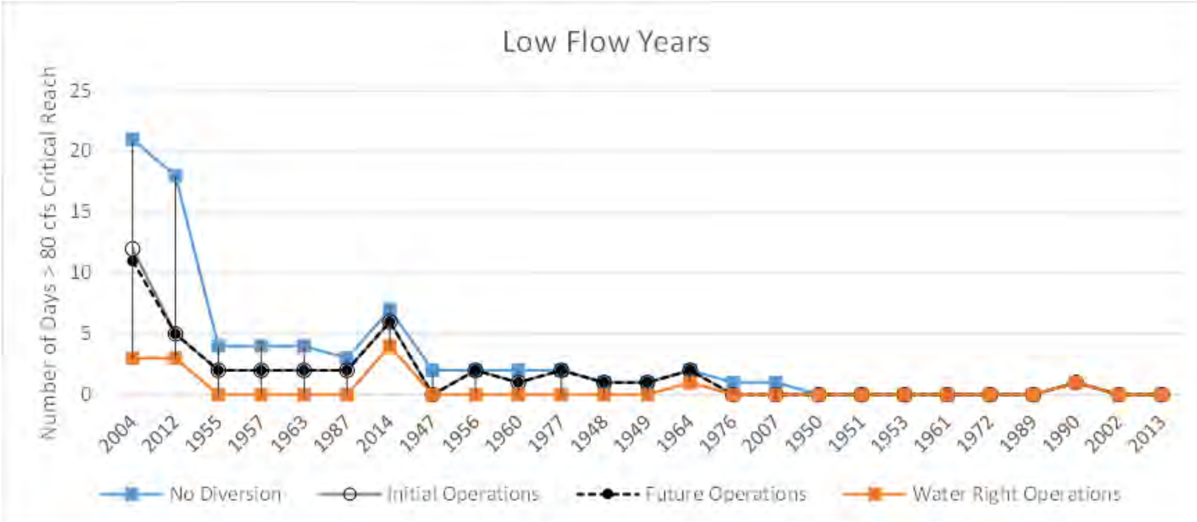
Under proposed operations for the period of record, the median annual days of potential passage for smolts is 25, with 13 out of 71 (18 percent) years having zero passage potential, and 25 out of 71 (35 percent) of years having three or fewer potential passage days (Table 7-14). This represents a median annual loss of 24 percent of potential passage opportunities for smolt migration compared to no diversion (median annual difference of 9-10 days). Under water rights operations for the period of record, the median annual days of potential passage is 4, with 25 out of 71 (35 percent) years having zero passage potential, and 34 out of 71 (48 percent) of years having 3 or fewer potential passage days (Table 7-9). This represents a median annual loss of 82 percent of potential passage with no diversion (median annual difference of 24 days). The proposed operations represent a median annual recovery of 54–56 percent of the potential passage days not available under water rights operations. This represents a median annual loss of 24 percent of potential passage compared to no diversion (median annual difference of 9-10 days).

The plots in Figure 7-32 show annual comparisons in steelhead smolt critical riffle potential passage days among the four considered flow scenarios, with years divided into high, moderate and low-flow years. In high flow years, Initial Operations represents a median annual recovery of 51 percent of the potential passage opportunities not available under water rights operations, with a median residual annual deficit of 20 percent of passage opportunities compared to no diversion (median difference of 26–27 days/year). In moderate flow years, an annual median of 60 percent of the adult passage potential not available under water rights operations are recovered under proposed operations, with a median residual annual deficit of 31 percent of passage opportunities compared to no diversion (median difference of 13 days/year). In low flow years, an annual median of 50 percent of the passage days unavailable under water rights operations are recovered with the proposed operations, with a median residual annual deficit of 43–48 percent of passage potential compared to no diversion (median difference is less than a single day of passage).

Proposed operations provide substantially greater smolt downstream passage opportunities through the critical riffle than water rights operations, which is important because passage opportunities under water rights operations are generally few (median of four days). Proposed operations provide fewer passage opportunities than those available under no diversion in most years. However, proposed operations provided more potential smolt passage days during the Feb 15 – June 30 migration window than those available with no diversion during 2001 (12 days), 2008 (7 days), and 1996 (5 days) because mounding from extensive artificial recharge caused the river adjacent to the critical riffle to gain water from the mounded water in the aquifer.

Figure 7-32 Comparison in Annual Steelhead Downstream Passage Days among Four Scenarios, Plotted by Water Year Type (high, moderate, and low flow years) and in order of Magnitude of Difference for Given Years Between Water Rights Operations and No Diversion





Migration from Upstream of the Freeman Diversion to the Ocean

For any single day to be counted as a potential day of steelhead smolt downstream passage through the entire migration corridor, three requirements must be met – flows greater than 80 cfs must be provided at the critical riffle, the beach berm at the river mouth must be breached by midnight (00:00) of the same day, and the beach berm must not be closed before noon on the third day after the downstream passage day. This assumes that any steelhead smolt entering the critical riffle for emigration, needs about three days to reach the ocean. If the river-mouth closes prior to three days after the smolt has cleared the critical riffle, some probability that the smolt will not be able to exit the estuary has been assumed. Because beach berm breaching was only modeled for six representative water years, the number of passage days through the entire migration corridor could only be estimated for these six years. Table 7-15 shows the comparison of steelhead smolt downstream passage days through the critical riffle, and then through the entire migration corridor downstream of Freeman Diversion. There were only a few days with flow at the critical riffle greater than 80 cfs with the river mouth closing less than three days later. Table 7-16 shows the potential no diversion full migration days that are not available under the three operational scenarios, and the percent of potential full migration days not available under water rights operations that are regained under proposed operations.

Table 7-15 Potential Days for Steelhead Smolt Downstream Migration through the Critical Riffle, and through the Critical Riffle to the Ocean

		Migration Through Critical Riffle				Full Downstream Migration Days			
Year Type	WY	No Diversion	Initial Operations	Future Operations	Water Rights	No Diversion	Initial Operations	Future Operations	Water Rights
Low	2002	0	0	0	0	0	0	0	0
Low	1990	1	1	1	1	1	1	1	1
Mod	2009	30	16	14	6	30	15	14	5
Mod	2000	63	52	51	16	63	52	50	16
Mod	2011	104	98	98	45	104	98	98	45
High	1998	136	124	124	135	136	124	124	135

Table 7-16 Percent Loss of Full Downstream Migration Days under Three Operational Scenarios Compared to No Diversion and Percent Recovery from Water Rights under Proposed Operations

Year Type	WY	Initial Operations			Future Operations			Water Rights	
		Days Lost Compared to No Diversion	% Less than No Diversion	% Recovered Over Water Rights	Days Lost Compared to No Diversion	% Less than No Diversion	% Recovered Over Water Rights	Days Lost Compared to No Diversion	% Less than No Diversion
Low	2002	0	N/A	N/A	0	N/A	N/A	0	N/A
Low	1990	0	N/A	N/A	0	N/A	N/A	0	N/A
Mod	2009	15	50%	40%	16	53%	36%	25	83%
Mod	2000	11	17%	77%	13	21%	72%	47	75%
Mod	2011	6	6%	90%	6	6%	90%	59	57%
High	1998	12	9%	N/A	12	9%	N/A	1	1%

Based on the six years evaluated for full migration corridor passage days, some general conclusions can be inferred. In most cases, sufficient flow for passage through the critical riffle and an open river mouth coincide. The differences that did arise occurred in years with moderate levels of passage opportunity overall; no changes were observed in 2011 or 1998, which had ample migration opportunities. In 2000 and 2009, one day with passage through the critical riffle under proposed operations could not be used by steelhead smolts because the beach berm closed before the inferred three-day migration time.

In summary, water rights operations resulted in an annual median loss of potential full migration corridor passage days under no diversion of 66 percent. The median annual recovery of full migration corridor passage opportunities under proposed operations was 72–77 percent. Compared to no diversion, the annual median reduction in full migration corridor passage opportunities under proposed operations was 13–15 percent. These results are based only on six representative years, so it is important to compare the results in these years to the critical-riffle only passage results to make more general conclusions (Table 7-14). In terms of passage opportunities compared to no diversion, the four years with any opportunities in Table 7-16 are showing no changes or very modest increases in migration reductions.

7.3.5 POTENTIAL DIVERSION AND INSTREAM FLOW OPERATIONS EFFECTS TO JUVENILE STEELHEAD REARING HABITAT AND TIDEWATER GOBY HABITAT

Tidewater gobies are known to occur in the Santa Clara River estuarine lagoon (see Chapter 4) and it is designated critical habitat for tidewater goby.

Although the affected reach of the Santa Clara River is primarily considered an upstream and downstream migration corridor for adult, kelt and smolt/juvenile steelhead, there is the potential for juvenile rearing habitats to exist both in the mainstem downstream of the critical riffle and within the estuary. Steelhead within the southern California DPS may potentially exhibit three or more life-history strategies including fluvial-anadromous, freshwater-resident, and lagoon – anadromous (NMFS 2016; Boughton et al. 2006), with a fourth variation consisting of a combined upper watershed and estuary – lagoon life history strategy (Hayes et al. 2008).

Steelhead in the Santa Clara River may also exhibit a lagoon – anadromous life history strategy, whereby spawning occurs in the tributaries and at least a portion of the juveniles move downstream to rear in the estuary, which can then become a lagoon when closed off from the ocean due to beach berm development. Lagoons can reportedly provide exceptionally good rearing conditions for steelhead. This has been documented in studies completed by Smith (1990) and Bond (2006), both of whom reported on increased growth and high densities of steelhead. Boughton et al. (2006) cited several other studies that pointed to the ecological benefits of lagoon rearing. In the Santa Clara River, both fluvial – anadromous and freshwater – resident forms have been identified and are at the center of United's instream flow commitments (CM 1.2.1 through CM 1.2.4). Juvenile steelhead have the potential to rear in the estuary (see Chapter 4, Section 4.2.1), but a lagoon-anadromous life history has not been documented in this watershed.

The effects of the proposed operations on tidewater goby and steelhead estuary-lagoon rearing habitat were assessed on a habitat area basis. Habitat acreages vary primarily by water year type. For steelhead rearing mean habitat area is between approximately 36 acres in high-flow years and 100 acres in low-flow years (Table 7-17) (Stillwater Sciences 2016). For tidewater goby mean habitat area is estimated between approximately 19 acres a high-flow year and 66 acres in low-flow years (7-22). This is a function of the persistence of a fuller lagoon throughout the year, where the lagoon remains less full during high-flow years due to more frequent and longer duration open-mouth periods, and vice-versa. More steelhead rearing habitat and tidewater goby habitat is available in a low-flow water year, when flow-driven breach events would be less common and, thus, the ponded lagoon volume and habitat area would be greater. Similarly, since the proposed operations result in slightly fewer breach events during low-flow and moderate years, there is slightly more steelhead rearing and tidewater goby habitat provided in the proposed operations compared to no diversion, and slightly more habitat under the water rights compared to the proposed operations in moderate years with little to no difference in dry years and the wet year (Table 7-17 and Table 7-15).

Table 7-17 Mean Available Juvenile Steelhead Rearing Habitat (Acres) Within the Santa Clara River Estuary Throughout Water Year (October 1–September 30)

Year Type	WY	Mean available juvenile rearing habitat (acres)			
		No Diversion	Initial Operations	Future Operations	Water Rights
Low	2002	79	103	103	103
Low	1990	96	96	96	96
Mod	2009	82	103	98	103
Mod	2000	73	83	85	90
Mod	2011	62	69	69	76
High	1998	35	36	36	36

*Data from Appendix F in Stillwater Sciences 2016a

Table 7-18 Mean Available Tidewater Goby Habitat (Acres) Within the Santa Clara River Estuary					
		Mean available habitat in non-incubation period (October 1-April 30) (acres)			
Year Type	**WY**	**No Diversion**	**Initial Operations**	**Future Operations**	**Water Rights**
Low	2002	66	66	66	66
Low	1990	64	64	64	64
Mod	2009	41	61	61	62
Mod	2000	47	49	51	55
Mod	2011	39	38	38	38
High	1998	32	33	33	33
Year Type	**WY**	**Mean available tidewater goby habitat in incubation period (May 1-September 30)(acres)**			
		No Diversion	**Initial Operations**	**Future Operations**	**Water Rights**
Low	2002	56	56	56	56
Low	1990	52	52	52	52
Mod	2009	67	63	52	63
Mod	2000	49	62	62	63
Mod	2011	49	57	57	64
High	1998	19	19	19	19
*Data from Appendix F in Stillwater Sciences 2016a					

When the estuary mouth berm is closed, the estuary tends to fill rapidly toward achieving an equilibrium state (Figure 7-33), which is when the greatest amount of potential steelhead rearing habitat is provided. Stillwater Sciences (2018) demonstrated that the habitat is not only suitable in terms of water depth and velocity for rearing based upon recommended ranges in reviews by Boughton et al. (2015), it also maintains suitable temperatures (<84°F annual maximum) and dissolved oxygen (DO; >6 mg/L) concentrations to support steelhead rearing under closed-mouth conditions. Santa Clara River estuary water temperatures vary from wintertime lows near 46°F to summertime highs approaching and sometimes exceeding 82°F, although median water temperatures varied from 63°F to 78°F during 2015–2016. While periods of unsuitable DO occurred intermittently in some locations within the estuary due to algal blooms, the estuary lagoon is relatively shallow and re-aeration by wind-mixing is relatively high, so extensive areas within the lagoon exhibiting hypoxic conditions were not observed during 2008–2016 monitoring. Salinity is temporally variable, with levels during closed-mouth periods typical of freshwater or oligohaline brackish environments, and periods of higher salinity driven by tidal exchange during open-mouth conditions. Water quality in the estuary is determined primarily by ambient conditions and discharge from the Ventura Water Treatment Facility, except for fluctuations in salinity driven by mouth open/closure status.

Figure 7-33 View of a Full Lagoon in the Santa Clara Estuary Following Weeks of a Closed River-Mouth at Beach Berm

(photo: Stillwater Sciences)

Rapid dewatering of the estuary or lagoon during otherwise stable conditions of summer is a potential threat to steelhead rearing and tidewater goby. Under the proposed operations, few berm-breaches are predicted to occur during summer (Table 7-19) similar to the no diversion scenario. Notably, under all scenarios there are more summer breach events predicted to occur during low-flow and moderate water years than high-flow years. This is because the accumulation of inflow during low-flow years will eventually lead to a breach. In a low-flow year, the accumulation is lower and thus the breach, if any, would occur later in the year (i.e., summer rather than winter or spring) due to a lack of storms earlier in the season; this despite the prediction that fewer breach events occur throughout the year than during wetter years. In a high-flow year, the accumulation is greater and typically the mouth will open earlier in the season (i.e., winter or spring) and remain open longer, sometimes persisting well through spring and summer in all operational scenarios.

Breach events during summer (May through September) can reduce the quality of tidewater goby habitat and steelhead rearing habitat (Smith 1990; Bond et al. 2008) by causing unstable fluctuations in DO, salinity, and water temperature (Sloan 2006; Atkinson 2010), and, in some lagoons, can be significant enough to result in fish kills (e.g., Pescadero Creek [Sloan 2006]). Breach events during the summer are a documented source of steelhead mortality in the estuary (see Chapter 4). While unauthorized breaching may occur due to human disturbance of the beach berm and this breaching can have deleterious effects on goby and steelhead due to rapid dewatering and stranding of fish, as well as changes in water quality, summer breach events caused by Freeman Diversion operations are predicted to be uncommon as seen in the comparison of no diversion to the proposed operations and water rights in Table 7-19. The number of breach events greater than 1 day in the summer are the same across all scenarios except in 2011, where 1 breach event is predicted in this moderate year for the diversion scenarios (proposed and water rights) compared to no predicted breach events under no diversion.

Table 7-19 Frequency of Breach Events (> 1 Day) During Summer Juvenile Steelhead Rearing Period (May 1–September 30)

Year Type	WY	Number of Breach Events (Events)			
		No Diversion	Initial Operations	Future Operations	Water Rights
Low	2002	1	1	1	1
Low	1990	1	1	1	1
Mod	2009	1	1	1	1
Mod	2000	1	1	1	1
Mod	2011	0	1	1	1
High	1998	0	0	0	0

Table 7-20 Difference (Events) Between Proposed Operations (initial and future), No Diversion, and Water Rights for Frequency Of Breach Events (>1 Day) During Summer Juvenile Steelhead Rearing Period (May 1–September 30)

Year Type	WY	Initial Operations			Future Operations			Water Rights	
		Frequency Increased over No Diversion	% Less than No Diversion	% Recovered Over Water Rights	Frequency Increased over No Diversion	% Less than No Diversion	% Recovered Over Water Rights	Frequency Increased over No Diversion	% Less than No Diversion
Low	2002	0	0%	NA	0	0%	NA	0	0%
Low	1990	0	0%	NA	0	0%	NA	0	0%
Mod	2009	0	0%	NA	0	0%	NA	0	0%
Mod	2000	0	0%	NA	0	0%	NA	0	0%
Mod	2011	1	NA	0%	1	NA	0%	1	NA
High	1998	0	NA	NA	0	NA	NA	0	NA

Overall, the results of the analysis indicate that there should be little if any effects of the proposed operation on the quantity and quality of steelhead juvenile rearing habitat and tidewater goby habitat in the estuary-lagoon. However, data are still lacking regarding the extent to which estuary-lagoon rearing by steelhead occurs in the Santa Clara River estuary and Booth (2020) hypothesized that it is unlikely that estuarine rearing plays a major role in the Santa Clara River system. No steelhead have been documented in routine seining surveys conducted by the City of Ventura (e.g., Nautilus Environmental 2009; Stillwater Sciences 2018), although several stranded steelhead in the size range of 10–12 inches were identified following an artificial breaching event in October 2010 (Cardno/Entrix 2010). However, this stranding event occurred after the relocation of juvenile steelhead from the river into the estuary associated with a fish rescue effort from the Freeman Diversion. Thus, it is not known whether volitional rearing by juvenile steelhead occurs in the estuary. Nevertheless, the analysis of habitats and observations of the stranded fish suggest the estuary should be able to sustain juvenile steelhead for at least short periods of time, although the overall extent, suitability, and use of rearing habitat is unknown, the proposed operations provides similar potential rearing habitat to the water rights and slightly more potential rearing habitat is expected, particularly in moderate years compared to no diversion.

7.3.6 WATER DIVERSION - EFFECTS TO AND TAKE OF LAMPREY

Lamprey use the Santa Clara River estuary as a migratory corridor during winter (primarily November 1–May 31) to enter from (adults migrating upstream), or leave to (juveniles migrating downstream), the ocean when flows are available to traverse the affected reach. The requirements for lamprey migration are typically less stringent than for steelhead, and minimum flow characteristics appropriate for steelhead exceed the minimum necessary for lamprey.

Habitat was used as a surrogate to estimate the take of lamprey from covered activities and assess the benefits of the instream flow commitments. The habitat surrogates selected for analysis to predict effects to lamprey were (1) riverine migratory habitat “passage days” and the hydrology of both the critical reach and the affected reach and (2) estuarine-lagoon habitat related to migration opportunity. The potential take associated with the water diversions and instream flow operations is presented in terms of biologically relevant passage days, which are defined separately for adult and juvenile lamprey:

- Adult lamprey – the annual maximum number of consecutive days with flows allowing passage of lamprey adults through the affected reach within the migration window November 1 – May 31.
- Juvenile (macrophthalmia) lamprey – annual number of passage events (within the migration window November 1 – May 31) defined as instances when flow at the critical reach exceeds 80 cfs on the peak flow and two following days

While it is possible that some larval (ammocoete) lamprey utilize areas of fine sediment in the lower river and estuary for rearing habitat, the fluctuating estuary is unlikely to provide suitable rearing habitat. Larval lampreys require long-term (5 to 7 years) habitat stability without desiccation, water velocities sufficient to transport suspended food particles without causing displacement, water temperature below 28°C, and anoxic near-bottom conditions, but the estuary experiences fluctuations in fresh and estuarine conditions, wetted area, water velocities, especially during breaching conditions, and near-bottom dissolved oxygen conditions. Also, large numbers of common carp occur in the estuary. Carp wallowing behavior likely adds to the estuary not being suitable for larval lampreys.

Successful migration of lamprey between the ocean and Freeman Diversion depends on sufficient instream flows at the critical riffle in the lower river, and fundamentally, access through the river-mouth in the estuary. As described for steelhead migration above, observations suggest that the beach berm has been found to open shortly after rainfall runoff events coinciding with continuous flow in the affected reach. When the river-mouth at the beach berm is open, water depths through the berm breach are almost always sufficient to allow passage from the estuary lagoon into the ocean. Conditions under which river flows exceed 80 cfs in the critical riffle during lamprey migration window and the river-mouth is closed were evaluated to assess whether ocean to estuary migration opportunities are limited by a closed-mouth condition. The modeled results indicate that under the proposed operations suitable flows would occur without an open-mouth for negligible periods of time (i.e., <1 percent) in all water year types. These results indicate that instream flows, rather than beach berm status, control migration conditions for lamprey in the lower river and estuary. Therefore, this analysis assumes that if sufficient flows occur at the critical riffle, the river-mouth will be open. These conditions were characterized by metrics to assess the potential effects of the proposed operations.

Methods

Like steelhead, the effects analysis for lamprey also focused on how proposed operations would affect the freshwater migration corridor and the dynamics of the estuary that regulate access to the corridor. For the riverine effects analysis, the two most important considerations pertain to understanding the flow conditions in the affected reach that facilitate the upstream migration of adults and the downstream migration of juveniles.

Lamprey use the estuary and lower river fundamentally as a migratory corridor (November 1–May 31) to enter or leave the ocean when flows are available to traverse the affected reach. This temporal window is determined by local climatic conditions, including periods when the mouth is open for ingress/egress and periods when high flow freshets can be expected to carry out-migrating juveniles downstream from upstream rearing areas and out to sea. The timeframe is further supported by observations from 1991–1997 of lampreys arriving at the Freeman Diversion (Chase 2001).

The instream flow requirements for lamprey migration are typically less stringent than those for steelhead, and minimum levels appropriate for steelhead are assumed to exceed the minimum necessary for lamprey. Lamprey take advantage generally of lower near–bottom current velocities by swimming within 2.5 in off the bottom and often follow near-bank routes, where currents are substantially lower (Reid and Goodman 2016).

Because ammocoetes require long-term (5-7 years) habitat stability without desiccation, the estuary and intermittent flow regime of the lower river are unlikely to have naturally provided suitable long-term rearing habitat and therefore, ammocoetes are not considered further in the diversion effects analysis. The two biological metrics used to evaluate effects of the Freeman Diversion on lamprey are described below.

Effects Assessment for Adult Pacific Lamprey Upstream Migration

In the Santa Clara River, anadromous adult lamprey may enter the system starting in the winter with the opening of the sand berm at the estuary and continue into May, as long as the river-mouth remains open (Chase 2001). Following sand-berm breaching events in the estuary, adult lamprey have been observed at the Freeman Diversion 6 to 16 days later (1991–1997; Chase 2001). Therefore, contiguous flow events were defined as “passage events” if suitable flow was available for at least 6 consecutive days.

Based on body depth and dorsal fin height for immigrating adult lamprey, a minimum depth of 0.4 foot would be needed for effective anguilliform swimming, which depends on lateral body surfaces rather than caudal propulsion (Gemmell et al. 2015). A review of rating curve information and channel morphology for cross sections surveyed by TRPA (2005) in the critical reach suggested flows of approximately 55 cfs, would likely provide adequate water depth and width at the critical riffle and velocities below a lamprey’s unconstrained swimming speed. However, as described above, more recent data collected by United water suggests that 80 cfs is the flow at the critical riffle considered adequate for providing a continuous migration corridor from the estuary to the Freeman Diversion; consequently, “passage events” were defined when flows exceeded 80 cfs at the critical reach from November 1 through May 31.

Under no diversion, 76 percent of years provided at least one 6-day passage event for adult Pacific lamprey, and the median duration of these passage events is 42 days. Under proposed operations, the probability of 6-day passage being provided in any given year is 59–62 percent, representing a reduction of 19–20 percent compared to no diversion. The water rights scenario is predicted to have a 41 percent reduction compared to no diversion. Proposed operations represent a recovery of 45–55 percent from water rights in passage events for adult lampreys.

In addition, the HOSS was used to evaluate the 71-year period of record for the percent of years that provide at least one passage event as well as the median duration of passage events for no diversion, proposed operations, and water rights operations. The median reduction in the maximum duration passage event greater than 5 days is 6 days for the proposed operations compared to no diversion, which is a 0-3 percent reduction from no diversion. Under the water rights, the median of the annual longest passage event (>5 days) is 29 days less than that of no diversion, which is a 76 percent reduction compared to no diversion. The proposed operations therefore represent a 48-58% recovery from the water rights scenario (Table 7-21).

Table 7-21 Comparison of Selected Statistics for Pacific Lamprey Adult Passage through the Critical Riffle among Four Scenarios Based On 80 cfs Passage Criteria from November 1 – May 31

Adult Upstream Passage Through Critical Riffle	No Diversion	Initial Operations	Future Operations	Water Rights
Years with at least one passage event (%)	76%	62%	59%	45%
Loss from No Diversion (%)		19%	22%	41%
Recovery from Water Rights (%)		55%	45%	
Median Duration of Longest Passage Event > 5 days[1]	42	33	29	15
Median of Annual Maximum Duration Lost from No Diversion (days)[2]		6	6	29
Loss from No Diversion (%)		0%	3.0%	76%
Recovery from Water Rights (%)		58%	48%	

[1]Median of annual maximum durations only for years with passage events > 5 days.
[2]Includes all years, but loss is zero if no diversion has zero passage events > 5 days.

A total of 6,740 adult upstream migrating Pacific lamprey is predicted over the 50-year permit term. It is assumed that flows of 80 cfs over 6 consecutive days is required for adult Pacific lamprey upstream migration. Based on this assumption, 75% of years have at least one upstream migration event for adult Pacific lamprey under a No Diversion scenario, and there will be an estimated loss of migration events in 19% and 22% of years under Initial and Future operations, respectively, compared to the No Diversion scenario. Assuming the more conservative loss of 22% under Future Operations being applied across the entire 50-year permit term and assuming an even distribution of adult Pacific lamprey entering the Santa Clara River over the 50-year term, the proposed operations would result in take of an estimated 1,380 adult Pacific lamprey over the 50-year permit term due to losses in migration opportunities. Under the Water Rights scenario with an estimated loss of migration events in 45% of years, an estimated 2,673 adult Pacific lamprey would not have an opportunity to migrate upstream. Thus, the proposed operations represent a 48% improvement and an additional 1,293 adult Pacific lamprey migrating upstream compared to the Water Rights scenario. These analyses assume adult Pacific lamprey would have been present in the ocean at the mouth of the Santa Clara River and prepared to migrate upstream during lost opportunities.

Lost migration opportunities for Pacific lamprey in the Santa Clara River would have individual and population level effects. Individuals that lost the opportunity to migrate in the Santa Clara River could a) wait for the next migration opportunity, which in this case would be a year, or b) leave the Santa Clara River and locate another river with suitable migration conditions. Waiting for a subsequent flow event could result in exhaustion or stranding mortality within the riverine habitat, spawning in poor quality habitat. Alternatively, adult Pacific lamprey could migrate downstream and out of the Santa Clara River to wait in the ocean for another migration opportunity, or these fish may migrate upstream in a different watershed. Holding in the ocean or selecting an alternative watershed for migration would increase the risk of exposure to predation, or exhaustion, potentially resulting in eventual mortality. The impact of this potential taking would be reduced reproductive success and increased risk of mortality or injury.

It is difficult to infer population level effects of the taking because Pacific lamprey do not have genetically discrete populations and do not return to natal rivers with a high degree of fidelity (Goodman et al. 2008, Moyle et al. 2009; Spice et al. 2012). Pacific lamprey select rivers to enter based on suitable conditions, and thus, any individual that experiences a lost opportunity to migrate into the Santa Clara River is more likely, compared to steelhead that display high natal size fidelity, to leave the river for the ocean to locate a different river and reproduce. Indeed, the non-specificity of spawning river selection of Pacific lamprey may be adaptive to variability in environmental conditions that increases reproductive success.

To better understand adult Pacific lamprey abundance, migration timing and relationships with flow, United will measure the impacts of reduced migration events by monitoring the occurrence of United flow diversions resulting in a reduction in flows to less than 80 cfs, the assumed threshold of suitable passage conditions. Per EMM-02, United will track time of arrival at the Freeman Diversion of any upstream-migrating Pacific lamprey throughout the life of the ITP, and United will monitor flow below the Freeman Diversion to relate to adult occurrence and to evaluate flow commitments specified in CM 1.2.1 and CM 1.2.3. As described in EMM-02, additional monitoring approaches for adult Pacific lamprey are being considered including mobile DIDSON surveys and eDNA analysis in holding locations below the diversion. Stranding potential as a result of lost migratory opportunities will be monitored under EMM-04, and salvage initiated under CM 2.1.4 if conditions are deemed unsuitable for adult Pacific lamprey in holding locations.

Number of Passage Events for Pacific Lamprey Juveniles Downstream Migration

Outmigration of juvenile lampreys often occurs at night and is associated with high flow events, with most emigration occurring during and within two days of punctuated flow events (Goodman et al. 2015). Timing emigration with high flow events has the benefit of providing turbid water for concealment and the potential to carry emigrating juveniles rapidly to the ocean. Outmigration rate is likely associated with current velocity, with travel time being faster during high stream-flow velocities following storm events (Goodman et al. 2015). In the Santa Clara River, high flow events can reach the ocean periodically from November through May. Juvenile outmigration is likely tied to these high flow events (Goodman et al. 2015). The longest potential route from rearing habitat to the ocean would be about 62 miles (near the Tule Creek/Sespe Creek confluence to the ocean), and well within the distance juvenile can travel in a few nights of high flow (Goodman et al. 2015; Reid 2015).

The annual number of passage events that have consecutive days with flows allowing passage through the critical reach November 1 through May 31 was analyzed. For this analysis, a “passage event” was considered triggered by an increase in 200 cfs at the Sespe Creek gauge and is defined as the time when flow at the critical riffle exceeded 80 cfs on the day that flows peak at the Freeman Diversion and the two following days.

Passage events were tabulated using the HOSS for each of the 71 years in the period of record and summary statistics computed over the 71-year period (Table 7-22). Under no diversion, 75 percent of years provide at least one three-day passage event for juveniles, with a median of 2 events per year. Under proposed operations, the probability of three-day passage being provided in any given year is 72 percent, representing a reduction of 4 percent from no diversion. For proposed operations, the median number of passage events is unchanged from no diversion (zero percent change). Under water rights operations, 65 percent of years provide at least one three-day passage event (a reduction of 11 percent compared to no diversion), with a median of one event per year (median reduction of 50 percent). Proposed operations represent a recovery of 11 percent from water rights operations in terms of years with juvenile downstream passage, and 100 percent recovery in median number of passage events. Although some years have small differences for two-day passage events, the median results are identical to the three-day passage event results.

Table 7-22 Comparison of Selected Statistics for Pacific Lamprey Juvenile Passage through the Critical Riffle among Four Scenarios Based On 80 cfs Passage Criteria from November 1 – May 31

Macrophthalmia Downstream Passage Through Critical Riffle[1]	No Diversion	Initial Operations	Future Operations	Water Rights
Years with at least one passage event (%)	75%	72%	72%	65%
Loss from No Diversion (%)		4%	4%	11%
Recovery from Water Rights (%)		11%	11%	
Median number of passage events per year	2	2	2	1
Median number of lost passage events per year		0	0	1
Loss from No Diversion (%)		0%	0%	50%
Recovery from Water Rights (%)		100%	100%	

A total of 135,750 downstream migrating juvenile Pacific lamprey are predicted over the 50-year permit term. It is assumed that flows of 80 cfs over 2-3 consecutive days is required for downstream migration of juvenile Pacific lamprey. Based on this assumption, 75% of years have at least one downstream migration event for juvenile Pacific lamprey under a No Diversion scenario and there will be an estimated 4% loss of years from a No Diversion scenario under Initial and Future operations. Based on a 4% loss and assuming an even distribution of juvenile Pacific lamprey migrating downstream over the 50-year term, the proposed operations would result in take of an estimated 5,430 juvenile Pacific lamprey over the 50-year permit term due to losses in migration opportunities compared to no diversion. Under the Water Rights scenario with an estimated loss of migration events in 11% of years, an estimated 14,933 juvenile Pacific lamprey would not have an opportunity to migrate downstream. The proposed operations represent a 64% improvement and an additional 9,503 juvenile Pacific lamprey migrating downstream compared to the Water Rights scenario.

Lost migration opportunities for Pacific lamprey in the Santa Clara River would have individual and population level effects. Individuals that lost the opportunity to migrate in the Santa Clara River would have to find a holding location and wait for the next migration opportunity, which in this case would be a year. Waiting for a subsequent flow event could result in increased risk of mortality within the riverine habitat due to stranding in habitat with poor water quality and increased predation risk. The impact of this potential taking would be reduced survival and lower reproductive success.

It is difficult to infer population level effects of the taking because Pacific lamprey do not have genetically discrete populations because they do not return to natal rivers with a high degree of fidelity (Goodman et al. 2008, Moyle et al. 2009; Spice et al. 2012). Unlike adult lamprey, downstream migrating juvenile do not have the option of entering a separate river and would have hold until the next migration opportunity, which would be a year under the analysis scenario used to estimate effects of water diversion. Thus, juveniles that are prevented from migrating downstream are unlikely to contribute to reproduction and the population as a whole. However, because Pacific lamprey populations do not necessarily return to their natal spawning sites, the loss of reproductive opportunity for Pacific lamprey that cannot reach the ocean does not necessarily influence the number of Pacific lamprey that will return to the Santa Clara River as adults, but also does not contribute to population level reproductive success.

To better understand juvenile Pacific lamprey abundance, migration timing and relationships with flow, United will measure the impacts of reduced migration events by monitoring the occurrence of United flow diversions resulting in a reduction in flows to less than 80 cfs, the assumed threshold of suitable passage conditions. Per EMM-05, United will track time of arrival at the Freeman Diversion of downstream-migrating Pacific lamprey during steelhead trapping activities throughout the life of the ITP, and United will monitor flow below the Freeman Diversion to relate to juvenile occurrence and to evaluate flow commitments specified in CM 1.2.2 and CM 1.2.4. Stranding potential as a result of lost migratory opportunities will be monitored under EMM-07, and trap and relocation initiated under CM 2.1.5 if conditions are deemed unsuitable for juvenile Pacific lamprey in holding locations.

7.3.7 WATER DIVERSION - EFFECTS TO AND TAKE OF POND TURTLES

Under the proposed flow operations, no permanent loss of suitable habitat for pond turtles is expected and covered activities are expected to have negligible effects to pond turtle populations along the Santa Clara River.

Suitable foraging and breeding habitat for pond turtle occurs along the river channel upstream and downstream of the Freeman Diversion. Suitable riparian habitat for pond turtle could expand or contract depending on variable rainfall levels that alter river channel depth, width, and associated riparian vegetation recruitment and survival. Based on Stillwater (2016b), proposed instream flows would have "relatively inconsequential effects on the hydrologic parameters that are most critical to riparian vegetation recruitment and growth downstream of the Freeman Diversion." The study found that the amount of riparian vegetation in the immediate area around the Freeman Diversion increased because of the operations of the Freeman Diversion, based on historic reports, and that the proposed instream flows likely continue to have a net beneficial effect on the growth and development of riparian vegetation compared to the water rights. Therefore, water diversion and in-stream flow operations would have negligible effects to pond turtle habitat in the permit area (see Stillwater 2016b for more detailed analysis).

Ramping down instream flows during water diversion operations could result in drying of the river channel downstream of the Freeman Diversion, especially at the critical reach, and could expose juvenile pond turtles to predators such as racoons, ravens, or gulls. Effects to adults are expected to be negligible. Under EMM-07, United would survey the critical reach during ramp down operations and any juvenile turtles would be rescued and relocated to deeper ponded habitat with adjacent riparian vegetation.

No take is anticipated from diversion and instream flow operations on western pond turtles from effects to riparian habitat. Take due to mortality is not expected from instream flow operations. United estimates up to 10 pond turtles would be taken during the permit term due by capture through implementation of the rescue and relocation plan in the critical reach during and following instream flow ramp down procedures.

7.3.8 WATER DIVERSION - EFFECTS TO AND TAKE OF COVERED BIRDS

Under proposed flow operations, no permanent loss of suitable riparian habitat for covered birds is expected and covered activities are expected to have a negligible effect on covered bird populations. United did not map specific habitat for the covered avian species outside the areas that could be directly affected by renovation of the fish passage and Freeman Diversion. United determined that assessing effects of water diversion operations on riparian vegetation is an adequate surrogate for take to individuals.

Individuals

Direct effects to covered birds because of diversion and instream flow operations are expected to be negligible. The covered birds share similar habitat characteristics and are assessed similarly here. Suitable breeding and foraging habitat for covered birds occurs in freshwater wetland and mixed riparian habitat upstream and downstream of the Freeman Diversion, and downstream as far as the estuary within the O&M permit area (Chapter 1, Figure 1-2). Suitable foraging and nesting habitat for covered birds could expand or contract depending on the effect of annual rainfall on the natural hydrograph that alters river channel depth, width, and associated riparian vegetation recruitment and survival. Conveyance of water through off-channel facilities (e.g., canals, pipelines, desilting basin) to recharge basins would have no effect on covered birds.

Based on Stillwater (2016b), proposed instream flow operations would have "relatively inconsequential effects on the hydrologic parameters that are most critical to riparian vegetation recruitment and growth downstream of the Freeman Diversion." The study found that the amount of riparian vegetation in the immediate area around the Freeman Diversion increased because of the operations of the Freeman Diversion, based on historic reports, and that the proposed instream flows likely continue to have a net beneficial effect on the growth and development of riparian vegetation compared to the water rights. Therefore, the downstream effects to shallow groundwater recharge and availability of water to riparian plants for recruitment and growth would be negligible (Stillwater 2016b).

Implementation of the proposed instream flow operations would have no adverse effect on the riparian habitat downstream of the Freeman Diversion and is expected to benefit the recruitment and development of riparian vegetation (i.e., breeding and foraging habitat for covered birds) downstream of the Freeman Diversion (Stillwater 2016b). No take of covered birds or loss of habitat is expected to result from water diversion during instream flow operations.

Critical Habitat

Designated critical habitat for southwestern willow flycatcher occurs within the river channel. Currently, 11,005.97 acres of critical habitat have been designated for this species. The implementation of the proposed instream flow operations would maintain the current and historical riparian conditions downstream of the Freeman Diversion and would continue to benefit the recruitment and development of riparian vegetation immediately upstream and downstream of the Freeman Diversion. Disturbance to or removal of suitable critical habitat for southwestern willow flycatcher is not expected to occur during water diversion operations, and any effects to flycatcher critical habitat because of diversion and instream flow operations are considered negligible.

7.3.9 CLIMATE CHANGE ANALYSIS

Climate change is expected to have a significant impact on coastal ecosystems in southern California over the next century (e.g., USGCRP 2009). Although climate change will affect all of the covered species in the MSHCP to some degree, climate change works on a long time scale and, therefore, is not expected to change short-term effects of the covered activities on riparian birds, reptiles, or Santa Ana suckers outlined above. Climate change will add some amount of uncertainty to long-term processes (e.g., estuary dynamics and instream flow) in the Santa Clara River watershed; however, certain predictions can be made regarding expected changes. While estuary effects are difficult to quantify given inconsistencies in how global climate models predict sediment transport and precipitation as well as anthropogenic considerations such as urban development, a qualitative prediction of the effects of climate change on the estuary effects can be made. In addition, although instream flows are subject to some uncertainty regarding precipitation. A study conducted for this MSHCP (R2 2016) was able to test a scenario that takes into account an increase in variability of precipitation, which is expected to occur under climate change models. Both of these are described below in more detail and in the context of the effects analyses described in this chapter. Overall, impacts from climate change do not interrelate with the covered activities and conservation program contained in the MSHCP and do not affect whether the conservation measures will achieve the biological goals and objectives.

Estuary

As explained in this chapter, the activities covered in the MSHCP, with implementation of the conservation program, would not affect the estuarine habitat and would not affect steelhead, Pacific lamprey, and tidewater gobies when they are utilizing that estuarine habitat. United has concluded that this holds true even given the potential effects of climate change on the bio-physical processes influencing the estuary morphology.

The cumulative effects of sea level rise, erosion, drought, and changes in the frequency and magnitude of storm events are expected to alter morphological dynamics in the estuary, with potential implications for estuarine-, lagoon-, and river-dependent species. Assuming moderately high levels of global greenhouse gas emissions used in climate modeling, mean sea level along the California coast south of Cape Mendocino relative to 2010 conditions is expected to rise 0.2 to 1 feet by 2030, 0.4 to 2 feet by 2060, and 1.4 to 5.5 feet by 2100 (National Resource Council 2012, ESA PWA 2013, California Coastal Commission 2015). The anticipated physical effects of climate change with associated sea level rise that are most relevant to the estuary and Oxnard Plain include flooding and inundation of low lying areas, wave impacts of coastal areas, erosion of oceanfront bluffs, changes in sediment supply and movement from upland sources and offshore within the Santa Barbara Littoral Cell, and saltwater intrusion particularly in unconfined aquifers along low-lying coasts (California Coastal Commission 2015).

Watershed-specific studies, such as TNC's Coastal Resilience Ventura Project (http://maps.coastalresilience.org/california/#), that examined probable impacts to the Ventura coastal areas by year 2100 have estimated increased frequency of extreme precipitation and runoff events, and expanded floodplain inundation along the lower river during a 100-year storm event (ESA PWA 2013). Sediment yield from tributary sources and delivery to the estuary may also change in response to climate change, but predicting those trends is made difficult by several factors, including land development, vegetative cover, and wildfire intensity and frequency, any of which could either slow or accelerate sediment production and delivery to the drainage network depending on their unique or combined changes (Stillwater Sciences 2011b, ESA PWA 2013). For example, an increase in wildfires would potentially lead to increased delivery of fine sediment, while increased land development would potentially intercept runoff and sediment delivery (Stillwater Sciences 2011b).

Climate change will affect the estuary over the long-term. However, these effects would occur regardless of United's actions under the MSHCP and are not influenced by the covered activities and conservation program.

Instream Flows

As stated previously in Chapter 2, global climate models for southern California offer no consensus on overall increases or decreases in total annual precipitation or river flow, but most of the global climate models indicate there will likely be longer dry periods and shorter more intense rain events (Boughton 2010; Cayan et al. 2008; Cayan et al. 2009; Dettinger 2011; Miller et al. 2001). Therefore, instream flows should trend toward more dry and wet years with fewer "normal" or "average" years based on historic data. Therefore, to inform this MSHCP, instream flow operations under the MSHCP conservation program were explored through the lens of this prediction regarding climate change to assess whether climate change would exacerbate or interact with effects from the instream flow operations identified in the study (R2 2016).

An altered flow condition was simulated to test for added effects of climate change on instream flow conditions important for migration of lamprey and steelhead. For this simulation, the historical flow record was altered to increase the length of dry periods, reduce the number of storms, and intensify existing storms without altering the total annual flow (R2 2016). Assuming recent changes in flow conditions are associated with climate change, the most recent 25 water years (1990-2014) may be more indicative of future flow conditions. Therefore, the instream flow effects analysis was run under the climate change assumptions using the entire 71-year dataset as well as truncating the data to the last 25 years. The results for the two simulated climate change scenarios under all migration and passage alternative assumptions showed only small differences from the previously identified effects. Changes in instream flow as a result of climate change will occur regardless of United's actions under the MSHCP and are not influenced by the covered activities and conservation program.

7.4 FACILITY INFRASTRUCTURE AND OPERATIONS

Infrastructure such as fish screens, bays, and bypasses as well as operations of the Freeman Diversion facility including the vertical slot fish passage, bypass channel, crest gates, etc. may result in incidental take of covered species.

For the purpose of estimating effects, it is assumed that the area affected facility infrastructure and operations includes the area within the fish passage facility itself and areas immediately upstream (i.e., the forebay) and downstream of the fish passage facility. To estimate effects to covered species, several operational components were considered including:

- Ladder startup
- Bypass channel operation (sediment sluicing)
- Crest gate operation
- Diversion and AWS bypass operation
- Fish capture and evaluation station operation
- Ladder shutdown – i.e., dewatering the fish ladder

Each of the operations components were further analyzed for their estimated frequency of occurrence in relation to the anticipated numbers of covered species present during operations. The presence of covered species is dependent on life history and habitat associations. For example, to estimate effects of ladder shutdown on migrating adult steelhead, the frequency of ladder shutdown events during a migration season was estimated and considered in relation to the predicted occurrence of adults during ladder shutdowns. Thus, incidental take tied to each operational component was assessed based on reasonable certainty of occurrence.

7.4.1 FACILITY INFRASTRUCTURE AND OPERATIONS – EFFECTS TO AND TAKE OF COVERED FISH

The fish passage system in the Freeman Diversion is designed to facilitate safe, timely and effective upstream and downstream passage of steelhead. Despite this, there are several operational components that could affect upstream and downstream migrating steelhead, including ladder startup and shutdown, sediment sluicing, and operations of the crest gate and bypass channel. The effects of each of these components on steelhead is discussed in further detail below.

Upstream passage for steelhead would be facilitated through a vertical slot fish ladder. The vertical slot fish passage facility is intended to be constructed and operated in a manner that approximates unimpeded upstream and downstream passage of steelhead, and thus is designed to reduce take and migration delay of covered fish species. Operation of the fish passage facility is intended to approximate unimpeded passage by operating during flows ranging from 35 – 6,000 cfs.

Downstream passage could occur across several pathways depending on flows including through the fish ladder, crest gates, bypass channel, and over the diversion crest. Most downstream passage is anticipated to occur through the diversion and AWS screened bypasses where fish can be bypassed back to the river channel or can be directed into a downstream migrant trap for monitoring and research studies. Also, fish will likely be passed through the bypass channel during high flows.

Ladder startup

During ladder startup, a gate upstream of the ladder is opened to inundate the fish ladder. During this process, fish holding near the gate could be drawn into the ladder system. The only identified effect is that juvenile steelhead or lamprey holding upstream of the ladder could be drawn into the ladder when the gates open. There is the potential for juveniles to hold upstream of the ladder entrance gate, but these fish would likely be actively attempting to migrate downstream and, thus, any downstream displacement is not considered a negative consequence and should facilitate migration. Overall, ladder startup is not anticipated to affect covered fish.

Sediment Sluicing

Although the new fish passage facility will require sediment management similar to that of the current facility, it will divert more water with higher SSC, have a comprehensive internal sediment management system, and the crest gates will add sediment and bedload management flexibility. Further, sluicing will be prioritized during times of high SSC in the river and will be minimized when there is not functional migratory connection downstream of the Freeman Diversion (CM 1.2.6). Despite all these minimization measures, there remains potential for impacts from sediment sluicing.

Sediment sluicing at higher flows when the river is connected downstream is estimate to have no effects on steelhead. However, based on historic observations, sediment sluicing when there is not a connection to the estuary downstream is likely to affect steelhead.

Based on operations over the last 5 years (more representative of future operations), it is assumed that United will conduct an average 1 sediment sluicing event every 2 years between January 1 and May 31 when there is no surface water connection to the estuary for a total of 25 events. It is also assumed that United will conduct an average of 3 sediment sluicing events per year between May 31 and December 31 when there is no surface water connection to the estuary for a total of 150 events.

While stranding surveys were sometimes performed in the past during sluicing events, stranding surveys have not been consistent through time. Sediment sluicing after August and before January 1 have never resulted in observed mortality. Mortality of juveniles has been observed during sediment sluicing during the migration season and into July. These observations are consistent with when smolts would be (1) expected to arrive at the Freeman Diversion, (2) expected to stop actively migrating and rear, residualize, and/or swim back upstream (i.e., more likely to linger around the facility)(Booth 2020). However, for simplicity and to be conservative, it was assumed that the most observed juveniles during any sluicing event without connection would represent the worst-case scenario for each event. This is represented by an event in July 14, 2009, where United staff observed 7 mortalities of juveniles and rescued and relocated 7 more juveniles. A similar event with similar numbers also occurred in June 2010.

Approximately half of the events will occur after August, when no juveniles have been observed during a sluicing event. Therefore if there are 150 events total and half occur when juveniles have been observed during a sluicing event and the worst-case scenario is applied, than 525 mortalities would be expected and

525 rescue and relocate (PIT tag if large enough) would be expected. It was also assumed that 80 percent of observation would be smolts (460 mortality and 460 rescue) and the rest would be other juveniles.

Because the worst-case scenario was applied to estimate take, then this should be considered a conservative analysis that over-estimates take and therefore did not include a provision for population growth. Also, there are likely some years that are dry and do not experience tributary connection, therefore less juveniles would be expected at the facility.

Even less information is available for lamprey, however lamprey display more resilience to increase SSC compared to steelhead. Therefore, the same level of take is assumed for lamprey as steelhead, but again is likely an overestimate of effects.

Sediment sluicing is conducted by opening the roller gate, allowing accumulated sediment and debris upstream to be carried downstream to maintain the thalweg on the south side of the bank and to prevent sediment from overwhelming the facility. If the thalweg moves away from the south bank, then United would be unable to operate the fish ladder or divert. When sediment overwhelms the facility, it can require complete shutdown of the diversions and fish ladder operations to clear out the sediment and debris, which would likely have greater effects through migration delay than short-duration sediment sluicing events conducted in a way to minimize risk to covered fish. Effects from sediment sluicing include downstream displacement of fish holding and exposure to high suspended sediment concentrations.

Sediment sluicing events would preferentially occur when adult steelhead are less likely to be actively swimming in an upstream direction (CM 1.2.6). For example, sediment sluicing during times of already high SSC in the river, as well as only when necessary to maintain facility function, minimizes risk to covered fish. Thus, the benefits of sediment sluicing (i.e., providing long-term access to the fish ladder) is greater than the small chance that steelhead would be exposed to high flows and suspended sediment concentrations by being present downstream. Therefore, effects to adult steelhead are not expected to occur during sediment sluicing. If sluicing events occur while an adult is migrating upstream in the affected reach, then there is potential for an approximate three-hour delay to upstream migration as the fish is likely to swim downstream, hold in a sediment refuge (Appendix E), or hold in the fish ladder entrance pools if it happens to be ascending the fish ladder at the time of sediment sluicing. This is more likely to occur when SSC is below 4,500 mg/L SSC and not expected to occur when SSC is above 4,500 mg/L (see Appendix E – Table 3). Therefore, an estimated 5 adults are expected to experience migration delay of 3 hours during the permit term, which was considered a minor delay that would not rise to the level of take.

There is uncertainty on how often sediment sluicing may cause take of steelhead and lamprey. However, the estimated level of take of juveniles is a conservative number given CM 1.2.6 – Minimize Impacts to Steelhead and Lamprey through Limitations on Sediment Management. Stranded fish that are rescued and relocated back to the river channel would have some delay in migration, but would be able to continue their downstream migration after a brief disturbance that could include temporary stress from stranding and/or handling. Take would be documented by stranding surveys during and after sluicing events, and effects to smolts passing through the bypass channel would be tested through EMM-05.

Ladder Shutdown

Since the construction of the Freeman Diversion in 1991, fish ladder dewatering and rewatering has not been consistent. However, operations over the last five years should be comparable to future operations, where the frequency of dewatering events was minimized to the extent possible. During ladder shutdown, the ladder is dewatered after the fish ladder exit gate is closed, which could result in stranding of fish within the ladder. Based on recent monitoring activities during fish ladder dewatering, 3 juvenile *O. mykiss* were observed stranded in the fish ladder over the last 5 years always at the end of May; therefore, it is anticipated that up to 30 juvenile steelhead could be stranded in the fish ladder over the course of the permit term. Stranding surveys will be conducted during ladder shutdown. If a steelhead is stranded in the ladder, then the fish would be passively relocated by turning the ladder on again for enough time to move the fish to the fish ladder entrance pool. If there is not enough flow to safely do this, then CM 2.1.4 would be initiated to rescue and relocate the fish. No adult steelhead have been observed in the last five years during fish ladder dewatering events at the current facility. However, detecting an adult in the fish ladder remains a possibility, particularly if the steelhead population increases. As a result, no more than 5 adult steelhead are estimated to be stranded in the ladder during the permit term. Mortality is not reasonably certain to occur and, if appropriate, juvenile and adult steelhead would be rescued and relocated.

Pacific lamprey have not been stranded in the current fish ladder during dewatering in the last 5 years, although in the late 1990s, hundreds of adult lamprey were trapped in the fish ladder (Chase 2001). Adult lamprey would have their own optimized passage facility, but there is still a chance that adult and juvenile lamprey could be stranded in the fish ladder, particularly if population sizes increase over time. As a result, few lampreys would be stranded in the ladder and passive relocation would be feasible without causing take or rescue and relocation of up to 20 individuals of any age class may be required over the course of the permit term.

Crest Gate Operation

Crest gates are operated during high flows when the capacity of all other paths through the facility is exceeded and flow needs to be conveyed downstream without spreading out over the diversion crest. Criteria that limit crest gate operation timing and rate of gate opening and closing would be implemented through CM 1.1.1 to prevent conditions that lead to stranding covered fish upstream or downstream of the crest gate. Given this, and the apron is designed to be protective of downstream moving fish, no take to covered fish is anticipated from operation of the crest gates.

Screened Bypass Operation

Both the AWS and diversion bypasses will be screened according to CDFW and NMFS criteria to protect all life history stages of *O. mykiss*, therefore no take to covered fish is anticipated from operating the screened bypasses.

Downstream Fish Capture and Evaluation Station Operation

Fish trapped at the evaluation station are the same fish taken through trapping at low flows and trapping for monitoring. Effects associated with fish capture and evaluation include stress and injury during crowding, capture, and handling, but this take is accounted for in Section 7.2.3-IA12 and in Section 7.7.1-Monitoring and the same percentages for injury and mortality described in those sections applies.

7.4.2 FACILITY INFRASTRUCTURE AND OPERATIONS - EFFECTS TO AND TAKE OF POND TURTLES

Operations of the Freeman Diversion facility and fish passage system that may have effects to pond turtle include operation of the various gates and screen systems associated with flow scenarios, sediment sluicing, and fish passage (Chapter 5). As water is conveyed from the river into the fish passage facility or through the headgates into the AWS or canal bays, pond turtles that are swimming and foraging in open water upstream of the facility may enter these components of the facility and become trapped or washed downstream. During sediment sluicing, while the crest gates are being operated, pond turtles on the upstream side of the facility could become caught in high flows and could be swept downstream of the facility. High sediment load in the water could result in pond turtles becoming trapped in sediment deposits downstream of the facility resulting in injury or mortality. Take in the form of stress, injury, or mortality of individuals could occur from stranding within the fish passage facility, impingement on the fish screens during water diversion, being washed through the facility, or from becoming trapped in sediment deposits downstream of the facility.

Between 1994 and 2020, United recorded 71 occurrences of pond turtles within the Freeman Diversion facility: 59 have been observed in the fish trap, 7 in the fish screen bay, and 5 in the fish ladder (United unpublished data). Of the 71 turtles observed within the facility, 10 mortalities were recorded over the 26-year period. Three of the ten documented mortalities can be attributed to the existence of the Freeman Diversion facility. Two individuals climbed into the fish ladder when it was out of operation, became trapped by the Denil plates, and perished. One individual (a juvenile) was found dead in the fish trap, apparently injured or killed by the fish screen brushes. The remaining seven documented mortalities are turtles recorded as "dead on arrival," in the downstream migrant fish trap with no indication that the cause of death was due to the Freeman Diversion. Some of these may have died due to natural causes and drifted (dead or near dying) into the fish trap. Although turtle mortality has been observed, not all documented mortalities can definitively be attributed to the existence or operation of the Freeman Diversion. However, the effects analysis makes the conservative assumption that all documented mortality is a result of the Freeman Diversion to ensure incidental take coverage under a "worst-case" scenario.

Ladder Startup and Operation

During ladder startup, a gate upstream of the ladder is opened to inundate the fish ladder. During this process, ponds turtles present in open water near the gate entrance could be drawn into the ladder system. Injury or mortality to pond turtles is not expect during this event; however, take in the form of harm from disruption of normal behavior could occur when individuals are displaced into the facility. Take in the form of capture would occur when individuals are captured and relocated out of the facility to adjacent suitable habitat. United estimates up to 150 pond turtles would be taken during the permit term due to capture and relocation of individuals from the fish passage facility to adjacent suitable habitat during and following ladder startup procedures.

The vertical slot facility does not contain angled smooth plates that may serve as a barrier similar to the existing Denil plates and no take is anticipated due to pond turtles climbing into the fish passage facility. Turtles that manage to climb into the fish passage facility while it is out of operation would not be trapped and may exit of their own volition.

Sediment Sluicing

Sediment sluicing events are intended to clear out the built-up sediment that collects on the upstream side of the diversion facility. On the downstream side of the diversion facility, sediment sluicing events will generate higher flows and can cause an increase in stage of the downstream channel through sediment deposition. If downstream flows were to inundate pond turtle nests, sediment sluicing could destroy those nests. However, pond turtle nesting occurs from late May to mid-July when flows in the Santa Clara River are receding. Pond turtles tend to nest in dry soil with sparse vegetation and typically well away from water; 200 meters or more (Reese and Welsh 1997). Effects of sediment sluicing on pond turtle nesting habitat are expected to be negligible and no take of pond turtle nests is reasonably certain to occur from sediment sluicing events.

Sediment sluicing increases flow downstream of the diversion facility and may dislodge pond turtle individuals from basking spots causing them to be washed downstream or struggle to exit high flows resulting in take from potential harm to individuals from increased energetic stress as they attempt to exit high flows, increased exposure to predators, and stress from being dislocated from home ranges when flows recede.

Take due to mortality may occur if pond turtles become entrapped in sediment deposits downstream of the Freeman Diversion. United estimates up to 10 pond turtles would be taken over the life of the permit term from mortality. No pond turtle nests are expected to be taken during sediment sluicing. Pond turtles swept downstream during sluicing events would not likely be detected by monitoring efforts unless incidentally captured and detected via a previously applied tag during a former monitoring event (EMM-10). Turtles incidentally captured and identified as having been dislocated from their home range upstream of the Freeman Diversion would be relocated back to suitable habitat upstream. Pond turtles would be taken during the permit term due to being swept downstream and due to capture and relocation following a sluicing event. United estimates up to 250 pond turtles could be taken from being swept downstream of the Freeman Diversion during sediment sluicing events.

Crest Gate Operation

When conditions are such that the crest gates are down and water is flowing over the crest spillway (or the crest itself), pond turtle individuals may be swept downstream over the crest spillway. Effects to pond turtle individuals could occur through injury as they pass over the crest spillway. At high flows, pond turtle are not expected to be present in the river and impacted by operation of the crest gates. As seasonal flows in the Santa Clara River increase, pond turtles are expected to seek refuge in still water eddies or in upland terrestrial refugia. High flows through the crest gate would occur at a maximum of 4,900 cfs when river elevation reaches 162 feet and pond turtle are expected to have vacated the river prior to being exposed to such high flows.

No take in the form of mortality to pond turtle individuals is expected from operation of the bypass channel and crest gates. While individuals are expected to be swept downstream during operation of the bypass channel and the crest gates, it is not expected that pond turtles would be fatally injured by this occurrence. No structures exist along the flow pathways where individuals could become impinged and drown, or where individuals might strike an object causing injury. Pond turtle individuals are expected to be able to swim out of the flow pathway once beyond the facility and climb out of the water on substrate downstream.

Take in the form of harm would occur to pond turtles swept downstream by flows through the bypass channel or over the crest gates. Harm resulting from energetic stress and from becoming displaced downstream of their home range could occur. The Freeman Diversion does present an obstacle for turtles moving from the downstream to upstream side of the facility and any turtles swept downstream of the facility would be isolated from upstream habitats. Harm from this event would be expected to be temporary and pond turtles would be expected to recover and reestablish on the downstream side of the diversion facility. Reduced fecundity because of stress may occur in any displaced pond turtles potentially resulting in failed breeding or nesting opportunities. United estimates that up to 250 individuals could be taken from being swept downstream during operations of the crest gates. Any individuals incidentally captured downstream of the facility, and identified via markings from previous monitoring events (EMM-10) to have originated from upstream of the facility, will be relocated back to suitable habitat upstream of the facility.

Screened Bypass Operation

During water diversion operations, individuals may also become impinged by the fish screen brush system where they may be injured or killed. There has been no documented observation of turtles stuck to the fish screens to date and it is expected to be unlikely that pond turtles would become impinged on the fish screen. It is also expected that if an individual were to become impinged, it would be able to gain a foothold and crawl its way clear of the fish screen. Mortality due to screened bypass operations is not expected. Take in the form of harm from stress and injury may occur.

As water is conveyed through the head bay, pond turtles that are swimming in open water near the upstream side of the head bay entrance may enter the facility and become trapped within the fish screen bays (AWS or canal fish screen bays). Historically, hatchling pond turtles were regularly encountered in the fish trap during the spring (United unpublished data), and adults were found in the fish trap and the fish screen bay. Trapped individuals would have difficulty returning to the main channel and would have no way of climbing out of the water when in the fish screen bay. Individuals would be required to float until rescued and relocated (CM 2.1.4). If individuals could make their way upstream to the trash rack, there are concrete blocks where turtles can haul out and rest. Otherwise, turtles may be exposed to take in the form of harm from thermoregulatory stress while floating for prolonged periods before rescue and relocation (12 to 24 hours). Turtles are not expected to experience mortality in the fish bay, however being entrained in the facility could result in adverse effects to foraging and breeding behavior resulting in lost reproductive opportunity and reduced fecundity.

As diverted water is conveyed past the fish screen and further into the off-channel facilities (canals, desilting basin, recharge basins, etc.), effects to pond turtles are unlikely. Pond turtles favor habitat with aquatic vegetation that provides refuge from predators and deep pools with emergent logs or boulders where they aggregate to bask. None of the canals, pipelines, or basins provide suitable habitat for pond turtles. Additionally, the fish screens are expected to preclude pond turtles from travelling downstream into off-channel facilities. Pond turtles could potentially travel into the off-channel facilities over land but given the lack of habitat in these areas it is not expected that they would commonly do so, and pond turtles have not been observed in the off-channel facilities to-date.

Take in the form of harm or mortality may occur to pond turtles if they enter and become trapped in the screened bays or the fish evaluation station, and from displacement due to proposed operations. Take due to mortality is expected during proposed operations and could occur if individuals become impinged on the fish screen or exhausted in the fish trap resulting in drowning. A haul out or raft will be provided for turtles to rest in the fish trap minimizing the potential for mortality and allowing escape from aquatic predators in the trap. Based on United's historic observations, most pond turtles that enter the facility are caught alive in the fish trap and released back into the river. Take of pond turtle would occur from predation of juveniles in the fish trap and from incidental trapping and relocation of individuals from the fish trap and screen bays. United estimates up to 50 individual juveniles would be taken from mortality by predators in the fish trap (adults are large enough to avoid predation in fish traps) and up to 300 individuals would be taken from incidental capture and relocation from the fish trap and screen bays

7.4.3 FACILITY INFRASTRUCTURE AND OPERATIONS - EFFECTS TO AND TAKE OF COVERED BIRDS

Operation of the facility infrastructure (e.g., crest gates) and fish passage system will have negligible effects on covered bird habitat and is expected to have a low to negligible potential to cause effects to individuals. Operation of the fish passage system that may have effects to covered birds include operation of the various gate systems associate with flow scenarios and sediment sluicing (Chapter 5, CM 1.1.1).

Individuals

Effects to covered bird individuals are not expected during operations of the fish passage facility. Operations of the various gates and flow pathways associated with the fish passage facility have no potential to directly impact covered birds.

Sediment sluicing events could result in temporary removal of riparian vegetation if present in areas of built up sediment upstream or downstream of the diversion facility. Sediment sluicing that results in removal of riparian vegetation could result in destruction of any nests present during the event. Removed vegetation would also temporarily limit nesting opportunities. Loss of nests and limitation of nesting opportunities due to sediment sluicing and removal of associated vegetation is expected to be minimal given the very small area (less than 2 acre) were vegetation removal would occur and the abundant available vegetation along the river channel adjacent to the impact area. On the upstream side of the facility, vireo nesting has primarily been documented in the abundant riparian vegetation along the north bank of the Santa Clara River (Figure 7-2). Whereas sediment sluicing is aimed at sediment build up along the south bank of the river, few vireo nesting territories are expected to be impacted there. Sluicing events have a greater potential to impact vireo downstream of the facility where nesting opportunities occur more broadly throughout the channel. During sluicing events, water levels will rise and could inundate nests and vegetation containing nests could generally be cleared out by rushing water. No loss of foraging opportunities is expected given the abundant available riparian community and foraging opportunities throughout the river channel adjacent to where sluicing events would impact.

Give the very low abundance of flycatcher observed around the Freeman Diversion (Griffith Wildlife Biology 2016, 2017), take of flycatcher is not expected to occur as a result of sediment sluicing. Over time, with implementation of the conservation program, the species may increase in abundance in the area around the Freeman Diversion and nest may become more common. If flycatcher begin to nest in greater frequency around the Freeman Diversion the species could become subject to impacts from covered activities. Take of adult individuals is still not expected, but nests could be taken during sluicing events. Exposure to take of flycatcher nests would be the same as for vireo discussed above.

No take of cuckoo individuals or nests is expected during sluicing events. Effects to cuckoo include the temporary loss of 2.83 acres of potential foraging habitat from sediment sluicing events. This effect is considered negligible given the small area impacted by sluicing events and the considerably larger area of suitable habitat where sediment sluicing would have no impact.

Take of covered birds in the form of mortality of adults is not expected due to operation of the fish passage facility. Focused bird surveys conducted over the 8-year period between 2012 and 2019 have resulting in the observation of 12 vireo nests in the area where sediment sluicing could result in the removal of vegetation. Over the 50-year permit term, up to 30 nests (fewer than one nest per year) could be impacted because of sediment sluicing resulting in take of up to 102 vireo chicks over the life of the permit term (based on reproductive rate of 3.4 young per nest; Griffith Wildlife Biology 2019). Flycatcher have only been observed to nest approximately 1.5 miles upstream of the Freeman Diversion. Over the 50-year permit term, up to 5 flycatcher nests could be impacted because of sediment sluicing resulting in take of up to 10 flycatcher chicks over the life of the permit term (based on reproductive rate of 2 young per nest; Griffith Wildlife Biology 2019).

Critical Habitat

No modification to flycatcher critical habitat is expected to occur because of facility infrastructure and operations. The specific area affected by sediment sluicing that could result in removal of vegetation is not considered critical habitat for flycatcher given that it does not meet the criteria for PBFs. The area directly adjacent to the Freeman Diversion provides limited critical habitat for flycatcher and would be unaffected by operation of the fish passage facility.

7.5 MAINTENANCE

7.5.1 MAINTENANCE - EFFECTS TO AND TAKE OF COVERED FISH

United staff have operated the Freeman Diversion for almost 30 years and have extensive experience in what the maintenance needs are for the current facility as well as similar needs for the future facility. Required maintenance to ensure that the facility is functioning properly and all the gates are calibrated and running smoothly, requires annual dewatering of the wetted area upstream of the Freeman Diversion. United staff have identified a protocol that will minimize take during these dewatering events (see Chapter 3). Experienced biologists monitor while the bypass channel gate is opened enough for fish to pass through. Biologists then either use a seine or dip nets to rescue stranded fish and relocate them to more suitable habitat or the fish are allowed to pass through the bypass channel to the downstream pool. No covered fish have been observed during similar dewatering events in 2017, 2018, or 2019; however, thousands of non-native fish have been observed and removed from the river and facility (common carp, sunfish spp., bullhead, bass, fathead minnows, mosquitofish, bullfrogs, African clawed frogs, red eared sliders, and crayfish).

Based on no historic observation of steelhead during the preferred maintenance window, no take of steelhead is expected. However, it was assumed that maintenance outside the preferred window may be needed once out of every 5 years or 10 times total during the permit term. In historic trapping data, 70 juveniles is the maximum number of juveniles observed in 1 day. Therefore, to be conservative, it was assumed that 70 juveniles per the 10 events would be seined or electrofished, tagged, and relocated to safer conditions prior to maintenance. This would total 700 juveniles during the permit term. Assuming 80 percent smolts, there would be an estimated 560 smolts and 140 juveniles over the permit term captured and relocated (PIT tagged if large enough) with 5 percent injury and 2 percent mortality. United would coordinate with NMFS per event to ensure no take of adult steelhead prior to and during maintenance work. The same assumptions and amount of take was also applied to lamprey.

7.5.2 MAINTENANCE - EFFECTS TO AND TAKE OF POND TURTLES

Pond turtles are presumed to be present every year at the Freeman Diversion and may vary in abundance only as a factor of the conditions of the environment at the given time. High storm flows may result in pond turtles "naturally" getting swept farther downstream or retreating to upland refugia. High storm flows also frequently alter the environment around the Freeman Diversion by wiping out emergent wetland and riparian vegetation communities and scouring sediment build-up. Alteration of potential habitat for pond turtles following high storm events will naturally affect the pond turtle population from one year to the next.

Estimates for take of pond turtle during maintenance activities are generally like that of renovation covered activities described above except that maintenance activities will occur at a much lower level of intensity and over a smaller footprint primarily contained within previously disturbed areas (i.e., no new habitat disturbance). Levels of take are expected to be lower for maintenance activities on a per occurrence basis. Routine maintenance activities (see Chapter 3, Section 3.3) not requiring dewatering, are expected to occur on a regular basis (i.e., monthly), while other more intensive maintenance will be required less frequently (i.e., once annually).

Rehabilitation, repair, and minor upgrade of existing structures made on an as-needed basis may result in harm to pond turtles through equipment strikes, crushing of turtle nests, crushing/removal of refugia, and general habitat disturbance or removal. General work activity from landscape maintenance and weed control within and around the Freeman Diversion may harm pond turtles from disrupting foraging or breeding activities leading to increased stress and reduced fecundity. Use of some access roads in the permit area (e.g., levee roads, riverbed access roads; Figure 3-1) at the Freeman Diversion has a low potential to cause direct effects to pond turtles from vehicle or equipment strike or crushing of turtle nests resulting in mortality of individuals. Maintenance activities occur within areas that have been routinely maintained since construction of the Freeman Diversion (e.g., vegetation management zones, hardscape earth/structure) and lack habitat. Therefore, adverse effects to pond turtle would be relatively low; however, some work will be required in the river channel in areas of currently occupied pond turtle habitat.

During maintenance activities, if pond turtles are present in work areas that require dewatering or ground disturbance (e.g., riprap repair, sediment management), or are trapped in areas of the facility or downstream in the critical reach without adjacent habitat or where they are unable to haul out to rest (e.g., head bay-fish bay, fish ladder), individuals will be captured and relocated to a safe location with suitable habitat upstream or downstream. Implementation of the capture (rescue) and relocation protocol to move pond turtles out of the way of maintenance activities has the potential to result in harm from efforts to capture and handle individuals, and while handling during relocation. Safe handling procedures (CM 2.1.4) are intended to result in no mortality and no lethal take is anticipated during relocation.

Pond turtles have not been observed on the off-channel access roads or in the downstream conveyance infrastructure (canals, desilting basin, recharge basins, etc.). Steep slopes and chain-link fences around these roads and facilities as well as the fish screens may prevent individual pond turtles from moving into existing access roads or into the conveyance infrastructure outside the river channel. Additionally, the fish screens are expected to preclude pond turtles from travelling downstream into off-channel facilities. Pond turtles could potentially travel into the off-channel facilities over land but given the lack of habitat in these areas it is not expected that they would commonly do so, and pond turtles have not been observed in the off-channel facilities to-date. Fencing around the basins will be maintained to exclude turtles (CM 2.1.8) and further reduce to likelihood of individuals entering the basins. No take of pond turtles is expected at the off-channel conveyance infrastructure during maintenance covered activities.

During maintenance covered activities, pond turtles will be rescued and relocated to avoid or reduce the potential for harm or mortality. Take of a total of 24 pond turtles (one individual every other year) are expected due to mortality over the course of the permit term because of routine and annual maintenance activities. United expects that up to 200 individual pond turtles (average of four individuals per year) would be taken because of rescue and relocation during routine maintenance.

7.5.3 MAINTENANCE - EFFECTS TO AND TAKE OF COVERED BIRDS

Suitable foraging and breeding habitat for covered avian species occurs upstream and downstream of the Freeman Diversion. Temporary effects to covered avian species is reasonably certain to occur from the temporary removal of 2 acres of riparian habitat during implementation of maintenance covered activities. The presence of suitable foraging and nesting habitat for covered bird species could expand or contract depending on annual rainfall and associated natural variation in the hydrograph that alters river channel depth, width, and associated riparian vegetation recruitment and survival. Maintenance, including routine activities such as vegetation management, and annual activities such as repair, rehabilitation, and upgrade of the Freeman Diversion, use of permit area roads, and/or use of heavy equipment in the river channel have a potential to result in harm of covered avian species.

Individuals

Temporary removal of up to 2 acres of riparian vegetation in the vegetation control areas (see Figure 3-1) around the upstream and downstream sides of the Freeman Diversion, along the toe of the riprap area on the downstream side of the facility, and along access roads could results in direct effects to covered birds in the form of temporary loss of nesting and foraging habitat and stress from noise and general disturbance from the work activity. Vegetation control would occur up to two times per year and would be conducted outside of the nesting season to reduce the potential for direct effects.

Routine maintenance, repair, rehabilitation, and upgrade of the Freeman Diversion in-channel structure as well as temporary dewatering of the river channel have the potential to adversely affect covered birds if performed during the breeding season. Use of permit area roads (dam and levee road; see Figures 3-1 and 3-2) by vehicles and equipment on the diversion structure and desilting basin levee have a low to moderate potential to affect covered birds due to increased habitat disturbances. Use of access roads during the nesting season could result in nest abandonment or disruption of nesting behavior if covered birds are actively nesting in the suitable habitat adjacent to Freeman Diversion. The use of heavy equipment in the river channel could result in nest destruction or abandonment. As-needed repairs along the desilting basin levee could result in similar effects from harm of individual birds as well as habitat removal or degradation. The greatest potential for take will be in the form of temporary disturbance from covered activities resulting in disruption of foraging or breeding behavior.

Take of covered birds during maintenance activities is not expected because of direct mortality. Effects from maintenance covered activities to suitable habitat is expected to be limited based on the small footprint (2.83 acres) and majority of maintenance work being performed in previously disturbed areas (i.e., no new habitat disturbance). Take of covered birds is expected from harm due to the temporary loss of 2.83 acres of suitable breeding and foraging habitat and because of noise and other general work disturbance. Harm to covered birds could result in increased stress, loss of breeding and foraging opportunities, and overall reduced fecundity of individuals.

Vireo have been documented to be present and nesting around the Freeman Diversion in increasing abundance and adverse effects are expected from loss of breeding, nesting, and foraging opportunities. Temporary loss of 2.83 acres of vireo suitable nesting and foraging riparian habitat is expected to result in take in the form of harm from a reduction of nesting opportunities and disruption of foraging behavior in the immediate area of the Freeman Diversion. Vireo territorial sites are known from the area of the Freeman Diversion, with a peak of 88 territorial sites in 2018 (see Section 4.2.5). Maintenance covered activities have the potential to result in take in the form of harm from the destruction of nests, if nests are present during covered activities (e.g., activities conducted in the nesting season). United estimates up to 10 nests could be impacted by maintenance covered activities resulting in take of 34 vireo chicks (based on reproductive rate of 3.4 young per nest; Griffith Wildlife Biology 2019) over the 50-year permit term with most years resulting in no take of nests.

No breeding territories for flycatcher have been documented to date within the area potentially effected by maintenance covered activities; however, a breeding territory for flycatcher is documented approximately 1.5 miles from the Freeman Diversion (see Section 4.2.6). Directs effects to flycatcher from maintenance covered activities are expected only from loss of potential habitat resulting in loss of potential breeding, nesting, and foraging opportunities. No take of flycatcher individuals will occur during maintenance activities over the life of the permit term. Take of flycatcher nests could occur if habitat is removed during maintenance activities where flycatcher have become present and started nesting. United estimates up to 5 nests could be impacted because of maintenance covered activities resulting in take of 10 flycatcher chicks over the 50-year permit term with most years resulting in no take of nests.

Cuckoo have not been documented to be present or nest around the Freeman Diversion and no breeding territories for cuckoo have been documented to date within the area potentially effected by maintenance covered activities (see Section 4.2.7). Adverse effects are only expected from the loss of potential breeding, nesting, and foraging opportunities. No take of cuckoo nests or individuals is expected because of maintenance covered activities. Temporary removal of 2.83 acres of cuckoo potential foraging habitat is expected to result in take in the form of harm from a reduction of potential breeding, nesting, and foraging opportunities in the immediate area of the Freeman Diversion.

Critical Habitat

Maintenance activities at the Freeman Diversion could temporarily adversely affect 2.83 acres of designated critical habitat for flycatcher (see Figure 7-1). Vegetation control will result in the removal of potential foraging habitat for flycatcher and dewater or removal of riparian vegetation during maintenance activities will result in removal of foraging and potential nesting habitat. Effects to flycatcher critical habitat from covered activities are negligible with respect to the species critical habitat overall (11,005.97 acres in the Santa Clara watershed) and would be temporary in nature with planned habitat restoration (CM 2.3.1).

7.6 HABITAT RESTORATION AND ENHANCEMENT

Habitat restoration and enhancement will occur following renovation of the fish passage and Freeman Diversion facility and could have direct effects to covered species. Habitat restoration and enhancement after temporary removal of riparian and aquatic habitat, because of covered activities, could result in potential take due to disturbance from activities. Covered activities associated with habitat restoration and enhancement are not expected to result in direct effects to pond turtles or avian species and take is not expected due to the implementation of the conservation program (Chapter 5).

7.6.1 METHODS FOR EVALUATING HABITAT RESTORATION AND ENHANCEMENT ACTIVITIES EFFECTS TO COVERED SPECIES

Methods, timing, and success criteria for habitat restoration and enhancement are outlined in the Habitat Restoration and Management Plan (Appendix C). A total of 1.05 acres of suitable riparian habitat directly upstream and downstream of the Freeman Diversion will be impacted during renovation of the fish passage and Freeman Diversion. Effects to riparian community because of on-going maintenance activities will be determined on an as needed basis and will depend on the specific maintenance activity required and actual presence of riparian community when maintenance activities are required. Variation in natural flows in the river are dependent on rainfall events and the presence of riparian community depends on the variation of natural flows from year to year. Habitat restoration will be in-kind depending on suitable habitat present at the time of, and temporarily removed by, covered activities. For example, if only unvegetated river wash is present during needed maintenance activities, no impacts to riparian community would be assessed, and the impacted area would subsequently be restored to conditions conducive to maintaining river connectivity with no needed restoration of riparian community.

7.6.2 RESTORATION - EFFECTS TO AND TAKE OF COVERED FISH

No effects and no take of covered fish is through habitat restoration is reasonably certain to occur because the activities would be focused in areas that were previously disturbed by renovation activities, are devoid of vegetation, and have no aquatic habitat.

7.6.3 RESTORATION - EFFECTS TO AND TAKE OF POND TURTLES

Restoration of temporarily impacted riparian community and river channel are expected to have a low effect on pond turtles because the activities would be focused in areas that were previously disturbed by renovation activities, are devoid of vegetation, and where nesting opportunities do not occur. Activities may result in take through harm if pond turtle individuals need to be removed from the work area and relocated to a safe place. Capture and handling could result in stress and disruption of breeding and foraging behavior that may result in reduced fecundity. Direct effects to pond turtles could occur during activities associated with replanting native plant species and general preparation and stabilization of the restoration site. Specifically, restoration and enhancement activities such as operation of heavy equipment to recontour and prepare the site for restoration, installation of straw wattle, and restoration plantings could result in direct effects to pond turtles. Vehicle and equipment operation are not expected to result in nest collapse or additional removal of refugia beyond that removed during renovation activities. Direct effects from noise and general disturbance include stress and disruption of breeding and foraging behavior, which could lead to reduced fecundity of individuals.

Direct effects would be minimized through the implementation of relevant conservation measures such as Best Management Practices (CM 2.1.1), Pre-activity Surveys (CM 2.1.3) and the Capture and Relocation plan (CM 2.1.4). Given that these activities are ultimately expected to result in preservation of the local population and improved habitat function and value within the river and associated riparian community, this covered activity would likely result in an overall benefit to pond turtles.

Estimated take of pond turtle during habitat restoration and enhancement activities is expected to be low. Any take that occurs from these covered activities would only occur during initial habitat restoration and would not occur during short- or long-term restoration monitoring activities. Take will occur primary in the form of harm from implementation of the capture and relocation plan (CM 2.1.4) to move individuals out of the way of harm before conducting restoration activities. Harm may also to individuals not relocated but that remain near the Freeman Diversion out of the direct path of activities. Individuals not relocated would be subject to effects from noise or disturbance from restoration activities but be expected to fare better than if captured and relocated. Take from mortality is not expected to occur.

All encounters would be tracked and reported to the USFWS annually. It is expected that pond turtles would be capture and relocated prior to implementation of renovation activities and so would not be present in large numbers during restoration activities. Nevertheless, some pond turtles may find their way back to the area where restoration will occur, or new individuals will recruit to the area. Up to 25 pond turtles may be taken in the form of capture and relocation (CM 2.1.4) prior to implementation of restoration activities.

7.6.4 RESTORATION - EFFECTS TO AND TAKE OF COVERED BIRDS

Implementation of covered activities associated with restoration and enhancement of temporarily removed habitat could have direct effects to covered birds such as disturbance from noise and general activity associated with the covered activity. No direct take of covered birds is expected, and no mortality of individuals or loss of nests is expected. Components of the Conservation Program (Chapter 5) are designed to specifically avoid these direct effects and restoration and management of temporarily effected riparian community would result in a long-term management and preservation of habitat for covered birds.

Individuals

Restoration of temporarily impacted riparian community has a low potential for direct effects to covered birds through harm because of stress and disruption of breeding, nesting, and foraging behavior and a result of noise and general human activity. Birds that could be directly affected by restoration activities would be in adjacent riparian community to where the restoration activities will be conducted. Operation of vehicles or equipment that generate noise could result in flushing and increased stress that results in loss of fecundity of individuals.

Given that restoration activities are ultimately expected to result in improved habitat function and value within the river and associated riparian corridor, this covered activity is expected to benefit covered birds in the long-term. To the extent practicable, restoration activities will be conducted outside of the nesting season.

Pre-activity surveys (CM 2.1.3) will be conducted if restoration activities will occur during the nesting season. Any nests detected will be avoided (CM 2.1.7) and monitoring (CM 2.1.6) will be provided to support avoidance of direct effects.

Take in the form of harm from noise and general activity-related disturbance during restoration activities is not expected, and no take in the form of mortality of individuals or loss of nests is expected to occur. No loss of suitable habitat will occur because of habitat restoration and management activities and no direct take of individuals is expected.

Critical Habitat

No adverse modification of critical habitat for flycatcher would result from habitat restoration and enhancement. These activities are intended to restore and enhance flycatcher critical habitat.

7.7 COW BIRD TRAPPING

Implementation of the cow bird trapping plan will provide mitigation for impacts to covered bird species through reduction of ecological pressures imposed by invasive species; this will facilitate recruitment and population recovery of native covered bird species. Activities associated with cow bird trapping are very low impact and no take of covered species is expected to occur because of this conservation activity.

7.7.1 COW BIRD TRAPPING - EFFECTS TO AND TAKE OF COVERED FISH

No take of fish will occur because of cow bird trapping. This conservation activity will be conducted entirely in upland terrestrial areas and will have no effect on the river channel and aquatic areas.

7.7.2 COWBIRD TRAPPING - EFFECTS TO AND TAKE OF POND TURTLES

No take of pond turtle will occur as a result of cow bird trapping. This conservation activity will be conducted in upland terrestrial areas where pond turtle could be present, but the level of activity associated with cow bird trapping is low and no adverse effects to pond turtle will occur. Best management practices (CM 2.1.1) will be implemented to avoid take of covered species during cow bird trapping.

Cow bird trapping will have no impact on the population of pond turtle in the permit area.

7.7.3 COW BIRD TRAPPING - EFFECTS TO AND TAKE OF COVERED BIRDS

Cow bird trapping is a significant contributor to the decline of vireo and a key requirement for the recovery of the species (Griffith Wildlife Biology 2018(b)). The same is likely true for flycatcher, though cow birds do not parasitize cuckoo nests. This conservation activity will be conducted in upland terrestrial areas where covered birds could be present, but the level of activity associated with cow bird trapping is low; no adverse effects to covered birds will occur. Best management practices (CM 2.1.1) will be implemented to avoid take of covered species during cow bird trapping. During cow bird trapping conducted around the Freeman Diversion, no covered birds have ever been caught in a cow bird trap (Griffith Wildlife Biology 2012 through 2019, 2018(b)). Cow bird trapping will have no adverse impact on the population of covered birds in the permit area and no take of covered birds is expected from cow bird trapping activities. Implementation of cow bird trapping is expected to have a significant positive effect on vireo and flycatcher recovery around the Freeman Diversion.

7.8 MONITORING PROGRAM

7.8.1 MONITORING - EFFECTS TO AND TAKE OF COVERED FISH

Estimated Take of Fish

Between trapping under CM 1.2.5 and surveys conducted for the monitoring program, United anticipates trapping or rescuing and relocating approximately 4,000 smolts over the course of the permit term. United intends to radio-tag a total of 200 of these smolts for EMM-05 and EMM-06. The rest of the 3,800 smolts would be PIT tagged to assess downstream migration rates, to monitor for returning adult steelhead, and to assess relocation survival.

United anticipates seining or electrofishing and radio-tagging up to 20 adults over the course of the permit term. These would be adults detected during surveys outlined in Chapter 6 under EMM-02, EMM-03, and EMM-07.

Monitoring, while intended to provide a benefit to steelhead and fill key data gaps for covered species, would result in take of individuals through trapping (trapping at the downstream passage facility and seining) or harassment (electrofishing, handling, and tagging) with these monitoring activities anticipated to result in up to 5 percent injury and 2 percent mortality of tagged adults and 5 percent injury and 2 percent mortality of tagged smolts overall. The level of take during monitoring activities will be minimized to the extent possible by using highly trained and experienced staff to conduct the activity and implementation of best management practices in carrying out the methods and protocols.

In the process of monitoring steelhead 1,000 lamprey larvae, juvenile lamprey, and adult lamprey are anticipated to be trapped or detected through seining and electrofishing. Monitoring for steelhead, will benefit lamprey as well by providing basic data on whether or not lamprey are still detected in the Santa Clara River. However, there would be take of individuals through trapping (trapping at the downstream passage facility and seining) or harassment (electrofishing) and handling) with these monitoring activities expected to result in up to 5 percent injury and 2 percent mortality of adults, 5 percent injury and 2 percent mortality of juveniles, and 5 percent injury and 2 percent mortality of larvae of the lamprey exposed to trapping and electrofishing, other than spawned out adults that are not included in the estimate of take as they are considered senescent and in the process of dying naturally.

In the process of monitoring steelhead tidewater gobies are reasonably certain to be disturbed or captured during seining in the estuary. However, United would minimize take of gobies by using a mesh size that allows gobies to escape during seining and seining will occur from a boat to reduce disturbance of the estuary bottom. If gobies are encountered, a qualified biologist will enumerate them and release them at the site of capture. No injury or mortality are anticipated to gobies from seining for steelhead. United anticipates no more than 50 gobies would be disturbed or captured during the 50 year permit term.

7.8.2 MONITORING - EFFECTS TO AND TAKE OF POND TURTLES

The monitoring program will be implemented to provide documentation that United is remaining in compliance with the biological goals and objectives of the MSHCP and to assess the ongoing effectiveness of the MSHCP in conservation of the covered species. Monitoring for pond turtle is proposed under EMM-10 and will include PIT tagging or marking by notching scutes during implementation of the capture and relocation plan. Monitoring conducted for covered birds (e.g., detection surveys) will occur where pond turtles may be nesting or basking.

No take in the form of mortality is expected during implementation of the monitoring program. Take of pond turtles as a result of implementation of the monitoring program is included under other covered activities addressed above during capture and relocation events. No additional capture of pond turtles will occur under the monitoring program.

Take in the form of harm from capture of pond turtles in the fish trap during fish monitoring is expected. Juveniles may be vulnerable to predation by fish and bullfrogs, although this hypothesis has never been scientifically tested. The fish trap will be checked at frequent intervals (12 hours) minimizing predation on pond turtles and minimizing energetic or metabolic stress experienced by individuals. Take of pond turtles from predation in the fish trap is address above under Section 7.3 Facility Infrastructure and Operations, *Screened Bypass Operations*.

7.8.3 MONITORING - EFFECTS TO AND TAKE OF COVERED BIRDS

The monitoring program will be implemented to provide documentation that United is remaining in compliance with the biological goals and objectives of the MSHCP and to assess the ongoing effectiveness of the MSHCP in conservation of the covered species. Monitoring activities that will be conducted in riparian community where birds may be present are limited to detection surveys involving very low levels of activity by United staff. Depending on whether vocalizations are passively detected, vocalization may be broadcast to elicit call-back responses. Use of vocalization broadcasts will be limited and performed only by experienced individuals.

Take of covered birds is only reasonably expected to occur during monitoring activities as a result of playback vocalization broadcasts. Vocalizations are not expected to be broadcasted for vireo call. For flycatcher, take of up to 15 individuals is expected from responding to broadcasts over the life of the permit term. For cuckoo, take of up to 5 individuals is expected from responding to broadcasts over the life of the permit term. No impact on flycatcher critical habitat is expected.

7.9 SUMMARY OF TAKE, IMPACTS OF THE TAKING, AND BENEFITS OF THE CONSERVATION PROGRAM

7.9.1 SOUTHERN CALIFORNIA STEELHEAD

Summary of Take and Impact of the Taking

Estimated take of southern California steelhead for the entire MSHCP is summarized in Table 7-23.

United's proposed operations would be the activity with the most source of potential take, but take estimates are vulnerable to assumptions based on limited scientific data and are considered overestimates to conservatively account for all take. The proposed operations clearly alter the Santa Clara River hydrology downstream of the Freeman Diversion, resulting in fewer potential opportunities for upstream and volitional downstream steelhead migration. In some years, the effect is fewer days of migration opportunity (IA's 1, 3, 8), and in other years there is a complete loss of migration opportunity for adults (IA 2) compared to a no diversion scenario. Alterations to the hydrology from proposed operations will potentially result in delays in migration for adults (IA 5) compared to no diversion.

The consequence of fewer migration opportunities is the loss of anadromous life history production in the Santa Clara River compared to what would be possible under no diversion. Anadromous adults are more fecund than resident adults, and the overall effect of reduced adult migratory opportunities can be a potential reduction in the abundance and resilience of the population to persist through time (Bell et al. 2011; NMFS

2012; Dagit et al. 2016). This is apparent in watersheds such as the Santa Maria River and Topanga Creek, where consecutive years of blocked anadromous access occur even during normal or moderate water years, corresponding with a predominant resident life history (Stillwater Sciences 2012; Dagit et al. 2017). However, under the initial and future operations, during most years (63 percent) migratory access will occur for at least three days per year, supporting an anadromous life history in the watershed.

Adults prevented from migrating are exposed to increased risk of mortality, but may remain in the population, either by delaying migration into the Santa Clara River or other watershed until the following year (Moyle et al. 2008) or straying to another watershed in the region (Clemento et al. 2009; Pearse et al. 2009; Garza et al., unpubl. data, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California). Adult steelhead that are prevented from migrating may contribute to the DPS if they can locate suitable migration conditions in an alternative watershed in the region. Straying of adult steelhead appears to be common in the southern California DPS (Clemento et al. 2009; Pearse et al. 2009; Garza et al., unpublished data, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California), which plays an important role in population spatial structure and genetic diversity, both of which support population viability (McElhaney et al. 2000). Adults that are prevented from migrating upstream in the Santa Clara River may migrate up the Ventura, Santa Ynez, Malibu, or other watershed in the DPS. Selecting an alternative watershed for migration would increase the risk of exposure to predation, or exhaustion, potentially resulting in mortality.

Table 7-23 Estimated Take of Steelhead

Covered Activity	Type of Take	Estimated Take – Adults	Estimated Take - Smolts	Estimated Take – Other Juveniles
7.1 Renovation of fish passage facility	Trap/Capture, tag, relocate	3	10	10
	Injury	0	5% of trapped/captured fish	5% of trapped/captured fish
	Harm	1	0	0
	Mortality	0	2% of trapped/captured fish	2% of trapped/captured fish
7.2 Water Diversion and Instream Flow Operations	Trap/Capture, tag, relocate	20	4,550	800
	Injury	5% of trapped/captured fish	5% of trapped/captured fish	5% of trapped/captured fish
	Harm	61	0	0
	Mortality	2% of trapped/captured fish	2% of trapped/captured fish	2% of trapped/captured fish
7.3 Facility Infrastructure and Operations	Trap/Capture, tag, relocate	0	460	115
	Injury	0	5% of trapped/captured fish	5% of trapped/captured fish
	Mortality	0	460; 2% of trapped/captured fish	125; 2% of trapped/captured fish
7.4 Maintenance	Trap/Capture	0	560	140
	Injury	0	5% of trapped/captured fish	5% of trapped/captured fish
	Mortality	0	2% of trapped/captured fish	2% of trapped/captured fish
7.5 Habitat Restoration and Enhancement	No Take			
7.6 Cowbird Trapping	No Take			
7.7 Monitoring Program	Trap/Capture	23 (includes trapped fish above)	5,580 (includes individuals above)	0
	Harm	0	0	0
	Injury	5% of trapped/captured fish	5% of trapped/captured fish	0
	Mortality	2% of trapped/captured fish	2% of trapped/captured fish	0

Adults may delay migration and remain in the ocean until the next migratory opportunity within the Santa Clara River. Moyle et al. (2008) suggested relatively large southern California steelhead may be the result of additional years of ocean rearing due to droughts that preclude upstream migration in some years. Thus, the elimination of migration opportunities that may result from proposed operations may not directly translate into recruitment loss. Several authors have suggested that resident populations that exhibit polymorphic traits for anadromy are important for long term viability in response to dynamic environmental conditions (Moyle et al. 2008, McEwan 2001). Moyle et al. (2008) predicted that a relatively high percentage of steelhead would mature and migrate after one year in the ocean during wet years, rather than marine rearing for the more typical two or three years, to take advantage of migration opportunities when available. These fish would be smaller than those with additional years of ocean rearing, and thus likely have lower fecundity. Each of the life history traits of polymorphism and shortened or lengthened ocean rearing is a "bet-hedging" response to environmental variability such as lost migration opportunities (Moyle et al. 2008) and a means to sustain population viability.

Take of steelhead is associated with activities that are required to maintain and operate the fish passage facility or to implement the monitoring program and, although the new fish passage facility would be much improved from the existing facility, there is likely still take that would be reasonably certain to occur. Operation of the fish passage facility is estimated to result in passive relocation or capture and relocation adult steelhead during fish ladder shut down, capture and relocation of juveniles. The impact of mortality of up to 2 percent trapped, tagged, and release/relocated juvenile steelhead would be a decrease in the anadromous production of juvenile steelhead potentially impacting the returns of adult steelhead to the Santa Clara watershed.

Most downstream migrating smolts would be transported downstream to the estuary. A relatively small number may be lost to the population from stranding if mainstem rearing is prevalent in the population, which current science does not suggest that mainstem rearing is common in the Santa Clara River, but the possibility remains in the absence of further study and information.

Summary of Benefits

NMFS has designated the Santa Clara watershed as a Core 1 watershed, meaning it has the ability or potential to support a viable southern California steelhead population and has the capacity to respond to recovery actions. Boughton et al. (2006) designated the Santa Clara River steelhead to be a "source" population, because they concluded it has the intrinsic potential to support a robust enough steelhead population to compensate for the occasional loss of anadromous production within other watersheds in the DPS. Therefore, NMFS considers the anadromous production in the Santa Clara River could help support the recovery of the entire DPS.

The MSHCP includes renovation and improvement of the fish passage facility at the Freeman Diversion, operating and maintaining that improved fish passage facility, a commitment to improved instream flows compared to United's otherwise lawful water rights, extensive monitoring to inform management goals for recovering southern California steelhead, habitat restoration after impacts from renovation, and invasive species removal. All of these activities benefit steelhead by improving fish passage conditions and, when necessary, allowing an informed, science-based process to modify the conservation program through adaptive management.

The conservation program describes the renovation of the fish passage facility at the Freeman Diversion. The renovation will update the Denil fish ladder that is estimated to work from 45-500 cfs with adequate attraction flow. NMFS considers the Denil fish ladder to be ineffective above 500 cfs, because of inadequate attraction flow emanating from the fish ladder entrances and distraction flow when water flows over the crest. The new fish passage facility is designed to operate between 45-6,000 cfs with much improved attraction flow. Crest gates will also be designed and installed to maintain spatial distribution of flows so that they are concentrated on the south bank versus spreading out across the diversion to assist in attraction by keeping upstream migrating steelhead and lamprey in the vicinity of the fish ladder entrances. The crest gates will include an improved spillway apron designed to safely pass covered fish downstream. An extra set of fish ladder entrances would be incorporated to further increase attraction to the fish ladder. In summary, the new fish passage facility will be a greatly improved facility with safer and more efficient fish passage for both adult and juvenile covered fish.

Booth (2020) demonstrated that several smolts migrate downstream after loss of connection to the estuary even if United were to bypass the total river flow. If smolts were bypassed when there is a functional migratory loss of surface water connection with the estuary, for any reason, in the later part of the migration season, they would be expected to perish in the river either from direct stranding during stage decrease or stranding in pools in which water quality is reasonably certain to degrade (e.g., temperatures too high or dissolved oxygen too low) over the summer. CM 1.2.5 would instead result in trapping downstream moving steelhead and relocation of these steelhead to more suitable and safe habitat compared to these poor conditions. Trapping and locating when downstream moving steelhead could successfully migrate to the estuary but for United's diversions (i.e., 40 cfs critical diversion) would be an impact to the species from a covered activity (water diversion) and 5 additional smolts per year are estimated to be trapped and relocated under those conditions. However, trapping and relocating when a functional loss of migratory connectivity to the estuary would occur despite water diversions (see Booth 2020) would be a benefit to the species from rescue and relocation of up to 70 smolts per year (3,500 total). Therefore, take from trapping is a more beneficial outcome to southern California steelhead than migration delay or mortality that could occur whether or not United was diverting water.

When United is implementing trapping for Monitoring studies or CM 1.2.5, dewatering for renovation/maintenances, or electrofishing, United staff would remove all invasive species encountered from the river. In the last 5 years of dewatering for maintenance activities, thousands of nonnative species have been observed and removed from the system, including common carp (*Cyprinus carpio*), sunfish spp. (fish in family Centrarchidaei), bullhead, largemouth bass (*Micropterus salmoides*), fathead minnows (*Pimephales promelas*), mosquitofish (*Gambusia affinis*), bullfrogs (*Lithobates catesbeianus*), African clawed frogs (*Xenopus laevis*), red eared sliders (*Trachemys scripta elegans*), and red swamp crayfish (*Procambarus clarkia*).

Largemouth bass, sunfish, bullfrogs, and African clawed frogs have the potential to prey on steelhead juveniles and may cause injury to steelhead if crowded into the trap together, but predator separation walls will be provided in the fish evaluation station.

United will implement habitat restoration for temporarily impacted riparian habitat during covered activities. Riparian habitat provides complexity and shading for steelhead that are sheltering while migrating or rearing. Also, invasive plants such as giant reed and tamarisk would be prevented from growing into restoration areas. These plants are known to diminish surface water and groundwater through evapotranspiration, therefore the prevention of growth of these plants will benefit steelhead by preventing these plants from diminishing water available to steelhead.

A number of uncertainties exist for southern California steelhead life history and United would be addressing several of these uncertainties through the monitoring program. The results of the monitoring program would address key uncertainties in the MSHCP as well as addressing basic biological questions from the Recovery Plan, such as whether or not steelhead rear in the mainstem or estuary or whether lagoon anadromy occurs in the Santa Clara Watershed. The Monitoring Program will benefit southern California steelhead by advancing the scientific information and literature used to make management decisions for southern California steelhead. It would remain difficult to protect what is not understood and it would be difficult to adapt management decisions in the context of climate change in the Santa Clara River if the Monitoring Program in this MSHCP were not implemented.

Conclusion and Discussion

Although, a comparison to no diversion would be logical for estimating take of new activities, the comparison is not determinative because the proposed action merely modifies existing and ongoing activities. As a result, this MSHCP uses two points of comparison to estimate the amount of take reasonably certain to occur as a result of implementing the proposed diversion operations. First, it provides an estimate of the amount of take in comparison to no diversion. Second, it provides an estimate of the habitat benefits of the MSHCP in comparison to implementation of United's water right license and permit. It should be noted, however, that no diversion does not represent a true environmental baseline or existing condition as this condition has not occurred since long before NMFS listed the southern California steelhead DPS as endangered and because the instream flows under United's water right license and permit represent United's otherwise lawful activity to conduct water resource management in the interest of combating salt water intrusion and addressing groundwater quality issues that affect human health it areas of the Oxnard Plain.

Comparing the proposed operations, there would be less migratory opportunity overall and therefore fewer anadromous steelhead compared to no diversion; therefore, the impact of the taking would be less abundance, diversity, and resilience of the Santa Clara River population and the entire southern California steelhead DPS compared to if United did not divert any water and if there was no Freeman Diversion. However, United has diverted water for over 9 decades and the Freeman Diversion has been existing infrastructure in the river since 1991. Therefore, the renovation, operations, and maintenance of an improved fish passage system at the Freeman Diversion constitute a significant improvement from the existing facility and water rights operations (United's otherwise lawful activity) offsetting the take of steelhead identified in the effects analysis. Additionally, resident life history *O. mykiss* occur in the headwaters of several tributaries and these fish are capable of reproducing offspring that are anadromous and therefore counted as "steelhead" buffering the anadromous form (southern California steelhead) from extinction by acting as a "natural hatchery" that can produce more steelhead. Together these factors demonstrate that, overall, the proposed project would not appreciably reduce the likelihood of survival and recovery of southern California steelhead.

7.9.2 PACIFIC LAMPREY

Summary of Take and Impact of the Taking

Take estimates for each activity and the impacts of the taking are summarized in Table 7-24. Under the proposed operations, there would be less migratory opportunity for lamprey and, therefore, it is inferred that there would be less abundance and resilience of the entire Pacific lamprey population compared to no water diversions and no Freeman Diversion. However, United has diverted water for over 9 decades and the Freeman Diversion is existing infrastructure in the river. Therefore, the renovation, operations, and maintenance of an improved fish passage system at the Freeman Diversion constitute a significant improvement in fish passage and a commitment to improved bypass flows from the existing water rights (United's otherwise lawful activity) that, taken together, offsets the take of lamprey identified in the effects analysis. Overall, the proposed project would not appreciably reduce the likelihood of survival and recovery of Pacific lamprey.

Table 7-24 Estimated Take of Pacific Lamprey				
Covered Activity	Type of Take	Estimated Take – Adults	Estimated Take - Juveniles	Estimated Take – Larvae
7.1 Renovation of fish passage facility	Trap/Capture, tag, relocate	20	40	20
	Injury	5% of capture	5% of capture	5% of capture
	Harm	0	0	0
	Mortality	2% or capture	2% of capture	2% of capture
7.2 Water Diversion and Instream Flow Operations	Habitat Surrogate – Lost Passage Days	Up to 4% decrease in passage opportunity as defined in this effects analysis compared to no diversion.		
7.3 Facility Infrastructure and Operations	Trap/Capture	0	460	115
	Injury	0	5% of capture	5% of capture
	Harm	0	0	0
	Mortality	0	460 and 2% of capture	115 and 2% of capture
7.4 Maintenance	Trap/Capture	0	560	140
	Injury	0	5% of capture	5% of capture
	Harm	0	0	0
	Mortality	0	0	0
7.5 Habitat Restoration and Enhancement	No Take			
7.6 Cowbird Trapping	No Take			
7.7 Monitoring Program	Trap/Capture	1,000		
	Harm	0		
	Injury	5 percent of trapped, tagged, and/or relocated individuals		
	Mortality	2 percent trapped, tagged, and/or relocated individuals (not counting spawned out adults)		

United's proposed operations would alter the Santa Clara River hydrology downstream of Freeman Diversion, resulting in reduced migration opportunities for Pacific lamprey adults and juveniles relative to no diversion, but will substantially increase opportunities relative to the water rights operations. There would be an estimated 19–22 percent fewer years when adult lamprey upstream migration is possible compared to no diversion, but in the years when immigration is possible, most years will have very little reduction in the duration of the migration window (i.e., <3 percent). For outmigration, there would be less effects since there is little difference between numbers of events provided between the no diversion and proposed operations. Based on the assessments above and predicted abundance for Pacific lamprey over the 50-yr permit term, under proposed operations there would be take of 1,380 and 5,430 adult and juvenile Pacific lamprey, respectively, over the 50-year permit term. These estimates represent improvements of 48% and 64% in numbers of adult and juvenile Pacific lamprey, respectively, compared to Water Rights. It should be noted that there is considerable uncertainty underlying abundance predictions due to the lack of available information on Pacific lamprey in the Santa Clara River and more broadly. Overall, the predicted reductions in migratory opportunities in the Santa Clara River under proposed operations are unlikely to appreciably affect the long-term survival and sustainability of Pacific lamprey populations in California. Potential population level effects due to proposed operations are discussed below.

Unlike Pacific lamprey in Pacific Northwest rivers, where perennially open river-mouths maintain passage potential regardless of instream flow conditions (e.g., Klamath River in northern California), episodic loss of passage through bar-built estuaries is common throughout the range of lamprey in California south of San Francisco Bay. Pacific lamprey adults and juveniles have adapted to these environments by responding rapidly and opportunistically to high-flow events that simultaneously breach estuary beach berms and support suitable passage conditions in upstream riverine reaches (Richards and Beamish 1981; Close et al. 1995; Busby et al. 1996; Hayes et al. 2011; Goodman et al. 2015). This pattern of migration in response to increased flow events has also been observed in the Santa Clara River (Chase 2001).

For immigrating adult lamprey, some reduction in the duration and frequency of passage opportunities is anticipated under the proposed operations. However, the extent of the reduction is unlikely to impair migration to a point that would substantially affect the population in most years. Another difference between Pacific salmon and steelhead is that lamprey do not necessarily home to natal spawning streams (Moyle et al. 2009; Spice et al. 2012), but rather are likely drawn to river systems that are providing suitable flow conditions and happen to be proximal to the lamprey's oceanic location at a time when adult lamprey are seeking to migrate into freshwater. For this reason, stray rates and gene flow between watersheds are intrinsically high and the species generally does not exhibit the fine-scale stock structure seen in migratory salmonids (Goodman et al. 2008; Spice 2012). When the river mouth is closed and there is no offshore river plume, it does not represent an attraction to lampreys in the ocean. Therefore, some reduction in migratory opportunities in the river may simply result in higher abundance of adult lamprey migrating into other watersheds in the region (e.g., Ventura River, Santa Ynez, San Luis Obispo and others) resulting in little to no effect on the general population.

For out-migrating juvenile, there will be a relatively minor reduction in the number of full three-day passage opportunities downstream of the Freeman Diversion under the proposed operations for all water year types. The effects of any reduction in opportunities will depend on the actual emigration behavior of the juveniles leaving Sespe Creek, which is currently unknown. If some outmigrants reach the Freeman Diversion when downstream passage to the ocean is not available, these fish will be relocated as part of CM 1.2.5. This measure both reduces the adverse impact of operations and reduces the potential for downstream stranding that might otherwise occur even under no diversion conditions.

Summary of Benefits

The MSHCP includes renovation and improvement of the fish passage facility at the Freeman Diversion, operating and maintaining that improved fish passage facility, a commitment to improved instream flows compared to United's otherwise lawful water rights, more focused lamprey passage that provide lamrey-focused monitoring options, habitat restoration after impacts from renovation, and invasive species removal. All of these activities benefit lamprey by improving fish passage conditions and, when necessary, allowing an informed, science-based process to modify the conservation program through adaptive management.

The conservation program describes the renovation of the fish passage facility at the Freeman Diversion. The renovation will update the Denil fish ladder that is estimated to work from 45-500 cfs with adequate attraction flow. NMFS considers the Denil fish ladder to be ineffective above 500 cfs, because of inadequate attraction flow emanating from the fish ladder entrances and distraction flow when water flows over the crest. It is unknown if the same challenges apply to lamprey but it is feasible. The new fish passage facility is designed to operate between 45-6,000 cfs with much improved attraction flow and a lamprey specific fish passage facility. Crest gates will also be designed and installed to maintain spatial distribution of flows so that they are concentrated on the south bank versus spreading out across the diversion to assist in attraction by keeping upstream migrating steelhead and lamprey in the vicinity of the fish ladder entrances. The crest gates will include an improved spillway apron designed to safely pass covered fish downstream. An extra set of fish ladder entrances would be incorporated to further increase attraction to the fish ladder. In summary, the new fish passage facility will be a greatly improved facility with safer and more efficient fish passage for both adult and juvenile covered fish.

Trapping and relocating when downstream moving lamprey could successfully migrate to the estuary but for United's diversions (i.e., 40 cfs critical diversion) would be an impact to the species from a covered activity (water diversion). However, trapping and relocating when a functional loss of migratory connectivity to the estuary would occur despite water diversions would be a benefit to the species from rescue and relocation. Therefore, take from trapping is a more beneficial outcome to lamprey than migration delay or mortality that could occur whether or not United was diverting water.

When United is implementing trapping for Monitoring studies or CM 1.2.5, dewatering for renovation/maintenances, or electrofishing, United staff would remove all invasive species encountered from the river. In the last 5 years of dewatering for maintenance activities, thousands of nonnative species have been observed and removed from the system, including common carp (*Cyprinus carpio*), sunfish spp. (fish in family Centrarchidaei), bullhead, largemouth bass (*Micropterus salmoides*), fathead minnows (*Pimephales promelas*), mosquitofish (*Gambusia affinis*), bullfrogs (*Lithobates catesbeianus*), African clawed frogs (*Xenopus laevis*), red eared sliders (*Trachemys scripta elegans*), and red swamp crayfish (*Procambarus clarkia*).

Largemouth bass, sunfish, bullfrogs, and African clawed frogs have the potential to prey on juveniles and may cause injury to lamprey if crowded into the trap together, but predator separation walls will be provided in the fish evaluation station.

United will implement habitat restoration for temporarily impacted riparian habitat during covered activities. Riparian habitat provides complexity and shading for steelhead that are sheltering while migrating or rearing. Also, invasive plants such as giant reed and tamarisk would be prevented from growing into restoration areas. These plants are known to diminish surface water and groundwater through evapotranspiration, therefore the prevention of growth of these plants would benefit lamprey by preventing these plants from diminishing water available to steelhead.

A lamprey focused monitoring system is not a component of the current fish passage facility but would be incorporated into the new facility. This would allow more efficient passage of lamprey with less angular surfaces that are challenging for them. It would also allow improved monitoring capabilities. The results of lamprey monitoring at the facility would address key uncertainties with regard to lamprey presence in the Santa Clara watershed. It is difficult to protect what is not understood and it would be difficult to adapt management decisions in the context of climate change in the Santa Clara River if more focused monitoring for lamprey is not implemented.

Conclusion and Discussion

The most intensive monitoring effort for upstream migrating adults occurred in a study by Chase (2001) that systematically trapped upstream migrant lamprey from 1991-1997 detecting anywhere from 20 adults to 908 adults per year of trapping effort. However, this sampling likely represents an underestimate of the total adults migrating at the time (Chase 2001).

More recent survey efforts by Reid and Goodman (2016) and the fact that only one adult lamprey has been observed at the Freeman Diversion since 2001, suggests that very few lamprey currently exist in the Santa Clara River watershed and the species may be extirpated or nearly extirpated from the drainage. Suitable habitat is available for larvae in Sespe Creek and in perennial flow in the main stem near 12th St Bridge and adult lamprey have demonstrated the ability to pass the Freeman Diversion effectively and efficiently with over 90% of adults making it through the ladder within 24 hours (Chase 2001), suggesting that the larger population decline observed in southern California may be driving the lack of persistence in the Santa Clara watershed perhaps due to more general threats (i.e., poor ocean conditions, climate change, etc.)(Reid and Goodman 2016).

Pacific lamprey is not currently listed as endangered or threatened, however declines in southern California are concerning. Overall, the MSHCP benefits lamprey by building a lamprey-focused passage system that will allow more consistent monitoring of lamprey in the watershed, instream flows that improve conditions compared to United's water rights (otherwise lawful activity), invasive species removal, and habitat restoration.

Together these factors demonstrate that, overall, the proposed project would not appreciably reduce the likelihood of survival and recovery of lamprey and the conservation program is expected to provide a net benefit to the species.

7.9.3 TIDEWATER GOBY

The only nexus for take of tidewater goby identified in this MSHCP would be the incidental take of gobies while seining for steelhead in the estuary under the Monitoring Program. This activity is expected to lead to occasional capture and short duration harassment. United will implement minimization measures to minimize disturbance and capture of gobies during monitoring. Despite those efforts, some take may occur to an estimated 50 gobies over the permit term. No injury or mortality is anticipated and the take is not likely to reduce the survival or recovery of gobies. The removal of common carp during maintenance and trapping would decrease the potential carp population that would transported to the estuary via instream flows. Carp display wallowing behavior that may disturb goby nests and eggs, therefore the removal of carp from the system would be a benefit to gobies.

7.9.4 WESTERN POND TURTLES

The following is a summary of the take of pond turtles, the impact of the taking on the pond turtle population, and the benefits of mitigation to offset the taking of pond turtles due to all covered activities.

Summary of Take and Impact of the Taking

Take of pond turtles in the form of mortality could occur from vehicle strikes, crushing of nests, removal of refugia, removal of habitat, impingement on the fish screen, or capture and relocation of individuals prior to conducting a given activity. Type of take, expected numbers of individuals to be taken, and acreage of habitat temporarily removed are summarized in Table 7-25.

Table 7-25 Estimated Take of Western Pond Turtle from Covered Activities		
	Form of Take	
Covered Activity	**Mortality (Individuals/Eggs)**	**Capture/Handle/Displace**
Renovation	10 individuals/11 eggs	56
Water Diversion	0/0	10
Ladder Startup	0/0	150
Sediment Sluicing	10/0	250*
Crest Gate Operation	0/0	250*
Screened Bypass Operations	50/0	300
Maintenance	24/0	200
Habitat Restoration and Enhancement	0/0	25
Cow Bird Trapping	0/0	0
Monitoring	0/0	0
Total Estimated Take	**94/11**	**1,241**
Total Estimated Take Per Year (average)	**<2/year/<1/year**	**24**

* Western pond turtles would not necessarily be captured or handled during this event but would be displaced downstream by flows through the bypass channel or over the crest gates.

Little is known of the effective population size of pond turtle in the permit area or the stability of the population. Recent observations at the Freeman Diversion suggest the pond turtle population has likely increased since the completion of the Freeman Diversion in 1991 and appears to remain healthy and stable with up to 20 individuals being observed at any one time in the ponded water around the facility. Implementation of the MSHCP is expected to benefit the pond turtle and provide conditions under which the species will persist and thrive and in the permit area. Implementation of the capture and relocation plan (CM 2.1.4) is intended to protect individual from harm during covered activities and maintain the gene pool in the population to support the persistence of the population.

Take of pond turtles because of covered activities and implementation of the conservation program over the life of the permit term is low and is not expected to have a detrimental impact on the population. Take because of mortality is expected to be one individual on average per year and take because of harm of is expected to be fewer than eight individuals per year on average, with no take expected in some years.

Impact of the Taking on the Western Pond Turtle Population

While little is known of the health and stability of the populations of pond turtles in the permit area, levels of take in the form of mortality from covered activities over the life of the permit term is expected to be low (Table 7-25). Take in the form of mortality of 84 individuals amounts to fewer than 2 individuals per year on average over the course of the permit term. On an average year, approximately 20 individuals are observed in the ponded water around diversion facility and likely more are present but undetected. The potential for take in the form of mortality will be minimized to the extent practicable given implementation of the CMs; however, if mortality does occur, the loss of up to 84 individuals and one clutch of eggs occurring in the immediate vicinity of the Freeman Diversion over a 50 year period is not expected to adversely affect the population of pond turtles as a whole.

Take of pond turtles in the form of capture and harm due to rescue and relocation may have immediate effects on individuals resulting is short-term loss of fecundity resulting from stress and disruption of breeding/nesting opportunities. In the long-term under the MSHCP, capture and relocation is expected to preserve the stability of the population by relocating individuals to suitable habitat locations out of harm’s way. Capture and relocation of up to 1,101 individuals during covered activities over the permit term would not have an impact on the population because these individuals would not be permanently removed from the breeding population. Relocation will be done strategically in consultation with USFWS to ensure turtles are relocated to suitable habitat, including breeding locations, in a way that best supports the breeding population of turtles in the Santa Clara River. Ongoing monitoring will be conducted to learn about the population and to best inform the relocation plan to support reproductive success of individuals and stability of the population.

Implementation of CMs outlined in Chapter 5 are intended to avoid or minimize the take of pond turtle to the extent practicable. Best management practices (CM 2.1.1) are intended to inform the design of the project to avoid or minimize impacts to pond turtle. Worker environmental awareness training (CM 2.1.2) and pre-construction surveys are intended to provide information to staff on the location, identification, and avoidance of pond turtle and biological monitoring (CM2.1.6) is intended to ensure avoidance and minimization of take during construction. Safe handling practices outlined in the Capture and Relocation Protocol (CM 2.1.4) is intended to avoid mortality of pond turtles during capturing and handling of individuals. Avoidance or minimization of take of pond turtles is further provided through implementation of CM 2.1.8 during any work that may occur in or near water or riparian habitat.

Estimated take in the form of harm from individuals becoming swept downstream is not expected to adversely affect the population of pond turtle in the permit area. Pond turtles that do become swept downstream are expected be able to reestablish downstream of the diversion facility. Given the seasonal high flow events experienced in the Santa Clara River, seasonal displacement of pond turtles along the river channel is likely a common occurrence under natural conditions.

The impact of the taking is estimated to be negligible to the western pond turtle population. Although, formal surveys are not conducted for pond turtles at the Freeman Diversion, their numbers appear to be increasing overall with at least 20 pond turtles observed in one dewatering event for maintenance in 2019 and with no individuals observed to be harmed or killed during that event.

After initial removal and relocation of individuals from the restoration work area, no further take is expected. Relocation of individuals away from the work area is expected to preserve the stability of the population by establishing individuals in suitable locations out of harm’s way.

Summary of Benefits

Conservation measures are designed to minimize and mitigate the taking of pond turtles and ensure the covered actives under the MSHCP do not interfere with the continued survival of the species. Relevant conservation measures for mitigation of the taking of pond turtles include Best Management Practices (CM 2.1.1), Worker Environmental Awareness Training (CM 2.1.2), Pre-activity Surveys (CM 2.1.3), Capture and Relocation Plan (CM 2.1.4), Biological Monitoring (CM 2.1.6), Pond Turtle Specific Avoidance (CM 2.1.8), Invasive Species Management (CM 2.2.1), General Habitat Avoidance (CM 2.2.2), and Habitat Restoration And Management (CM 2.3.1). The overall goal of the conservation program is to contribute to the conservation of western pond turtles, and every effort will be made to avoid take during these activities.

EMM-10 (Chapter 6) would involve tracking the population of pond turtles around the Freeman Diversion to determine the effectiveness of the conservation measures and inform adaptive management of the relocation strategy.

Conclusion and Discussion

Because of the benefits of the conservation program, no appreciable reduction in the survival or recovery of western pond turtles is expected because of covered activities. Western pond turtle populations are expected to benefit from implementation of this MSHCP and the status of the population in the permit area is expected to stay the same or increase over time following renovation of the Freeman Diversion.

7.9.5 COVERED BIRDS

The following is a summary of the take of covered birds, the impact of the taking on populations of covered birds, and the benefits of mitigation to offset the take of covered birds due to all covered activities.

Summary of Take and Impact of the Taking

Take of covered birds as a result of covered activities is expected to be very low on an annual basis and over the life of the permit term. Take of covered birds does not include take in the form of mortality of adults. Type of take, expected numbers of nest to be taken, and acreage of habitat temporarily removed is summarized in Table 7-26.

Table 7-26 Estimated Take of Vireo from Covered Activities

Covered Activity	Take Due to Harm			
	Individuals*/Offspring**			Temporary Habitat Loss (Harm)
	LBVI	SWFL	YBCU	
Renovation	0/50	0	0	2.83 acres
Water Diversion and Instream Flows Operations	0	0	0	0
Facility Infrastructure and Operations - Sluicing	0/102	0/10	0	2.83 acres
Maintenance	0/34	0/10	0	2.83 acres***
Habitat Restoration and Enhancement	0	0	0	0
Cow Bird Trapping	0	0	0	0
Monitoring	0	15/0	5/0	0
Total Estimated Take	**70/100**	**0/10**	**5/0**	**2.83 acres**
Total Estimated Take Per Year (Average)			**0**	**2.83 acres*** **

*Take is due to harm from stress of vocalization playback broadcasting.

**Take of offspring is the result of loss of nests

***Loss of habitat considered a maximum per year estimate. Typical years will be less.

Take of vireo includes the loss of nests during renovation, sediment sluicing, and maintenance. Loss of nests will result in the lethal take of eggs or chicks (collectively, offspring) and would result in reduced recruitment of individuals back into the population. Take in the form of harm could occur from removal of habitat, loss of nests or nesting opportunities, and stress from noise and general disturbance near nesting habitat; however, this take will be avoided through implementation of the conservation program.

Take of flycatcher includes the limited loss of nests during sediment sluicing and maintenance. Loss of nests will result in the lethal take of eggs or chicks (collectively, offspring) and would result in reduced recruitment of individuals back into the population. Take of flycatcher may also occur as a result of the monitoring program from vocalization playback broadcasting. No net loss of flycatcher critical habitat will result from proposed covered activities. Impacts to flycatcher critical habitat are temporary; habitat will be restored and managed for up to 10 years after initial impacts.

No take of cuckoo in the form of mortality of individuals is expected to occur over the life of permit term. Take of cuckoo may also occur as a result of the monitoring program from vocalization playback broadcasting.

United has conducted studies of covered birds in the permit area since 2012 (Chapter 4, Section 4.2.5 through 4.2.7) and much is now known about the population status of covered birds in the area around the Freeman Diversion. The general trend in the vireo population around the Freeman Diversion shows an increase in breeding territories and territorial males/pairs, with a peak of 88 pairs in 2018, showing that the vireo population is increasing overall in the permit area. Flycatcher have not been observed within 2 miles and cuckoo have not been observed within 5 miles of the Freeman Diversion despite the large increase in riparian community and increase in the vireo population following completion of the diversion.

The level of take expected from covered activities on covered birds over the life of the permit term is not expected to have an impact on the continued survival or recovery of covered birds. Temporary loss of suitable breeding and foraging habitat could result in short-term reduced fecundity of individuals dependent on the habitat and could lead to short-term increased competition from displaced individuals searching for foraging or nesting opportunities in the adjacent established territories of conspecifics. These effects are expected to be temporary and to have a negligible effect on the population of covered birds in the permit area.

Impact of the Taking on Covered Bird Populations

United has conducted studies of covered birds in the permit area since 2012 (see Section 4.2.5 through 4.2.7) and much is now known about their population status in the permit area around the Freeman Diversion. The general trend for the vireo population around the Freeman Diversion is an increase in breeding territories and territorial males/pairs between 2012 and 2019, suggesting that the vireo population is increasing overall in the area around the Freeman Diversion. The level of take expected from covered activities under the MSHCP is not expected to have an adverse impact on the continued survival of covered birds.

Since 2012, vireo surveys have observed a maximum of 88 breeding territories (in 2018) detected in one year in the survey area 1.5 miles upstream and downstream of the Freeman Diversion. Incidental nest observations were also documented within this survey area during protocol-level surveys for vireos. Approximately 292 vireo nests have been detected over the 8 years since surveys began (average 37 nests/year). The temporary loss of 1.05 acres of breeding habitat resulting in the estimated take of 15 vireo nests over the two-year construction period is expected to have a negligible impact on the vireo population.

This is a general trend observed in many vireo populations studied, and in the 2006, 5-year review, the USFWS recommended down-listing of the species. Since 2012 (8-year period), 436 nests (average of 55 nests per year) have been detected within the 1.5-miles survey area upstream and downstream of the Freeman Diversion. The potential take of 10 vireo nests over the 50-year permit term is not expected to impact the nesting vireo population in the area of the Freeman Diversion. Loss of 2.83 acres of potential habitat in the immediate vicinity of the Freeman Diversion is not expected to have an adverse impact on the least Bell’s vireo population.

A single territorial pair of flycatchers was observed approximately 1.5 miles downstream of the Freeman Diversion in 2016 and 2017. The temporary loss of 2.83 acres of potential foraging habitat in the immediate vicinity of the Freeman Diversion is not expected to have any impact on the flycatcher population. No cuckoo have been detected around the Freeman Diversion since surveys began in 2012 and the temporary removal of 2.83 acres of potential foraging habitat in the immediate vicinity of the Freeman Diversion is not expected to have any impact on the cuckoo population.

Flycatchers have only been observed a few times in the area with a nesting pair observed in 2016 and 2017. Cuckoos have not been observed around the Freeman Diversion to United's knowledge, but they have been observed in other parts of the watershed in the last five years.

Surveys conducted in the area surrounding the Freeman Diversion have resulted in detection of one nesting flycatcher pair in 2016 and 2017 (Section 4.2.6). The flycatcher population in the permit area does not appear to be increasing. United expects to have no take of flycatcher individuals or nests but is accounting for the possibility of the flycatcher population increasing throughout the life of the permit term and estimates up to five flycatcher nests could be taken during maintenance covered activities. The loss of up to five flycatcher nests at the Freeman Diversion over a 50-year period is not expected to adversely affect the flycatcher population in the permit area. Loss of 1.05 acres of potential nesting habitat in the immediate vicinity of the Freeman Diversion is not expected to have an adverse impact on the flycatcher population.

Surveys conducted in the permit area surrounding the Freeman Diversion since 2012 have failed to detect the presence of cuckoo (see Section 4.2.7). No take of cuckoo individuals or nest is expected and no impact to the cuckoo population in the permit area is expected. Loss of 2.83 acres of potential foraging habitat in the immediate vicinity of the Freeman Diversion is expected to have a negligible impact on the cuckoo population.

Summary of Benefits

The take of covered birds would be fully offset through the implementation of the Conservation Program. Relevant conservation measures for mitigation of the taking of covered birds include Best Management Practices (CM 2.1.1), Worker Environmental Awareness Training (CM 2.1.2), Pre-activity Surveys (CM 2.1.3), biological monitoring (CM 2.1.6), general habitat avoidance (CM 2.2.2), cowbird trapping (CM 2.3.2), and habitat restoration and management (CM 2.3.1). The overall goal of the conservation program is to contribute to the conservation of the covered birds, and every effort will be made to avoid take during these activities. Habitat restoration and management is intended to maintain suitable habitat for covered birds through the focused restoration of any disturbed habitat and long-term management of habitat in the permit area.

A single cowbird trap through one nesting season has been shown to protect native bird nests within a 1-mile radius of the trap, including vireo and flycatcher. Operating three cowbird traps for two years is estimated to benefit as much as 88 vireos and any flycatchers that might move into the area surrounding the Freeman Diversion.

The relatively small amount of suitable habitat temporarily removed, compared to the available habitat within the permit area, is expected to have a negligible effect on the overall populations of covered birds within the permit area. However, this habitat will be restored through CM 2.3.1 and post-restoration conditions are expected to be better than pre-construction conditions due to active management of the restoration area. Also, cowbird trapping will provide significant benefit to vireos and other native birds, including any flycatchers and cuckoos that may come into the area. Because the mitigation described in the conservation strategy fully offsets the impacts of the taking, no appreciable reduction in the survival or recovery of the covered birds is expected because of covered activities. Covered birds are expected to benefit from implementation of the MSHCP and, overall, the status of covered bird populations is expected to improve.

Restoration and management of temporarily impacted suitable critical habitat is expected to conserve and enhance critical habitat for southwestern willow flycatcher within the permit area and result in no net loss of critical habitat to the species.

Conclusion and Discussion

Because of the benefits of the conservation program, no appreciable reduction in the survival or recovery of covered birds is expected because of covered activities. Populations of covered birds are expected to benefit from implementation of this MSHCP and the status of the population in the permit area is expected to stay the same or increase over time following renovation of the Freeman Diversion.

7.10 LITERATURE CITED

Atkinson, K.A. 2010. Habitat conditions and steelhead abundance and growth in a California lagoon. San Jose State University, San Jose, CA. Master's Theses. 3746.

Baigún, C.R., 2003. Characteristics of deep pools used by adult summer steelhead in Steamboat Creek, Oregon. North American Journal of Fisheries Management, 23(4), pp.1167-1174.

Beamish, F.W.H. 1978. Swimming capacity. In: Hoar WS, Randall DJ (eds) Fish physiology, vol VII. Academic Press, New York, pp 101–187.

Beamish, R. J. 1980. Adult biology of the River Lamprey (*Lampetra ayresii*) and the Pacific Lamprey (*Lampetra tridentata*) from the Pacific coast of Canada. Canadian Journal of Fisheries and Aquatic Sciences 37:1906–1923.

Beamish, R.J. and T.G. Northcote. 1989. Extinction of a population of anadromous parasitic lamprey, *Lampetra tridentata*, upstream of an impassable dam. Can. J. Fish. Aquat. Sci. 46: 420-425.

Behrens, D.K., F.A. Bombardelli, J.L. Largier, and E. Twohy. 2013. Episodic closure of the tidal inlet at the mouth of the Russian River – A small bar-built estuary in California. Geomorphology 189: 66-80.

Bond, M.H. 2006. Importance of estuarine rearing to central California steelhead (*Oncorhynchus mykiss*) growth and marine survival. M.A. Thesis. University of California Santa Cruz. 68 pp.

Bond, M.H., S.A. Hayes, C.V. Hanson, and R.B. MacFarlane. 2008. Marine survival of steelhead (*Oncorhynchus mykiss*) enhanced by a seasonally closed estuary. Canadian Journal of Fisheries and Aquatic Sciences 65:2242-2252.

Booth, M.T. 2016. Fish passage monitoring at the Freeman Diversion 1993-2014. United Water Conservation District. Santa Paula, CA. 13 pp.

Booth, M.T. 2020. Patterns and Potential Drivers of Steelhead Smolt Migration in Southern California. North American Journal of Fisheries Management.

Boughton, D. A. 2010. A Forward-Looking Scientific Frame of Reference for Steelhead Recovery on the South-Central and Southern California Coast. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-466. October 2010.

Boughton, D. A., and M. Goslin. 2006. Potential steelhead over-summering habitat in the South-Central/Southern California Coast recovery domain: maps based on the envelope method. NOAA-TM-NMFS-SWFSC-391. Prepared by National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.

Boughton, D.A., P.B. Adams, E. Anderson, C. Fusaro, E. Keller, E. Kelley, L. Lentsch, J. Nielson, K. Perry, H. Regan, J. Smoth, C. Swift, L. Thomson, and F. Watson. 2006. Steelhead of the south-central/southern California coast: population characterization for recovery planning. NOAA Technical Memorandum NMFS-SWFSC-394.

Boughton, D.A., L.R. Harrison, A.S. Pike, J.L. Arriaza, and M. Mangel. 2015. Thermal potential for steelhead life history expression in a Southern California alluvial river. Transactions of the American Fisheries Society 144: 258-273.

Brown, L. R., S.D. Chase, M. G. Mesa, R. J. Beamish, and P. B. Moyle, editors. 2009. Biology, management, and conservation of lampreys in North America. American Fisheries Society, Symposium 72, Bethesda, Maryland.

Brumo, A. F. 2006. Spawning, larval recruitment, and early life survival of Pacific lamprey in the South Fork Coquille River, Oregon. Master's thesis. Oregon State University, Corvallis, Oregon.

Brumo, A.F., L. Grandmontagne, S.N. Namitz and D.F. Markle. 2009. Approaches for monitoring Pacific Lamprey spawning populations in a coastal Oregon stream. Pages 203-222 in L. R. Brown, S. D. Chase, M. G. Mesa, R. J. Beamish, and P. B. Moyle, editors. 2009. Biology, management, and conservation of lampreys in North America. American Fisheries Society, Symposium 72, Bethesda, Maryland.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-27. 261 pp.

California Coastal Commission (CCC). 2015. California Coastal Commission sea level rise policy guidance, interpretive guidelines for addressing sea level rise in local coastal programs and coastal development permits. Adopted by California Coastal Commission, August 12, 2015. Available online: https://www.coastal.ca.gov/climate/slrguidance.html. Accessed October, 2016.

California Department Fish and Wildlife. 2015. Natural Diversity Database, March 2015. Special Animals List. Periodic publication. 51 pp.

Cayan, D., E. Maurer, M. Dettinger, M. Tyree, and K. Hayhoe. 2008. Climate change scenarios for the California region. Climatic Change 87(Suppl 1): S21-S42.

Cayan, D., M. Tyree, M. Dettinger, H. Hidalgo, T. Das, E. Maurer, P. Bromirski, N. Graham, and R. Flick. 2009. Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment. California Climate Change Center. CEC-500-2009-014-F. August 2009.Chase, S.D. 2001. Contributions to the Life History of Adult Pacific Lamprey (*Lampetra tridentata*) in the Santa Clara River of Southern California. Bull. Southern California Acad. Sci. 100(2): 74-85.

Chase, S.D. 2001. Contributions to the life history of adult Pacific Lamprey (*Lampetra tridentata*) in the Santa Clara River of Southern California. Bull. Southern California Acad. Sci. 100(2), pp. 74-85.

Chapin, D.M., R.L. Beschta, and H. W.Shen. 2002. Relationships between flood frequencies and riparian plant communities in the upper Klamath Basin, Oregon. Journal of the American Water Resources Association 38(3):603-617.

Clemens, B. J., M. G. Mesa, R. J. Magie, D. A. Young and C. B. Schreck. 2012. Pre-spawning migration of adult Pacific lamprey, *Entosphenus tridentatus*, in the Willamette River, Oregon, U.S.A. Environmental Biology of Fishes 93:245–254.

Clemento, A. J., E. C. Anderson, D. Boughton, D. Girman, and J. C. Garza. 2009. "Population Genetic Structure and Ancestry of Oncorhynchus mykiss Populations Above and Below Dams in South-central California." *Conservation Genetics* 10:1321-1336.

Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (*Lampetra tridentata*) in the Columbia Basin. Bonneville Power Administration. Portland, Oregon.

Dagit, R., E. Bell, A.J. Mongolo, and E. Montgomery. 2017. The effects of a prolonged drought on southern steelhead trout (Oncorhynchus mykiss) in a coastal creek, Los Angeles County, California. Bulletin of the Southern California Academy of Sciences 116: 162-173.

Dagit R., M.T. Booth, M. Gomez, T. Hovey, S. Howard, S.D. Lewis, S. Jacobson, M. Larson, D. McCanne, and T.H. Robinson. 2020. Occurrences of steelhead trout (Oncorhynchus mykiss) in southern California, 1994-2018. California Fish and Wildlife Journal 106(1).

Dauble, D.D., R.A. Moursund and M.D. Bleich. 2006. Swimming behaviour of juvenile Pacific lamprey, *Lampetra tridentata*. Environmental Biology of Fishes 75:167–171.

Dawson, H.A., B.R. Quintella, P.R. Almeida, A.J. Treble and J.C. Jolley. 2015. The ecology of larval and metamorphosing lampreys. In Docker, M.F., editor. 2015. Lampreys: biology, conservation and control, Volume 1. Springer, Dordrecht.

Dettinger, Michael. 2011. Climate change, atmospheric rivers, and floods in California – a multimodel analysis of storm frequency and magnitude changes. Journal of the American Water Resources Association 47(3): 514-523.

Docker, M. F. 2015. Lampreys: biology, conservation and control, Volume 1. Fish and Fisheries Series no. 37. Springer, Dordrecht, Netherlands. 438 pp.

Ernst, C.H. and R.W. Barbour. 1972. Turtles of the United States. Univ. Kentucky Press, Lexington. 347pp.

ESA PWA. 2013. Final Coastal Resilience Ventura Technical Report for Coastal Hazards Mapping. Prepared for The Nature Conservancy, 39 p.

Evermann, B.W. and S.E. Meek. 1896. A report upon salmon investigations in the Columbia River Basin and elsewhere on the Pacific Coast in 1896. Bulletin of the United States Fish Commission, Washington, D.C.

Griffith Wildlife Biology. 2018. 2018 Santa Clara River Fillmore Brown-Headed Cowbird Control Program. Unpublished report prepared for Heritage Valley Park, Fillmore, California, by Griffith Wildlife Biology, Ventura, California.

Goodman, D.H., S.B. Reid, M.F. Docker, G.R. Haas, and A.P. Kinziger. 2008. Mitochondrial DNA evidence for high levels of gene flow among populations of a widely distributed anadromous lamprey *Entosphenus tridentatus* (Petromyzontidae). Journal of Fish Biology (2008) 72, 400–417.

Goodman, D.H., S.B. Reid, N.A. Som and W.R. Poytress. 2015. The punctuated seaward migration of Pacific Lamprey (*Entosphenus tridentatus*): environmental cues and implications for streamflow management. Canadian Journal of Fisheries and Aquatic Sciences 72(12): 1817-1828, 10.1139/cjfas-2015-0063.

Gunckel, S.L., K.K. Jones, and S.E. Jacobs. 2009. Spawning distribution and habitat use of adult Pacific and Western Brook lampreys in Smith River, Oregon. Pages 173-189 in L. R. Brown, S. D. Chase, M. G. Mesa, R. J. Beamish, and P. B. Moyle, editors. 2009. Biology, management, and conservation of lampreys in North America. American Fisheries Society, Symposium 72, Bethesda, Maryland.

Hall, L.S., B.K. Orr, J.R. Hatten, A. Lambert, and T. Dudley. 2020. Final Report: Southwestern Willow Flycatcher (Empidonax traillii extimus) and western Yellow-billed Cuckoo (Coccyzus americanus occidentalis) surveys and habitat availability modeling on the Santa Clara River, California, 26 March 2020. Prepared by Western Foundation of Vertebrate Zoology, Camarillo, CA. Submitted to the California Department of Fish and Wildlife.

Hayes, S.A., M.H. Bond, C.V. Hanson, et al. 2008. Steelhead growth in a small central California watershed: upstream and estuarine rearing patterns. Transactions of the American Fisheries Society 137: 114-128.

Hayes, S.A., M.H. Bond. C.V. Hanson, A.W. Jones., A.J. Ammann, J.A. Harding, A.L. Collins, J. Peres, and R.B. MacFarlane. 2011. Down, up, down and "smolting" twice? Seasonal movement patterns by juvenile steelhead (*Oncorhynchus mykiss*) in a coastal watershed with a bar closing estuary. Canadian Journal of Fisheries and Aquatic Sciences 68, 80:1341-1350.

Hecht, B.C., F.P. Thrower, M.C. Hale, et al. 2012. Genetic architecture of migration-related traits in rainbow and steelhead trout, *Oncorhynchus mykiss.* G3 (Bathesda) 2(9): 1113-1127.

Hecht, B.C., N.R. Campbell, D.E. Holecek, and S.R. Narum. Genome-wide association reveals genetic basis for the propensity to migrate in wild populations of rainbow and steelhead trout. Molecular Ecology 22(11): 3061-3076.

Hockersmith, E., J. Vella, L. Stuehrenberg, R.N. Iwamoto, and G. Swan. 1995. Yakima River radio-telemetry study: steelhead, 1989-1993. U.S. Department of Energy, Bonneville Power Administration, DOE/BP-89-089. Portland, Oregon. 95pp.

Holland, D.C. 1994. The Western Pond Turtle: Habitat and History Final Report. Wildlife Diversity Program. Oregon Department of Fish and Wildlife. Portland, OR:1-303.

Holland, Robert F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. State of California, The Resources Agency Non-game Heritage Program Department of Fish and Game, Sacramento, California. 1986.

Hooton, R.S., and M.G. Lirette. 1986. Telemetric studies of winter steelhead, Gold River, 1982-83. Ministry of Environment, Fisheries Management Report No. 86, Nanaimo, B.C. 18pp.

Johnson, N.S., T.J. Buchinger and W. Li. 2015. Reproductive ecology of lampreys. Chapter 6 in M. F. Docker, editor. 2015. Lampreys: biology, conservation and control, Volume 1. Fish and Fisheries Series no. 37. Springer, Dordrecht, Netherlands.

Keefer, M. L., M. L. Moser, C. T. Boggs, W. R. Daigle, and C. A. Peery. 2009a. Effects of body size and river environment on the upstream migration of adult Pacific lampreys (Lampetra tridentata). North American Journal of Fisheries Management 29:1214–1224.

Keefer, M.L., M.L. Moser, C.T. Boggs, W.R. Daigle, C.A. Peery. 2009b. Variability in migration timing of adult Pacific lamprey (Lampetra tridentata) in the Columbia river, U.S.A. Environmental Biology of Fishes 85:253–264.

Keefer ML, Peery CA, Caudill CC et al (2009c) Adult Pacific lamprey migration in the lower Columbia River: 2008 radiotelemetry and half-duplex PIT tag studies. Final Report to the U.S. Army Corps of Engineers, Portland District, Portland, OR

Keefer, M.L., W.R. Daigle, C.A. Peery, H.T. Pennington, S.R. Lee, M.L. Moser. 2010. Testing adult Pacific lamprey performance at structural challenges in fishways. North American Journal of Fisheries Management 30:376–385.

Keefer M.L., C.C. Caudill, E.L. Johnson, T.S. Clabough, M.A. Jepson, C.T. Boggs and M.L. Moser. 2012. Adult Pacific Lamprey migration in the lower Columbia River: 2011 half-duplex pit tag studies. Idaho Cooperative Fish and Wildlife Research Unit, Moscow ID. Tech. Report 2012-3.

Kemp P.S., T. Tsuzaki and M.L. Moser. 2009. Linking behavior and performance: intermittent locomotion in a climbing fish. J. Zoology 277:171–178.

Luzier, C.W., H.A. Schaller, J.K. Brostrom, C. Cook-Tabor, D.H. Goodman, R.D. Nelle, K. Ostrand and B. Streif. 2011. Pacific Lamprey (*Entosphenus tridentatus*) assessment and template for conservation measures. U.S. Fish and Wildlife Service, Portland, Oregon. 282 pp.

Lusardi, R. A., and P. B. Moyle. 2017. Two-way trap and haul as a conservation strategy for anadromous salmonids. Fisheries 42: 478–487.

Manzon, R.G., J.H. Youson and J.A. Holmes. 2015. Lamprey Metamorphosis. Chapter 4 in M. F. Docker, editor. 2015. Lampreys: biology, conservation and control, Volume 1. Fish and Fisheries Series no. 37. Springer, Dordrecht, Netherlands.

Martinez, A., J.C. Garza, and D.E. Pearse. 2010. A microsatellite genome screen identifies chromosomal regions under differential selection in steelhead and rainbow trout. Transactions of the American Fisheries Society 140: 829-842.

McEwan, D.R. 2001. Central Valley Steelhead. Pages 1-44 In: Brown, R. (ed.) Fish Bulletin 179. Contributions to the Biology of Central Valley Salmonids. Scripps Institution of Oceanography, UC San Diego, CA.

McMillan, J.R., J.B. Dunham, G.H. Reeves, J.S. Mulls, C.E. Jordan. 2012. Individual condition and stream temperature influence early maturation of rainbow and steelhead trout, *Oncorhynchus mykiss*. Environmental Biology of Fishes. 93: 343-355.

McCammon, G. 1953. The Pacific Lamprey, *Entosphenus tridentatus*, in Sespe Creek, Ventura County. Field Correspondence - April 15, 1953; California Dept. Fish and Game, Whittier, California. 3 pp.

McIlraith, B.J. 2011. The adult migration, spatial distribution, and spawning behaviors of anadromous Pacific lamprey (*Lampetra tridentata*) in the lower Snake River. MS thesis, University of Idaho, Moscow, ID.

Meckley, T.D., E. Gurarie, C.M. Wagner. 2014. Coastal movements of migrating sea lamprey (*Petromyzon marinus*) in response to a partial pheromone added to river water: implications for management of invasive populations. Can. J. Fish. Aquat. Sci. 71(4): 533-544.

Meeuwig, M.H., J.M. Bayer, J.G. Seelye. 2005. Effects of temperature on survival and development of early life stage Pacific and western brook lampreys. Trans Am Fish Soc 134:19-27.

Mesa, M.G., J.M. Bayer, and J.G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. Transactions of the American Fisheries Society **132**: 483-492.

Miller, N., K. Bashford, and E. Strem. 2001. Climate change sensitivity study of California hydrology: A report to the California Energy Commission. LBNL Technical Report No. 49110. Published online: http://www.researchgate.net/publication/237632705.

Moser, M.L. and M.G. Mesa. 2009. Passage considerations for lamprey. In: Brown LR, Chase SD, Mesa MG, Beamish RJ, Moyle PB (eds) Biology, management and conservation of lampreys in North America. American Fisheries Society Symposium 72, Bethesda, pp 115–124.

Moser, M.L., P.R. Almeida, P.S. Kemp and P.W. Sorensen. 2015. Lamprey Spawning Migration. Chapter 5 in M. F. Docker, editor. 2015. Lampreys: biology, conservation and control, Volume 1. Fish and Fisheries Series no. 37. Springer, Dordrecht, Netherlands.

Moursund, R.A., D.D. Dauble and M.D. Bleich. 2000. Effects of John Day Dam bypass screens and project operations on the behavior and survival of juvenile Pacific Lamprey (*Lampetra tridentata*). Final report to U.S. Army Corps of Engineers, Portland. Batelle, Pacific Northwest National Laboratory, Richland, WA. 34p.

Moyle, P.B., L.R. Brown, S.D. Chase, and R.M. Quiñones. 2009. Status and conservation of lampreys in California. Pages 279-292 in L. R. Brown, S. D. Chase, M. G. Mesa, R. J. Beamish, and P. B. Moyle, editors. 2009. Biology, management, and conservation of lampreys in North America. American Fisheries Society, Symposium 72, Bethesda, Maryland.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Los Angeles.

Moyle, P.B., J.A. Israel, and S.E. Purdy. 2008. Salmon, Steelhead, and Trout in California. Status of an Emblematic Fauna. U.C. Davis Center for Watershed Sciences. Prepared for California Trout. 316 pp.

Moyle, P.B., R.A. Lusardi, P.J. Samuel, and J.V.E. Katz. State of Salmonids: Status of California's Emblematic Fishes 2017. 2017. Center for Watershed Sciences, University of California, Davis and California Trout, San Francisco, CA. 579 pp.

Nakamoto, R.J., 1994. Characteristics of pools used by adult summer steelhead oversummering in the New River, California. Transactions of the American Fisheries Society, 123(5), pp.757-765.

National Marine Fisheries Service (NMFS). 2002. Letter to David Young, USDI Bureau of Reclamation, Fresno Office. Dated 4 April 2002.

National Marine Fisheries Service (NMFS). 2008. Final Biological Opinion on the United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility. National Marine Fisheries Service, Southwest Region. 122 pp.

National Marine Fisheries Service (NMFS). 2011. Anadromous Salmonid Passage Facility Design. National Marine Fisheries Service, Northwest Region, Portland, Oregon. 137 pp

National Marine Fisheries Service (NMFS). 2012. Southern California Steelhead Recovery Plan. Southwest Region, Protected Resources Division, Long Beach, California.

National Marine Fisheries Service (NMFS). 2014. Recovery Plan for the Evolutionary Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. July 2014.

National Marine Fisheries Service (NMFS). 2016. 5-Year Review: Summary and Evaluation of Southern California Coast Steelhead District Population Segment. National Marine Fisheries Service. West Coast Region. California Coastal Office. Long Beach, California.

National Research Council (NRC). 2012. Sea-level rise for the coasts of California, Oregon, and Washington: past, present, and future. Report by the Committee on Sea Level Rise in California, Oregon, and Washington. National Academies Press, Washington, DC. Available online: https://www.nap.edu/catalog/13389/sea-level-rise-for-the-coasts-of-california-oregon-and-washington.https://www.nap.edu/catalog/13389/sea-level-rise-for-the-coasts-of-california-oregon-and-washington Accessed October 2016.

Narum, S.R., D. Hatch, A. J. Talbot, P. Moran, and M. S. Powell. 2008. Iteroparity in complex mating systems of Steelhead, Oncorhynchus mykiss (Walbaum). Journal of Fish Biology 72:45-60

Nawa, R.K., J.E. Vaile, P. Lind, T.M. K Nadananda, T. McKay, C. Elkins, B. Bakke, J. Miller, W. Wood, K. Beardslee, and D. Wales. 2003. A petition for rules to list: Pacific lamprey (*Lampetra tridentata*); river lamprey (*Lampetra ayresi*); western brook lamprey (Lampetra richardsoni); and Kern brook lamprey (*Lampetra hubbsi*) as threatened or endangered under the Endangered Species Act. January 23, 2003.

Nichols, Krist M., Alicia Felip Edo, Paul A Wheeler, Gary H. Thorgaard. 2008. The Genetic Basis of Smoltification-Related Traits in Oncorhynchus mykiss. Genetics. July 2008. 179(3): 1559-1575.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16: 693-727.

Orlov, A.M., V.F. Savinyh and D.V. Pelenev. 2008. Features of the spatial distribution and size structure of the Pacific Lamprey, *Lampetra tridentata*, in the North Pacific. Russian Journal of Marine Biology, 2008, Vol. 34, No. 5, pp. 276–287.

Orlov, A. M., R. J. Beamish, A. V. Vinnikov, and D. Pelenev. 2009. Feeding and prey of Pacific Lamprey in coastal waters of the western North Pacific. Pages 875–877 in A. Haro, K. L. Smith, R. A. Rulifson, C. M. Moffitt, R. J. Klauda, M. J. Dadswell, R. A. Cunjak, J. E. Cooper, K. L. Beal, and T. S. Avery, editors. Challenges for diadromous fishes in a dynamic global environment. American Fisheries Society, Symposium 69, Bethesda, Maryland.

Pletcher, F. T. 1963. The life history and distribution of lamprey in the Salmon and certain other rivers in British Columbia, Canada. Master's thesis. University of British Columbia, Vancouver. B.C. 195 pp.

Puckett, L.K. and N.A. Villa. 1985. Lower Santa Clara River Steelhead Study. State of California Department of Fish and Game. Report Prepared under Interagency Agreement No. B54179 funded by the California Department of Water Resources. 31pp.

Quinn, T.P. The Behavior and Ecology of Pacific Salmon and Trout.

Rathburn, G.B., N. J. Scott, T. G. Murphey. 2002. Terrestrial habitat use by Pacific pond turtles in a Mediterranean climate. The Southwestern Natural 47(2):225-235.

Rathburn, G. B., M. R. Jennings, T. G. Murphey, and N. R. Siepel. 1993. Status and ecology of sensitive aquatic vertebrates in lower San Simeon and Pico Creeks, San Luis Obispo County, California. Unpublished report, National Ecology Research Center, Piedras Blancas Research Station, San Simeon, California, under Cooperative Agreement (14-16-0009-91-1909).

Reid, S.B. 2015. Assessment of occupancy and potential habitat for Pacific Lamprey (*Entosphenus tridentatus*) in the Santa Clara River Basin. Report to United Water Conservation District, Santa Paula CA. 73 p.

Reid, S.B. 2017. A conceptual framework and recommendations for Pacific Lamprey passage at the existing Freeman Diversion fishway. Report to United Water Conservation District, Santa Paula CA. 16p.

Reid, S.B. and D.H. Goodman. 2016. Pacific Lamprey in coastal drainages of California: occupancy patterns and contraction of the southern range. Transactions of the American Fisheries Society 145(4): 703-711.

Reid, S.B. and D.H. Goodman. 2016. Free swimming speeds and behavior in adult Pacific Lamprey, *Entosphenus tridentatus*. Environmental Biology of Fishes 99: 969. doi:10.1007/s10641-016-0537-2.

Reid, S.B. and D.H. Goodman. 2017. Pacific Lamprey: Historical and Current Distribution - USFWS [ds2673]. California Dept. Fish and Wildlife, Biogeographic Information and Observation System (BIOS). https://map.dfg.ca.gov/bios/.

Reinhardt U.G., L. Eidietis, S.E. Friedl and M.L. Moser. 2008. Pacific lamprey climbing behavior. Canadian Journal of Zoology 86:1264–1272.

Renaud, C.B. 2008. Petromyzontidae, *Entosphenus tridentatus*: southern distribution record, Isla Clarión, Revillagigedo Archipelago, Mexico. Check List 4(1): 82–85.

Renaud, C.B. 2011. Lampreys of the world. An annotated and illustrated catalogue of lamprey species known to date, FAO Species Catalogue for Fishery Purposes. No. 5. Rome, FAO. 109 pp.

Richards, J.E., and F.W.H. Beamish. 1981. Initiation of feeding and salinity tolerance in the Pacific lamprey, *Lampetra tridentata*. Marine Biology 63: 73-77.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Brau. 1996. A Method for Assessing Hydrologic Alteration within Ecosystems. Conservation Biology 10:1163-1174.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Brau. 1996. A Method for Assessing Hydrologic Alteration within Ecosystems. Conservation Biology 10: 1163-1174.

Robinson, T.C. and J.M. Bayer. 2005. Upstream migration of Pacific lampreys in the John Day River, Oregon: behavior, timing, and habitat use. Northwest Sci 79:106–119.

Ruiz-Campos, G. and S. Gonzalez-Guzman. 1996. First freshwater record of Pacific lamprey, *Lampetra tridentata*, from Baja California, Mexico. California Fish and Game 82:144-146.

R2 Resource Consultants, 2015. Hydrologic Operations Simulation System Review, Technical Memorandum, Prepared for United Water Conservation District; contained in Appendix F of R2 2016, Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey.

R2 Resource Consultants. 2016. Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey. Prepared for United Water Conservation District. September 2016.

____. 2016. Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey. Prepared for United Water Conservation District, Santa Paula, California.

____. 2016b. Freeman Operations Model Documentation (Version 2.3), Prepared for United Water Conservation District; contained in Attachment A of R2 2016 Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey.

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A manual of California vegetation, 2nd ed. California Native Plant Society. Sacramento. 1300 p.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Fish Bulletin 98, California Department of Fish and Game.

Sloan, R. Ecological investigations of a fish kill in Pescadero Lagoon, California. 2006. San Jose State University. *Master's Theses*. 3032.

Smith, J. J. 1990. The Effects of Sandbar Formation and Inflows on Aquatic Habitat and Fish Utilization in Pescadero, San Gregorio, Waddell and Pomponio Creek Estuary/Lagoon Systems, 1985–1989. Report prepared by San Jose State University under Interagency Agreement 84-04-324 for the California Department of Parks and Recreation, Sacramento, California.

Smith, I.P., and G. W. Smith. 1997. Tidal and diel timing of river entry by adult Atlantic salmon returning to the Aberdeenshire Dee, Scotland. J. Fish Biol. 50

Spice, E.K., Goodman, D.H., Reid, S.B. and M.F. Docker. (2012). Neither philopatric nor panmictic: microsatellite and mtDNA evidence suggests lack of natal homing but limits to dispersal in Pacific lamprey. Molecular Ecology 21:2916-2930.

Spina, A.P., M.A. Allen, M. Clark. 2005. Downstream migration, rearing abundance, and pool habitat associations of juvenile steelhead in the lower main stem of a South-Central California Stream. N. Am. J. Fish. Management. 25:919-930.

Stillwater Sciences. 2011a. City of Ventura special studies: estuary subwatershed study assessment of the physical and biological condition of the Santa Clara River Estuary, Ventura County, California. Amended Final Report. Prepared for City of Ventura, CA.

Stillwater Sciences. 2011b. Geomorphic assessment of the Santa Clara River watershed: synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences, Berkeley, California for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and the U.S. Army Corps of Engineers–L.A. District.

____. 2016a. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Habitat Conditions in the Santa Clara River Estuary. September 2016.

____. 2016b. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Riparian Conditions in the Santa Clara River.

____. 2018a. Geomorphic assessment of the Santa Clara River watershed: synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences, Berkeley, California for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and the U.S. Army Corps of Engineers. Los Angeles District.

____. 2018b. City of Ventura Special Studies – Phase 3: assessment of the physical and biological conditions of the Santa Clara River Estuary, Ventura County, California. Final Report. Prepared by Stillwater Sciences, Berkeley California for City of Ventura, California. February.

Stillwater Sciences, and Kear Groundwater (Stillwater and Kear). 2012. Santa Maria River Instream Flow Study: Flow Recommendations for Steelhead Passage Final Report. Prepared for California Ocean Protection Council, Oakland, CA, and California Department of Fish and Game, Sacramento, CA. 139 pp.

Stone J (2006) Observations on nest characteristics, spawning habitat, and spawning behavior of Pacific and western brook lamprey in a Washington stream. Northwest Nat 87:225–232.

Swift, C.C. and Howard, S.R. (2009) Current status and distribution of the Pacific Lamprey south of Point Conception, southern coastal California, USA. In American Fisheries Society Symposium (Vol. 72, pp. 000-000).

Tetra Tech Inc. 2000. Final report intensive habitat survey for Lake Earl and Lake Talawa, del Norte County, California. Prepared by Tetra Tech, Inc., San Francisco, California for U.S. Army Corps of Engineers, San Francisco District, San Francisco, California.

The Nature Conservancy (TNC). 2009. Indicators of hydrologic alteration, Version 7.1, User's Manual. Prepared by the Nature Conservancy.

Thompson, K. 1972. Determining stream flows for fish life. Presented at Pacific Northwest River Basins Commission Instream Flow Requirement Workshop. March, 1972. 20pp.

United Water Conservation District (United). 2016. Minimizing effects of river recession due to turn-in at the Freeman Diversion, Groundwater Resources Department, Open-file Report 2016-02, October 2016.

USGCRP (U.S. Global Change Research Program). 2009. Global climate change impacts in the United States. *In* T. R. Karl, J. M. Melillo, and T. C. Peterson, editors. United States Global Change Research Program. Cambridge University Press, New York. Available online: http://www.globalchange.gov/browse/reports/global-climate-change-impacts-united-states. Accessed October, 2016].

Vadas, R.L. Jr. 2000. Instream-flow needs for anadromous salmonids and lamprey on the Pacific coast, with special reference to the Pacific Southwest. Environmental Monitoring and Assessment 64:331-358.

Van de Wetering, S.J., 1998. Aspects of life history characteristics and physiological processes in smolting Pacific Lamprey, Lampetra tridentata, in a central Oregon coast stream. Master's thesis. Oregon State University.

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8 PLAN IMPLEMENTATION

This chapter describes how the MSHCP will be implemented, including the following:

- MSHCP administration responsibilities
- Changed and unforeseen circumstances
- Amendments to incidental take permits
- Suspension, revocation, relinquishment, and termination of incidental take permits
- Renewal or transfer of incidental take permits

If there is a direct contradiction between the terms of the ITPs and the MSHCP, the terms of the ITPs shall control. In all other cases, the terms of the ITPs and MSHCP shall be interpreted to be supplementary to each other. United also intends to enter one or more agreements with CDFW that will include terms for implementing the CESA ITP, if issued, and other regulatory measures under state law. Implementation measures may be included in the CESA ITP itself, which will be coordinated and consistent with the ITPs and MSHCP to the extent possible.

8.1 MULTIPLE SPECIES HABITAT CONSERVATION PLAN ADMINISTRATION

Implementation and administration of the MSHCP, under the conditions of the ITPs, will follow the reporting requirements and adaptive management decision-making process described in Chapter 6. It is through these mechanisms that the Services will be involved in the implementation of the MSHCP.

8.2 CHANGED AND UNFORESEEN CIRCUMSTANCES

Federal regulations implementing Section 10 of the ESA contain requirements and procedures for addressing changed and unforeseen circumstances in HCPs. In general, as long as the permittee is properly implementing the ITPs and HCP, “No Surprises” regulations furnish assurances that permittees, such as United, will not be required to commit additional resources, or be required to implement additional restrictions on the use of resources, beyond the level otherwise agreed for the species covered in the conservation plan without the consent of the permittee.

8.2.1 CHANGED CIRCUMSTANCES

50 CFR 17.3 and 50 CFR 222.102 define changed circumstances as those affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the Services and that can be planned for (e.g., the new listing of species, a fire, or other natural catastrophic event in areas prone to such an event). Under the federal regulations (50 CFR 17.22(b)(2)(5)(i), (ii) and 50 CFR 222.307(g)(1), (2)), if additional conservation and mitigation measures are deemed necessary to respond to changed circumstances, and these additional measures are provided for in the MSHCP, then United will implement those measures. However, if additional measures deemed necessary to respond to changed circumstances are not provided for the MSHCP, the Services will not require these additional measures without the consent of United, provided United continues to properly implement the MSHCP.

United assessed potential changed circumstances, including those identified in Table 8-1, and several others that were ultimately excluded due to the lack of effect on covered species, including climate change. The potential variables related to covered species, particularly covered fish species, as a result of climate change are accounted for in the design of the Freeman diversion renovation and conveyance expansion projects, the conservation program, and the effectiveness monitoring and adaptive management framework. Potential effects to other covered species as a result of climate change are not anticipated to occur because of the implementation of covered activities and the conservation program. Reasonably foreseeable circumstances for which United will implement remedial measures, should they occur, are listed in Table 8-1.

Table 8-1 Potential Changed Circumstances and Remedial Measures

Changed Circumstances	Remedial Measures
Listing/delisting of a covered species	If NMFS, or USFWS, lists a covered species during the permit term, that species will be subject to incidental take coverage for the federal ITPs at the time of listing. The terms and conditions of the MSHCP and ITPs shall not change. If NMFS, or USFWS, delists a covered species, terms and conditions of the ITP shall be revisited in consultation with the Services.
Listing of a non-covered species or expansion of non-covered listed species into plan area	During the permit term, NMFS or USFWS may list a non-covered species, or an existing non-covered listed species could expand its distribution into the plan area. Should this occur, and if the species may be affected by the covered activities under the MSHCP, the listing agency and United will identify measures to avoid take, including those measures that may already be included in the MSHCP and can support the amendment of the ITP(s) without need of further conservation measures. United may also implement further measures in order to allow the Services to approve an amendment to the MSHCP to cover the newly-listed species or until such measures are no longer necessary.
Emergency sluicing	Emergency conditions may require sediment sluicing by way of the diversion canal due to accumulation upstream of the diversion headworks and/or within the headworks. As part of the engineering design, the vertical slot facility includes equipment to resuspend sediment, which would then discharge to the river through the AWS, smolt bypass pipe and/ or drains built into the facility. However, in emergency situations where use of this equipment is infeasible, the fish screens may need to be removed and sediment would be sluiced down the canal and subsequently discharged back to the river through the waste gate at the Floc building. Capture and relocation (CM 2.1.4) of covered species would be implemented as soon as conditions permit safe entry into the diversion canal. The outcome of emergency sluicing and conservation measures will be documented and included in required monthly and annual reports.
Earthquake	Following a major earthquake, the Freeman Diversion will be inspected as soon as it is safe and feasible. United will develop a plan for repair, including the necessary materials and equipment necessary to complete the repairs, and conservation measures to be implemented to avoid covered species (e.g., CM 2.1.1 – 2.1.7), for implementation as conditions permit. The outcome of repairs and conservation measures will be documented and included in required monthly and annual reports to the Services.
Drought	Periods of drought extending for several years may have an adverse effect on the habitat restoration areas, including aquatic and riparian vegetation stress, habitat conversion (e.g., from predominantly hydrophytes to upland-adapted species), and invasion by exotic invasive species. United will prepare a specific response plan as part of the annual meeting process under the adaptive management framework for the incidence of drought based on the resulting effects to the habitat restoration areas, which may include monitoring, invasive species removal, or revegetation with native species lost to the drought. Following approval by the USFWS and NMFS, the response plan would be implemented.
Facility repairs or maintenance due to severe storm damage	Damage to the facility resulting from severe storms may require repair and rehabilitation of facility infrastructure and/or sediment and debris removal. Storm events resulting in runoff up to or above the 100-year flood elevation, as determined by the Federal Emergency Management Agency (FEMA) and the Ventura County Watershed Protection District (VCWPD), as well as events resulting in excessive sediment and debris load (e.g., events following a wildfire), have the potential to damage the facility, requiring immediate maintenance. The severe storm damage may occur during the steelhead migration season. United will assess any damage as soon as is feasible and develop a plan for repair, including the materials and equipment necessary to complete the repairs, and conservation measures to be implemented to avoid covered species (e.g., CM 2.1.1 – 2.1.7), for implementation as conditions permit. The outcome of repairs and conservation measures will be documented and included in required monthly and annual reports.

Changed Circumstances	Remedial Measures
Aquatic, riparian, and native upland habitat impacts resulting from flood and/or fire	Vegetation scour due to channel-forming flood events is considered to be a natural occurrence, and regeneration of the habitat within the river is anticipated to occur naturally. Similarly, wildfires are a natural occurrence in the region, and there is potential for these events to result in impacts to the riparian habitat restoration area, as well as surrounding native upland habitat, during the permit term. United does not propose active revegetation of the habitat restoration areas, but rather the ongoing monitoring and reporting associated with the conservation program will document natural recruitment and passive restoration of these habitats following flood and/ or fire. Should monitoring indicate that the habitat restoration areas would benefit from active management (e.g., invasive exotic species control), United will prepare a specific response plan as part of the annual meeting process under the adaptive management framework to be implemented following approval by the USFWS and NMFS.
Aquatic, riparian, and native upland habitat impacts resulting from unanticipated maintenance needs	Both routine and non-routine maintenance activities identified in Chapter 3 are confined to known areal extents; however, should more extensive maintenance become necessary due to severe and unexpected damage to the facility, United will provide mitigation for aquatic, riparian, and native upland habitat impacts at prescribed ratios, including 1:1 for temporary impacts and 3:1 for permanent impacts. Planning and implementation of mitigation for habitat impacts will be coordinated with NMFS and USFWS, and will conform to the standards of the habitat restoration program (CM 2.3.1) to the extent feasible.

8.2.2 UNFORESEEN CIRCUMSTANCES

The section 10 regulations define unforeseen circumstances as changes in circumstances that affect a species or geographic area covered by the HCP that could not reasonably be anticipated by plan developers and Services at the time of the plan's negotiations and development and that result in a substantial and adverse change in status of a covered species (50 CFR 17.3, 50 CFR 222.102).

In response to unforeseen circumstances, the Services may request (but not require) additional measures where the conservation plan is being properly implemented. However, such additional conservation measures are limited to modifications within any conserved habitat areas or to the conservation program for the affected species. The original terms of the conservation plan will be maintained to the maximum extent possible. Additional conservation and mitigation measures will not involve the commitment of additional land, water, or financial compensation, or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the conservation plan without the consent of the permittee (50 CFR 17.22(b)(5)(iii), 50 CFR 222.307(g)). United will consider requests by the Services to amend or supplement conservation measures in response to unforeseen circumstances.

8.3 AMENDMENTS

Two types of changes may be made to the MSHCP and the ITPs:

- Minor modifications
- Major amendments

Minor modifications and major amendments shall be processed in accordance with all applicable legal requirements for ESA ITPs.

8.3.1 MINOR MODIFICATIONS

Minor modifications will be administratively incorporated into the MSHCP when United and NMFS, or United and USFWS (as applicable based on species), agree on the modification. Minor modifications are changes to the MSHCP or ITPs that do not modify the scope or nature of activities or actions covered by the ITPs, result in operations under the MSHCP that are significantly different from those contemplated or analyzed in connection with the MSHCP as approved, result in adverse impacts on the environment that are new or significantly different from those analyzed in connection with the MSHCP as approved, or result in additional take not analyzed in connection with the MSHCP as approved. Examples of minor modifications include, but are not limited to: (1) corrections of typographic, grammatical, and similar editing errors that do not change the intended meaning; (2) correction and updates to reflect previously approved changes in an ITP or the MSHCP; (3) minor changes to survey, monitoring, or reporting protocols; (4) clarifications of vague or undefined language or phrases; or (5) minor changes to the MSHCP actions that do not diminish the conservation value of the MSHCP to covered species, including but not limited to changes or adjustments to conservation actions recommended through the adaptive management program and monitoring.

Under this MSHCP and the ITPs, United, NMFS, or USFWS may submit a request for a minor modification. The request must be submitted to the appropriate representatives of each agency for review and consideration. If the applicable Service and United concur with the proposed minor modification in writing, it becomes effective. If a party objects to a proposed minor modification, the proposal is not approved as a minor modification but may be processed as a major amendment.

8.3.2 MAJOR AMENDMENTS

An amendment that may affect the impact analysis or conservation strategy in the HCP requires amending the HCP and the incidental take permit through a formal review process. This may include evaluation under the National Environmental Policy Act (NEPA) and/or the California Environmental Quality Act (CEQA), public notice, and ESA Section 7 consultation by USFWS. Examples of changes that would require this type of amendment include those listed below:

- Significant alterations in plan area or permit area boundary
- The addition or deletion of covered species
- The addition or deletion of covered activities
- Changing the allowable take limit
- Modifications of any important action or component of the conservation strategy that may substantially affect levels of authorized take, effects of the covered activities, or the nature or scope of the conservation strategy
- Extending the duration of the permit except as provided below in a permit renewal.

Pursuant to ESA regulations at 50 CFR §§ 13.23 and 50 CFR § 222.306, and in accordance with all applicable legal requirements, United or the Services may submit a request for a major amendment. The request must be submitted to the appropriate representatives at the Services and United for review and consideration. Any major amendment must have approval of NMFS, USFWS, and United.

Any major amendment will generally follow the same process as the original permit application and will require: (1) an amendment to the MSHCP addressing the new circumstance, (2) a Federal Register notice, (3) NEPA and CEQA compliance, and (4) and intra-service Section 7 consultation if the amendment is likely to adversely affect a listed species.

8.4 PERMIT SUSPENSION, REVOCATION, RELINQUISHMENT, AND TERMINATION

Pursuant to ESA regulations at 50 CFR §§ 13.27, 13.28 and 50 CFR § 222.306, the Services may suspend or revoke ITPs as a result of a failure to implement the HCP properly or comply with the terms of the HCP or ITPs. Prior to taking any action to suspend, revoke, or terminate an ITP, the Services shall meet and confer with United to attempt to resolve the need to suspend, revoke, or terminate the ITP. Any such suspension or revocation will apply only to the specifically identified Covered Species, Covered Activities, or portions of the Permit Area.

Pursuant to ESA regulations at 50 CFR §§ 13.26 and 50 CFR § 222.306(d), United may relinquish one or more of the ITPs, or a portion thereof, in accordance with regulations in effect on the date of such relinquishment. Unless later modification of these regulations dictate otherwise, to relinquish an ITP, United shall, within thirty (30) calendar days of discontinuing incidental take and the exercise of other rights granted by the ITP, return the ITP to USFWS or NMFS as applicable, at the Service's issuing office, together with a written statement surrendering the ITP for cancellation. Relinquishment of an ITP will result in the termination of United's responsibilities and obligations to covered species listed and either or both (as applicable) of the Services' responsibilities and obligations as provided for in the ITP.

Any termination, relinquishment, or revocation of an ITP automatically terminates United's and USFWS or NMFS's obligations and responsibilities under the MSHCP as related to the subjects of the specific ITP. Activities thereafter conducted by United will be subject to all applicable provisions of the ESA and related regulations as if the ITP had never been issued. A termination or revocation by either USFWS or NMFS limited to one or more species, but less than all of the covered species then provided for in an ITP, shall apply only to the affected species. The ITPs shall continue in full force and effect as to all other covered species.

8.5 RENEWAL OF INCIDENTAL TAKE PERMITS

Pursuant to ESA regulations at 50 CFR §§ 13.22 and 50 CFR § 222.304, the Services will consider a request for renewal of the ITPs, provided that the request is submitted by United at least 30 days prior to permit expiration. The request for permit renewal will include a description of covered activities still to be completed along with a certified statement verifying that the information in the original application is still currently correct. If the information is incorrect, the permittee shall file a statement of all changes in the original application. If the Services concur with the information provided in the renewal request, they will renew the ITPs pursuant to the regulations identified above.

8.6 PERMIT TRANSFER

Pursuant to ESA regulations at 50 CFR §§ 13.24(b), (c) and 50 CFR § 222.305 (a)(3), in the event of sale or transfer of one or more of United's covered facilities, during the life of the permit, a new permit application, permit fee, and an Assumption Agreement would be submitted to the Services. The ITPs and each of its covenants and conditions shall be binding on and shall inure to the benefit of the new owner(s) and their respective successors and assigns. The new owner(s) will commit to all requirements regarding the take authorization and conservation measure obligations of this MSHCP, and agreed to in advance with the Services.

8.7 LITERATURE CITED

Stillwater Sciences. 2016. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Habitat Conditions in the Santa Clara River Estuary. September 2016.

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9 FUNDING

As required by Section 10(a)(2)(a)(ii) of the ESA, this chapter provides planning-level estimates of the costs to implement the multi-species habitat conservation plan (MSHCP), identifies funding sources to pay for implementation, and describes the rationale for funding assurances.

The cost estimates presented in this chapter have been developed for the purpose of budgeting and are not to be confused with legally authorized or required cost expenditures. Actual year-to-year expenditures would be based on MSHCP implementation priorities as developed by United and consultants. This budget is based on a projected MSHCP implementation schedule that may not conform with how the MSHCP is actually implemented. The estimates presented should not be assumed to be commitments or limits, upper or lower, on potential expenses. These estimates are expected to be adapted throughout the implementation process.

9.1 COSTS TO IMPLEMENT THE MSHCP

The MSHCP, including the construction and operation of the renovated Freeman Diversion facilities as specified in the covered activities, is estimated to cost approximately $184 million to implement in current or undiscounted 2020-dollar expenditures over the 50-year permit term. This equates to $132 million on a net present value over 50 years.[1] This cost estimate includes all costs to:

- Implement the renovated Freeman Diversion facilities as described in Chapter 3, *Covered Activities*,
- All conservation measures as described in Chapter 5, *Conservation Program*,
- All monitoring and adaptive management measures described in Chapter 6, *Monitoring and Adaptive Management*, and
- Contingency to implement remedial measures as necessary to address changed circumstances described in Chapter 8, *Plan Implementation*.

This cost estimate does not include any costs to United and its customers from changes in water diversions created by the MSHCP covered activities compared to historic or existing conditions prior to implementing the MSHCP covered activities.[2]

The cost analysis is based on several assumptions regarding the timing of implementation of various components of the MSHCP and the estimated costs of construction, labor, and materials. Unit cost estimates were based on the best available information and represent average unit costs. The costs of individual items would fluctuate above and below these averages. The total cost presented herein should therefore be regarded as a planning-level estimate to aid in the determination of the approximate amount of funding needed to implement the MSHCP. Specific costs would be refined as they are determined during the first years of MSHCP implementation, and any adjustments to the overall costs, cost-sharing agreements, and endowment requirements would be made as needed. The construction costs are

[1] Net present value discounting accounts for the “time value of money.” That is a dollar spent in the future (e.g., 10 years from today) has less value to us than a dollar spent today. This is the principle behind interest rates on mortgages and savings accounts. The current or undiscounted expenditures simply sums up the total amount spent over the 50-year period without accounting for the time value of money. The comparison of costs on a net present value basis puts all spending on an equal basis when accounting for differences in timing of that spending.
[2] Projected economic impacts to United customers are described in Chapter 10 under the Proposed MSHCP Alternative.

conservative (i.e., at the higher end of the range of uncertainty) for purposes of projecting an upper bound on required funding. For detailed assumptions of all cost estimates, see Section 9.2, *Cost Estimate Methodology* and Appendix J, *MSHCP Cost Data*.

Table 9-1 to 9-3 summarize the total, capital, and operational costs likely to be necessary to implement the MSHCP. Costs are organized by the following cost categories, which are described fully in Section 9.2, *Cost Estimate Methodology*:

- Program administration
- Migratory corridor
- Instream flows and fish monitoring
- Minimizing species impacts
- Riparian restoration and management
- Post-permit endowment
- Contingency

All cost categories are mutually exclusive so that summing the category costs yields the total expected cost to implement the program. Note, however, that some cost items are allocated across the categories. For example, United staff salaries and overhead are allocated across the categories because staff would perform a range of functions. Each cost category is divided into capital and operational costs. Capital costs are typically one-time costs for land, equipment, structures, or improvements. Operational costs are ongoing costs such as staff salaries and contractor fees.

Costs are summarized by five-year periods spanning the 50-year permit period. Costs are in current 2020 dollars unless noted otherwise. Note that in all tables in this chapter items may not sum to the displayed total due to rounding. In addition, at the time of annual MSHCP budgeting, these figures would be updated to reflect general inflation and cost escalation that cannot be readily forecasted today. Constant dollar budget estimates are used throughout this chapter to allow for straightforward comparisons across years.

Table 9-1 Summary of MSHCP Total Implementation Costs (2020 dollars)

Category	Implementation Period (Years)1										Total
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	
Administration	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$8,300,000
Migratory Corridor	$91,681,000	$6,109,000	$6,374,000	$6,149,000	$6,374,000	$13,375,000	$6,374,000	$6,149,000	$6,374,000	$6,149,000	$155,111,000
Instream Flows and Fish Monitoring	$1,388,000	$624,000	$474,000	$474,000	$474,000	$474,000	$474,000	$599,000	$474,000	$474,000	$5,926,000
Minimizing Species Impact	$3,548,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$10,464,000
Riparian Restoration and Management	$325,000	$129,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	$608,000
Subtotal CMs	**$97,772,000**	**$8,460,000**	**$8,465,000**	**$8,240,000**	**$8,465,000**	**$15,466,000**	**$8,465,000**	**$8,365,000**	**$8,465,000**	**$8,240,000**	**$180,403,000**
Endowment Fund	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	**$100,000**
Contingency Fund	$600,000	$254,000	$254,000	$247,000	$254,000	$464,000	$254,000	$251,000	$254,000	$247,000	**$3,079,000**
Total	**$98,382,000**	**$8,724,000**	**$8,729,000**	**$8,497,000**	**$8,729,000**	**$15,940,000**	**$8,729,000**	**$8,626,000**	**$8,729,000**	**$8,497,000**	**$183,582,000**

[1] All costs rounded to the nearest $1,000.
Note items may not sum to total due to rounding.

Table 9-2 Summary of MSHCP Capital Costs (2020 dollars)

Category	Implementation Period (Years)[1]										Total
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	
Administration	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Migratory Corridor	$86,000,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$86,000,000**
Instream Flows and Fish Monitoring	$156,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$156,000**
Minimizing Species Impact	$1,753,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$1,753,000**
Riparian Restoration and Management	$80,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$80,000**
Endowment Fund	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Contingency Fund	$306,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$306,000**
Total	$88,295,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$88,296,000**

[1] All costs rounded to the nearest $1,000.
Note items may not sum to total due to rounding.

Table 9-3 Summary of MSHCP Operating Costs (2020 dollars)

Category	Implementation Period (Years)[1]										Total
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	
Administration	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	$830,000	**$8,300,000**
Migratory Corridor	$5,681,000	$6,109,000	$6,374,000	$6,149,000	$6,374,000	$13,375,000	$6,374,000	$6,149,000	$6,374,000	$6,149,000	**$69,111,000**
Instream Flows and Fish Monitoring	$1,232,000	$624,000	$474,000	$474,000	$474,000	$474,000	$474,000	$599,000	$474,000	$474,000	**$5,770,000**
Minimizing Species Impact	$1,794,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	$768,000	**$8,710,000**
Riparian Restoration and Management	$245,000	$129,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	$19,000	**$528,000**
Endowment Fund	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	**$100,000**
Contingency Fund	$293,000	$254,000	$254,000	$247,000	$254,000	$464,000	$254,000	$251,000	$254,000	$247,000	**$2,773,000**
Total	$10,086,000	$8,725,000	$8,730,000	$8,498,000	$8,730,000	$15,940,000	$8,730,000	$8,627,000	$8,730,000	$8,498,000	**$95,292,000**

[1] All costs rounded to the nearest $1,000.
Note items may not sum to total due to rounding.

9.2 COST ESTIMATE METHODOLOGY

This section provides an explanation of each cost category and the methods that were used to develop the MSHCP cost estimate. The spreadsheets used to develop the MSHCP cost estimate are provided in Appendix J, *MSHCP Cost Data*.

Table 9-4 shows all the MSHCP goals and biological objectives and the conservation measures developed in Chapter *5, Conservation Program*. The table shows how each conservation measure maps to the cost categories used in this chapter as well as the total 50-year cost estimate. It is important to note that costs associated with each conservation measure are not all individually separable. For example, although Conservation Measure (CM) 1.1.2, *Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion*, is related to creating fish passage for Pacific lamprey, it is not possible to separate the majority of that cost from CM 1.1.1, *Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion,* to create fish passage for southern California steelhead. Where it is not possible to distinguish costs by CM, Table 9-4 includes notes on where and how those costs are covered under other CMs. More detail is provided in the sections of this chapter dedicated to each cost category. Several of the CMs in Table 9-4 do not have additional costs of their own because their costs are fully subsumed in other CMs, as described in the *Notes* column of Table 9-4 and discussed in detail in Section 9.2.5, *Minimizing Species Impacts*. This approach avoids arbitrary cost allocation and potential double counting of monitoring costs in the overall program.

Note that monitoring costs are not organized into a single section but are rather considered in each of the relevant sections where monitoring would occur. Fish and some western pond turtle monitoring costs are included under Instream Flows and Fish Monitoring costs. All other monitoring-type costs associated with Best Management Practices (BMPs) implementation (CM 2.1.1), pre-activity surveys (CM 2.1.3), species capture and relocation (CM 2.1.4), noise monitoring (CM 2.1.5), biological monitoring (CM 2.1.6), nesting bird monitoring (CM 2.1.7), avoidance of western pond turtle (CM 2.1.8), and invasive species management (CM 2.2.1) are all included under Minimizing Species Impacts. Monitoring to Implement Habitat Restoration and Management Monitoring (CM 2.3.1) is considered under Riparian Restoration and Management.

Table 9-4 Summary of Cost Estimates by Conservation Measure

MSHCP Goals & Biological Objectives	MSHCP Conservation Measures	Chapter 9 Cost Category	Cost Estimate	Notes
Goal 1 Biological Objective 1.1	CM 1.1.1 Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion	Migratory Corridor	$155,083,000	
Goal 1 Biological Objective 1.1	CM 1.1.2 Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion	Migratory Corridor	$28,000	Additional costs subsumed in CM 1.1.1
Goal 1 Biological Objective 1.2	CM 1.2.1 Instream Flow Commitment for Upstream Migration – Initial[2] Operations (maximum instantaneous diversion of 375 cfs)	Instream Flows and Fish Monitoring	$5,926,000	Monitoring and reporting costs only, total for 1.2.1-1.2.5. Operations included in Migratory Corridor operations
Goal 1 Biological Objective 1.2	CM 1.2.2 Instream Flow Commitment downstream of Freeman Diversion for Downstream Migration – Initial Operations (maximum instantaneous diversion of 375 cfs)	Instream Flows and Fish Monitoring	See Notes column.	No additional direct costs associated with CM. Monitoring and reporting costs only, total for 1.2.1-1.2.5. Operations included in Migratory Corridor operations

Table 9-4 Summary of Cost Estimates by Conservation Measure

MSHCP Goals & Biological Objectives	MSHCP Conservation Measures	Chapter 9 Cost Category	Cost Estimate	Notes
Goal 1 Biological Objective 1.2	CM 1.2.3 Instream Flow Commitment Downstream of Freeman Diversion for Upstream Migration - Future Operations (water right change to maximum instantaneous diversion rate – 750 cfs)	Instream Flows and Fish Monitoring	See Notes column.	No additional direct costs associated with CM. Monitoring and reporting costs only, total for 1.2.1-1.2.5. Operations included in Migratory Corridor operations
Goal 1 Biological Objective 1.2	CM 1.2.4 Instream Flow Commitment Downstream of Freeman Diversion for Downstream Migration–Future Operations (Water Right Change to Maximum Instantaneous Diversion Rate – 750 cfs)	Instream Flows and Fish Monitoring	See Notes column.	No additional direct costs associated with CM. Monitoring and reporting costs only, total for 1.2.1-1.2.5. Operations included in Migratory Corridor operations
Goal 1 Biological Objective 1.2	CM 1.2.5 Relocate Downstream Migrant Steelhead and Lamprey at Low Flows	Instream Flows and Fish Monitoring	See Notes column.	No additional direct costs associated with CM. Monitoring and reporting costs only, total for 1.2.1-1.2.5. Operations included in Migratory Corridor operations
Goal 1 Biological Objective 1.2	CM 1.2.6 Minimize impacts to steelhead and lamprey through limitations on sediment management activities	Instream Flows and Fish Monitoring	See Notes column.	Costs captured in Migratory Corridor operations
Goal 2 Biological Objective 2.1	CM 2.1.1 Best Management Practices	Minimizing Species Impact	$50,000	Reporting costs included in 1.1.1 and 1.1.2
Goal 2 Biological Objective 2.1	CM 2.1.2 Worker Environmental Awareness Training	Minimizing Species Impact	$245,000	Reporting costs included in 1.1.1 and 1.1.2
Goal 2 Biological Objective 2.1	CM 2.1.3 Pre-activity Surveys	Minimizing Species Impact	$5,463,000	
Goal 2 Biological Objective 2.1	CM 2.1.4 Covered Species Capture and Relocation Protocol	Minimizing Species Impact	$856,000	
Goal 2 Biological Objective 2.1	CM 2.1.5 Noise Abatement Protocol	Minimizing Species Impact	$265,000	
Goal 2 Biological Objective 2.1	CM 2.1.6 Biological Monitoring	Minimizing Species Impact	$3,584,000	Reporting costs included in 1.1.1 and 1.1.2
Goal 2 Biological Objective 2.1	CM 2.1.7 Avoid Nests of Covered Species of Birds During Nesting Bird Season	Minimizing Species Impact	See Notes column.	No additional direct costs associated with CM. Costs subsumed in CM 1.1.1, CM 2.1.3, and CM 2.1.6. Reporting costs included in 1.1.1 and 1.1.2
Goal 2 Biological Objective 2.1	CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones	Minimizing Species Impact	See Notes column.	No additional direct costs associated with CM. Costs subsumed in CM 1.1.1, CM 2.1.3, CM 2.1.4, and CM 2.1.6. Reporting costs included in 1.1.1 and 1.1.2
Goal 2 Biological Objective 2.2	CM 2.2.1 Invasive Species Management	Minimizing Species Impact	See Notes column.	No additional direct costs associated with CM. Costs subsumed in CM 1.1.1. Reporting cost included in estimate of the implementation of CM 2.1.1, 2.1.2, and 2.1.6.

Table 9-4 Summary of Cost Estimates by Conservation Measure				
MSHCP Goals & Biological Objectives	**MSHCP Conservation Measures**	**Chapter 9 Cost Category**	**Cost Estimate**	**Notes**
Goal 2 Biological Objective 2.2	CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events	Minimizing Species Impact	See Notes column.	Assume no additional costs associated with the CM. Costs subsumed in CM 1.1.1 and CM 2.1.6.
Goal 2 Biological Objective 2.3	CM 2.3.1 Implement Habitat Restoration and Management	Riparian Restoration and Management	$580,000	
Goal 2 Biological Objective 2.3	CM 2.3.2 Implement the Invasive Brown-headed Cowbird Control Plan	Riparian Restoration and Management	$28,000	
Direct Conservation Measures Implementation Subtotal			$172,108,000	
Administration			$8,300,000	
Total Conservation Measures Implementation			**$180,408,000**	

9.2.1 PROGRAM ADMINISTRATION

Program administration costs involve the support of facilities, equipment, and vehicles needed to implement, support and communicate the MSHCP, but that are not tied to any specific conservation measure. Cost estimates for program administration average $166,000 annually during the permit term. A fraction of the program administration costs are assumed to continue beyond the permit term if the permit is not renewed and the facility is demolished. These post-permit administration cost estimates are addressed in subsection 9.2.7, *Post-Permit Endowment*.

Administrative costs include vehicle mileage allowance costs, travel expenses, legal and accounting assistance, and public relations and outreach (including the cost of published materials, public events, and web development). We applied similar cost assumptions to this estimate as have been used in other MSHCP cost estimates, including the Upper Santa Ana River MSHCP and the East Contra Costa County MSHCP. Table 9-5 provides detail on these costs.

Table 9-5 Other Administrative Costs by Category			
Administrative Activity	**Average Annual Cost**	**Average Cost per 5-year Period**	**Total Cost over Permit Term**
Vehicle/Mileage Allowance	$2,000	$10,000	$100,000
Travel	$6,000	$30,000	$300,000
Legal & Accounting	$133,000	$665,000	$6,650,000
Public Relations/Outreach	$25,000	$125,000	$1,250,000
Total	**$166,000**	**$830,000**	**$8,300,000**

9.2.2 STAFFING AND OVERHEAD

Staffing costs comprise the annual salaries and non-wage costs for program administration personnel. United looked at each element of the MSHCP to estimate how much staff time would be needed at each position over the life of the permit to carry out the conservation measures identified in Chapter 5, *Conservation Program*.

United has estimated that there would need to be two additional full-time positions and additional hours for 29 part-time positions to implement the MSHCP.

The two full-time positions that would support implementation of the MSHCP permit requirements are both at the Operations and Maintenance Recharge Worker I level. Twenty-nine additional part-time or seasonal positions are required to meet the obligations of the MSHCP. These positions and other identified labor hours by conservation measures category have been identified as incremental to current staffing requirements at United and at the Freeman Diversion facility.

Staff cost estimates are summarized in the tables below and are included as a portion of the total cost estimate of each cost category in the following sections.

The positions and estimated time requirement (in hours per year) necessary to support the MSHCP are summarized in Table 9-6. Note that the hours included in Table 9-6 are not inclusive of all staff hours needed to implement the conservation program and effectiveness monitoring. Rather, Table 9-6 includes hours for the operations and maintenance of the renovated Freeman diversion facility as well as operation and management of the renovated fish passage facility. These hours and associated cost estimates are reflected in subsection 9.2.3, *Migratory Corridor.* Subsequent subsections include the costs of both labor and materials to implement the remainder of the conservation program and effectiveness monitoring.

Table 9-6 Staffing Hour Estimates by Program Area (hours per year on average)

Staff Position	Migratory Corridor	Instream Flows	Minimizing Species Impact	Restoration and Management	Total
Project Manager	210	-	374	9	594
Hydrology Staff Member	-	55	-	-	55
Associate Ecologist	342	5	-	-	347
Field Technician	165	806	-	-	971
O&M Staff	-	-	118	-	118
Senior Hydrologist	73	1	-	-	74
O&M Recharge Worker I (two full-time staff members)	4,190	-	-	-	4,190
Assistant Ecologist	30	-	-	-	30
Field Assistants	177	-	-	-	177
Senior Ecologist	77	-	-	-	77
Senior Environmental Scientist	27	-	-	-	27
Assistant General Manager	25	-	-	-	25
Chief Operations Officer	47	-	-	-	47
Chief Water Treatment Operator	35	-	-	-	35
Dam Operator	22	-	-	-	22
Recharge O&M II	47	-	-	-	47
Facilities Maintenance Worker II	701	-	-	-	701
Hydrologist	210	-	-	-	210
Instrument & Electrical Technician	444	-	-	-	444
Lead Recharge O&M Worker	448	-	-	-	448
O&M Manager	102	-	-	-	102
Recharge O&M Worker II	502	-	-	-	502
Senior Water Treatment Operator	292	-	-	-	292
Supervising Instrument & Electrical Tech	15	-	-	-	15
Water System Electrician	20	-	-	-	20
Water Treatment Operator II	54	-	-	-	54
Water Treatment Operator III	72	-	-	-	72
Staff Hydrogeologist	6	-	-	-	6
Other Miscellaneous Staff	3	-	-	-	3
Total	**8,336**	**867**	**493**	**40**	**9,705**

For each staff position in the MSHCP staffing plan, United estimated average hourly labor costs, which include all benefits. We apply an overhead multiplier to these costs to arrive at a fully burdened labor rate, which accounts for the non-wage cost of staff, the cost of administrative support (secretaries, IT staff, payroll, etc.) not directly included in the MSHCP work plan, and associated overhead. The overhead multiplier is a ratio of total overhead to direct labor. We use a multiplier of 1.6 based on United's historic ratio of labor costs to overhead. This ratio is in line with the non-wage staffing cost ratios available from the Bureau of Labor statistics.[3] Staff costs by position are shown in Table 9-7.

[3] The average employer cost ratio for management, professional, and related positions, office and administrative support, and natural resources, construction, and maintenance is 1.48 (Bureau of Labor Statistics 2020).

Table 9-7 Staffing Hourly Costs

Staff Position	Hourly Labor Cost ($/hour)	Fully Burdened Labor Rate ($/hour)
Project Manager	$101	$162
Hydrology Staff Member	$110	$176
Associate Ecologist	$76	$122
Field Technician	$75	$120
O&M Staff	$100	$160
Senior Hydrologist	$115	$184
O&M Recharge Worker I	$67	$107
Assistant Ecologist	$71	$114
Env Planning & Cons Manager	$110	$176
Field Assistants	$15	$24
Senior Ecologist	$110	$176
Senior Environmental Scientist	$101	$162
Assistant General Manager	$181	$289
Chief Engineer	$151	$242
Chief Operations Officer	$143	$229
Chief Water Treatment Operator	$101	$162
Dam Operator	$83	$133
Recharge O&M II	$83	$133
Facilities Maintenance Worker II	$51	$81
Hydrologist	$87	$139
Instrument & Electrical Technician	$91	$145
Lead Recharge O&M Worker	$85	$136
O&M Manager	$135	$216
Recharge O&M Worker II	$75	$119
Senior Water Treatment Operator	$89	$142
Supervising Instrument & Electrical Tech	$97	$155
Water System Electrician	$83	$133
Water Treatment Operator II	$76	$122
Water Treatment Operator III	$76	$122
Staff Hydrogeologist	$76	$122

The hourly rates and associated overhead costs for these positions are applied to the staffing plan in Table 9-6 by cost category for each year of the MSHCP to arrive at total staffing costs for MSHCP. These costs are presented by cost category in Table 9-8. Because construction and mitigation activities are concentrated in the first five years of the MSHCP, the table presents average annual costs for years 1-5, and years 6-50 separately, as well as the 50-year average annual staffing costs. Over the 50-year term of the MSHCP permit total staffing costs are estimated at $52.6 million in current dollars.

Table 9-8 Staffing Costs by Category			
	Average Annual Cost	Average Cost per 5-year Period	Total Cost over Permit Term
Migratory Corridor	$879,000	$4,395,000	$43,950,000
Instream Flows and Fish Monitoring	$99,000	$495,000	$4,950,000
Minimizing Species Impact	$72,000	$360,000	$3,590,000
Riparian Restoration and Management	$1,000	$5,000	$64,000
Total	$1,051,000	$5,255,000	$52,550,000

9.2.3 MIGRATORY CORRIDOR

The Migratory Corridor functional group corresponds to Biological Objective 1.1 identified in Chapter 5, which is the construction and maintenance of a new fish passage facility designed to approximate unimpeded migratory passage of adult and juvenile southern California steelhead and lamprey at and through the Freeman Diversion. It includes all capital, operations of the fish ladder, diversion, and all other Freeman facilities, and maintenance costs associated with constructing and managing the vertical slot fish passage facility.

Table 9-9 shows total costs for each of the conservation measures under the migratory corridor cost category. Total capital costs are estimated to be $86.0 million while O&M costs total $69.1 million over the life of the MSHCP, which includes $44 million in staffing costs. Total costs over the permit term are $155.1 million. Note that the majority of capital and O&M costs for the fish passage facility are not separable between the southern California steelhead passage and lamprey passage conservation measures. Where costs were not separable, they were all included under CM 1.1.1.

Table 9-9 Biological Objectives Under Migratory Corridor Cost Category			
MSHCP Goals & Biological Objectives[1]	MSHCP Conservation Measures	Chapter 9 Cost Category	Total Cost Estimate Over Permit Term
Goal 1 Biological Objective 1.1	CM 1.1.1 Construct, Operate, and Maintain an Updated Steelhead Passage Facility at the Freeman Diversion	Migratory Corridor	$155,083,000
Goal 1 Biological Objective 1.1	CM 1.1.2 Construct, Operate, and Maintain an Updated Pacific Lamprey Passage Facility at the Freeman Diversion	Migratory Corridor	$28,000
Total			**$155,111,000**

Some activities to maintain and operate the migratory corridor are assumed to be required in perpetuity. These post-permit costs are addressed in subsection 9.2.7., *Post-Permit Endowment*.

Costs for the Migratory Corridor are divided into the following four categories:

- Staffing and overhead costs for Migratory Corridor objective oversight and implementation
- Design and permitting of the fish passage facility
- Capital construction over a period of two years
- Operations and maintenance over the 50-year permit term

Associated fish monitoring costs for the Migratory Corridor are accounted for in subsection 9.2.4, *Instream Flows and Fish Monitoring.* See *Chapter* 6 – *Monitoring and Adaptive Management* for descriptions of monitoring activities.

Staffing and Overhead

Staffing and overhead costs for construction, operations, and maintenance of the migratory corridor are expected to average $879,000 per year during the permit term. The estimate is based on the allocation of staffing and overhead costs presented in subsection 9.2.1 – *Program Administration* and in subsection 9.2.2 – *Staffing and Overhead* (see Table 9-8). Table 9-10 summarizes staffing costs for the migratory corridor cost category).

Table 9-10 Migratory Corridor Staffing and Overhead Costs

	Average Annual Cost	Average Cost per 5-year Period	Total Cost over Permit Term
Migratory Corridor	$879,000	$4,395,000	$43,950,000
Total	**$879,000**	**$4,395,000**	**$43,950,000**

Design and Permitting

Design and Permitting costs are one-time costs that would take place at the start of the MSHCP. Estimated costs for design of the project and all necessary permits is $7.9 million. Design of the vertical slot fish passage facility is estimated to cost $6.3 million, based on consultant estimates and costs incurred in-house by United. A range of permits would be necessary for the development and maintenance of the facility, including as required under CEQA, NEPA, Federal Clean Water Action compliance under Sections 401 and 404, California Department of Fish and Wildlife (CDFW) Lake and Streambed Alteration Agreement (LSAA), and California Endangered Species Act (CESA) incidental take permit.[4] Construction permits including a Generic Construction Permit and a grading permit would also be necessary. Costs for permit fees as well as any consulting and preparation necessary to acquire permits has been estimated by United. The costs are summarized in Table 9-11.

Table 9-11 One-time Design and Permitting Costs*

Category	Cost
Design	$6,300,000
CEQA	$587,000
NEPA	$644,000
Other Permitting (404/401/LSAA, CESA ITP)	$165,000
Construction Permits	$200,000
Total	**$7,896,000**

*One-time design and permitting costs include estimated costs for permit fees and consulting and preparation necessary for acquiring permits.

Construction

Construction is estimated to take place over the first two years of the MSHCP. A range of cost estimates to construct the fish passage facility were developed. Costs were drawn from the Draft *Hydraulic Basis of Design Report* for the MSHCP,[5] available in Appendix C. To be conservative we use the high-range cost estimate for construction of $78.1 million. This includes all costs associated with construction, a 10 percent adjustment for construction management, and a standard 15 percent contingency.

[4] The cost of federal Endangered Species Act compliance (i.e., preparation of this MSHCP) is excluded from these estimates.

[5] Vern Freeman Diversion Vertical Slot Fish Ladder – Hydraulic Basis of Design Report, December 6, 2019, p. 33. (Stantec 2019).

Operations and Maintenance

After the initial two-year construction period, the facility would require regular maintenance and staff time to operate the facility. The cost of staff time required to operate the fish ladder, diversion, and all other Freeman operations is covered under the Staffing and Overhead section above. In addition to staff time, regular maintenance would be necessary. Routine maintenance includes costs of materials, and heavy equipment rentals for dewatering and flow rerouting as well as headworks and desilting basin maintenance (See Chapter 3, Section 3.3.2 for more detail on the specific maintenance items included), vegetation control, and basin stabilization repair (assumed to be necessary an average of three times every 10 years). United is exploring alternate sediment management methods (e.g., selective dredging); however, these activities, if determined to be feasible and effective, are not anticipated to increase the total cost estimate for sediment removal. Besides the actual cost of maintenance, obtaining routine maintenance permits under the CDFW LSAA program would also be necessary over the life of the MSHCP. We use an assumption of 30 maintenance projects over 50 years. Table 9-12 summarizes the estimated routine maintenance costs as an annual cost, even if some maintenance activities or permits occur less frequently than annually. According to these estimates, routine maintenance costs are, on average, an estimated $340,000 per year.

Table 9-12 Routine Maintenance Costs

Maintenance Activity	Average Annual Cost	Timing Assumption	Total Cost over Permit Term
Maintenance Permits	$1,000	$3,666 every 5 years. $300 for assumed 30 maintenance projects over MSHCP term	$50,000
Dewatering/Flow Rerouting	$78,000	Every year starting in year 2	$3,900,000
Headworks and Sediment Removal	$105,000	Every year starting in year 2	$5,250,000
Desilting Basin	$133,000	Every year starting in year 2. Costs start at $100,000 per year and increase to $140,000 at year 7	$6,650,000
Vegetation Control	$5,000	Every year starting in year 2	$250,000
Riprap/Bank Stabilization	$18,000	Every year starting in year 2	$900,000
Total	**$340,000**		**$17,000,000**

Other maintenance activities would be carried out much less frequently than annually. These non-routine maintenance activities include repair of the entire channel bottom, replacement of the Obermeyer gates, and replacement of the fish screens. These estimated costs and their assumed frequencies are summarized in Table 9-13.

Table 9-13 Non-Routine Maintenance Costs

Maintenance Activity	Frequency	Cost per Maintenance Event	Total Cost over Permit Term
Bypass Channel Bottom	4 times: every 10 years	$225,000	$900,000
Obermeyer Gate Replacement	1 time: every 25 years	$926,000	$926,000
Fish Screen Replacement	1 time: every 25 years	$6,300,000	$6,300,000
Total			**$8,126,000**

Summary of Migratory Corridor Costs

Table 9-14 summarizes cost estimates for the Migratory Corridor. Capital and one-time costs total $86.0 million. Annual average O&M costs, including staff time for operating the facility and all routine and non-routine maintenance, is estimated at $1.4 million annually over the life of the MSHCP.

Table 9-14 Summary of Migratory Corridor Costs			
Cost Category	**Capital and One-time Costs**	**Average Annual Cost**	**Total Cost over Permit Term**
Staffing and Overhead		$879,000	$43,948,000
Design and Permitting	$7,896,000		$7,896,000
Construction	$78,104,000		$78,104,000
Operations and Maintenance, Routine		$340,000	$17,000,000
Operations and Maintenance, Non-Routine		$163,000	$8,126,000
Total	**$86,000,000**	**$1,382,000**	**$155,100,000**

9.2.4 INSTREAM FLOWS AND FISH MONITORING

The Instream Flows functional group corresponds to activities undertaken to meet Biological Objective 1.2 identified in Chapter 5, *Conservation Program,* to create instream flows that support migration of southern California steelhead and lamprey, as well as associated monitoring activities. CMs 1.2.1 through 1.2.6 are all included under this cost category as summarized in Table 9-15. This functional group is closely related to the operation of the fish ladder and the Freeman Diversion, and many costs related to creating instream flows to facilitate fish migration cannot be distinguished. The costs of design, permitting, and operation are all captured under Section 9.2.1 on Migratory Corridor costs. There are no additional monitoring costs associated with CM 1.2.6, Minimize Impacts to Steelhead and Lamprey through Limitations on Sediment Management Activities, as United does not expect a substantial change in diversions or loss in water due to this measure; monitoring costs for minimization of species impacts during sediment management activities (e.g., biological monitoring of sediment removal activities) are subsumed in conservation measures addressed in Section 9.2.5, *Minimizing Species Impacts*.

Table 9-15 Biological Objectives Under Instream Flows Cost Category			
MSHCP Goals & Biological Objectives[1]	**MSHCP Conservation Measures**	**Chapter 9 Cost Category**	**Total Cost Estimate Over Permit Term**
Goal 1 Biological Objective 1.2	CM 1.2.1 Instream Flow Commitment for Upstream Migration – Initial[2] Operations (maximum instantaneous diversion of 375 cfs)	Instream Flows and Fish Monitoring	$5,929,000 (combined CM 1.2.1 through CM 1.2.5)
Goal 1 Biological Objective 1.2	CM 1.2.2 Instream Flow Commitment downstream of Freeman Diversion for Downstream Migration – Initial Operations (maximum instantaneous diversion of 375 cfs)	Instream Flows and Fish Monitoring	
Goal 1 Biological Objective 1.2	CM 1.2.3 Instream Flow Commitment Downstream of Freeman Diversion for Upstream Migration - Future Operations (water right change to maximum instantaneous diversion rate – 750 cfs)	Instream Flows and Fish Monitoring	
Goal 1 Biological Objective 1.2	CM 1.2.4 Instream Flow Commitment Downstream of Freeman Diversion for Downstream Migration–Future Operations (Water Right Change to Maximum Instantaneous Diversion Rate – 750 cfs)	Instream Flows and Fish Monitoring	
Goal 1 Biological Objective 1.2	CM 1.2.5 Relocate Downstream Migrant Steelhead and Lamprey at Low Flows	Instream Flows and Fish Monitoring	
Goal 1 Biological Objective 1.2	CM 1.2.6 Minimize impacts to steelhead and lamprey through limitations on sediment management activities	Instream Flows and Fish Monitoring	$0[1]
Total			**$5,929,000**

[1] All costs associated with sediment management activities are inseparable from the costs of operating the Freeman Diversion. These costs are captured under the Migratory Corridor section. Costs associated with avoiding and minimizing impacts to species during sediment management activities are subsumed in costs evaluated under the Minimizing Species Impacts section.

Included in Instream Flows costs are the costs of effectiveness monitoring for fish migration, described in Chapter 6 – *Monitoring and Adaptive Management*. This section includes the following cost categories:

- Staffing and Overhead Costs.
- Effectiveness monitoring for fish migration

Capital costs related to monitoring are estimated at $156,000, while O&M costs are estimated at $800,000 over the life of the MSHCP. Additional staffing costs for carrying out monitoring are estimated to be $162,000 per year, or a total of $5.0 million. Together these estimated costs total $5.9 million over the life of the MSHCP.

Staffing and Overhead Costs

The cost of staff time to operate the Freeman Diversion to minimize impacts to fish species are captured under the Migratory Corridor section. However, staff time needed for reporting on instream flows and monitoring their impact on the migration of southern California steelhead and lamprey are included under *Effectiveness Monitoring Costs*, below.

Effectiveness Monitoring Costs

To estimate monitoring costs, it was assumed that United staff time would be needed to carry out trap monitoring and sampling for adult migration, stranding, and fish migration several times per year over the first three years of the MSHCP, as described in Chapter 5, *Conservation Program,* and Chapter 6, *Monitoring and Adaptive Management*. It was assumed that trap monitoring would continue over the full permit term. Reporting would also require time at the project manager level every year. Based on the estimated time requirements, total staffing costs are estimated at an average of $99,000 per year over 50 years, as shown in Table 9-8. Staffing cost estimates for effectiveness monitoring of instream flows are summarized in Table 9-16.

Table 9-16 Instream Flows Staffing and Overhead Costs

	Average Annual Cost	Average Cost per 5-year Period	Total Cost over Permit Term
Instream Flows	$99,000	$495,000	$4,950,000
Total	**$99,000**	**$495,000**	**$4,950,000**

It was assumed that monitoring of fish migration and western pond turtles would also require purchase of radio telemetry and Passive Integrated Transponder (PIT) tagging equipment and carrying out telemetry studies. United plans to hire consultants to carry out radio and PIT tag telemetry studies as well as mobile DIDSON surveys, eDNA and any other necessary technical work as described in Chapter 5, *Conservation Program,* and Chapter 6, *Monitoring and Adaptive Management*. The estimated costs for effectiveness monitoring through telemetry studies are summarized in Table 9-17.

Table 9-17 Effectiveness Monitoring Costs				
	One-time Capital Cost	Annual O&M Cost (years 1-5)	Annual O&M Cost (years 1-10)	O&M (averaged over 50-year term)
Radio Telemetry Equipment	$56,000	$0	$0	
PIT Telemetry Equipment	$100,000	$0	$0	
Radio Telemetry Consultant	$0	$80,000	$0	$8,000
PIT Telemetry Consultant,	$0	$20,000	$0	$2,000
Mobile DIDSON Surveys, eDNA, Other—Consultant	$0	$0	$30,000	$6,000
Total	**$156,000**	**$100,000**	**$30,000**	**$16,000**

Summary of Instream Flow Costs

Table 9-18 summarizes cost estimates for Instream Flows. Capital and one-time costs total an estimated $156,000. Annual average O&M costs, including staff time and effectiveness monitoring, are estimated at $115,000 annually over the life of the MSHCP.

Table 9-18 Summary of Instream Flows Costs			
Cost Category	Capital and One-time Costs	Average Annual Cost	Total Cost over Permit Term
Staffing and Overhead		$99,000	$4,970,000
Effectiveness Monitoring	$156,000	$16,000	$956,000
Total	$156,000	$115,000	$5,926,000

9.2.5 MINIMIZING SPECIES IMPACTS

The Minimizing Species Impacts functional group covers Biological Objectives 2.1 and 2.2 identified in Chapter 5, *Conservation Program*. These goals help to minimize the impact of renovation, operation, and maintenance of the Freeman Diversion to covered species and their habitat. Table 9-19 summarizes all the conservation measures that fall under the Minimizing Species Impacts category and their estimated costs across the 50-year term.

Table 9-19 Conservation Measures Under Minimizing Species Impact Cost Category			
MSHCP Goals & Biological Objectives[1]	**MSHCP Conservation Measures**	**Chapter 9 Cost Category**	**Total Cost Estimate Over Permit Term**
Goal 2 Biological Objective 2.1	CM 2.1.1 Best Management Practices	Minimizing Species Impact	$50,000
Goal 2 Biological Objective 2.1	CM 2.1.2 Worker Environmental Awareness Training	Minimizing Species Impact	$245,000
Goal 2 Biological Objective 2.1	CM 2.1.3 Pre-activity Surveys	Minimizing Species Impact	$5,463,000
Goal 2 Biological Objective 2.1	CM 2.1.4 Covered Species Capture and Relocation Protocol	Minimizing Species Impact	$856,000
Goal 2 Biological Objective 2.1	CM 2.1.5 Noise Abatement Protocol	Minimizing Species Impact	$265,000
Goal 2 Biological Objective 2.1	CM 2.1.6 Biological Monitoring	Minimizing Species Impact	$3,584,000
Goal 2 Biological Objective 2.1	CM 2.1.7 Avoid Nests of Covered Species of Birds During Nesting Bird Season	Minimizing Species Impact	$0[1]
Goal 2 Biological Objective 2.1	CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones	Minimizing Species Impact	$0[1]
Goal 2 Biological Objective 2.2	CM 2.2.1 Invasive Species Management	Minimizing Species Impact	$0[1]
Goal 2 Biological Objective 2.2	CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events	Minimizing Species Impact	$0[1]
Total			**$10,463,000**

[1] Costs are assumed to be minimal. These measures are adjustments to construction and maintenance activities and their costs are fully subsumed in and inseparable from the corresponding construction and maintenance estimate and in CMs 2.1.3, 2.1.4, and 2.1.6. Costs of carrying out reporting requirements for all these CMs are included under the Migratory Corridor cost category and/or in CMs 2.1.3, 2.1.4, and 2.1.6.

Several of the CMs under this category do not have additional costs of their own. For example, CM 2.1.7 *Avoid Nests of Covered Species of Birds During Nesting Bird Season*, CM 2.1.8 *Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones*, CM 2.2.1 *Invasive Species Management,* and CM 2.2.2 *Avoid Riparian and Aquatic Habitat During Rainfall Events*, do not have direct costs associated with the avoided activity. These measures are adjustments to construction and maintenance activities and their costs are fully subsumed in the corresponding construction and maintenance estimate and/or are subsumed in CM 2.1.3, *Pre-activity Surveys*, CM 2.1.4, *Covered Species Capture and Relocation Protocol*, and C.M. 2.1.6, *Biological Monitoring*. Costs of carrying out reporting requirements for all these CMs are included under the Migratory Corridor cost category and/or in the costs of CMs 2.1.3, 2.1.4, and 2.1.6.

Capital costs are estimated at $1.8 million, while O&M costs are estimated at $8.7 million over the permit term, which includes an estimated $3.6 million in staffing costs. Together total costs for minimizing species impacts are estimated at $10.5 million.

The cost estimate for Minimizing Species Impacts includes the following categories:

- Staffing and Overhead
- Best Management Practices
- Worker Environmental Awareness Training
- Pre-Activity Surveys
- Covered Species Capture and Relocation Protocol

- Noise Abatement
- Biological Monitoring

Staffing and Overhead

Staffing and overhead costs for Minimizing Species Impacts are expected to average $72,000 per year over the permit term. This figure is based on an estimate of time required by a project manager to oversee impact mitigation during the two-year construction period, as well as to complete required monthly and yearly reporting over the MSHCP term. O&M Staff time is also required to capture and relocate stranded fish during initial dewatering, to carry out dewatering and flow rerouting, and instream cessation dewatering, and to select relocation sites.

Table 9-20 summarizes staffing costs for this category. The allocation of staffing and overhead costs is presented in subsection 9.2.1 – *Program Administration* and subsection 9.2.2 – *Staffing and Overhead* (see Table 9-8).

Table 9-20 Minimizing Species Impact Staffing and Overhead Costs

	Average Annual Cost	Average Cost per 5-year Period	Total Cost over Permit Term
Staffing Costs	$72,000	$360,000	$3,590,000
Total	**$72,000**	**$360,000**	**$3,590,000**

Best Management Practices

It was assumed that oversight of the best management practices (BMP) conservation measure would be done by an outside consultant. Estimates for the cost of monitoring BMP goals were assumed to be required during the two-year construction period. Assuming that one person would spend one day per week on site for Stormwater Pollution Prevention Plan monitoring, the estimate is that 672 labor hours would be required at a cost of $75 per hour. The total cost is estimated at $50,400 over the two-year period.

Other biological monitoring costs are included under *Biological Monitoring*, below. Maintenance-related BMP costs are subsumed under the staff time and material costs that are estimated in CM 1.1.1 to operate and maintain the fish passage facility.

Worker Environmental Awareness Training

It was assumed that WEAT sessions would take place at the start of construction and would continue on a quarterly basis throughout the construction period. Additional training sessions are estimated to take place quarterly during the entire period of operation and maintenance. Each session would require one facilitator and would take a full day at a cost of $150 per hour. A consultant would provide these trainings and develop the necessary training materials. Total costs estimates are summarized in Table 9-21.

Table 9-21 WEAT Costs

	Cost during Construction Period	Annual Cost during Operation Period	Total Cost
Pamphlet Development	$4,000		$4,000
WEAT—Initial Session	$1,000		$1,000
WEAT—As-needed Construction	$10,000		$10,000
WEAT—1-year Maintenance		$5,000	$240,000
Total	**$15,000**	**$5,000**	**$255,000**

Pre-Activity Surveys

Pre-activity surveys were assumed necessary for covered bird, fish, and reptile species and were assumed to be carried out by outside consultants. It was estimated that a pre-activity bird clearance survey and a pre-activity fish and reptile clearance study would each require a 2-person crew working for two days at a rate of $150 per hour and $200 per hour, respectively. For reporting purposes, these surveys are planned to continue annually over the period of operation of the project. To be conservative we assumed that monitoring surveys would take place 5 times per year. In addition, United estimates that a protocol-level species survey prior to construction to cover the required number of surveys for necessary species would cost $30,000. These costs are summarized in Table 9-22.

Table 9-22 Pre-activity Survey Costs

	Cost during Construction Period	Annual Cost during Operation Period	Total Cost
Pre-activity Bird Clearance Survey	$5,000	$24,000	$1,157,000
Protocol-level Species Surveys	$30,000	$0	$30,000
Pre-Construction Fish and Herp Clearance Survey	$6,000	$32,000	$1,542,000
Total	**$41,000**	**$56,000**	**$2,729,000**

Covered Species Capture and Relocation Protocol

Costs under this CM would include capture and relocation of stranded individuals during the initial dewatering and flow rerouting and during dewatering and flow rerouting, instream flow cessation dewatering events that take place over the projects period of operation, as well as selection of an appropriate relocation site. These activities would be carried out by United O&M staff. During the initial dewatering and flow rerouting United estimates that 3 staff working half-time for one week would be required. United also assumes that the same cost would be needed once per year during dewatering events. Instream flow cessation events are estimated to take place three times per year and would need 3 staff working full time for one day. These costs are included in the staffing costs developed by United and summarized in Table 9-20.

During construction, it is assumed that the on-site biological monitor would capture and relocate species opportunistically and as-needed during regular monitoring. Thus, associated costs would be captured under CM 2.1.6, *Biological Monitoring*.

Noise Abatement

It was assumed that capital costs at the time of construction would include the purchase of noise monitoring equipment and the purchase of reusable acoustic blankets for noise reduction. United plans to purchase equipment to carry out 3D modeling of the permit area to determine reference noise levels throughout the habitat, a noise monitoring setup for complex activities such as construction with several pieces of heavy equipment, a hydroacoustic noise monitoring setup, and a noise monitoring database. These one-time costs are summarized in Table 9-23, with an estimated total of $105,000.

O&M costs around noise abatement are expected to take place throughout the 50-year life of the MSHCP. United anticipates periodic noise monitoring costs at approximately $6,000 every 5 years, to include temporary and permanent shielding. The estimate also anticipates $2,000 per year for maintenance costs on noise abatement equipment. These cost estimates sum to approximately $3,200 per year over the 50-year permit term.

Table 9-23 Noise-Abatement Costs			
Purchase	**Initial Cost**	**Annual Cost during Operation Period**	**Total Cost**
3D Modeling Software	$6,000		$6,000
Noise Monitoring Setup	$8,000		$8,000
Hydroacoustic Noise Monitoring Setup	$6,000		$6,000
Noise Monitoring Database	$2,000		$2,000
Acoustic Blankets	$83,000		$83,000
Shielding		$1,200	$60,000
Maintenance		$2,000	$100,000
Total	**$105,000**	**$3,200**	**$265,000**

Biological Monitoring

Biological monitors[6] would be present to monitor species impacts during all project activities occurring within or adjacent to sensitive or suitable habitat for covered species, or as directed under any other conservation measures, BMP, or Habitat Restoration and Management Plan. This includes monitoring a 500-foot buffer surrounding the active work area. ICF has provided cost estimates for all biological monitoring activities, including diversion check, water quality monitoring, ESA check, and nesting bird monitoring. For estimation, it is assumed that one person would be on site every day of construction for biological monitoring over the two-year construction period. Diversion check, water quality monitoring and ESA check are each estimated to require approximately 2.5 hours of consultant time per week over the course of the two-year construction period and 2.5 hours once per year over the period of operation (during one week of maintenance activities). It is also estimated that nesting bird monitoring would be done by one person on site every day of the two-year construction period during the nesting season and for an assumed one week per year over the period of operation. Estimates of labor requirements were created for the purpose of cost estimation, and do not indicate required hours or limitation. Actual time to complete these tasks may be greater or less than these average estimates. An average cost estimate of $145 per hour for these monitoring activities was used. Based on this estimate of hours and hourly costs, total estimated costs are summarized in Table 9-24.

Table 9-24 Biological Monitoring Costs			
Monitoring Task Type	**Construction-period Cost**	**Annual Maintenance Cost**	**Total Cost**
Biological Monitoring	$846,800		$846,800
Diversion Check	$32,480	$1,933	$125,280
Water Quality Monitoring	$32,480	$1,933	$125,280
ESA Check	$32,480	$9,667	$496,480
Nesting Bird Monitoring	$598,560	$29,000	$1,990,560
Total	**$1,542,800**	**$42,533**	$3,584,400

Summary of Minimizing Species Impacts Costs

Table 9-25 summarizes cost estimates for Minimizing Species Impacts. Capital and one-time costs total an estimated $1.8 million. Annual average O&M costs, including staff time for operations, are estimated at $179,000 annually over the life of the MSHCP.

[6] See Chapter 5, *Conservation Measures*, for definition of qualified biological monitors.

Table 9-25 Summary of Minimizing Species Impact Costs

Cost Category	Capital and One-time Costs	Annual Cost during Operation Period	Total Cost over Permit Term
Staffing and Overhead		$72,000	$3,590,000
Best Management Practices	$50,000		$50,000
WEAT	$15,000	$5,000	$245,000
Pre-Activity Surveys	$41,000	$56,000	$2,729,000
Covered Species Capture and Relocation Protocol			
Noise Abatement	$105,000	$3,000	$265,000
Biological Monitoring	$1,542,000	$43,000	$3,584,000
Total	$1,753,000	$179,000	$10,463,000

9.2.6 RIPARIAN RESTORATION AND MANAGEMENT

The Riparian Restoration and Management functional group covers Biological Objective 2.3 identified in Chapter 5. Table 9-26 summarizes the conservation measures that fall under Riparian Restoration and Management and their cost estimates. Costs in this category are generally separable from other costs. We consider one-time costs that are to take place during the construction period to be capital costs.

Table 9-26 Conservation Measures Under Riparian Restoration and Management Cost Category

MSHCP Goals & Biological Objectives[1]	MSHCP Conservation Measures	Chapter 9 Cost Category	Total Cost Estimate Over Permit Term
Goal 2	CM 2.3.1 Implement Habitat Restoration and Management	Riparian Restoration and Management	$580,000
Biological Objective 2.3			
Goal 2	CM 2.3.2 Implement the Invasive Brown-headed Cowbird Control Plan	Riparian Restoration and Management	$28,000
Biological Objective 2.3			
Total			**$608,000**

The cost of Riparian Restoration and Management includes the following categories:

- Staffing and Overhead
- Habitat Restoration

Capital costs associated with habitat restoration are estimated at $80,000. O&M costs total an estimated $528,000, including $64,000 of staffing costs. Together, these total approximately $608,000.

Staffing and Overhead

Staffing and overhead costs for Restoration and Management are estimated to total $64,000 over the permit term. The assessment is based on an estimate of time required by a project manager to oversee restoration construction activities and maintenance of the restoration sites. Maintenance is planned over the first five years of the project. An additional five years may be necessary if circumstances require. To be conservative we assume that project management would be required for the full 10 years. The allocation of staffing and overhead costs is presented in subsection 9.2.1 – *Program Administration* and in subsection 9.2.2 – *Staffing and Overhead* (see Table 9-8). Table 9-27 provides a summary of total staffing costs.

Table 9-27 Restoration and Management Staffing and Overhead Costs			
	Staffing Costs--Years 1-5	Staffing Costs--Years 6-10	Total Cost over Permit Term
Staffing Costs	$37,000	$28,000	$64,000
Total	**$37,000**	**$28,000**	**$64,000**

Habitat Restoration

For the purpose of cost estimation, it was assumed that implementation of United's habitat restoration plan would offset temporary impacts from construction of the project at a 1:1 ratio. It was assumed that the restoration plan would include grading and site prep, setting up temporary irrigation, and acquiring and installing plant and seed materials.

The MSHCP would also include implementation of the Invasive Brown-headed Cowbird Control plan to fully offset impacts to covered riparian birds. It was assumed that implementation of the plan would consist of setting traps for the birds for a period of two years.

One-time capital costs of restoration and capital costs for the Invasive Brown-headed Cowbird Control plan are summarized in Table 9-28 and are estimated at $80,000.

Table 9-28 Habitat Restoration Capital Costs	
Activity	**Cost**
Grading and site prep	$2,000
Temp irrigation	$10,000
Plant and Seed materials	$40,000
Invasive Brown-headed Cowbird Control	$28,000
Total	**$80,000**

After these one-time restoration efforts are complete, United plans for 5 year of maintenance and monitoring of the restored habitat, with an additional 5 years of maintenance possible if circumstances require. To be conservative, these cost estimates include a full 10 years of maintenance. It was assumed that maintenance and reporting would be contracted out. To arrive at maintenance costs, United assumes that three annual maintenance visits would be necessary, each consisting of four crew and one foreman working for one week at an estimated $50 to $75 per hour. The estimate assumes that costs would decrease by half in years 6 through 10 as the restored habitat becomes more established. It was assumed that annual monitoring of the restoration work would also be contracted out. United assumes four 8-hour visits per year to carry our monitoring activities. Short-term O&M cost estimates are summarized in Table 9-29.

Table 9-29 Habitat Restoration O&M Costs				
	Years	Assumptions	Total Cost per Year	Total Cost
Maintenance	1-5	Four crew @ $50/hour and one foreman @ $75/hour working for one week three times per year	$33,000	$165,000
Maintenance	6-10	half the cost of years 1-5	$17,000	$82,500
Reporting	1-5	40 hours per year @ $120/hour	$5,000	$24,000
Monitoring	1-50	Four 8-hour visits per year @$120/hour	$4,000	$192,000
Total				**$463,500**

Summary of Riparian Restoration and Management Costs

Table 9-30 summarizes cost estimates for Habitat Restoration activities. Capital and one-time costs total an estimated $80,000. O&M costs are estimated at $528,000. Total costs are estimated at $608,000.

Table 9-30 Summary of Habitat Restoration Costs					
Cost Category	Capital	O&M (total cost, years 1-5)	O&M (total cost, years 6-10)	O&M (total cost, years 1-50)	Total costs
Staffing and Overhead		$37,000	$28,000		$64,000
Restoration Construction costs	$80,000				$80,000
Maintenance		$165,000	$83,000		$248,000
Reporting		$24,000			$24,000
Monitoring				$192,000	$192,000
Total	**$80,000**	**$226,000**	**$111,000**	**$192,000**	**$608,000**

9.2.7 POST-PERMIT ENDOWMENT

During the MSHCP permit term, capital and operating costs of the program would be directly funded by United. At the end of the permit term, United may choose, if it continues to operate or replaces the facility, to renew the incidental take permits, apply for new permits, or, if it chooses to demolish the facility, to allow the permits to expire. As already noted, certain management, monitoring, and administration costs would need to continue if United chooses to allow the permits to expire. However, as noted below, these costs after permit expiration are anticipated to be minimal. If the facility is demolished, that action would likely require an environmental review that would put into place a different set of requirements for post-permit activities and associated funding. Those requirements, if ever needed, cannot be anticipated and budgeted at this time. The purpose of the endowment would be to fund in perpetuity the portion of the post-permit costs that might be reasonably anticipated now.

A small amount of riparian restoration may need to be managed in perpetuity (approximately two acres, as described in Chapter 5, *Conservation Program*), a scale of management that may not be appropriate for an endowment. Only riparian restoration monitoring is expected to be required regardless of the decision at the end of the permit term; thus, those costs are assumed to continue beyond the 50-year permit period, post-permit costs are estimated to average $4,000 annually and are summarized in Table 9-31. The final calculation of post-permit costs includes an additional 3 percent contingency, bringing the annual cost estimate to $4,120.

To account for inflation over the life of the permit, the annual cost is inflated by 2 percent per year to estimate the amount that would be necessary to fund the program at the end of the permit term. The required endowment by the end of the permit term to fund these costs is estimated at $318,000 (in 2020 dollars). It is assumed that United would pay into the endowment at the beginning of each year commencing in the first year of the permit and each year thereafter until the last year of the permit and that the endowment would be prudently managed by a qualified financial investment entity and would earn an annual real rate of return of 4 percent on average. Under these assumptions, the annual contribution rate to the endowment over the term of the permit is $2,000 (in 2020 dollars).

If United chooses to renew or replace the incidental take permits, the endowment may be used to support implementation of the next HCP permit term, as approved by USFWS and NMFS as part of those future permit negotiations.

Table 9-31 Post-Permit Endowment Costs

Cost Category	Annual Post-permit Cost	Required Endowment by End of 50-year Permit Term*
Restoration and Management	$4,000	$318,000
TOTAL	**$4,000**	**$318,000**

*In 2020 dollars.

9.2.8 COST CONTINGENCY AND CHANGED CIRCUMSTANCES

Due to cost uncertainties and the possibility of changed circumstances that could affect annual program requirements and expenditures (see Chapter 8, *Plan Implementation*, for details of changed circumstances and remedial measures that may be needed to address them), contingency values are included in total cost calculations, and shown as a line item in Tables 9-1, 9-2 and 9-3. No additional contingency is applied to the diversion construction cost estimates which already include a standard 15 percent contingency. Restoration construction costs includes a greater contingency to account for the need to adaptively manage restoration work to ensure its long-term success. The contingency applied to restoration construction is 15 percent. The remaining cost categories, including administration and overhead, general maintenance, and monitoring, all use a 3 percent contingency, to account for uncertainties and unforeseeable changed circumstances. The total cost of the contingency is estimated at $3.1 million, which averages $61,000 annually. Table 9-32 summarizes this contingency across capital and operating costs.

Table 9-32 Summary of Cost Contingency

Contingency	Capital Cost	Capital Contingency	Operating Cost	Operating Contingency	Total Contingency
15% Restoration construction contingency	$80,000	$12,000	$0	$0	**$12,000**
3% Remaining contingency	$9,805,000	$294,000	$92,419,000	$2,773,000	**$3,067,000**
Total Contingency	**-**	**$306,000**	**-**	**$2,773,000**	**$3,079,000**

9.3 FUNDING SOURCES AND ASSURANCES

United plans to fund the MSHCP using revenues it currently collects in accordance with its principal act in the California Water Code, supplemented by potential grants and contributions from other organizations (i.e. groundwater sustainability agencies). Due to the high cost of the capital projects associated with the MSHCP, with the development of new water resources for the service area, and with its dam safety program, United is actively seeking funding from outside agencies, including the federal and state governments, as well as local agencies, such as the Fox Canyon Groundwater Management Agency. These outside sources of funding would be sought and maximized to the fullest extent. However, until those opportunities are realized and for the purposes of this MSHCP, United will assume that the MSHCP is fully funded by United, without the support of any outside funding.

United anticipates funding the construction of the conservation program's capital improvement projects by the issuance of debt, and repayment over the term of that debt instrument from its authorized sources of revenues. United typically funds the construction of infrastructure projects via the issuance of revenue bonds and other forms of financing, as allowed through United's principal act. Table 9-33 lists recent debt issued to finance.

Table 9-33 United Water Conservation District Debt Issues

Year Issue	Amount ($M)	Purpose	Outstanding ($M)
2009	15.5	Land Acquisition	8.6
2006	8.5	PV Reservoir	0
2005	9.6	Freeman improvement	5.6
2001	2	OH System Upgrade	0.4
1998	1.3	Multiple CIP	0
1996	13.8	Refinance; Water supply	0
1994	1.6	Seawater intrusion abatement	0
1993	11.3	Multiple CIP	0

United is a local public agency and water conservation district established in 1950 in accordance with the California Water Code Section 74000 et seq. It is managed by a seven-member elected Board of Directors, which serves as United's legislative body. United's general manager performs United's executive duties, implementing the policies of the Board of Directors.

The Freeman Diversion Fund covers United's facilities and activities that recharge the groundwater aquifers of the Oxnard Plain region (Oxnard Plain, Pleasant Valley, West Las Posas, Mound). United's current revenues are principally derived from the following sources:

- Groundwater extraction charges (both direct and in-lieu delivery charges), annually levied on multiple zones by the Board of Directors
  - Zone A charges – purposed for district-wide water conservation activities
  - Zone B charges – purposed for United's water conservation activities for the coastal Oxnard Plain area
- Ad valorem property taxes – purposed for general administration and overhead activities
- Investment earnings

Revenue is raised by collecting groundwater extraction charges from the Oxnard Plain region groundwater users and in-lieu charges to some surface water users. The Freeman Diversion Fund's current revenue is approximately $4.7 million in fiscal year 2020-2021, based upon approximately 85,000 acre-feet (AF) per year of groundwater and eligible surface water use in the Oxnard Plain region.

9.3.1 FUNDING CONSTRAINTS AND REQUIREMENTS IMPOSED BY STATE LAW

This section discusses funding constraints and requirements imposed by state law; refer to Chapter 1, *Introduction*, for additional regulatory context for the MSHCP. The local implementation of the California Sustainable Groundwater Management Act of 2014 (SGMA) in the Oxnard Plain region by the Fox Canyon Groundwater Management Agency (FCGMA), the designated groundwater sustainability agency, will likely have significant impacts upon United's operations and associated finances in the region. Initial findings of the FCGMA's groundwater management planning effort confirm past studies' findings that the sustainable yield will be about 40,000 AF below historic groundwater pumping levels, and that target includes continued diversions at roughly equal to the historic annual average artificial recharge by United's Freeman Diversion, under operations consistent with United's water rights.

If the FCGMA chooses to achieve sustainability goals by reductions in pumping alone, United would need to institute higher extraction charges, in order to maintain current Freeman Diversion and groundwater recharge operations, for which costs are largely invariant with diversion rates. Funding the new projects and activities described in this MSHCP would require even higher extraction charges to pumpers and in-lieu surface water users. If sustainability were to be met through water supply projects developed by United, then groundwater extraction charges must be increased to fund the new projects and activities. If diversion operations at the Freeman Diversion facility were to be decreased, then the sustainable yield of the Oxnard Plain region would decrease also, further diminishing United's ability to raise sufficient revenue to sustain its existing operations and fund the new projects and activities of the MSHCP's conservation program. Conversely, the FCGMA, as a groundwater sustainability agency under the SGMA, now has the authority to issue groundwater extraction charges to fund water supply projects, subject to a California Proposition 218 majority protest vote of the pumpers. Once the FCGMA receives approval of its groundwater sustainability plan (GSP) from the State of California, it would be able to levy groundwater extraction charges. This could be a source of revenue for United's (as well as other agencies') proposed water supply projects, reducing the burden on United's Freeman Diversion fund.

In order to offset the negative impacts of the conservation program on the water resources of the Oxnard Plain, United would need to design and construct a set of projects that would facilitate future diversions of extremely turbid water during high river flow periods, when there are either no fish expected to be present or there are adequate flows for fish migration and diversions. United would construct a separate companion set of projects at the same time as those included in the fishery-related elements of the conservation program that would expand the capacity of the Freeman Diversion headworks, remove conveyance restrictions, and improve United's ability to remove sediment from the diverted water. The Freeman Expansion Project's estimated cost is $5.1 million. The capacity enhancement project is part of the MSHCP covered activities. United proposes to construct the capacity enhancement project at the same time as it constructs the replacement fish passage system, in order to reduce fish passage and diversion construction down-time. The conveyance capacity and sediment removal capacity projects' total estimated cost is $8.4 million. Finally, United proposes to seek a modification to its State Water Resources Control Board water diversion license and permit, or a new permit, to increase the maximum authorized rate of diversion. United would also need to construct a series of projects to expand its water conveyance and groundwater recharge capacity, if it were to enhance its ability to divert extremely turbid water during high river flow periods. The estimated cost for the water diversion rights modification and capacity enhancement projects is approximately $14 million. Although implementing these projects could maintain the sustainable yield of the Oxnard Plain region supplied from United at the historical 65,000 AF per year level, they would increase the financial burden on the Freeman Diversion Fund, which would be responsible for any debt service and additional operational costs for these capacity enhancement projects.

Issuing revenue bonds to fund the construction of just the two projects included in the conservation program would use most of United's current total bonding capacity of $90 million.[7] The agency could fund the project as proposed in the MSHCP with current debt capacity, and funding future projects is the responsibility of United and beyond relevance and consideration within this MSHCP. The agency is exploring other means of funding those other projects, including from outside sources and in cooperation with other entities. United would seek funding through special legislation, federal and state bonds funding, federal and state grants funding, and funding thorough local partnerships.

9.3.2 FUNDING ASSURANCE

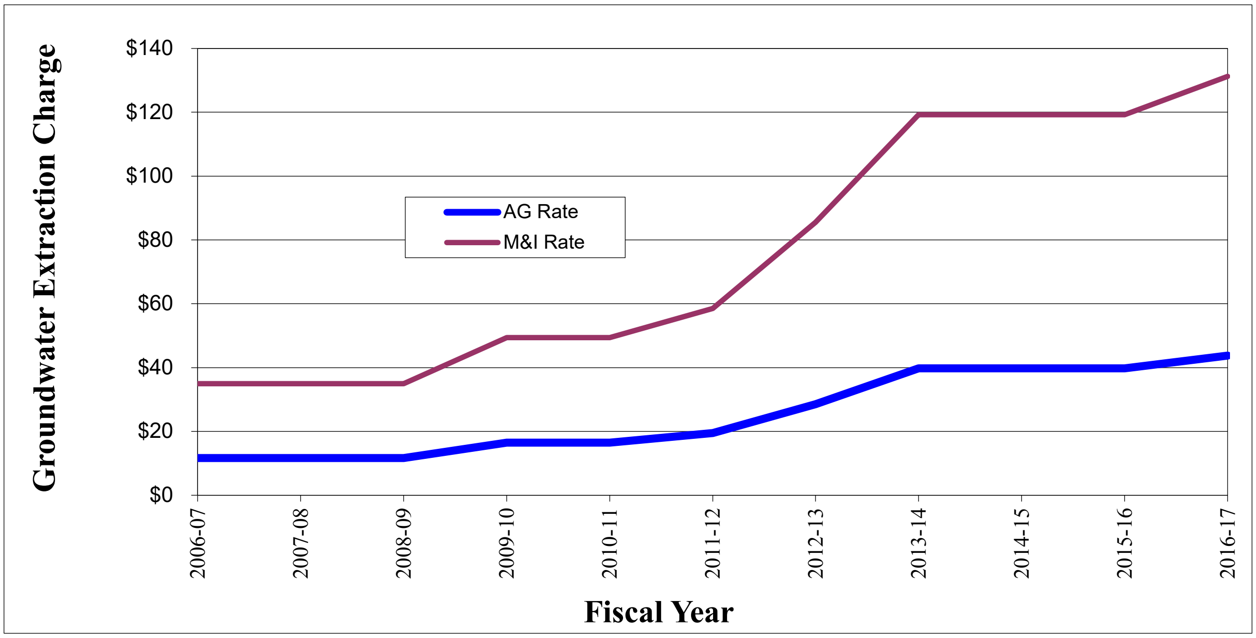
United develops a budget every fiscal year (July 1-June 30) based on a rigorous budgeting process that culminates with United's Board of Directors' approval of a final budget. As part of the annual budget development process, United's staff forecasts the anticipated revenues for the coming fiscal year, together

[7] "Water District Debt Capacity" (KNN 2020).

with costs for implementation of United's activities, including environmental compliance actions. These projections, along with recommendations regarding any necessary increases in groundwater extraction rates to ensure revenues are adequate to cover United's costs, are provided to the Board for consideration.

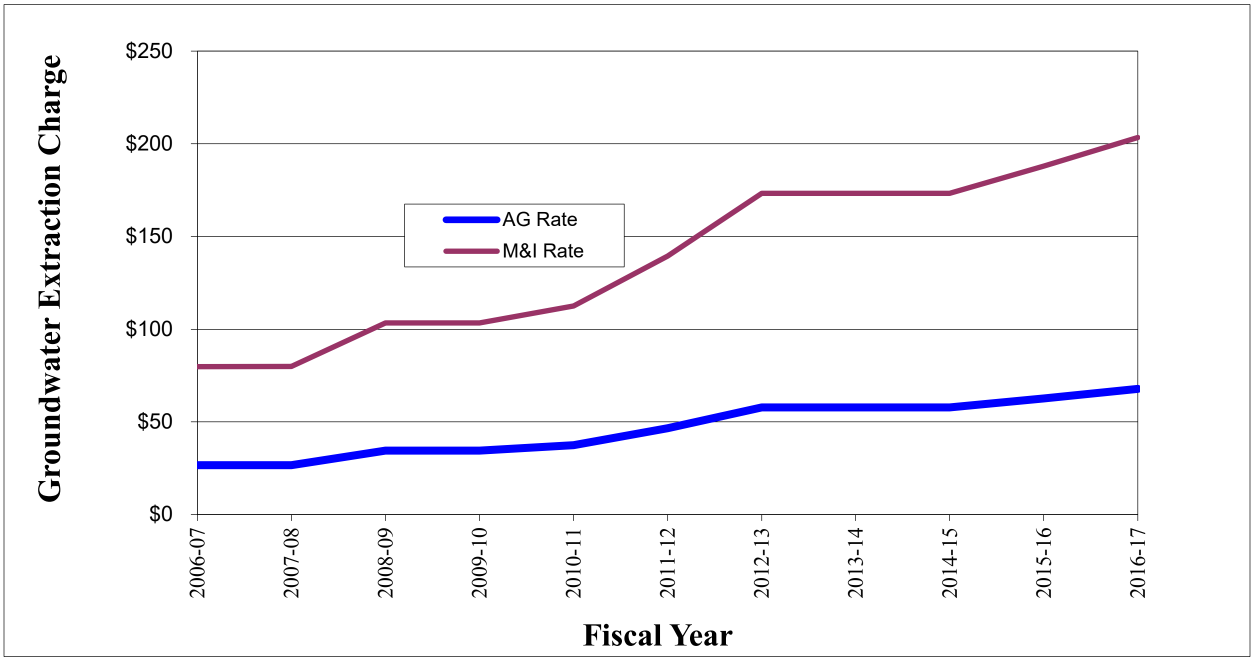
United's Board has demonstrated a commitment to adequately fund the costs of meeting its environmental obligations or commitments through a series of annual groundwater extraction rate increases. Figures 9-1 and 9-2 show the extent of the rate increases since 2006. Significant portions of these rate increases are directly attributable to environmental and regulatory compliance. In fiscal year 2012-2013, United's Board voted to raise Zone A rates (paid by all users in the district) for agricultural users (AG) and municipal and industrial water supply agencies (M&I) by an overall 46 percent, most of which was to ensure that United continued to comply with various environmental laws. For the fiscal year 2013-2014, the Board approved a 40 percent rate hike to ensure adequate reserves and funding for United's activities. In addition, as part of the annual budget process, United's Board adopts an Environmental Activities Cost Allocation Policy that is contained in the annual budget (United 2018).[8] For the 2019-2020 fiscal year, United raised Zone A rates 18 percent and Zone B rates 33 percent.

Figure 9-1 Zone A Groundwater Extraction Rate Increases between 2006-07 and 2016-17



[8] "Adopted Budget Plan, Fiscal Year 2018-19" (United 2018)

Figure 9-2 Zone B Groundwater Extraction Rate Increases between 2006-07 and 2016-17



Based on the projected MSHCP costs and the current revenue requirements for operating and financing United, Table 9-34 shows the total revenues with current rates for fiscal year 2019-2020, and the required revenues with projected rates for the year after the ITP is issued. Revenue requirements would rise from the current level for the 2019-2020 fiscal year from $15.8 million by 91 percent to $24.4 million. These rates do not reflect changes in groundwater pumping likely to result from the implementation of the GSP because the GSP is not implemented immediately, and projects targeted reductions out to 2040.

Table 9-34 Projected Revenue Requirements and Rates per Acre-Foot for the MSHCP

Scenario and Comparisons	Annual Revenues	Zone A - AG	Zone A - M&I	Zone B - AG	Zone B - M&I
Total Rates (Initial Year)					
Current Rates (FY 19-20)	*$15,747,000*	*$57.04*	*$171.12*	*$90.97*	*$272.92*
Existing: Diversion consistent with 2008 BO	*$18,796,000*	*$57.04*	*$171.12*	*$119.65*	*$358.96*
Proposed MSHCP: Vertical slot structure	$24,396,000	$57.04	$171.12	$173.85	$521.60
Rate Changes in Initial Year					
vs. Current Rates (FY 19-20)		0%	0%	91%	91%
vs. Existing Conditions		0%	0%	45%	45%
Total Rates (2040 GSP Horizon)					
Existing: Diversion consistent with 2008 BO	*$19,009,000*	*$57.04*	*$171.12*	*$132.18*	*$396.56*
Proposed MSHCP: Vertical slot structure	$24,364,000	$57.04	$171.12	$173.85	$521.60
Rate Changes in 2040 GSP Horizon					
vs. Current Rates (FY 19-20)		0%	0%	91%	91%
vs. Existing Conditions		0%	0%	32%	32%

The largest cost associated with implementing the conservation measures in the MSHCP is the construction of the new fish passage facility at the Freeman Diversion. It is also a one-time cost. United would derive funding for the construction of this facility by issuing debt, most likely through revenue bonds, as well as through special legislation, federal and state bonds funding, federal and state grants funding, and funding through local partnerships to the fullest extent possible. Zone B revenues would be used to cover all debt service payments. Zone B, which funds the Freeman Diversion Fund, was originally established for operation and maintenance activities and debt service, all in connection with the Freeman Diversion. United has used these revenues for many years and in April 2011 completed repayment of a 20-year facility construction loan from the U.S. Bureau of Reclamation. United's intention is to start construction of the fish passage facility the first March following the issuance of the ITPs (barring weather delays). United would either have the funding already secured when the ITPs are issued or would have it secured soon after that.

United currently has in place a financing team which includes outside counsel, underwriters and financial advisors. United has analyzed its financing capacity and is willing and able to issue debt as needed to finance the MSHCP. A comprehensive financing plan and any bond issuance needed to construct the facility would be created prior to issuance of the ITPs and would need to coincide with the length of the permits.

9.4 LITERATURE CITED

Bureau of Labor Statistics. 2020. News Release: Employer Costs for Employee Compensation – March 2020. U.S. Department of Labor; USDL-20-1232, June 18. Available online: https://www.bls.gov/news.release/pdf/ecec.pdf; accessed June 2020.

KNN Public Finance, LLC (KNN). 2020. Memorandum, Re: Water District Debt Capacity. Memorandum to Joseph Jareb, Chief Financial Officer, United Water Conservation District, from David Brodsly, KNN Public Finance, LLC. May 22.

Stantec Consulting Services, Inc. (Stantec). 2019. Vern Freeman Diversion Vertical Slot Fish Ladder – Hydraulic Basis of Design Report. Prepared for United Water Conservation District; December 6, 2019, p. 33.

United Water Conservation District (United). 2018. Adopted Budget Plan, Fiscal Year 2018-19. July 1. Available online: http://www.unitedwater.org/reports-5/financial-repoe; accessed May 2020.

10 ALTERNATIVES TO TAKE

Under the Endangered Species Act (ESA{ TC "Endangered Species Act (ESA" \f A \l "1" }) and its implementing regulations, a habitat conservation plan (HCP{ TC "habitat conservation plan (HCP" \f A \l "1" }) must describe alternative actions to the taking to be authorized in the incidental take permits (ITPs{ TC "incidental take permit (ITP" \f A \l "1" }) and the reasons the alternatives are not being utilized. Over a number of years, United Water Conservation District (United{ TC "United Water Conservation District (United" \f A \l "1" }) has conducted extensive analysis of many alternatives to address flows for southern California steelhead (*Oncorhynchus mykiss*) migration and facility modifications for steelhead passage. This chapter describes these alternatives considered in the context of the ESA requirement to evaluate alternatives to take.

The chapter begins with an overview of the ESA regulations concerning this analysis. Next, the chapter describes how the proposed Multiple Species Habitat Conservation Plan (Proposed MSHCP{ TC "Multiple Species Habitat Conservation Plan (MSHCP" \f A \l "1" }) and alternatives were developed. Section 10.3 describes each of the alternatives to take evaluated in this chapter. Section 10.4 describes the methods used to evaluate each alternative to take, and Section 10.5 provides the evaluation by alternative. The final sections provide a summary and conclusion (Section 10.6).

10.1 REGULATORY BACKGROUND

The ESA requires that Section 10 permit applicants specify in HCPs that the alternatives to the taking of federally listed threatened and endangered species were considered and why those take alternatives are not being proposed (50 Code of Federal Regulations [CFR{ TC "Code of Federal Regulations (CFR" \f A \l "1" }] 17.22(b)(1)(iii)(C) and 222.307 (b)(5)(iv)). This chapter addresses this requirement by identifying and analyzing a range of take alternatives that would avoid or reduce the level of take of the covered fish and wildlife species likely to result from the activities covered by the MSHCP.

The U.S. Fish and Wildlife Service (USFWS{ TC "U.S. Fish and Wildlife Service (USFWS" \f A \l "1" }) and National Marine Fisheries Service (NMFS{ TC "National Marine Fisheries Service (NMFS" \f A \l "1" }) *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCP Handbook{ TC "Habitat Conservation Planning and Incidental Take Permit Processing Handbook (HCP Handbook" \f A \l "1" }) (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016{ TC "U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016" \f C \l "1" }) provides guidance for the analysis of take alternatives. Specifically, the HCP Handbook identifies two types of take alternatives that are typically considered in HCPs: take alternatives that would result in take levels below those anticipated for the Proposed MSHCPs, and take alternatives that would cause no incidental take, thereby eliminating the need for an ITP. The analysis must explain why the take alternatives were not adopted (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016{ TC "U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016" \f C \l "1" }). The evaluation of take alternatives is a requirement solely of the ESA. The following descriptions and analyses of take alternatives have, therefore, been developed solely for the purpose of meeting the requirements of Section 10 of the ESA.

As part of the California Environmental Quality Act (CEQA{ TC "California Environmental Quality Act (CEQA" \f A \l "1" }) and the National Environmental Policy Act (NEPA{ TC "National Environmental Policy Act (NEPA" \f A \l "1" }) process, a wider range of project alternatives has been identified and evaluated. The analysis of take alternatives in this chapter serves a specific and narrow regulatory purpose, which is separate and apart from the analysis of project alternatives under CEQA and NEPA. The environmental impact report (EIR{ TC "environmental impact report (EIR" \f A \l "1" }) and environmental impact statement (EIS{ TC "environmental impact statement (EIS" \f A \l "1" }) for the MSHCP each identify a reasonable range of project alternatives and evaluate the potential environmental impacts of those alternatives in relation to the no-action or no-project alternative.[1] Section 10.3 includes a summary comparison of the alternatives to take and the alternatives evaluated in the EIR and EIS.

10.2 DEVELOPMENT OF THE MSHCP AND TAKE ALTERNATIVES

This section describes the process used to develop alternative approaches to the MSHCP. These alternative conservation measures formed the basis of the take alternatives in this chapter.

Following construction of the Freeman Diversion, southern California steelhead were federally listed as endangered and United pursued incidental take coverage under Section 7 of the ESA. A federal nexus was established through the Bureau of Reclamation based on a loan agreement, and the Bureau of Reclamation consulted with NMFS regarding the operation of the Freeman Diversion Project; in 2008, this culminated in a final jeopardy biological opinion (BO{ TC "biological opinion (BO" \f A \l "1" }) with reasonable and prudent alternatives. The Bureau of Reclamation concluded that it had no authority to adopt or enforce the reasonable and prudent alternatives and, therefore, the BO was not adopted by the Bureau of Reclamation. However, in response to a potential lawsuit by California Trout (CalTrout), United agreed to abide by Element 1 of the reasonable and prudent alternatives that included a process in which a panel of fish passage experts would evaluate fish passage at the Freeman Diversion. The panel was given criteria and guidance from NMFS to evaluate the current fish passage system (i.e., the Denil fish ladder) and was charged with recommending feasible options to improve fish passage. Based on its assessment, the panel made the determination that “the existing fishway was not an adequate fish passage system” (VFDFPP 2010{ TC "VFDFPP 2010" \f C \l "1" }). The panel recommended that the Vertical Slot Fishway and the Hardened Ramp concepts receive further consideration as potential alternatives for a new passage facility at the diversion. The panel provided recommendations for improving passage through the existing facility, but concluded that “these potential improvements to the existing fishway, when performed together, are essentially the same as, and with no apparent cost advantage over the vertical slot or nature-like fishways” (VFDFPP 2010{ TC "VFDFPP 2010" \f C \l "1" }).

The alternative new fish passage facilities are designed to meet the criteria and guidance stated by NMFS northwest region (NMFS 2011{ TC "NMFS 2011" \f C \l "1" }), NMFS southwest region (NMFS 1997{ TC "NMFS 1997" \f C \l "1" }), California Department of Fish and Wildlife (CDFW{ TC "California Department of Fish and Wildlife (CDFW" \f A \l "1" }) Statewide Fish Screening Policy, and applicable sections of the California Salmonid Stream Habitat Restoration Manual Part XII (CDFW 2009{ TC "CDFW 2009" \f C \l "1" }). Additionally, in an Amicus Brief filed by NMFS on January 19, 2018, in litigation brought against United by third parties, NMFS provided guidance for choosing a preferred alternative that is expected to meet issuance criteria for an incidental take permit under Section 10(a)(1)(B) of the ESA. United used this guidance to design the fish passage facility renovation. Criteria for the new facility design also include the ability to pass flows of 750 cubic feet per second (cfs{ TC "cubic feet per second (cfs" \f A \l "1" }) into the diversion canal once United acquires a modified water right (from the State Water Resources Control Board) that allows for increased instantaneous diversions at the facility.

During litigation of a citizen lawsuit brought by Wishtoyo et al. against United, the hardened ramp, a gated partial notch, and infiltration gallery alternatives were discussed in detail. In the meantime, United also pursued more detailed investigation of the vertical slot alternative recommended by the panel and, prior to the Court issuing a ruling in the case, United concluded that a vertical slot fish passage system would be the best alternative to meet the needs of the biological resources in the river while balancing the water resource needs of the community. This decision was bolstered by the fact that a vertical slot fish passage facility would be

[1] The term *take alternative* refers to take alternatives associated with the MSHCP; the term *alternative* refers to the project alternatives evaluated in the EIR or EIS.

protected during catastrophic floods and remain functional during flood years when significant fish passage opportunities exist. United's Board directed staff to proceed with the third administrative draft of the MSHCP focused on a vertical slot alternative, which was submitted to the resource agencies on September 7, 2018.

Just 16 days later, the Court issued a decision in the case. Among other things, the Court required United to proceed with design work on the hardened ramp and gated notch, while also recognizing that the vertical slot or infiltration gallery could continue to be studied. At the time of its ruling, however, the Court was not aware of the considerable progress and conclusions that United had reached regarding the vertical slot. Immediately after the trial, but prior to issuing its decision, the Court requested from NMFS (although not a party to the litigation) "…which alternative fish passage design (or designs) should the Court specify?" (Order dated January 5, 2018, *Wishtoyo Foundation, et al. v. United Water Conservation District*, Central District of California Case No. 2:16-cv-03869-DOC-PLA (ECF No. 173)). In its January 19, 2018, Amicus Brief, NMFS recommended two design alternatives be considered further: (1) the Northwest Hydraulics Consultants, Inc.**{** TC "Northwest Hydraulics Consultants, Inc. 2017" \f C \l "1" **}**, November 2017 report, (p. 44) Alternative 2 (the "notch alternative"); and (2) the hardened ramp described in AECOM et al. (2016**{** TC "AECOM et al. 2016" \f C \l "1" **}**). The Court's September 23, 2018, judgment in the litigation directs United to "strongly consider" and reject "only with clearly articulable reasons" the design criteria identified in the Amicus Brief.

Thereafter, United continued design work on the hardened ramp, gated notch, and vertical slot fish passage design alternatives. At a status conference on June 3, 2019, the Court requested that United and NMFS technical staff and engineers meet to decide on a pathway to selecting a fish passage alternative to carry forward in the MSHCP. United and NMFS biologists, ESA practitioners, and engineers met and developed an Action Plan and Schedule (Action Plan**{** TC "Action Plan and Schedule (Action Plan" \f A \l "1" **}**). On June 12, 2019, United submitted the Action Plan to the Court detailing a process to select a preferred fish passage alternative to carry forward in the MSHCP. The Action Plan involved bringing each of the three alternatives to a hydraulic basis of design stage, so that NMFS could then provide guidance on each hydraulic basis of design report and prepare a guidance document that synthesized comments on each fish passage design alternative. United could then review all the fish passage design guidance in order to make a final decision on which alternative to carry forward in the MSHCP. Following the Action Plan, and after careful consideration of the guidance, United selected the vertical slot fish passage system as the preferred functional and most practicable alternative to be carried forward in the MSHCP. See United's formal letter explaining this decision (United 2020). The proposed fish passage alternative is the basis for comparison to the other fish passage structure alternatives in this chapter.

The current design for the vertical slot has undergone several iterations and is a traditional style of fish ladder with a long history of successful operation in passing steelhead and salmon. It was developed by the International Pacific Salmon Fisheries Commission to provide fish passage through a large land slide area at Hell's Gate on the Frasier River in British Columbia. Due to the slide, there was a large sediment debris load, and the vertical slot ladder was designed and is proven to pass both sediment and debris load. Refer to Chapter 5 for a description of CM 1.1.1, including a detailed description of the Proposed MSHCP's preferred alternative vertical slot fishway (Figure 5-1). Refer to Appendix C for the Hydraulic Basis of Design Report for the vertical slot fishway.

The take alternatives described below are limited to fish passage design changes and alternative approaches to water diversion because the construction and operation of water diversion facilities is the primary form of take of the covered species. Therefore, different designs and construction approaches to these facilities and water operations provide the greatest opportunity to reduce or eliminate take of the covered species.

Sources of information for this chapter include the following:

- Final Biological Opinion for United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility (NMFS 2008**{** TC "NMFS 2008" \f C \l "1" **}**)

- California Trout v. Bureau of Reclamation, et al. (2009 Settlement)
- Forecasted Water Resource Impacts from Changes in Operation of Freeman Diversion (Appendix B, United 2016{ TC "United 2016" \f C \l "1" })
- Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey (R2 Resource Consultants 2016{ TC "R2 Resource Consultants 2016" \f C \l "1" })
- United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Habitat Conditions in the Santa Clara River Estuary (Stillwater Sciences 2016a{ TC "Stillwater Sciences 2016a" \f C \l "1" })
- United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Riparian Vegetation in the Santa Clara River (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" })
- *Final Vern Freeman Dam Fish Passage Conceptual Design Report* (VFDFPP 2010{ TC "United Water Conservation District 2010" \f C \l "1" })
- Evaluation of Vern Freeman Diversion Dam Modification Alternatives, Detailed Feasibility Examination – Final Report (NHC 2016{ TC "NHC 2016" \f C \l "1" })
- 2018 Court Order dictating engineering designs for specific alternatives (Amended Judgment dated December 1, 2018 in *Wishtoyo Foundation, et al. v. United Water Conservation District*, Central District of California Case No. 2:16-cv-03869-DOC-PLA (ECF No. 248)).
- Alternative refinement process 2018–2019 as engineering design progressed and feasibility was determined, including the following hydraulic basis of design reports:
  - Vern Freeman Diversion Dam Notch Fish Passage Improvements – Draft Hydraulic Basis of Design Report, June 21, 2019 (NHC 2019a{ TC "NHC 2019a" \f C \l "1" })
  - Vern Freeman Diversion Hardened Ramp Fish Passage Improvements –Hydraulic Basis of Design Draft Report, July 21, 2019 (NHC 2019b{ TC "NHC 2019b" \f C \l "1" })
  - Vern Freeman Diversion Vertical Slot Fish Ladder – Hydraulic Basis of Design Report, December 6, 2019 (Stantec 2019{ TC "Stantec 2019" \f C \l "1" })
- Input from NMFS, USFWS, and CDFW on MSHCP and alternatives
  - Hydraulic Basis of Design Comments:
    - Letter from NMFS to United dated July 19, 2019, Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Notch Fish Passage Improvements dated June 21, 2019 (NMFS 2019a{ TC "NMFS 2019a" \f C \l "1" })
    - Letter from NMFS to United dated August 21, 2019, Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Hardened Ramp Fish Passage Improvements dated July 21, 2019 (NMFS 2019b{ TC "NMFS 2019b" \f C \l "1" })
    - Letter from NMFS to United dated September 16, 2019, Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Vertical Slot Fish Passage Improvements dated August 15, 2019 (NMFS 2019c{ TC "NMFS 2019c" \f C \l "1" })
    - Letter from NMFS to United dated September 26, 2019, Re: Summary of NOAA's National Marine Fisheries Service's (NMFS) Review and Recommendation for Three Fish Passage Facility Design Alternatives for Vern Freeman Diversion Dam (NMFS 2019d{ TC "NMFS 2019d" \f C \l "1" })
    - Letter from CDFW to United dated March 18, 2020, Re: United Water District, Vern Freeman Diversion Habitat Conservation Plan/Fish Passage, Ventura, California (CDFW 2020a).
    - Written comments on hardened ramp design and work plan transmitted by email from CDFW to United, March 18, 2020 (CDFW 2020b).

- MSHCP Live Edit Meetings:
  - Live Edit Meeting 1 between United, NMFS, USFWS, and CDFW for MSHCP Chapters 1 and 2 (Introduction and Existing Conditions), on March 25, 2019
  - Live Edit Meeting 2 between United, NMFS, USFWS, and CDFW for MSHCP Chapters 3 and 4 (Covered Activities and Covered Species), on April 12, 2019
  - Live Edit Meeting 3 between United, NMFS, USFWS, and CDFW for MSHCP Chapter 5 (Conservation Strategy), on June 19, 2019
  - Live Edit Meeting 4 between United, NMFS, USFWS, and CDFW for MSHCP Chapter 7 (Effects Analysis), on August 19, 2019
  - Live Edit Meeting 5 between United, NMFS, USFWS, and CDFW for MSHCP Chapters 2, 3, 4, and 5 with Appendices, on June 19, 2020
  - Live Edit Meeting 6 between United, NMFS, USFWS, and CDFW for MSHCP Chapter 6 (Adaptive Management and Monitoring), on May 28, 2020
  - Live Edit Meeting 7 between United, NMFS, USFWS, and CDFW for MSHCP Chapter 9 (Funding) and Conjunctive Use Projects Appendix, on June 17, 2010
  - Live Edit Meeting 8 between United, NMFS, USFWS, and CDFW for MSHCP Chapter 10 (Alternatives to Take)
  - Live Edit Meeting 9 between United, NMFS, USFWS, and CDFW for MSHCP Chapters 7, 8, and 10

10.3 DESCRIPTION OF THE TAKE ALTERNATIVES

This section summarizes the alternatives to take that are evaluated in this chapter using the methods described in the following section (Section 10.4). Refer to Chapter 5, for a description of CM 1.1.1, including a detailed description of the Proposed MSHCP's preferred alternative vertical slot fishway (Figure 5-1). The alternatives differ primarily in the design and operation of water conveyance facilities and improvements to the existing Freeman Diversion structure. Additionally, each take alternative includes operating criteria for the water supply infrastructure and conservation measures. The take alternatives vary with respect to elements associated with operations and/or structural modification.

The seven take alternatives discussed in this chapter fall into three general groups: (1) operational alternatives under which water operations differ from those of the Proposed MSHCP but use the existing facilities without structural modifications; (2) structural alternatives, which modify the Freeman Diversion and fish passage facilities but use the same water operations as those of the Proposed MSHCP; and (3) operational and structural alternatives, which both structurally modify the existing facilities and alter water operations compared to the Proposed MSHCP. Operational alternatives vary by flow parameters (i.e., amount of water diverted), but do not vary by the fish passage facility structure, fish passage facility operational interruption times, and sediment conveyance. Structural alternatives vary by fish passage facility structure, fish passage facility operational interruption times, and sediment conveyance but do not vary by diversion parameters.

The various approaches to modification of the existing structure were assembled to create a range of take alternatives that could be directly compared to the Proposed MSHCP, allowing for a meaningful comparison. For covered fish and wildlife species, the effect of changing these components was evaluated to assess the level of incidental take and conservation benefit in comparison with the Proposed MSHCP (Section 10.4.1, *Level of Take and Conservation Benefit to Covered Species*, describes methods used for this comparison). Estimates of incidental take are based on uncertain and unpredictable circumstances and are intended to be estimates of relative differences among alternatives based on the data and analytical tools available.

Most of the operational alternatives were modeled by United as detailed in the *Forecasted Water Resource Impacts from Changes in Operation of Freeman Diversion* (Appendix B). The hydrologic cycle included in the modeling was defined as the 1985–2015 period (31 years), and the assumptions included a repeat of this hydrologic cycle to simulate a 31-year future period. As noted in Appendix B, the 1985–2015 period included two severe droughts as well as several of the wettest years on record during the 1990s, and these highly variably climatic conditions were characterized as potentially representative of the range of future climatic conditions when considering global climate change. The resulting average annual diversion amounts (in acre-feet [AF{ TC "acre-feet [AF" \f A \l "1" }]) represent the best estimate of the Freeman Diversion yield due to the modeled operational alternatives. The average annual diversion yields for each operational alternative are summarized below.

Table 10-1 summarizes the alternatives to take that are evaluated in terms of the permitting and construction, and water operations. Components that do not vary from those of the Proposed MSHCP are not described. Similarly, components that differ among take alternatives but retain the conclusions regarding level of potential take of covered fish or wildlife species are not identified in this summary table (however, these differences are discussed later in the chapter in Section 10.5, *Assessment of Take Alternatives*). Table 10-2 summarizes the characteristics of each alternative as compared to the Proposed MSHCP. This approach is intended to highlight the differences between each take alternative and the Proposed MSHCP that could affect the level of take. For some take alternatives, a single conservation measure has been altered; for others, multiple conservation measures have been altered.

Table 10-1 Summary of MSHCP Alternatives to Take Evaluated in this Chapter		
Alternative	**Summary of Alternative – Permitting and Construction**	**Summary of Alternative – Water Operations**
Proposed MSHCP	The existing Denil fish ladder would be removed and United would construct a vertical slot fishway coupled with crest gates and other appurtenances to operate the diversion.	United would initially divert water up to 375 cfs under specific conservation measures designed to maintain fish passage and habitat characteristics downstream of Freeman Diversion. Following construction of the new fish passage and diversion facility, United would divert up to 750 cfs under the same conservation measures.
Operational Alternatives		
Alternative A – Wishtoyo Operational Remedies Plus Santa Felicia Water Diversion	No change in diversion structure would occur. Freeman Diversion would remain in place as is with no fish passage or water conveyance improvements.	Operating rules for water diversion at the existing structure would be modified to enhance passage characteristics for all life stages of steelhead that may pass the diversion grade control structure. In summary, these rule changes would extend the adult and juvenile fish migration seasons and restrict the rate and duration of water diversion. These changes would result in reduced diversion of surface water at the diversion structure and increased discharge downstream. This would include continued water transfer from the Santa Felicia Project, which is regulated under a separate Federal Energy Regulatory Commission license.
Structural Alternatives		
Alternative B – Notch structure with low-flow technical fishway	A portion of the existing diversion facility, including the Denil fish ladder, would be removed and United would construct a wide notch in Freeman Diversion of approximately 400 feet wide and 13 feet deep. A series of Obermeyer gates actuated using rubber bladders would be used to regulate flows through the notch. United would construct a roughened channel downstream of the notch to serve as a fish passage facility when the notch was open. A low-flow technical fishway would be constructed to allow fish passage at lower flows.	The notch design requires switching from a low-flow fishway to a high-flow fishway at a threshold of 2,375 cfs. The notch design is incapable of diverting flows above this threshold, whereas both the vertical slot and hardened ramp designs can. Operations would be otherwise identical to that of the Proposed MSHCP.
Alternative C – Hardened ramp structure	The existing Denil fish ladder and portions of the diversion facility would be removed and United would construct a hardened ramp fish passage facility that would extend both up- and downstream of Freeman Diversion. It would be an asymmetrical concrete structure that features a series of gates, baffles, and walls.	Same as that of the Proposed MSHCP.
Structural & Operational Alternatives		
Alternative D – Vertical Slot plus water diversion consistent with 2008 Biological Opinion	Same as that of the Proposed MSHCP.	At flows less than 635 cfs, United would only divert up to 20% of river flows consistent with its proposed ramping protocol. At flows between 635 and 750 cfs, United would only divert up to 30% of river flows consistent with its proposed ramping protocol. Smolt and adult migration protocols restrict diversion when a connection to the estuary could be maintained.
Alternative E – Hardened Ramp plus water diversion consistent with 2008 Biological Opinion	Same as that of Alternative C	Same as that of Alternative D (water diversion consistent with 2008 Biological Opinion)
Alternative F – Infiltration gallery	The Freeman Diversion structure and fish passage facility would be removed, and an instream infiltration gallery would be built under the riverbed.	Same as that of the Proposed MSHCP.
Alternative G – Remove structure	The Freeman Diversion would be removed along with the current fish passage structure and would not be replaced with an alternative structure.	All diversions would cease because they would no longer be possible without a diversion facility.

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Table 10-2 Summary of Alternatives' Characteristics, Compared to Proposed MSHCP

Alternative	Average Annual Diversion Yield	Daily or Instantaneous Diversion Rate	Maximum Flow Capacity Prior to Spilling	Minimum Flow Capacity	Attraction Flow %	Estimated # Annual Interruptions (e.g., no passage possible)	Estimated Sediment Conveyance Capacity	Estimated Passage Delay/Issues	Construction/Maintenance/Monitoring[1]
Proposed MSHCP with Vertical Slot Fish Passage Facility	71,800 AF (after increase of max diversion rate to 750 cfs).	375 cfs instantaneous diversion rate in interim period. 750 cfs future max diversion rate.	6,000 cfs as criteria for max flow; fish passage facility would need to be able to be operated at this max to satisfy passage criteria. Facility may operate >6,000 cfs upstream of diversion, but passage criteria may not be met. Flows >6,000 cfs result in spill over diversion crest.	0–45 cfs upstream of diversion. Ladder would pass 34–37 cfs, at design upstream water level of 161.5 ft. elevation.	"Fish bypass flows" = ladder flow (34–37 cfs) plus auxiliary water supply (570 cfs) = approximately 600 cfs. Approximately 100% attraction flow up to 1,150 cfs total upstream flow (600 cfs in fish bypass flows + 750 cfs diversion), which is expected approximately 94% of the time. As flows increase beyond approximately 1,150 cfs, attraction flow percentage reduces due to flow through crest gates. At least 10% attraction flow at a total upstream flow of 6,000 cfs (600 cfs/6,000 cfs). Use of bypass channel to pass water delays spill over diversion crest.	Annual sediment sluicing operation for maintenance would interrupt fish passage if fish ladder were in operation at that time.	Sediment accumulation would be managed with sediment sluicing operations, sparger system/educator manifold (i.e., water jets), and manual removal.	Less delay than current facility due to improved fish passage facility including increased attraction flow. Additional delay due to sediment sluicing operations, though minimal in timing (~2 hours), would occur because ladder cannot be operated concurrently. Injury/disorientation of juveniles may occur if passed over the diversion crest when flows exceed capacity of fishway/diversion/auxiliary channels, etc. Injury/disorientation of juveniles also may occur during sediment sluicing operations.	Construction would require approximately 2.83 acres of temporary and 0.03 acre of permanent direct impacts to riparian and streambed habitats. Construction would. be completed within 2 years from permit issuance. Maintenance would be similar to that of current facility: annual fish ladder inspection & cleaning (dewatering), sediment sluicing operations, and periodic large debris removal/screen cleaning without dewatering, vegetation control, and road maintenance. Monitoring via upstream migrant trap within or at the exit of the vertical slot fish ladder, DIDSON, PIT tag and radio-telemetry antenna arrays, and evaluation station with downstream trapping and tagging capabilities.
A – Wishtoyo Operational Remedies Plus Santa Felicia Water Diversion	Approximately 30,000 AF. Lower than Proposed MSHCP.	375 cfs instantaneous diversion rate but would depend on time of year (diversion limited to outside adult/juvenile migration windows) and implementation of modified CMs 1.2.1–1.2.4. Often, diversions would be lower than under Proposed MSHCP, and more water would be bypassed for enhanced fish passage characteristics below the diversion.	Same as current facility, less than Proposed MSHCP.	45 cfs. Same as current facility, same as Proposed MSHCP.	Same as current facility. Under this scenario, attraction flows would be lower than under Proposed MSHCP.	Same as current facility, greater than Proposed MSHCP.	Same as current facility, same as Proposed MSHCP.	Less passage delay/interruption downstream of diversion than under Proposed MSHCP because more flows would be bypassed. However, existing fish ladder operates less effectively than fish passage facility included in Proposed MSHCP. Also, potential issue associated with reduced attraction flow because of increased discharge over diversion crest.	No construction. Less construction-related impact than under Proposed MSHCP. Similar maintenance activities/effects as under Proposed MSHCP. Similar monitoring capability as under Proposed MSHCP.
B – Notch Structure	66,800 AF. Lower than Proposed MSHCP because diversion at high flow is precluded.	375 cfs instantaneous diversion rate in interim period. 750 cfs future max diversion rate. Diversions would not occur at river flows greater than 2,375 cfs when notch crest gates are open.	6,000 cfs. Same as Proposed MSHCP.	45 cfs. Same as Proposed MSHCP.	During diversion operations, low-flow fishway is used or spill occurs over notch (notch opening threshold of 2,375 cfs). Approximately 25% attraction flow from 45–400 cfs (low-flow fishway capacity) and 100% attraction flow from 400–6,000 cfs. Similar to Proposed MSHCP at discharge less than 2,375 cfs. Greater attraction flow percentage than under Proposed MSHCP at discharge greater than 2,375 cfs.	Passage interruptions would occur whenever crest gates are opening or closing (at notch opening threshold of 2,375 cfs). Could also occur during maintenance shut-down of passage facility following large storm flow events due to damage from high debris loads Greater than Proposed MSHCP.	Scour issues expected, particularly at right containment wall of rock ramp. Bypass channel not included in design. The river would be expected to evolve toward more natural grade and uniform profile (aggradation downstream of lowered crest elevation and degradation upstream). This could cause issues with adjacent landowners whose properties are being managed for preservation, and it presents challenges for fish passage facilities design to accommodate changing bed elevations. Greater sediment conveyance issues than Proposed MSHCP (more sediment conveyance capacity but greater aggradation/degradation of riverbed, resulting in greater design challenges and effects to other resources).	Several hours delay during all notch crest gate opening/closing (when transitioning from low-flow fishway to/from ramp). Passage barrier occurs when crest gates close until water level upstream of diversion structure increases sufficiently to operate low-flow fishway. Inverse occurs during gate opening as flow increases on ramp and water levels upstream decrease below level necessary to operate low-flow fishway. Potential for large-scale damage to ramp facility from high-flow large debris mobilizing events, resulting in long periods when passage facility could be out of commission. At some flows, fish would have to travel laterally at the diversion crest to connect from the ramp to the low-flow fishway before exiting the structure. Greater delays than Proposed MSHCP.	Construction activities would be similar to the Proposed MSHCP. Construction could have temporary and permanent direct impacts on approximately 18 acres of riparian and streambed habitats. Overall, effects from routine maintenance activities/impacts would be comparable to under Proposed MSHCP. The reduction in maintenance activities associated with no bypass channel would be offset by higher maintenance needs from in-channel sediment management for channel training, Obermeyer gate bladder replacements, and repair of damage to the in-river fishway from high flow debris. Monitoring would be more difficult than under Proposed MSHCP because flows would be routed through the ramp at high flows. When low-flow fishway is used and river conditions permit, monitoring may be possible.

Table 10-2 Summary of Alternatives' Characteristics, Compared to Proposed MSHCP

Alternative	Average Annual Diversion Yield	Daily or Instantaneous Diversion Rate	Maximum Flow Capacity Prior to Spilling	Minimum Flow Capacity	Attraction Flow %	Estimated # Annual Interruptions (e.g., no passage possible)	Estimated Sediment Conveyance Capacity	Estimated Passage Delay/Issues	Construction/Maintenance/Monitoring[1]
C – Hardened Ramp Structure	71,800 AF. Same as Proposed MSHCP.	375 cfs instantaneous diversion rate in interim period. 750 cfs future max diversion rate. Same as Proposed MSHCP.	6,000 cfs. Same as Proposed MSHCP.	45 cfs. Same as Proposed MSHCP.	To be determined but approximately 100% up to 2,600 cfs total upstream flow (1,800 cfs fish bypass flows + 750 cfs diversion), then reducing to near 50% in excess of 7,000 cfs total upstream flow (due to spill over diversion crest). Use of bypass channel to pass water adjusts these flow values higher by delaying spill over diversion crest. Higher than Proposed MSHCP.	Potentially less frequent but of longer duration than under Proposed MSHCP. Potential interruptions during maintenance shut-down of ramp following large storm flow events due to damage from high debris load.	High potential for damage to ramp from large debris and bedload transported during storm flow events. Sediment accumulation to be managed with sediment sluicing operations and manual removal, and there may be a need for less fine sediment management compared to the Proposed MSHCP. However, because the facility is in-channel, there is much greater potential for damage to fish passage facility from high debris loads that occur during storm flow events. May be higher than Proposed MSHCP but with high risk of passage facility damage.	Ramp may not be shut down during sediment sluicing operations. Injury/disorientation of juveniles may occur if passed over the diversion crest when flows exceed capacity of fishway/diversion/auxiliary channels, etc. Injury/disorientation of juveniles also may occur during sluicing operations. Less than Proposed MSHCP.	Construction activities would be similar to the Proposed MSHCP. Construction could have temporary and permanent direct impacts on approximately 5.5 acres of riparian and streambed habitats. Maintenance activities anticipated to be required more often than under Proposed MSHCP due to increased damage potential from debris transported during storm flows. Additionally, due to the ability of debris to accumulate in the fishway, rescue of stranded fish within the hardened ramp when dewatered would be more difficult compared to the Proposed MSHCP. Monitoring of upstream fish passage would be more difficult than under Proposed MSHCP. Monitoring of bypassed downstream moving fish is possible and the same as Proposed MSHCP.
D – Vertical Slot plus 2008 BO	50,000 AF. Lower than Proposed MSHCP.	375 cfs instantaneous diversion rate in interim period. 750 cfs future max diversion rate. Same as Proposed MSHCP.	6,000 cfs. Same as Proposed MSHCP.	45 cfs. Same as Proposed MSHCP.	Same as Proposed MSHCP.	Same as Proposed MSHCP.	Same as Proposed MSHCP.	Reduced surface water diversions associated with 2008 BO would result in more water discharged downstream providing more passage days for steelhead through the critical reach. Greater than Proposed MSHCP.	Same as Proposed MSHCP.
E – Hardened Ramp plus 2008 BO	50,000 AF. Lower than Proposed MSHCP.	375 cfs instantaneous diversion rate in interim period. 750 cfs future max diversion rate. Same as Proposed MSHCP.	6,000 cfs. Same as Proposed MSHCP.	45 cfs. Same as Proposed MSHCP.	100% under most flows, below approximately 2,600 cfs. Same as Alternative C. Higher than Proposed MSHCP.	Same as Alternative C. Potentially less frequent but of longer duration than under Proposed MSHCP.	May be higher than Proposed MSHCP but with high risk of passage facility damage.	Same as Alternative C. Less than Proposed MSHCP.	Same as Alternative C.
G – Infiltration Gallery	71,800 AF. Same as Proposed MSHCP.	Could capture maximum of 750 cfs of infiltration withdraw if gallery is approximately 11.5 feet deep; however, a large enough gallery would be extremely costly and energy consumption for pumping would be prohibitive.	All remaining river flow minus water taken from infiltration withdraw by gallery.	N/A	N/A	None. Less than Proposed MSHCP.	Maintenance of intakes to keep them clear of sediment would be needed at an undetermined frequency, which could require isolation of part of or the entire river channel if wetted at that time This alternative would result in long-term degradation of the river upstream of the diversion and aggradation downstream. At the structure, the upstream riverbed is expected to degrade by as much as 15 feet from current conditions.	None during normal operations; however, maintenance for sediment clearing may result in substantial passage delays if diversion of the river is needed during the migration season.	The 750 cfs diversion rate gallery could have temporary and permanent direct impacts on approximately 40 acres of riparian and streambed habitats. There would be no maintenance required of fish passage or diversion facilities; however, emergency maintenance associated with sedimentation inside gallery may offset this difference. Roads/vegetation maintenance, etc. similar. No monitoring capabilities during high flows; low-flow monitoring could be accomplished (e.g., PIT tagging or trapping).
H – Remove Structure and Cease Diversion	Zero AF. Less than Proposed MSHCP.	0 cfs. Less than Proposed MSHCP.	N/A	N/A	N/A	None. Less than Proposed MSHCP.	N/A	None. Less than Proposed MSHCP.	Compared to Proposed MSHCP, demolition would likely be limited to dry season. Demolition could have temporary direct impacts on approximately 5 acres of riparian and streambed habitats. Maintenance would be less than under Proposed MSHCP because no structure would be in place. No monitoring capabilities during high flows; low-flow monitoring could be accomplished (e.g., PIT tagging or trapping).

[1] Monitoring activities discussed in this table and in Section 10.4.3, *Practicability*, pertain to migrant fish monitoring; additional monitoring activities included in the MSHCP are described in Chapter 5, *Conservation Program*, and Chapter 6, *Monitoring and Adaptive Management*, but are not expected to vary across the alternatives. Effects of monitoring activities under the proposed MSHCP are evaluated in Chapter 7, *Effects Analysis*.

Table 10-3 describes the relationship between MSHCP alternatives analyzed in this chapter and alternatives analyzed in the EIR and EIS for the MSHCP. Three MSHCP alternatives were also evaluated in the EIR and EIS, although they may have different names in those documents. This MSHCP chapter explored several alternatives that were considered in the EIR and EIS but were not further evaluated at the level of detail as the Proposed MSHCP, Notch Structure, and Hardened Ramp alternatives.

Table 10-3 Relationship of MSHCP Alternatives to Take with EIR and EIS Alternatives

MSHCP Alternative to Take	EIR Alternative	EIS Alternative
Proposed MSHCP	Proposed Project	Proposed MSHCP
A: Wishtoyo Operational Remedies + Santa Felicia	Considered but not evaluated further	Considered but not evaluated further
B: Notch Structure	Notch Structure	Notch Structure
C: Hardened Ramp	Hardened Ramp	Hardened Ramp
D: Vertical Slot + 2008 BO	Considered but not evaluated further	Considered but not evaluated further
E: Hardened Ramp + 2008 BO	Considered but not evaluated further	Considered but not evaluated further
G: Infiltration Gallery	Considered but not evaluated further	Considered but not evaluated further
H: Remove Structure and Cease Diversion	Considered but not evaluated further	Considered but not evaluated further

10.3.1 ALTERNATIVE A – WISHTOYO OPERATIONAL REMEDIES PLUS SANTA FELICIA PROJECT

Under **Take Alternative A: Wishtoyo Operational Remedies Plus Santa Felicia Project**, United would not undertake any new construction activities at Freeman Diversion that have any potential to take the covered species. No new diversion facility or fish passage structure would be built. Instead, the current Freeman Diversion and Denil fish ladder would remain in place and would continue to be operated in a fashion similar to under the Proposed MSHCP but operating criteria for Freeman Diversion would be derived from the "no take scenario" put forth by Sharon Kramer PhD as part of testimony supporting plaintiffs in the recent court case *Wishtoyo et al. vs. United Water Conservation District* (Kramer 2017{ TC "Kramer 2017" \f C \l "1" }). The operating criteria described in the scenario are characterized by Dr. Kramer as actions associated with the operation of Freeman Diversion "needed to eliminate or at least greatly minimize any take of steelhead." However, in spite of its name, the "no take scenario" and **Take Alternative A** would still involve potential take of steelhead, primarily through a variety of mechanisms associated with the existing fish passage facility and diversion operations.

Water diversion operations associated with **Take Alternative A** would be otherwise identical to those under the Proposed MSHCP including water releases associated with the Santa Felicia Project on Piru Creek, which is regulated under a separate Federal Energy Regulatory Commission license, but would have operational modifications to the following conservation measures:

1. Expand adult steelhead migration window (CMs{ TC "conservation measure (CM" \f A \l "1" } 1.2.1/1.2.3).
2. Under the Proposed MSHCP, the primary adult steelhead migration window is defined as the period from January 1 to May 31. Outside of this period, United may divert 100 percent of river flows up to 375 cfs. Under **Take Alternative A**, the primary adult steelhead migration window is defined as the period from November 1 to June 30. In most years, there is little to no flow in the Santa Clara River outside of this window. Outside of this expanded migration window, United would continue to be allowed to divert 100 percent of river flows up to 375 cfs. United's proposed operating rules stipulate the release of bypass flows within this window as necessary to achieve flow conditions in the Santa Clara River downstream of Freeman Diversion sufficient for adult steelhead migration whenever flows in the Santa Clara River would allow this, absent United's diversion.
3. Expand juvenile steelhead migration window (CM 1.2.2/1.2.4).

4. Under the Proposed MSHCP, the primary juvenile steelhead migration window is defined as the period from March 15 to May 31. Under **Take Alternative A**, the primary juvenile steelhead migration window is defined as the period from November 1 to July 31. In most years, there is little to no flow in the Santa Clara River outside of this window. Outside of this expanded migration window, United would continue to be allowed to divert 100 percent of river flows up to 375 cfs. United's proposed operating rules stipulate the release of bypass flows during this period as necessary to achieve flow conditions in the Santa Clara River downstream of Freeman Diversion sufficient for juvenile steelhead migration whenever flows in the Santa Clara River would allow this minus 40 cfs for United's critical diversions.
5. Release bypass flows sufficient to create depths at the critical riffle necessary for unimpeded adult steelhead migration (CM 1.2.1/1.2.3).
6. Under the Proposed MSHCP, United would bypass flows according to the five operational protocols outlined in CM 1.2.1 with 160 cfs downstream of the critical riffle considered to be the minimum amount of instream flow needed to provide a more than adequate functional upstream migration corridor for adult steelhead and Pacific lamprey (*Entosphenus tridentatus*) (to produce a water depth greater than 0.5 foot over a continuous width of 5 feet). The bypass flows would last for a 30-day period. Under Take Alternative A, the bypass flow is defined as 700 cfs, a value estimated to produce a water depth of 0.8 foot over a continuous width of 10 feet. This bypass flow would be released whenever the No Diversion Hydrograph allows for it; there is no triggering criteria for this bypass flow.
7. Maintain the greatest amount of flows between 120–160 cfs at the critical riffle as attainable (CM 1.2.1–1.2.4).
8. Under the Proposed MSHCP, and within the bypass flow regime, United may cease releasing water at Freeman Diversion when flows at the critical riffle are between 160 and 120 cfs. These are flows where steelhead migration is considered possible. Under **Take Alternative A**, United would be required to release bypass flows from Freeman Diversion to maintain the greatest amount of flow between 120–160 cfs at the critical riffle as attainable without diversions during the adult steelhead migration window.
9. Maintain continuous flow through the critical riffle when attainable (CM 1.2.1–1.2.4).
10. Under the Proposed MSHCP, there may be periods when diversion activities result in the river reach downstream of Freeman Diversion loosing continuous flow to the estuary. Under **Take Alternative A**, United would be required to release bypass flows from Freeman Diversion to maintain continuous flow through the critical riffle to the estuary whenever this would be attainable during the juvenile steelhead migration window with no diversion by United.
11. Implement appropriate trigger criteria for bypass flows (CM 1.2.1–1.2.4).
12. Under the Proposed MSHCP, United's diversion rules employ a trigger to initiate bypass flows during adult and juvenile migration windows. This trigger is a 200 cfs increase in flow over current conditions at the Sespe Creek gage. Under **Take Alternative A**, United would be required to implement a different trigger to initiate bypass flows during adult and juvenile migration windows. This trigger is a prediction that given forecasted storm events, flow levels in the Santa Clara River are expected to be sufficient to sustain flows of 160 cfs or greater at the critical riffle for a period of 3 days.
13. Release bypass flows sufficient to maintain appropriate ramping flows (CM 1.2.1–1.2.4).
14. Under the Proposed MSHCP, United's Variable Flow Protocol (VFP{ TC "Adult Migration Variable Flow Protocol (AMVFP" \f A \l "1" }), Base Flow Protocol (BFP{ TC "Adult Migration Base Flow Protocol (AMBFP" \f A \l "1" }), and Transition Protocol are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion. The VFP is broadly characterized by provision of 650 cfs at the

critical riffle on the first day following a trigger event, with flows decaying over the course of 30 days to zero and dependent on upstream flow rates. The BFP may be activated during the 30-day draw-down and requires provision of 160 cfs decaying over the course of 20 days to zero and dependent on upstream flow rates. The Transition Protocol is used to ease transitions between the two adult migration protocols.

15. Under **Take Alternative A**, United's capacity to divert would be dependent on flows at the critical riffle in the absence of diversion. At flows of ≥700 cfs, United could divert up to 30 percent of excess water. Once flows dropped below 700 cfs, United would be precluded from diverting any water.
16. Release bypass flows sufficient to cue oceangoing steelhead to migrate into the Santa Clara River (CM 1.2.1–1.2.4).
17. Under **Take Alternative A**, taken as the summary of the preceding components (1–8), total flows that United is allowed to divert would be curtailed, particularly in fall and early winter. Curtailment of diversion would result in increased freshwater inputs into the estuary and nearshore marine environment for the purposes of cuing oceangoing steelhead to migrate into the Santa Clara River.

Additional flows would be conveyed through the diversion structure, including the fish ladder, auxiliary bypass channel, smolt bypass, diversion crest, and bypass channel chute, but would not be routed into the diversion canal. The current estimate of what average annual diversion would be possible under **Take Alternative A** is roughly 30,000 AF (McEachron, pers. comm. 2020).

General maintenance operations associated with **Take Alternative A** would be similar to those in the Proposed MSHCP. This includes the following activities along with their anticipated frequency: dewatering and flow rerouting (annually), fish passage facility routine maintenance including sediment and debris management (annually), vegetation management (quarterly to annually), access road grading, compaction, and fill (annually), and use of permit area roads and access points (daily/weekly). Routine maintenance and sediment/debris management require the dewatering of the wetted area upstream of the diversion and may require operation of heavy equipment in the dewatered stream channel. Vegetation management would require foot access and may require operation of heavy equipment in the stream channel. Vehicles and heavy equipment may be operated on permit area roads and access points. Infrequent maintenance including facility repair and upgrade, as well as instream sediment and debris removal would also be necessary at the frequencies described in Chapter 3, *Covered Activities*, Section 3.3.5.

10.3.2 ALTERNATIVE B – NOTCH STRUCTURE

Under **Take Alternative B: Notch structure**, United would construct an approximately 400-foot-wide by 13-foot-deep notch in Freeman Diversion. A series of 20 Obermeyer gates actuated using rubber bladders would be used to regulate flows through the notch. Downstream of the notch, a roughened rock ramp-style structure would be constructed to serve as a high-flow fishway (HFF{ TC "high-flow fishway (HFF" \f A \l "1" }) when the notch was open, and a low-flow fishway (LFF{ TC "low-flow fishway (LFF" \f A \l "1" }) would be constructed along the south bank to serve as a fish passage facility when the notch was closed.

Most elements of the existing Freeman Diversion would be modified to accommodate new design features. The approach channel, sediment sluicing channel, diversion channel, auxiliary water supply, Denil fish ladder, and trash rack would be altered or demolished and replaced. Construction would last approximately the same duration as the Proposed MSHCP, 2 years, including approximately 503 active construction days within approximately 700 calendar days, and would include construction during the wet season. The project's construction footprint would be located mostly on United's property. Construction could have temporary and permanent direct impacts on approximately 18 acres of riparian and streambed habitats. Construction activities would use similar practices and equipment to that of the Proposed MSHCP. Major modifications and additions associated with **Take Alternative B** include the following elements:

- Notch: The notch is designed with three steps in cross-sectional height to concentrate lower flows to the left side of the HFF (looking downstream) and to provide a range of depths and velocities across the width of the HFF at a given discharge. A low-flow section is located along the left side of the HFF to align with the LFF which extends upstream of the diversion structure.
- Crest gates: Crest gates consist of a series of 20 Obermeyer gates in a stepped design, whereby three different bottom elevations, necessitating differently sized gates, are specified. The gates are bladder-operated and can be operated individually or in series to change the crest height of the diversion structure. At flows above 2,375 cfs, the gates are lowered, providing unimpeded access through the facility.
- HFF and LFF: The HFF fishway is a sloping rock spillway structure extending downstream from the crest of the notch to the riverbed downstream. The diversion notch grade control structure is approximately 400 feet wide but the HFF extends to the limits of the LFF on its left-hand side with no separation between the LFF section and the HFF sections. The LFF extends past the HFF through two alternatives, a roughened channel or a pool and chute fishway with baffles, that allow for fish passage past the diversion crest during low-flow operations when the notch is closed.
- Diversion intake and fish screen: The notch alternative includes three options for the diversion intake. The first option consists of using the existing intake, the second is to expand the existing intake, and the third is to expand and relocate the intake. For purposes of the analysis, only the third option (relocation of the intake) was considered. This option offers several advantages over use or modification of the existing intake structure, primarily sediment management. For the third option, the fish screen bay would also be replaced, allowing for a larger structure that meets NMFS criteria for avoidance of injury to fish. Fish entering the diversion intake are routed through a bypass fishway.

Water operations associated with **Take Alternative B** would follow all the protocols and conservation measures described in the Proposed MSHCP. These protocols include the VFP, BFP, Smolt Migration Protocol (SMP{ TC "Smolt Migration Protocol (SMP" \f A \l "1" }), and Turn-in Rate Protocol (TRP{ TC "Turn-in Rate Protocol (TRP" \f A \l "1" }) detailed in CMs 1.2.1–1.2.4. Fish passage design flows range from 45 to 6,000 cfs, with the notch opening at a threshold of 2,375 cfs. Once the notch is opened, the LFF is dewatered and ceases operation. The LFF has a capacity of up to 400 cfs before additional flow is diverted over the crest. In the current design, when operation of the HFF is commenced, opening of the notch crest gates would decrease water levels upstream of the diversion structure below the levels necessary to operate the LFF. Conversely, during transition from the HFF back to the LFF, gate closure would interrupt flow into the fishways until the water level upstream of the diversion structure is sufficient to operate the LFF. Flow interruptions could last several hours based on assumptions made regarding ramping rates and inflows. Current estimates by United indicate that average annual diversion under this scenario is likely to be approximately 66,800 AF.

Overall, maintenance needs associated with **Take Alternative B** would be greater than those in the Proposed MSHCP. The following activities would be similar to the Proposed MSHCP, along with their anticipated frequency: dewatering and flow rerouting (annually), fish passage facility routine maintenance including sediment and debris management (annually, but may be less frequent than under the Proposed MSHCP), vegetation management (quarterly to annually), access road grading, compaction, and fill (annually), and use of permit area roads and access points (daily/weekly). Access requirements for these activities would also be similar to those of the Proposed MSHCP. **Take Alternative B** may require more frequent dry-season in-channel sediment maintenance. However, due to the location of the fishway structure across the main river channel, nonroutine repairs are anticipated to be necessary following flood flows that are capable of transporting large debris, which could damage the HFF facility. Additionally, the 20 Obermeyer crest gates require bladder replacement at approximately 30 years of service life, and in addition, may require maintenance due to damage sustained during flood flows or component malfunction. These potential maintenance events are anticipated to be nonroutine and their frequency cannot be estimated with any accuracy.

10.3.3 ALTERNATIVE C – HARDENED RAMP STRUCTURE

Under **Take Alternative C: Hardened ramp structure**, United would construct a hardened ramp fish passage facility to replace the existing Freeman Diversion structure. Several components of Freeman Diversion would be extensively modified or replaced. The hardened ramp would extend both up- and downstream of Freeman Diversion and would be an asymmetrical concrete structure. The alternative consists of the following additions or modifications of existing components: crest gate, hardened ramp, bypass channel (i.e., sediment sluicing channel), and diversion canal with fish screens.

Most elements of the existing Freeman Diversion would be modified to accommodate new design features. The approach channel would be redesigned, with a new sediment sluicing channel and diversion channel intakes. The current auxiliary water supply, Denil fish ladder, and trash rack would be demolished. Crest gates would be added at the mouth of the hardened ramp. Major modifications and additions include the following elements:

- Sediment sluicing channel: The existing bypass channel used for sediment sluicing is located between the diversion structure crest to the north and the intake and fish ladder to the south. From upstream to downstream, the bypass channel consists of a concrete apron a slide gate, and a chute section. The bypass channel approach would be modified as part of the alternative to extend upstream along the southern edge of the hardened ramp to an intake flush with the crest of the hardened ramp. The bypass channel chute from the existing roller gate location downstream to the end of the present chute would remain in place.
- Trash rack: The existing trash rack would be replaced to accommodate the larger flows expected with 750 cfs diversion. The new trash rack would be positioned in approximately the same location as the existing structure.
- Diversion canal: Two existing canal gates would be retained, and two additional gates of the same size would be added adjacent to the existing gates. The diversion canal would be widened to accommodate the increased flows associated with 750 cfs diversion.
- Fish screens and fish bypass: Vertical panel fish screens would be added to the canal intakes. Screen panels would be stainless-steel frames and profile wire screens having 1.75-millimeter slots to meet juvenile fry screening requirements. Secondary and finishing screens placed behind the primary screens would channel and direct fish through a fish bypass toward a fish trapping and evaluation station that can be used to monitor downstream fish runs, then to a release location for return to the river downstream of the diversion.
- Hardened ramp fishway. The existing Denil fish ladder would be decommissioned and demolished. In its place, a hardened ramp fishway would be constructed. The hardened ramp fishway would have a 90-foot-wide cross-section and asymmetrical shape. It would utilize a roughened channel during low flows, expanding into a metal baffled lateral section at moderate and higher flows. The asymmetrical shape would provide fish passage at a range of flows up to 6,000 cfs. A crest gate would be added at the intake of the hardened ramp to control water surface elevations in the forebay during diversion and would consist of two 30-foot-long and two 15-foot-long Obermeyer gates.

Construction of the hardened ramp would last approximately 2 years, or 720 to 730 calendar days, and would include construction during the wet season. The construction footprint would be located mostly on United's property. Construction would have temporary and permanent direct impacts on approximately 5.5 acres of riparian and streambed habitats. Construction activities would use similar practices and equipment to that of the Proposed MSHCP.

Water operations associated with **Take Alternative C** would follow all the protocols and conservation measures described in the Proposed MSHCP. These protocols include the TRP, VFP, BFP, SMP, transition protocol, and pulse protocol detailed in CMs 1.2.1–1.2.4. As discharge increases in the river, and when diversion criteria are met, water is diverted through the various elements of the proposed diversion depending on priorities. During the primary migration season, water is first prioritized for flows through the fishway, then to the diversion canal or to the bypass channel (if sediment management activities are needed), and lastly past the crest gates if flows exceed the capacity of the diversion, bypass, and fishways. Average annual diversion under this alternative would be approximately 71,800 AF, which is identical to the Proposed MSHCP (Appendix B).

General maintenance needs associated with **Take Alternative C** would be similar to those in the Proposed MSHCP. This includes the following activities along with their anticipated frequency: dewatering and flow rerouting (annually), facility routine maintenance (annually, but may be less frequent than under the Proposed MSHCP), vegetation management (quarterly to annually), sediment and debris management (annually as needed but may be less frequent than under the Proposed MSHCP), access road grading, compaction, and fill (annually), and use of permit area roads and access points (daily/weekly). Access requirements for these maintenance activities would also be similar to those of the Proposed MSHCP. However, due to the location of the hardened ramp structure across the main river channel, nonroutine/emergency repairs are anticipated to be necessary following flood flows that are capable of transporting large debris and bedload, which could damage components of the hardened ramp. Infrequent repairs could potentially include removal of accumulated sediment, reconstruction of baffles as well as damaged portions of the concrete structure, up to an including a complete rebuild depending on the severity of the damage.

10.3.4 ALTERNATIVE D – VERTICAL SLOT PLUS WATER DIVERSION CONSISTENT WITH 2008 BIOLOGICAL OPINION

Under **Take Alternative D: Vertical Slot + 2008 BO**, United would construct a vertical slot fish passage facility to replace the existing Freeman Diversion structure. Several components of the Freeman Diversion would be modified or replaced. The alternative consists of the following additions or modifications of existing components: diversion structure crest, vertical slot fish ladder, north ladder entrance, south ladder entrance, auxiliary water supply, sediment sluicing channel (bypass channel), fish evaluation station, fish screens and canal facilities.

Most elements of the existing Freeman Diversion would be modified to accommodate new design features. The existing diversion structure crest would be notched adjacent to the bypass channel and an Obermeyer gate would be fitted on the new crest notch. The approach channel would be retained, along with the bypass channel and diversion channel intake. The current auxiliary water supply, fish screen, and Denil fish ladder would be demolished. The downstream face of the diversion structure would be filled to accommodate a fish transport channel and minimize potential injury of fish migrating downstream. Major modifications and additions include the following elements:

- Bypass channel: The existing bypass channel used for sediment sluicing is located between the diversion structure crest to the north and the intake and fish ladder to the south. From upstream to downstream, the bypass channel consists of a concrete apron, a roller gate, and a chute section. The bypass channel approach would not be modified as part of the alternative except where the chute slab would be raised to accommodate the new transport channel.
- Trash rack: The existing trash rack would be expanded by about 25% to accommodate the additional diverted flow. Trash rack bars would be spaced between 4-inches and 6-inches on center to enhance debris screening. The existing fish ladder entrance behind the trash rack would be filled.
- Diversion canal: Two existing canal gates would be removed, and two additional gates of the same size would be added adjacent to the existing gates. The diversion canal would be widened to accommodate the increased flows associated with 750 cfs diversion.
- Fish screens and fish bypass: Vertical panel fish screens would be added to the canal intakes. Screen panels would be stainless steel frames and profile wire screens having 1.75-millimeter slots to meet juvenile fry screening requirements. Secondary and finishing screens placed behind the primary screens would channel and direct fish through a fish bypass toward a fish trapping and evaluation

station that can be used to monitor downstream fish runs, then to a release location for return to the river downstream of the diversion.

- Vertical slot fish ladder. The existing Denil fish ladder would be decommissioned and demolished. In its place, a 23 step vertical slot fish ladder would be constructed. Ladder steps would have 1-foot drops except the upper two pools. A sluice gate would be added at the exit of the fish ladder to control flows during operation.

Construction of the vertical slot would last approximately 2 years, including approximately 503 active construction days within approximately 700 calendar days, and would include construction during the wet season. The construction footprint would be located completely on United's property. Construction would have 2.83 acres of temporary and 0.03 acre of permanent direct impacts to riparian and streambed habitats. The remainder of the permanent and temporary impacts would occur to existing operational (i.e., disturbed) areas. Construction activities would use identical practices and equipment to that of the Proposed MSHCP.

Water operations associated with **Take Alternative D** would follow all the protocols and conservation measures described in the Proposed MSHCP, but diversions would be modified to match the measures described in the 2008 BO. This includes modification of the TRP, VFP, BFP, SMP, transition protocol, and pulse protocol detailed in CMs 1.2.1–1.2.4. Additional flows would be conveyed through the diversion structure, including the fish ladder, auxiliary water supply, smolt bypass, diversion crest, and bypass channel, but would not be routed into the diversion canal. Average annual diversion under this alternative would be approximately 50,000 AF, assuming a maximum instantaneous diversion rate of 375 cfs (Appendix B).

Under **Take Alternative D**, United would divert water on the following schedule as presented in the Reasonable and Prudent Alternative: Sections 2.A and 2.B of the 2008 BO and reprinted below.

2(a) When initiating the turning-in procedure (i.e., directing river water into the diversion intake), the daily rate at which the Vern Freeman Diversion reaches its operating capacity of 375 cfs (ramping rate) shall not exceed the rates in the following table for each category of total river discharge in the Santa Clara River as measured immediately upstream of the Vern Freeman Diversion Dam.[2] The rates in the table below apply only to turning-in procedures undertaken during the principal steelhead migration season (January through May) when total river discharge is ≤ 750 cfs:

[2] The phrase "total river discharge in the Santa Clara River immediately upstream of the Vern Freeman Diversion Dam" (and similar phrases) refers to the total amount of water that would pass downstream of Freeman Diversion if none was diverted.

Total River Discharge	Ramping Rate[3]
≤ 635 cfs	Upon initiating the turning-in procedure, and only after providing the necessary bypass flow required to maintain a minimum of 160 cfs over the critical riffle,[4] United shall divert no more than 20% of the remaining river discharge, provided that diverting 20% of the remaining river discharge does not reduce river discharge downstream of the diversion dam more than (1) the river discharge that is expected to result from the operating criteria that are the basis of the action as proposed by United and the Bureau, and (2) the river discharge resulting from reasonable and prudent alternative element 2(b).
> 635 cfs and ≤ 750 cfs	Upon initiating the turning-in procedure, and only after providing the necessary bypass flow required to maintain a minimum of 160 cfs over the critical riffle, United shall divert no more than 30% of the remaining river discharge, provided that diverting 30% of the remaining river discharge does not reduce river discharge downstream of the diversion dam more than (1) the river discharge that is expected to result from the operating criteria that are the basis of the action as proposed by United and the Bureau, and (2) the river discharge resulting from reasonable and prudent alternative element 2(b).

2(b) Trapping and then trucking juvenile steelhead shall be undertaken solely as a rescue operation, not the principal means of moving juvenile steelhead to the Santa Clara River estuary or ocean especially when total river discharge is sufficient to maintain connectivity with the Santa Clara River estuary.[5] Therefore, when total river discharge immediately upstream of the Vern Freeman Diversion Dam is sufficient to maintain connectivity with the Santa Clara River estuary during the emigration season for juvenile steelhead (March 1 through May 31), United shall extend the proposed 18-day and 30-day bypass flows to ensure volitional emigration of juvenile steelhead to the estuary. The magnitude of the substantive aspects of the 18-day and 30-day bypass flows as defined under the Proposed MSHCP are intended, in part, to maintain connectivity with the estuary and ocean; we expect that the same and at times lower bypass flows (particularly as total river discharge declines) will be necessary to meet the purpose and intent of reasonable and prudent alternative element 2(b). When total river discharge immediately upstream of the Vern Freeman Diversion Dam recedes to a magnitude no longer capable of maintaining connectivity with the Santa Clara River estuary, even with all water in the river passing downstream and none being diverted, the extension in the bypass flows that is required in this reasonable and prudent alternative may cease in accordance with the ramping down criterion set forth in the Proposed MSHCP, provided that before ceasing the bypass flows, United documents that total river discharge immediately upstream of the Vern Freeman Diversion Dam is not sufficient to maintain connectivity with the estuary and then in writing notifies NMFS (501 West Ocean Blvd., Suite 4200, Long Beach, California 90802) of the documented conditions indicating that ceasing the bypass flows is warranted."

General maintenance operations associated with **Take Alternative D** would be identical those in the Proposed MSHCP. This includes the following activities along with their anticipated frequency: dewatering and flow rerouting (annually), fish passage facility routine maintenance including sediment and debris management (annually), vegetation management (quarterly to annually), access road grading, compaction, and fill (annually), and use of permit area roads and access points (daily/weekly). Infrequent maintenance including facility repair and upgrade, as well as instream sediment and debris removal would also be necessary at the frequencies described in Chapter 3, *Covered Activities*, Section 3.3.5. Access requirements for these activities would also be identical those of the Proposed MSHCP.

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[3] Rates were developed from an analysis of discharge decay rates in Sespe Creek and the Santa Clara River (page 3, Bureau of Reclamation 2008 as cited in NMFS 2008{ TC "Bureau of Reclamation 2008" \f C \l "1" }).

[4] "The critical riffle is a term we use that would describe the most difficult riffle for an upstream migrant. Due to our everchanging river, the critical riffle can also move. In the past it has been up towards the 118 bridge, but normally is about 1.5 to 1.9 miles upstream of the 101 bridge. Normally when that stretch of the river is a loosing reach the critical riffle will be further downstream due to less water in the river. When it is a gaining reach, it can be closer to the 118 bridge. Big riffle is located at about 1.7 miles upstream of the 101 bridge. The critical riffle will have to be located after every major storm. In general the channel morphology will change with peaks that exceed several thousand cfs" (M. McEachron, hydrologist, United Water Conservation District, pers. comm. November 21, 2007{ TC "pers. comm., M. McEachron, hydrologist, United Water Conservation District, November 21, 2007" \f C \l "1" }).

[5] A flow-related threshold effect has been noted in the Santa Clara River downstream of the Vern Freeman Diversion Dam. Under certain environmental conditions, in particular periods of low groundwater storage and low river discharge, surface water can percolate entirely into the channel bed downstream of the diversion dam, rendering the river discontinuous (NMFS 2008).

10.3.5 ALTERNATIVE E – HARDENED RAMP STRUCTURE PLUS WATER DIVERSION CONSISTENT WITH 2008 BIOLOGICAL OPINION

Under **Take Alternative E: Hardened ramp structure+ 2008 BO**, United would construct a hardened ramp fish passage facility to replace the existing Freeman Diversion structure. Refer to Section 10.3.3 for description of the hardened ramp structure physical facility and structural modifications under Take Alternative C, which would be the same under **Take Alternative E**. Maintenance needs under **Take Alternative E** would be the same as under Take Alternative C; refer to Section 10.3.3 for description of maintenance needs of the hardened ramp structure.

Water operations associated with **Take Alternative E** would follow all the protocols and conservation measures described in the Proposed MSHCP, but diversions would be modified to match the measures described in the 2008 BO. This includes modification of the TRP, VFP, BFP, SMP, transition protocol, and pulse protocol detailed in CMs 1.2.1–1.2.4. As discharge increases in the river, and when diversion criteria are met, water is diverted through the various elements of the proposed diversion depending on priorities. During the primary migration season, water is first prioritized for flows through the hardened ramp, then to the diversion canal or to the bypass channel (if sediment management activities are needed)and lastly past the crest gates if flows exceed the capacity of the diversion, bypass, and fishways. Average annual diversion under this alternative would be approximately 50,000 AF, assuming a maximum instantaneous diversion rate of 375 cfs (Appendix B). Under **Take Alternative E**, United would divert water on the schedule as presented in the Reasonable and Prudent Alternative: Section 2.A. of the 2008 BO, as described above in Take Alternative D (Section 10.3.4).

10.3.6 ALTERNATIVE F – INFILTRATION GALLERY

Under **Take Alternative F: Infiltration gallery**, United would remove the Freeman Diversion structure and construct an infiltration gallery to divert water from the Santa Clara River. Under this alternative, United would decommission and remove the diversion, Denil fish ladder, smolt bypass, and all other existing support structures within the wetted river channel. In order to continue diverting water in accordance with United's mission, an infiltration gallery would be installed within and adjacent to the existing project footprint.

Take Alternative F would involve the construction of a stand-alone infiltration gallery upstream of the Freeman Diversion structure along the bed of the river. The water from the gallery would be collected in a clearwell/sump and eventually pumped for conveyance to the existing diversion canal. The general design approach applied was as follows:

- The length of the gallery is a function of the number of collector pipes placed along the bed of the gallery, the submergence of the pipes, and the permeability of material placed in the riverbed.
- The main component of the gallery would be an excavated trench refilled with selected gravel materials to provide the desired rate of infiltration. Collector pipes would be placed perpendicular to the direction of the flow at the bottom of these layers.
- These pipes capture the flows percolating through the infiltration bed and deliver them to the header pipes. Header pipes would carry intercepted flows into the sump area close to the south bank near the diversion canal. Pumps placed in this facility would draw and release the water into the diversion canal. A backwash facility is assumed to be necessary along the infiltration gallery to avoid or reduce any binding or clogging expected from upstream sediment transport and deposition.

It is assumed that the bed would be graded down to the estimated post-scour profile before the placement of the infiltration gallery. A geotextile layer would be placed between the riprap and the gravel bed for sedimentation protection. To capture 750 cfs flows, an infiltration gallery about 11.5 feet deep by approximately 21 acres of surface area would be required to accommodate the piping and backwash components in the gallery. A gallery of this size would extend beyond United's property at the existing project site, requiring acquisition of additional lands. Construction could have temporary and permanent direct impacts on approximately 40 acres of riparian and streambed habitats.

It is assumed that demolition of the existing diversion and grade control structure followed by construction of the infiltration gallery could be accomplished within a 2-year period. Demolition of the existing impoundment structure and construction of the infiltration gallery and other facilities responsible for conveying or retaining water would need to be timed carefully around prevailing weather and river flow conditions. Demolition and construction activities taking place in the wetted channel would likely be restricted to the dry season. Similar to under the Proposed MSHCP, demolition and construction under **Take Alternative F** would require the use of heavy equipment within the wetted channel and would likely involve vegetation removal associated with the construction and maintenance of access points and infiltration gallery infrastructure. Some falsework structures may need to be installed in order to support heavy equipment such as cranes and excavators required for demolition and excavation. Falsework and infiltration gallery structures would occupy areas outside the current footprint of the existing diversion facility and would require temporary recontouring of river channels and/or removal of riparian vegetation during demolition and construction.

Water operations associated with **Take Alternative F** would deviate from the protocols and conservation measures described in the Proposed MSHCP for those elements of the protocols related to operation of the diversion structure, but would follow those elements of the protocol related to discharge past the diversion. With the Freeman Diversion structure removed and an infiltration gallery in place, diversion of flows would take place through infiltration withdraw and no diversion protocols would be implemented. All river flows with the exception of surface water diverted (through infiltration) to fulfill water rights and those associated with the Santa Felicia Project would be conveyed downstream to fulfill bypass flow requirements through the action area unimpeded. Elements of the conservation measures detailed in the Proposed MSHCP pertaining to sluicing of sediment would no longer be implemented because sediment would be transported unimpeded past the diversion. Those portions of the adult and smolt migration protocols related to ramping flows and fish passage characteristics at the critical riffle below the diversion would be followed under **Take Alternative F**. Average annual diversion under this alternative would be approximately 71,800 AF, which is identical to the Proposed MSHCP (Appendix B).

General maintenance operations associated with **Take Alternative F** would deviate significantly from the measures in the Proposed MSHCP. With the structure removed, no fish passage facility routine maintenance or debris management would take place. Routine vegetation management would occur on a quarterly to annual basis. There is some unknown maintenance obligation associated with the potential for the infiltration gallery to become clogged with fine sediment. Clearing the gallery may require back-flushing under pressure or, in extreme cases, re-excavation of the gallery, potentially requiring dewatering and/or river diversion during the wet-season. It is assumed that this type of maintenance activity would occur at intervals greater than 1 year, but potential clogging rates are unknown at present. Permit area access road grading, compaction, and fill would occur annually, and roads and access points would continue to be utilized on a daily or weekly basis.

10.3.7 ALTERNATIVE G – REMOVE STRUCTURE AND CEASE DIVERSIONS

Under **Take Alternative G: Remove structure**, United would remove the Freeman Diversion structure and cease diverting water from the Santa Clara River. Under this alternative, United would decommission and remove the diversion, Denil fish ladder, smolt bypass, and all other support structures within the wetted river channel.

Demolition activities of the impoundment structure and other facilities responsible for conveying or retaining water would need to be timed carefully around prevailing weather and river flow conditions. Active demolition activities in the wetted channel would likely be restricted to the dry season, though it is assumed that demolition could be accomplished within 2 years of permit issuance. Demolition activities would use similar practices and equipment to those of the Proposed MSHCP. Demolition would require the use of heavy equipment within the wetted channel and would likely involve some vegetation removal associated with the demolition and maintenance of access points during in-channel removal activities. Some falsework structures may need to be installed in order to support heavy equipment such as cranes and excavators required for demolition. Falsework structures would occupy areas outside the current footprint of the diversion and may require temporary recontouring of river channels and/or removal of riparian vegetation during demolition. The project footprint would be located entirely on United's property. Demolition could have temporary direct impacts on approximately 5 acres of riparian and streambed habitats. Following demolition, no maintenance would be needed because all structures would be removed.

10.4 METHODS USED TO EVALUATE ALTERNATIVES TO TAKE

Take alternatives were evaluated against five criteria, each of which is explained below.

1. Does the take alternative reduce take of covered species?
2. Does the take alternative increase conservation benefit to covered species?
3. Is the take alternative consistent with the goals of United Water Conservation District?
4. Is the take alternative practicable in terms of costs, logistics, and technical feasibility?
5. Are there additional significant and unavoidable adverse effects on other resources (i.e., besides covered fish and wildlife species and their habitat)?

10.4.1 LEVEL OF TAKE AND CONSERVATION BENEFIT TO COVERED SPECIES

Take expected to result and conservation benefits likely to accrue to covered species were assessed by comparing the likely effects of the implementation of the proposed MSHCP (level of take and conservation benefit), based on the primary mechanisms of impact (stressors), during three project stages: construction, operations, and maintenance. Where available, these assessments were based on quantitative data such as geographic information system (GIS{ TC "geographic information system (GIS" \f A \l "1" }) overlays of species habitat, modeling results of operations scenarios on key stressors of covered fish species, overlap between stressors and fish occurrence, and best professional judgment. This process provides a basis for qualitatively comparing the potential overall impacts of the take alternatives on the covered species, relative to the impacts expected for the proposed MSHCP.

After evaluating the potential effects of each individual stressor on a species, a three-stage relative ranking was assigned to each stressor and take alternative relative to the proposed MSHCP. The three-stage scale, below, indicates how the level of take or conservation benefit is expected to affect a species relative to the proposed MSHCP.

- Take is likely measurably less than under the proposed MSHCP.
- Take is not measurably different from that of the proposed MSHCP.
- Take is likely measurably greater than under the proposed MSHCP.

For covered fishes, the expected impacts were based on the likelihood of the species occurring in the area influenced by the impact or stressor, the degree of overlap between the species and stressor occurrences, the relative intensity and duration of the stressor, the expected effect of the stressor, and the conservation benefit of actions to reduce the stressor relative to existing conditions. For covered terrestrial species, the expected impacts were based primarily on the amounts of modeled habitat identified using GIS and/or professional judgment within the construction and restoration footprints (Table 10-4). In addition, the nature of the activity and the frequency and duration of those activities were also considered in discussing and comparing the potential for take and conservation benefit.

Table 10-4 Alternative Construction Footprint Acreages – Riparian and Streambed / Open Water Habitat		
Alternative	Permanent Impact Area (acres)	Temporary Impact Area (acres)
Proposed MSHCP	0.03	2.83
Alternative A – Wishtoyo Operational Remedies	---	---
Alternative B – Notch Structure	4.66	13.30
Alternative C – Hardened Ramp Structure	1.63	3.87
Alternative D – Vertical Slot + 2008 BO	0.03[1]	2.83[1]
Alternative E – Hardened Ramp Structure + 2008 BO	1.63	3.87
Alternative F – Infiltration Gallery	21.00	40.26
Alternative G – Remove Structure	---	4.86

[1]Permanent and temporary impacts associated with construction of Alternative D are identical to habitat impacts of the proposed MSHCP.

The methods used to assess flows and the various flow-related parameters for covered fish species are informed by the hydraulic basis of design reports produced for the notch (NHC 2019a{ TC "NHC 2019a" \f C \l "1" }), hardened ramp (NHC 2019b{ TC "NHC 2019b" \f C \l "1" }), and vertical slot (Stantec 2019{ TC "Stantec 2019" \f C \l "1" }), including NMFS and CDFW written feedback on those alternatives (NMFS 2019a, NMFS 2019b, NMFS 2019c, NMFS 2019d, CDFW 2020a, CDFW 2020b), the feasibility examination of the infiltration gallery (NHC 2016{ TC "NHC 2016" \f C \l "1" }), the expert report of Dr. Sharon Kramer (Kramer 2017), the forecasted water impacts report published by United (Appendix B, United 2016), and additional comparative analyses conducted by United (McEachron, pers comm 2020). These sources were referenced in a comparison of the alternatives with operational and structural conditions at Freeman Diversion under the Proposed MSHCP.

The qualitative and quantitative methods used to analyze the levels of take and conservation benefits of the take alternatives are generally similar to those used to analyze the proposed MSHCP in Chapter 7, *Effects Analysis*. However, the take alternatives are described here in less detail to enable comparison.

10.4.2 CONSISTENCY WITH GOALS OF UNITED AND MSHCP

Each take alternative was evaluated by its ability to help meet the mission of United, 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." Take alternatives were also evaluated qualitatively against each of the goals of the MSHCP. For each alternative, consistency with each goal was scored based on whether the alternative met one of the following four categories:

- Consistent with goal, but less so than the proposed MSHCP or United's mission;
- Consistency is not measurably different from that of the proposed MSHCP or United's mission;
- Consistency with goal is greater than that of the proposed MSHCP or United's mission; or
- Inconsistent with goals of the proposed MSHCP or United's mission.

In some cases, the alternative either met the goal or it did not, with no continuum of degrees of achievement. In these situations, the alternative to take was either deemed consistent or inconsistent with that particular goal. Most criteria could not be evaluated in isolation and were assessed on a continuum of achievement with the stated goals of United and the MSHCP. United defined the following goals for the MSHCP consistent with its mission, in no particular order:

1. Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
2. Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.
3. Implement actions on land that United owns or can feasibly acquire.
4. Allow United to manage sediment deposition in the desilting basin or other settling basin in a sustainable manner.

United worked closely with USFWS, NMFS, and CDFW to develop the following additional goals for the MSHCP covered species, in no particular order:

1. Improve migration of steelhead through the diversion.
2. Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31).
3. Improve upstream migration of adult steelhead and downstream migration of smolts before and after the primary migration periods (e.g., November, December, and June) when sufficient rainfall could also allow passage in the Santa Clara River downstream of the Freeman Diversion.
4. Promote migration of lamprey through the diversion.
5. Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.
6. Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United’s mission and purpose.
7. Minimize impacts on riparian habitat and other covered species.
8. Minimize operational complexity including operational transitions between different fish passage systems.
9. Minimize impacts on nesting riparian birds from maintenance activities by ensuring feasibility of conducting annual maintenance in the period between the nesting bird season (March 15 to September 15) and the rainy season (November 1 to May 31).
10. Do not pose a significant stranding risk to steelhead.

United also worked closely with NMFS and CDFW to develop the following additional facility design and operational criteria (which apply only to alternatives to take with an operational fish passage facility), in no particular order:

1. Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs.
2. Minimize interruption of passage opportunities for necessary sediment management and other maintenance activities.
3. If ramps are used, build ramps with slope of 5 percent or less.
4. Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows.
5. Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.

6. Ensure hydraulic conditions meet the needs of all steelhead life stages expected to pass through the facility.
7. Prevent passage over diversion structure crest and under sluice gates.
8. Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.
9. Preclude fish passage through partially open gates or weirs.
10. Ensure fish screens are protective of all life stages of covered aquatic species[6] from impingement and entrainment.
11. Ensure that project construction be completed within 2 years of permitting, as required by Court Order.

A summary of whether and how each take alternative is or is not consistent with the MSHCP goals and the fish passage facility criteria is found below in Table 10-5. The explanation of these evaluations can be found in Section 10.5, *Assessment of Take Alternatives*.

[6] Fish screens that meet NMFS 2011 criteria will not prevent young-of-year lamprey ammocoetes from being impinged or entrained during water diversion operations. Fish screens proposed in the MSHCP are considered to be broadly protective of all other life stages of covered aquatic species expected to encounter the structure during water diversion operations.

Table 10-5 Summary of Take Alternatives' Consistency with MSHCP Goals and Fish Passage Facility Criteria

MSHCP Goals and Fish Passage Facility Design and Operational Criteria	Take Alternative: Alt. A: Wishtoyo Operational Remedies Plus Santa Felicia	Alt. B: Notch structure	Alt. C: Hardened ramp	Alt D: Vertical slot + 2008 BO	Alt E: Hardened ramp + 2008 BO	Alt. F: Infiltration gallery	Alt. G: Remove structure and cease diversion
MSHCP Goals to Achieve United's Mission							
Goal 1 – Ensure a total average annual water diversion yield of 71,800 AF at Freeman Diversion	⊗	⊗	▯	⊗	⊗	▯	⊗
Goal 2 – Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.	⊗	▯	▯	⊗	⊗	▯	⊗
Goal 3 – Implement actions on land that United owns or can feasibly acquire	▯	⊗	⊗	▯	⊗	⊗	▯
Goal 4 – Allow United to manage sediment deposition in the desilting basin or other settling basin in a sustainable manner	+	▯	▯	▯	▯	+	+
MSHCP Covered Species Goals							
Goal 1 – Improve migration of steelhead through the diversion	–	▯	▯	▯	▯	+	+
Goal 2 – Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31)	+	▯	▯	+	+	▯	+
Goal 3 – Improve upstream migration of adult steelhead and downstream migration of smolts before and after the primary migration periods (e.g., November, December, and June) when sufficient rainfall could also allow passage in the Santa Clara River downstream of the Freeman Diversion	+	▯	▯	▯	▯	▯	+
Goal 4 – Promote migration of lamprey through the diversion	–	▯	+	▯	+	+	+
Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.	+	–	▯	+	+	▯	+
Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose	⊗	⊗	▯	–	–	▯	⊗
Goal 7 – Minimize impacts on riparian habitat and other covered species	+	–	–	+	–	–	–
Goal 8 – Minimize operational complexity including operational transitions between different fish passage systems	+	–	▯	▯	▯	+	+
Goal 9 – Minimize impacts on nesting riparian birds from maintenance activities by ensuring feasibility of conducting annual maintenance in the period between the nesting bird season (March 15 to September 15) and the rainy season (November 1).	▯	▯	▯	▯	▯	▯	+
Goal 10 – Do not pose a significant stranding risk to steelhead	▯	–	▯	▯	▯	+	+
Fish Passage Facility Criteria							
Criterion 1 – Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs	⊗	⊗	▯	▯	▯	+	+
Criterion 2 – Minimize interruption of passage opportunities for necessary sediment management and other maintenance activities	⊗	⊗	+	▯	+	+	+
Criterion 3 – If ramps are used, build ramps with slope of 5% or less	▯	▯	▯	▯	▯	▯	▯
Criterion 4 – Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows	⊗	–	▯	▯	▯	+	+
Criterion 5 – Provide discharge attraction flows of at least 5–10% of river discharge at each fish passage location	⊗	▯	+	▯	+	+	+
Criterion 6 – Ensure hydraulic conditions meet the needs of all steelhead life stages expected to pass through the facility	⊗	▯	▯	▯	▯	▯	+
Criterion 7 – Prevent passage over diversion structure crest and under sluice gates	⊗	–	+	▯	+	+	+
Criterion 8 – Preclude nuisance attraction flows across the prescribed flow range, which can be	⊗	⊗	+	▯	+	+	+

Table 10-5 Summary of Take Alternatives' Consistency with MSHCP Goals and Fish Passage Facility Criteria

MSHCP Goals and Fish Passage Facility Design and Operational Criteria	Take Alternative: Alt. A: Wishtoyo Operational Remedies Plus Santa Felicia	Alt. B: Notch structure	Alt. C: Hardened ramp	Alt D: Vertical slot + 2008 BO	Alt E: Hardened ramp + 2008 BO	Alt. F: Infiltration gallery	Alt. G: Remove structure and cease diversion
accomplished by conveying all flows less than 1,200 cfs within the fishway.							
Criterion 9 – Preclude fish passage through partially open gates or weirs	⊗	⊗	□	□	□	+	+
Criterion 10 – Ensure fish screens are protective of all life stages of covered aquatic species from impingement and entrainment	⊗	□	□	□	□	+	+
Criterion 11 - Ensure project construction be completed within 2 years of permitting, as required by Court Order	+	□	□	□	□	□	+
Summary: Is take alternative consistent with MSHCP goals and fish passage criteria?	No	No	No	No	No	No	No

Key:

–	Consistent with goal, but less so than the Proposed MSHCP.
□	Consistency is not measurably different from that of the Proposed MSHCP.
+	Consistency with goal is greater than that of the Proposed MSHCP.
⊗	Inconsistent with goal.

10.4.3 PRACTICABILITY

The key regulatory requirement in any HCP is that the impacts of the taking on each covered species must be minimized and mitigated to the maximum extent practicable. As described in the HCP Handbook, this standard can be met by one of two means. Firstly, the HCP applicant can demonstrate the proposed mitigation has "fully offset" the impacts of the taking on each of the covered species. If the applicant cannot demonstrate that the conservation strategy, including mitigation, fully offsets the impacts of the taking, then the applicant must demonstrate why the proposed mitigation is the maximum practicable.

As described in Chapter 7, *Effects Analysis*, it is United's position that it has fully offset the impacts of the taking on all of the covered species based on the conservation strategy described in Chapter 5. United recognizes, however, that this analysis and the conclusion of fully offset is dependent on numerous assumptions about the expected level and timing of impacts, particularly for steelhead. To account for differences in opinion of these assumptions, United also presents this detailed practicability analysis to demonstrate that the proposed conservation strategy is also the maximum practicable. Thus, using either test (fully offsetting impacts or providing the maximum extent practicable of mitigation), United has met the key regulatory requirement of the ESA with this MSHCP.

As defined in the HCP Handbook, *maximum practicable* means, within their available means, the applicant can feasibly do no more to minimize or mitigate the impacts of the taking. The handbook recommends evaluating practicability in terms of two broad categories: insufficient implementation options and financial constraints.[7]{ TC "U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016 in footnote" \f C \l "1" }

[7] HCP Handbook Section 9.5.2, page 9-33.

The practicability analysis includes an evaluation of actions proposed under the Proposed MSHCP and take alternatives relative to three factors: cost, logistics, and technology. Cost is equivalent to the "financial feasibility" factor described in the HCP Handbook. The combination of logistics and technology is equivalent to the "insufficient implementation options" category described in the HCP Handbook. The sections below describe the approach used to evaluate each of these practicability factors and the metrics used to determine whether a take alternative would be practicable in relation to that factor. A take alternative is deemed to be impracticable if it fails any one of these tests.

Logistics

To be logistically practicable, a take alternative must meet all of the following logistical criteria:

- Access to the necessary construction and restoration sites
- Availability of resources necessary for construction, operation, and maintenance of facilities and restoration sites
- Availability of sufficient land suitable for the new fish passage facility and habitat restoration

A summary of the logistical evaluations are provided in Table 10-9 at the bottom of this section and the detailed evaluations are described in Section 10.5, *Assessment of Take Alternatives*.

Technology

For a take alternative to be technologically practicable, it must use existing, proven technology that can be implemented with a high level of certainty. Untried or untested designs constitute a technological problem because they entail a significant risk that a critical facility component may fail or not perform as intended. This criterion incorporates the reliability of the facility. For an alternative to take to meet this criterion, it must meet all of the following:

- **Maintenance.** The alternative to take should be capable of being maintained over the term of the permit to its intended design standards and with reasonable maintenance costs.
- **Durability**. The alternative to take should be durable and resistant to high storm flows. In other words, the facility must withstand impacts from large debris flows and heavy bedload (e.g., up to 2- to 3-foot-diameter boulders or other objects) during winter flood events with either no or minimal damage. Debris and bedload would not render the fish passage system inoperable for more than one storm event.
- Capable of **timely repair**. In the event of damage that shuts down the fish passage facility, it should be capable of being repaired and restored to service within the same migration season and with reasonable and expected maintenance costs. The deadline is established in order to minimize passage delays for covered fish.
- **Fish monitoring** is technologically feasible. Fish monitoring can be accomplished with existing technology to measure achievement of all of the biological objectives for covered fish.
- **Construction risk.** In-water construction entails significant risk of damage and delays from flood events based on two primary factors: (1) size and complexity of construction equipment and footprint in-river, and (2) the amount of time of construction occurring during the rainy season.
- **100-year flood line** unchanged or decreased. The 100-year flood elevation line at the Freeman Diversion facility is currently established by the Federal Emergency Management Agency. Building a facility that increases the 100-year flood line would require extensive additional review and permitting by the Federal Emergency Management Agency, and potentially extensive fortifications or flood control structures to maintain the flood line as is.
- **Safety.** The alternative does not pose a safety hazard to United's staff or to people in the river downstream of the diversion.

The “all known, available, and reasonable technology” standard was applied to test whether the take alternative uses existing, proven technology. Technology considerations were deemed to render a take alternative impracticable in cases when an alternative would require the use of untested technologies, i.e., technologies that do not meet this standard. A summary of the technology evaluations are provided in Table 10-9 at the bottom of this section and the detailed evaluations are described in Section 10.5, *Assessment of Take Alternatives*.

The assessment of technology relies on information contained in the following documents:

- Vern Freeman Dam Vertical Slot Fish Ladder – Hydraulic Basis of Design Report, dated December 6, 2019 (Stantec 2019{ TC "Stantec 2019" \f C \l "1" })
- Vern Freeman Diversion Dam Notch Fish Passage Improvements – Draft Hydraulic Basis of Design Report, dated June 21, 2019 (NHC 2019a{ TC "NHC 2019a" \f C \l "1" })
- Vern Freeman Diversion Hardened Ramp Fish Passage Improvements – Hydraulic Basis of Design Draft Report, dated July 21, 2019 (NHC 2019b{ TC "NHC 2019b" \f C \l "1" })
- Evaluation of Vern Freeman Diversion Dam Modification Alternatives – Detailed Feasibility Examination (NHC 2016{ TC "NHC 2016" \f C \l "1" })
- Final Biological Opinion - Approve United Water Conservation District’s Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility (NMFS 2008{ TC "NMFS 2008" \f C \l "1" })

Financial Constraints Imposed by Rate Increases and Economic Impacts

For a take alternative to meet this criterion, it must be economically feasible for United to implement, both in the short term and the long term. The economic feasibility is evaluated in four dimensions: (1) direct rate impacts from changes in costs; (2) rate impacts from changes in delivered water, which changes the denominator in calculating rates (i.e., smaller sales leads to increase rates); (3) regional economic impacts from reduced water supplies; and (4) financial feasibility of issuing debt to cover upfront costs.

United charges customers based on the amount of groundwater that those customers pump or for deliveries through United’s pipeline system. In the case of pumping, the usage is not directly linked to the amount diverted at Freeman Diversion as there is not yet a restriction on pumping in Oxnard Plain basin.

United’s annual budget rate design model (United 2019) is used to estimate rate impacts for each of the two customer classes, agriculture, and wholesale municipal and industrial (M&I{ TC "municipal and industrial (M&I" \f A \l "1" }) for each alternative. United is divided into two delivery areas, Zone A and Zone B, and Freeman Diversion waters are supplied to Zone B, so most of these costs would be borne by this latter customer group. The rate design model also maintains the ratio of agricultural and M&I rates as required in its charter. Rates were calculated using the same methodology used by United in developing its annual budget but relied on an average of water deliveries for the last five years rather than a forecast for deliveries in fiscal year 2019-2020. Where surface water diversions were changed from the historic pumping and delivery conditions, the rates were adjusted to recover the same revenues over a smaller amount of sales, effectively increasing the rates. For existing conditions that set an average annual diversion of 50,000 AF, rates needed to increase when constrained to a sustainable yield. Alternatively, increased diversions, as would occur with the Proposed MSHCP, decreased rates.

This analysis was conducted on the premise that compliance with the Fox Canyon Groundwater Sustainability Plans (GSPs{ TC "Groundwater Sustainability Plan (GSP" \f A \l "1" }) relies on increased diversions at the Freeman Diversion identified with the Proposed MSHCP here to maintain that pumping level.[8] It also would

[8] However, in comparison to the modeling completed for the operational alternatives (described in Section 10.3), the GSPs utilized a 1930–1979 hydrologic cycle adjusted for future California Department of Water Resources climate-

include providing additional resources to offset the pumping reductions specified in the GSPs (FCGMA 2019). In other words, the GSPs would not change the water use substantially from historic conditions.

Alternatives requiring operational changes compared to the Proposed MSHCP (Take Alternatives A, D, E, and G), which would result in reduced diversions and water supply deliveries, in turn would both increase rates and result in regional economic impacts to income and employment. The Fox Canyon GSP identifies several projects to supplement water supplies, but it relies on continued—and even the increase associated with United's water rights application—to backfill the reduction in pumping that would be required to otherwise achieve the sustainable yield mandated under the Sustainable Groundwater Management Act (SGMA) (FCGMA 2019).

Costs for each alternative when construction is proposed were drawn from draft *Hydraulic Basis of Design Reports* for each alternative, listed in Section 10.2, *Development of the MSHCP and Take Alternatives*. In addition, habitat conservation and mitigation measure costs as derived in Chapter 9, *Funding*, for funding of the MSHCP were included. These would be incremental costs above costs already incurred by United to provide service. Table 10-6 summarizes the ranges of these costs for each alternative and the water supply provided by the diversion associated with each alternative. Costs used for the rates analysis are the sum of the mid-range and mitigation costs shown in the table. For the Proposed MSHCP, the total mid-range cost would be $88 million in initial capital investment and an average of $1.7 million in annual operating costs. The only alternatives that would be lower cost are Alternative A, which is the "Wishtoyo Operational Remedies" option that reduces diversions by more than half, and Alternative G, that removes the structure and ceases all diversions (decommissioning). Both alternatives would be inconsistent with the GSP and have significant economic consequences to the region that are discussed further below which make those options infeasible. The water diversion amounts are annual average yields drawn from the modeling results conducted for the initial MSHCP draft report in 2016 (Appendix B, United 2016) and additional analyses conducted by United (McEachron, pers comm 2020).

Table 10-6 Costs and Water Supply for Each Alternative

Alternatives	Conservative Initial Investment	Annual Mitigation	Average Annual Diversion Yield (AF)
Existing conditions: water diversion consistent with 2008 Biological Opinion	$0	$1,720,000	50,000
Proposed MSHCP: Vertical slot	$87,990,000	$1,720,000	71,850
A. Wishtoyo Operational Remedies Plus Santa Felicia Project	Operational	$1,720,000	30,000
B. Notch structure with low-flow technical fishway	$89,490,000	$1,720,000	66,800
C. Hardened ramp structure	$126,290,000	$1,720,000	71,850
D. Vertical Slot plus water diversion consistent with 2008 BO	$87,990,000	$1,720,000	50,000
E. Hardened Ramp water diversion consistent with 2008 BO	$126,290,000	$1,720,000	50,000
F. Infiltration gallery	$391,990,000	$4,141,000	71,850
G. Remove structure and cease diversion	$37,000,000	$0	0

Notes:
- Sources: Appendix B (United 2016), (United 2019), Stantech (2019), NHC (2019a, 2019b), and AECOM (2016).
- Alternative F cost estimates scaled from 48.5 million gallons per day (MGD) to 485 MGD, and escalated from 2016 to 2019 nominal dollars.
- Alternative G cost was calculated based on cost per foot to remove the diversion structure.

change factors, and estimated diversions based on similar historical Santa Clara River flows changes. Although the hydrologic cycles differ between the GSPs and the cases presented in Appendix B, which is used in this analysis as the estimate of average annual diversion yield for the various operational alternatives, both modeling efforts account for future climatic conditions with respect to climate change. Also, note that the GSPs require updates every 5 years, which include an analysis of new water supply projects as well as extractions to re-evaluate sustainable yield.

Recent (2016 to present) operational parameters consistent with the 2008 BO employed at the Freeman Diversion have resulted in reduced diversion yield compared to past operations, and the diversions during this period are best quantified by the modeling completed by United for the 2008 BO (Appendix B, United 2016), totaling 50,000 AF average annual diversion yield. Average annual diversion yield modeled for the various operational alternatives provides a quantification of the changes relative to the existing condition. The change in average annual diversion yield does not immediately impact United's demand and sales because the pumping is not yet constrained under SGMA. However, that would change as the Fox Canyon Groundwater Management Agency GSPs are implemented to achieve sustainable yields. The GSPs would evaluate Freeman Diversion yield as part of the five-year update process to reassess sustainable yield, which would eventually directly tie diversions to water deliveries and, in turn, future rates.

Table 10-7 shows the current rates for Fiscal Year 2019–2020 and the rates for each Alternative in the GSPs target horizon year of 2040 when sustainable yield is achieved, as well as the percentage changes from the current rates for each alternative. This rate comparison used current revenue requirements for United as representative of future rates under the Fox Canyon GSP to avoid introducing additional uncertainties about other potential significant investments may be required elsewhere in United's system and what outside funding sources may be used for financing. The economic costs of each alternative needed to be compared to current economics of the agency, because that is how the cost of the Proposed MSHCP is calculated. The Proposed MSHCP would increase rates by 81 percent from existing conditions for customers in Zone B. Other alternatives with construction for renovations would increase rates by 88 percent to 317 percent. In the case of the scenarios with operational changes (existing conditions and Alternative A), although rate increases are smaller, this is only part of the story because water supplies also are reduced, which causes economic consequences discussed below. For Alternative G, Zone B rates would no longer apply with the end of diversions, and rates in Zone A would increase 89 percent due to the reduced overall sales across United and recovery of decommissioning costs.

Table 10-7 Comparison of United Rates for Each Alternative

Alternatives	Total Rates (5 Year Average)			
	Zone A - AG	Zone A - M&I	Zone B - AG	Zone B - M&I
Current Rates (FY 19-20)	$57.04	$171.12	$90.97	$272.92
Existing Conditions: Diversion consistent with 2008 BO	$57.04	$171.12	$117.00	$351.02
Proposed MSHCP: Vertical Slot Structure	$57.04	$171.12	$164.55	$493.67
A. Wishtoyo Operational Remedies Plus Santa Felicia Project	$57.04	$171.12	$134.36	$403.09
B. Gated Notch Structure	$57.04	$171.12	$171.13	$513.41
C. Hardened Ramp Structure	$57.04	$171.12	$188.69	$566.11
D. Vertical Slot with 2008 BO	$57.04	$171.12	$196.70	$590.14
E. Hardened Ramp with 2008 BO	$57.04	$171.12	$231.39	$694.23
F. Infiltration Gallery	$57.04	$171.12	$379.62	$1,138.96
G. Remove Structure and Cease Diversion	$107.86	$323.58	NA	NA
	Rate Changes vs. Current Rates (FY19–20)			
Existing Conditions: Diversion consistent with 2008 BO	0%	0%	29%	29%
Proposed MSHCP: Vertical Slot Structure	0%	0%	81%	81%
A. Wishtoyo Operational Remedies Plus Santa Felicia Project	0%	0%	48%	48%
B. Gated Notch Structure	0%	0%	88%	88%
C. Hardened Ramp Structure	0%	0%	107%	107%
D. Vertical Slot with 2008 BO	0%	0%	116%	116%
E. Hardened Ramp with 2008 BO	0%	0%	154%	154%
F. Infiltration Gallery	0%	0%	317%	317%
G. Remove Structure and Cease Diversion	89%	89%	NA	NA

Ability to Pay Analysis

Urban Impact

Project scenarios would have a sizeable impact on M&I rates in United's Zone B service area. To evaluate urban ability to pay for this rate increases, we compared the projected rates to other alternative water supply sources for Ventura County. If lower cost alternative water supplies are not available, the project scenarios represent the best option for United.

To evaluate alternative water supply options, we collected cost information for a range of potential water supplies that are feasible in Ventura County. These include State Water Project water wheeled through Metropolitan Water District of Southern California (MWDSC{ TC "Metropolitan Water District of Southern California (MWDSC" \f A \l "1" }), additional supplies purchased directly from MWDSC, desalination, recycled water (both direct use and indirect use through groundwater recharge), and conservation or efficiency measures that produce additional supply.

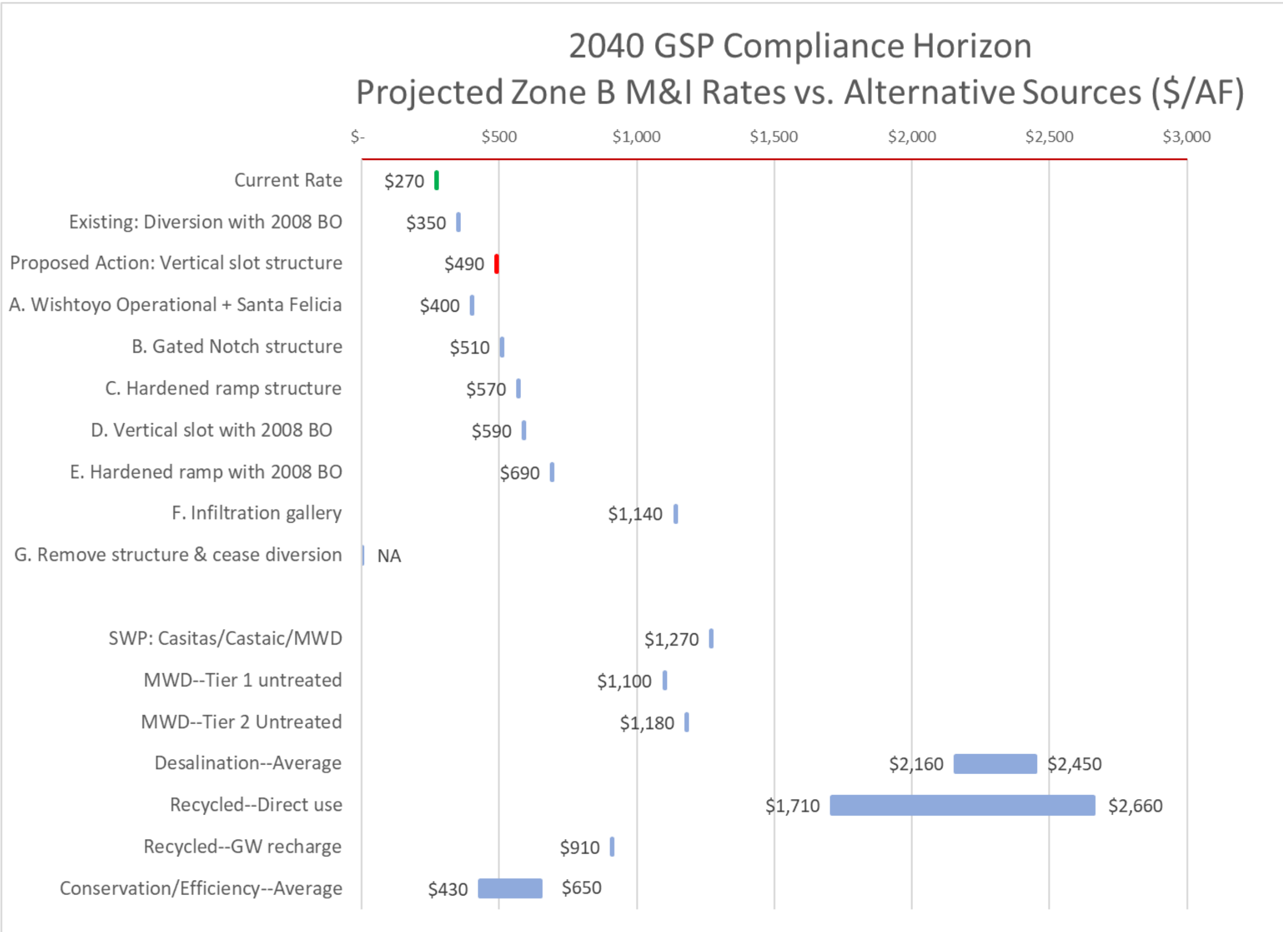
State Water Project cost estimates were based on United purchasing water through Calleguas Water District and wheeling that water through MWDSC. To estimate this cost, we used the equivalent unit charge from the State Water Project's Bulletin 132-17 for Castaic Lake, which is $260 per AF (DWR 2019). To this we added MWDSC's wheeling charges, which included system access, water stewardship, system power, readiness-to-serve, capacity charges, and treatment surcharges, which amount to $949 per AF (MWDSC 2017, MWDSC 2020). Bringing both charges into 2019 dollars yielded a price of $1,270 per AF. Purchasing additional supplies directly from MWDSC would take place at its Tier 1 and Tier 2 prices for untreated water (assuming it would use the same treatment facilities that it currently uses for imported water). This ranged from $1,100 to $1,180 per AF. Desalination cost estimates were based on Municipal Water District of Orange County's (MWDOC{ TC "Municipal Water District of Orange County's (MWDOC" \f A \l "1" }) two facilities built by Poseidon, as well as estimates from the Pacific Institute for brackish and seawater desalination costs (Cooley and Phurisamban 2016). These ranged in cost from $2,160 to $2,450 per AF.

To estimate the cost of recycled water, we drew on estimates from a range of different sources, including the Pacific Institute, MWDSC's Recycled Water Program, West Basin Municipal Water District, the Water Replenishment District of Southern California, the City of San Diego, Santa Clara Valley Water District, Padre Dam Municipal Water District, Monterey Regional Water Pollution Control District, and MWDSC's Integrated Resource Plan. Taking an average of the various range estimates that are available, we estimated a cost of between $1,710 and $2,660 per AF for direct use. Recycled water for groundwater recharge is slightly less costly because treatment level requirements are not as high as for direct use. Based on Orange County Water Districts' Groundwater Replenishment Program, we estimated costs for indirect use at approximately $910 per AF.

Finally, conservation and efficiency costs were estimated based on three different cost estimates, including MWDOC's and California Water Service Company's conservation programs, and estimates of the cost of water loss reduction from the Alliance for Water Efficiency's Water Conservation Tracking Tool (MWDOC 2014, California Water Service Company 2015, Alliance for Water Efficiency 2015). Based on these sources, conservation and efficiency could save water at a cost ranging from approximately $430 to $650 per AF.

Figure 10-1 shows a comparison of the current M&I water rate, as well as estimated rates associated with the seven alternatives and all the alternative water supply sources on a per-AF basis. The MSHCP scenario rates compare favorably to most of the water source options, except for Conservation and Efficiency. However, there are limits to how much supply would be available through additional conservation and efficiency measures, and 19,000 AF of urban conservation in the district is not likely. Alternative F would be more expensive than some of the other options, indicating that some M&I sales would likely defect from United, putting more stress on its rates and financial stability.

Figure 10-1 Comparison of M&I Rates to Alternative Water Supply Sources{ TC "Figure 10-1. Comparison of M&I Rates to Alternative Water Supply Sources " \f \l "1" }



Agricultural Impacts

Changes to agricultural water rates under the six different project scenarios would increase costs to agricultural operations in United's Zone B and/or reduce water supplies significantly, and ultimately impact net income and employment in Ventura County. Because agriculture in Ventura County does not have effective access to other water sources, or those sources are cost prohibitive (as shown in the M&I analysis above), the increased rates and/or reduced supplies would result in reductions in net income for agricultural operations. These economic changes are the metric used for comparing the impacts of the alternatives.

This analysis drew on several different data sources to get the most accurate picture of agriculture in Ventura County. We used the Ventura County Agricultural Commissioner 2018 Crop Report (Ventura County Office of the Agricultural Commissioner 2019), IMPLAN Economic modeling software, and University of California, Davis Cooperative Extension Cost and Return Studies (UCD various years), as well as Statewide Crop Mapping data (California Natural Resources Agency 2016) as the main sources of agricultural data.

IMPLAN is an input/output economic modeling software that is the industry standard in estimating regional economic impacts. It includes detailed industry-level data for each zip code in the United States. There are 10 agricultural industry categories in IMPLAN; however, because over 90 percent of the agricultural acres in Zone B are in vegetables and fruit, we focused this analysis on those two crop categories.

We collected all of the zip codes that make up United's Zone B. For each zip code, we gathered economic output, value added (or locally generated net income), and employee compensation from the IMPLAN database for the two largest agricultural sectors. We arrived at the net revenue for fruit and vegetable crop categories by subtracting Employee Compensation from Value Added. This calculation of net revenue then includes only proprietor income, property income, and taxes on production and imports net of subsidies. Using crop acreages within Zone B from the California Natural Resources Agency (2016) and Net Revenue calculations we arrive at an estimate of net revenues per acre for fruit farming and vegetable and melon farming. Table 10-8 summarizes the acreages and net revenues in vegetable and fruit farming in United's Zone B.

Table 10-8 Zone B Agricultural Acreage and Net Revenue for High Value Crops

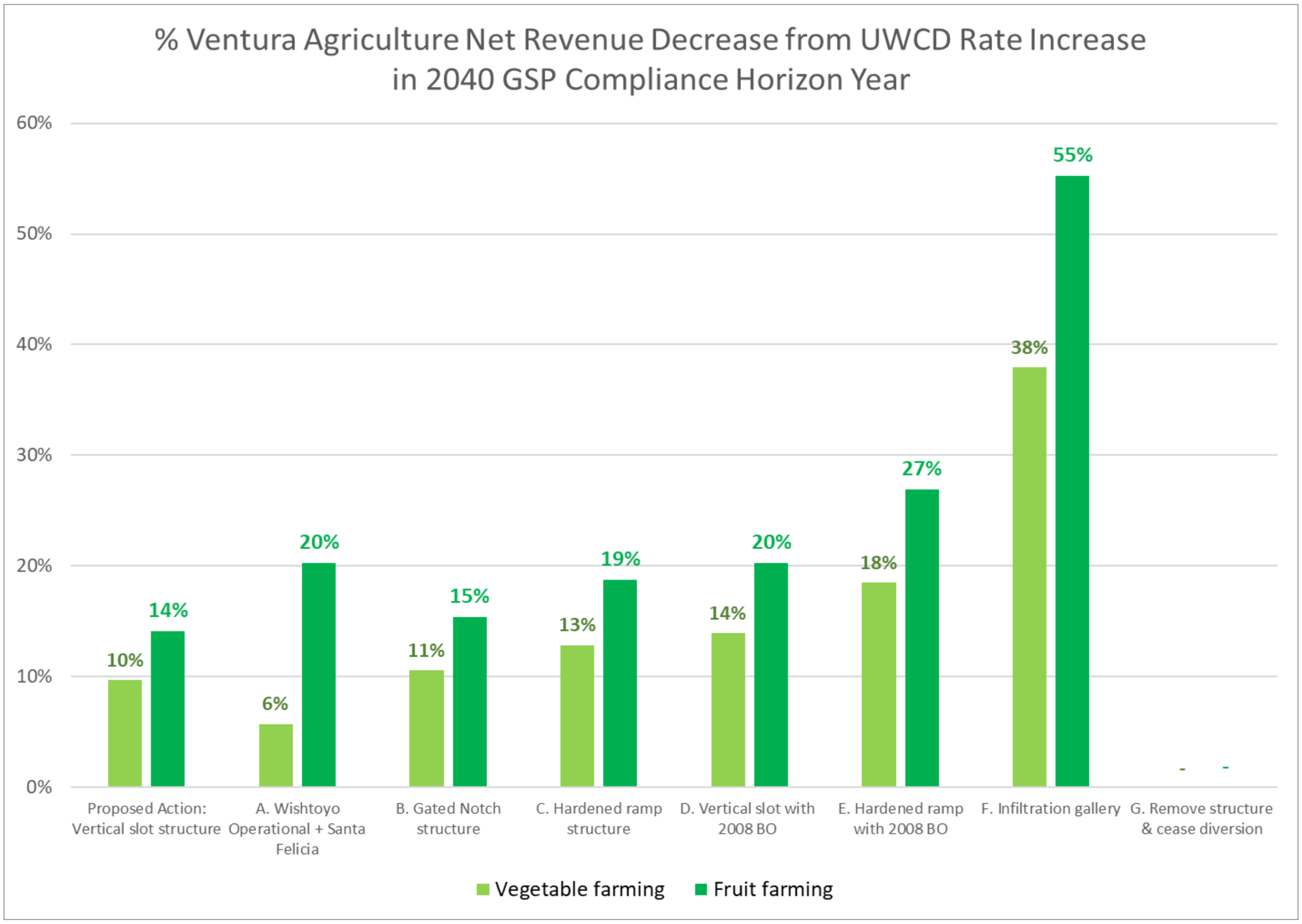
	Vegetable and Melon Farming	Fruit Farming
Acres in production	12,395	15,226
Net revenue per acre	$1,232	$1,078

Agricultural Economic Impacts from Increased Rates

In order to estimate how an increase in the cost of water would impact net revenues we rely on the rate impacts developed as part of this analysis presented in Table 10-7 and estimates of irrigation volumes required for representative crops from UC Davis Cooperative Extension cost models (UCD various years), which outline specific inputs and costs used for agricultural production in Ventura County. For vegetable farming we use celery and cabbage cost models and for fruit farming, we use strawberry, avocado, mandarin, and blueberries. Based on these crop reports we estimate a 1.5 AF per acre water requirement for vegetable farming and 2.2 AF per acre water requirement for fruit farming. Multiplying estimated rate impacts by these average water requirements we arrive at an estimate of how implementation of the alternatives could impact net revenues.

Figure 10-2 shows the potential impact to net revenues on a percentage basis from rate increases. Impacts to fruit farming are slightly greater, owing to the greater water requirement in fruit farming as compared to vegetable farming in Ventura County. The Proposed MSHCP would reduce net revenues in vegetable farming by approximately 10 percent, or $1.5 million and reduce net revenues in fruit farming by 14 percent or about $2.3 million. The Infiltration Gallery alternative (Alternative F) is the scenario with the greatest potential impacts to agriculture, with a potential revenue reduction of 55 percent in fruit farming, effectively driving that sector out of business. Note that the Alternative G—Decommissioning impact does not include the reduction in net revenues because United would not be diverting water for use in Zone B and would no longer charge rates to those customers. The impacts of reduced diversions on agriculture are discussed in the next section.

**Figure 10-2 Rate Impacts as Percent of Agricultural Net Revenues under Each Alternative{ TC "Figure 10-2. Rate Impacts as Percent of Agricultural Net Revenues under Each Alternative
" \f F \l "1" }**



Impact of Reduced Water Supply from Operational Changes and Decommissioning

In the alternatives that require operational changes compared to the Proposed MSHCP (Alternatives A, D, and E) or decommissioning of the facilities (Alternative G), the water supply would be reduced. We assumed that this reduction would be borne entirely by agriculture in the county because the pumping rights are now tradeable as part of the GSP compliance path and M&I customers are able to outbid growers for those rights (USDA 2020).

The adoption of the Fox Canyon GSPs has set planned reductions in groundwater pumping and precluded continued overdraft to make up deficits such as would occur with removal of the Freeman Diversion. Based on the modeling results presented in the GSP, we estimated that water supply in United's Zone B could be reduced by 21,800 AF with Alternative A (Wishtoyo Operational Remedies + Santa Felicia Project), 2,700 AF with Alternative B (Notch Structure), and 34,800 AF with Alternative G (Decommissioning). For the operational changes consistent with the 2008 Biological Opinion in Alternative D (Vertical Slot + 2008 BO) and Alternative E (Hardened Ramp + 2008 BO), the modeled reductions was 7,940 AF. With just historic diversions at the Freeman Diversion, the GSPs found the sustainable yield to be just 49,000 AF; thus, each of these alternatives represent a sizable proportion of that yield, ranging from 6 percent up to 71 percent.

To estimate the economic impact of a water supply reduction in United's service area, we projected what specific crop categories would be most likely to be reduced, based on their net returns per acre of production. We assumed that as water supplies decreased and water prices increased, lowest value crop farming would be reduced until the entire amount of water reduction were offset, while higher value crops like fruits and nursery crops would continue to be farmed, absorbing the additional water costs. We used IMPLAN modeling software to estimate how changes to farmed acreages would impact Ventura County's total economic output, employment, and income, as well as how the direct impacts to agriculture could impact associated industries.

Based on per acre returns from cost and return studies published by UC Davis Cooperative Extension (UCD various years), we determined that the crops that would be most likely to be pulled from production include miscellaneous grasses, mixed pasture, miscellaneous field crops, cole crops, lettuce and leafy greens, melons, squash and cucumbers, and tomatoes. These crops combined account for approximately 10,000 AF of water. Additional reductions would be required from miscellaneous truck crops and strawberries, leaving the highest return crops of citrus, bush berries, and avocados unaffected. Because we were unable to disaggregate the category of miscellaneous truck crops into its component individual crops, we distributed the remaining needed water reduction to truck crops and strawberries equally.

IMPLAN provided an estimate of the broader economic impact that this change would have in Ventura County. A total of approximately 469,000 people are employed in Ventura County, out of which approximately 14,000 are employed in the agricultural sector. The existing or current condition used for comparison of environmental effects led to a reduction of 7,900 AF in groundwater pumping at the sustainable yield led to a loss of 4,100 acres. Applying Ventura Agricultural Commissioner values of agricultural output for individual crop type, agricultural output fell $33 million in that case. Agricultural employment would fall by 220, or 1.5 percent of that sector, and 0.1 percent of the county total. Along with the loss of direct agricultural sales or output, indirect and induced impacts would also result from this change in agricultural production.[9] The loss to county income (or value added) would be $15 million or less than 0.1 percent of the total county wide economic income or gross regional product of $47.3 billion.

The structural alternatives operating under new water right parameters of the Proposed MSHCP, Alternative B (Notch Structure) and Alternative C (Hardened Ramp), would lead to similar impacts on agricultural output and income. Acreage reductions would range from 550 to 1,400 acres and employment losses would be 30 to 35 jobs. Lost revenue would range from $4 to $5 million and net income would be reduced just over $2 million.

Alternatives D (Vertical Slot + 2008 BO) and E (Hardened Ramp +2008 BO) operating under the 2008 BO would have nearly identical impacts, with cultivated land reductions of 4,250 to 4,350 acres, job losses of about 230 positions, reduced revenue of $34 million, and income losses of $16 million.

Alternative F (Infiltration Gallery), because it would maintain the same average annual diversion yield as the Proposed MSHCP, would experience effects only through the rate increases. The revenue loss of $15 million would cause a reduction in agricultural on 1,800 acres with 100 jobs lost. Net income would fall $7 million.

For Alternative A, with the Wishtoyo operational remedy water operations changes, the projected reduction of 21,800 AF in pumping would cause a loss of 11,000 acres. Agricultural output would fall $220 million and agricultural employment would fall by 1,450, or 10 percent of that sector, and 0.4 percent of the county total. The county income would fall $100 million or 0.2 percent of the total county gross regional product.

For Alternative G (Decommissioning), we estimated that approximately 17,600 acres of agriculture would be taken out of production in response to a 34,800-AF reduction in supply. This represents a $322 million reduction in agricultural output. Reducing agricultural water use would reduce agricultural employment by 2,200, representing a 16 percent reduction in agricultural employment and a 0.5 percent reduction in overall

[9] Indirect impacts include impacts to related sectors of the economy that depend on agricultural for their business. Induced impacts are the impacts from a reduction in labor income that would otherwise be spent on local economic goods.

county employment. Altogether, the total economic loss would be $149 million. This represents a decrease of 1 percent of county gross regional product.

Overall Agricultural Economic Impact

Figure 10-3 shows the total impact on agricultural customers on Zone B through the combination of rate increases and water supply cutbacks. This shows the combination of loss of agricultural net income after retirement of acreage induced by water supply cutbacks, plus the loss of net income from increased water rates on the remainder of cultivated lands. The impacts from Alternative A (Wishtoyo Operational Remedies with Santa Felicia Project deliveries) and Alternative G (Decommissioning) would both threaten elimination of agriculture in Zone B. The two alternatives that rely on the BO water release operations (Alternatives D and E) have similar impacts. Of the other scenarios that achieve, or nearly achieve, the diversions under the proposed water rights, the Proposed MSHCP (vertical slot) has the smallest cumulative impacts compared to Alternatives B, C, and F.

Figure 10-3 Decrease in Dollar Value and Employment of Agricultural Net Income for Each Alternative{ TC "Figure 10-3. Decrease in Dollar Value and Employment of Agricultural Net Income for Each Alternative " \f F \l "1" }

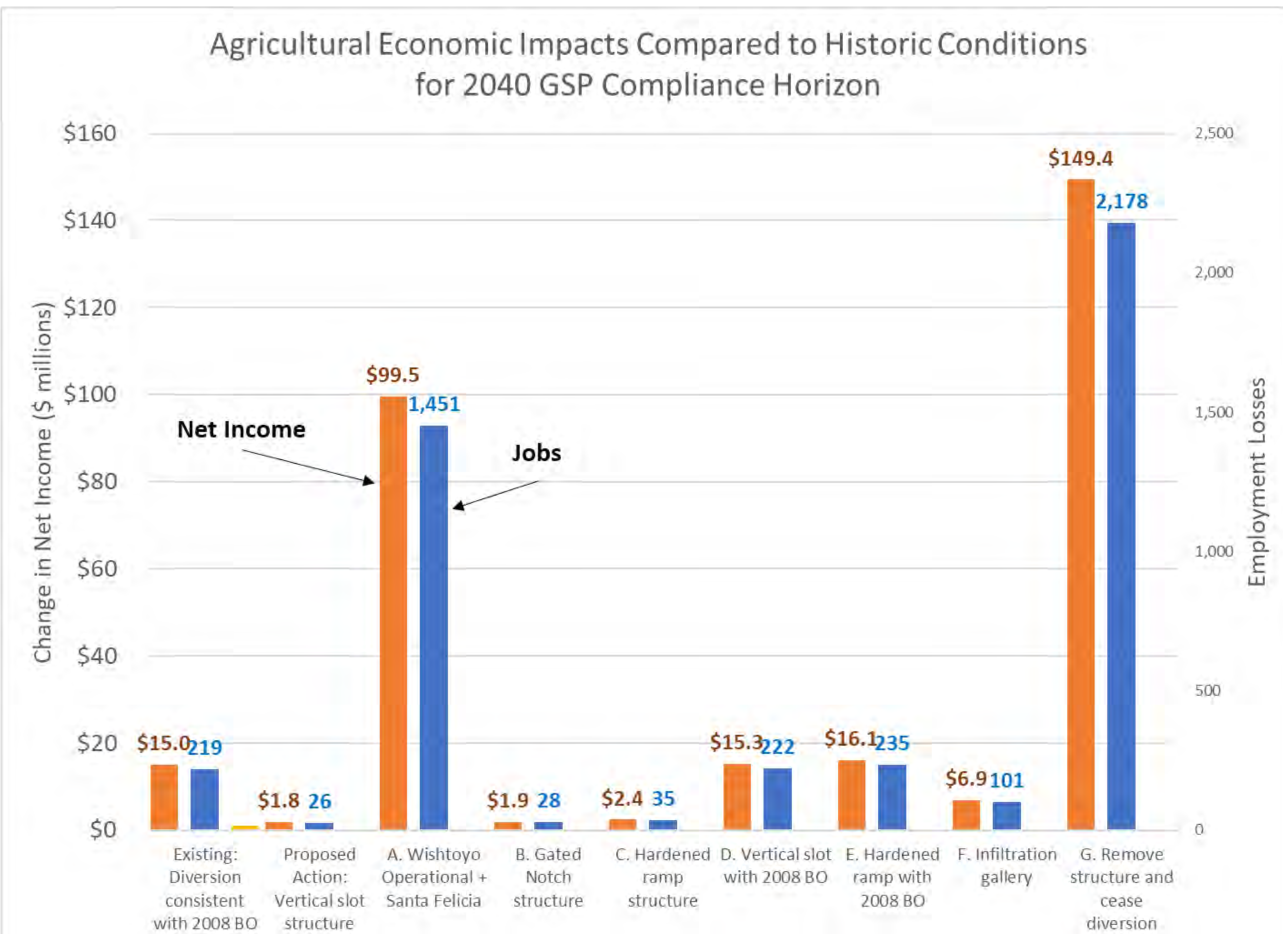


Table 10-9 Summary of Take Alternatives' Logistical and Technological Practicability, Compared to Proposed MSHCP

	Logistics*			Technology*						
Alternative	**Access**	**Availability of Resources**	**Availability of Sufficient Land**	**Standard Maintenance**	**Durability**	**Major Repair Timeframe**	**Fish Monitoring**	**Construction Risk**	**100-year Flood Elevation**	**Safety**
Proposed MSHCP	Project footprint accessible from United's property primarily on south bank. Two new temporary access roads would be needed for construction. → Logistically practicable	Standard construction and dewatering/diversion equipment can be used. → Logistically practicable	Project footprint is entirely within United's property. → Logistically practicable	Able to be maintained over the term of the permit to intended design standards and with reasonable maintenance costs. Standard maintenance activities would include debris clearing from screens and entrance gates, sediment management, and annual inspection/repairs. → Technologically practicable	Would be reasonably durable and resistant to high storm flows, particularly because the fish passage facility is off the main portion of the channel. → Technologically practicable	Most components could be accessed/isolated for major repairs during high flows. Obermeyer inflatable bladder/ steel gate plates and north fish entrance gates not accessible at high flows for major maintenance, (would need to be done at low flows), but accessible by walkways for minor maintenance. → Technologically practicable	Design includes an evaluation station through which bypass flow would be routed, allowing for monitoring and trap/haul. Also includes a fish counting station consisting of upstream migrant trap within or at the exit of the vertical slot fish ladder, DIDSON, PIT tag and radio-telemetry antenna arrays; capable of monitoring at low flows. Monitoring capabilities for upstream migrants would be good at high and low flows. Monitoring capabilities for downstream migrants would be moderate at high flows and good at low flows. → Technologically practicable	Construction would occur over 2 years and consist of approximately 503 active construction days within approximately 700 calendar days. High/flood flows during the wet season pose risks of damage and delays. Construction activities would include use of protection levees for in-channel work. The in-channel footprint of construction, complexity of activities, and duration of construction during the wet season would be minimized to maximum extent practicable. → Technologically practicable	Unchanged from current conditions. → Technologically practicable	Does not pose a safety hazard to United's staff or to people in the river downstream of the diversion. → Technologically practicable
A – Wishtoyo Operational Remedies + Santa Felicia Project	No new construction; existing facilities and access used. → Logistically practicable	No new construction; current availability of resources would remain sufficient for maintenance and operation activities of existing facilities. → Logistically practicable	No additional land beyond the existing project site would be needed because no new construction would occur. → Logistically practicable	Existing facilities are capable of being maintained over the permit term with reasonable maintenance costs. → Technologically practicable	Existing facilities are durable enough to withstand debris loads from high storm flows. → Technologically practicable	Existing facilities can be repaired in a timely manner should major damage shut down the facility temporarily. → Technologically practicable	Existing facility is equipped with downstream migrant fish trap, false weir and camera, and DIDSON camera. Monitoring capabilities for upstream migrants would be good at high and low flows. Monitoring capabilities for downstream migrants would be moderate at high flows and good at low flows. → Technologically practicable	There would be no construction risks from flood damage or delay because no new construction would occur. → Technologically practicable	The 100-year flood elevation would remain unchanged from current conditions. → Technologically practicable	Existing facilities do not pose a safety hazard to United's staff or to people in the river downstream of the diversion. → Technologically practicable
B – Notch Structure	Project footprint would be accessible from United's property primarily on south bank. Some new temporary access roads would likely be needed for construction and could be further evaluated in design process. → Logistically practicable	Standard construction and dewatering/diversion equipment can be used. → Logistically practicable	Project footprint is mostly within United's property, though some property acquisition upstream may be required → Logistically impracticable[1]	Standard maintenance activities would include debris clearing from screens, sediment management, and annual inspection/repairs. Concerns include access to LFF (riverside of structure) if a bypass channel were included, and to the upstream end of a ramp-style HFF for maintenance activities. Access for maintenance to some components of the structure is uncertain but would likely be accommodated during the design process. → Technologically practicable	Uncertainty about the durability and hydraulic design is a concern, especially the life of the grouted rock surface of a ramp-style HFF. Due to high debris and bedload during flood flows, the ramp component of the notch design could be damaged or rendered inoperable. Additionally, the use of 20 Obermeyer gates across a 400-foot width along the diversion crest is a concern for structure durability. → Technologically impracticable	Should repair of the rock ramp or Obermeyer gates be required, it could not be accomplished during high-flow periods, potentially rendering fish passage facility inoperable until repairs could be made at low-flow conditions. → Technologically impracticable	Depending on HFF design (e.g., ramp or pool and chute), monitoring of upstream passage may be possible at low flows but was not included in most recent design. Inclusion of the LFF would likely allow for monitoring of downstream migrants. Monitoring capabilities for upstream migrants would be zero at high flows and moderate at low flows. Monitoring capabilities for downstream migrants would be zero at high flows and good at low flows. → Technologically impracticable	Similar to Proposed MSHCP. → Technologically practicable	Reduced 100-year flood elevation compared to current conditions. → Technologically practicable	Does not pose a safety hazard to United's staff or to people in the river downstream of the diversion if operations are carefully defined so the impound is not released too fast downstream when transitioning to the HFF. → Technologically practicable
C – Hardened Ramp Structure	Project footprint would be accessible from United's property primarily on south bank. Some new temporary access roads would likely be needed for construction. Concerns include access to ramp which could be further evaluated in design process. → Logistically practicable	Standard construction and dewatering/diversion equipment can be used. → Logistically practicable	Project footprint is mostly within United's property, though some property acquisition upstream may be required if a ramp slope of 5% is pursued. → Logistically impracticable[1]	Standard maintenance activities would include debris clearing from screens, sediment management, and annual inspection/repairs. Additional concerns regarding access to some components would be addressed during further design. → Technologically impracticable	Uncertainty about the durability is a concern, especially the ramp fishway. Due to high debris and bedload during flood flows, the ramp could be damaged or rendered inoperable. This design is considered experimental and no similarly sized ramp structure has been built, particularly in a episodic and debris-heavy system such as exists in the Santa Clara River. → Technologically impracticable[2]	Should repair of the hardened ramp be required, it could not be accomplished during high-flow periods, potentially rendering the fish passage facility inoperable until repairs could be made at low-flow conditions. → Technologically impracticable	Monitoring of upstream passage may be possible at low flows but was not included in the most recent design; the wide high-flow facility may not allow for monitoring in turbid conditions; zero capability at high flows and moderate capability at low flows. Downstream migrant monitoring could be included in an evaluation station similar to proposed project, but not included in current design; poor capability at high flows and moderate capability at low flows. → Technologically	Construction would occur over a similar period as the Proposed MSHCP. High/flood flows during the wet season pose risks of damage and delays. Construction activities would include use of protection levees for in-channel work. In-channel construction during the wet season would be minimized to maximum extent practicable. → Technologically practicable	Similar 100-year flood elevation compared to current conditions. → Technologically practicable	Does not pose a safety hazard to United's staff or to people in the river downstream of the diversion. → Technologically practicable

Table 10-9 Summary of Take Alternatives' Logistical and Technological Practicability, Compared to Proposed MSHCP

	Logistics*			Technology*						
Alternative	**Access**	**Availability of Resources**	**Availability of Sufficient Land**	**Standard Maintenance**	**Durability**	**Major Repair Timeframe**	**Fish Monitoring**	**Construction Risk**	**100-year Flood Elevation**	**Safety**
							impracticable			
D – Vertical slot + 2008 BO	Same as Proposed MSHCP → Logistically practicable	Same as Proposed MSHCP → Logistically practicable	Same as Proposed MSHCP → Logistically practicable	Same as Proposed MSHCP → Technologically practicable	Same as Proposed MSHCP → Technologically practicable	Same as Proposed MSHCP → Technologically practicable	Same as Proposed MSHCP → Technologically practicable	Same as Proposed MSHCP → Technologically practicable	Unchanged from current conditions → Technologically practicable	Same as Proposed MSHCP → Technologically practicable
E – Hardened Ramp + 2008 BO	Same as Alternative C → Logistically practicable	Same as Alternative C → Logistically practicable	Same as Alternative C → Logistically impracticable	Same as Alternative C → Technologically impracticable	Same as Alternative C → Technologically impracticable	Same as Alternative C → Technologically impracticable	Same as Alternative C → Technologically impracticable	Same as Alternative C → Technologically practicable	Same as Alternative C → Technologically practicable	Same as Alternative C → Technologically practicable
F – Infiltration Gallery	Project footprint would be accessible from United's property primarily on the south bank. Many new access roads and infrastructure would likely be needed for construction and operations. → Logistically impracticable	Operation of the infiltration gallery would require use of large pumps to transfer large flows of water to United's existing fixed elevation diversion canal. Therefore, a lot of energy would be required to run the pumps, compared to current operations, which use a gravity-fed system; the energy use would be cost prohibitive. → Logistically impracticable	Project footprint would require large areas of land outside of United's property. → Logistically impracticable	Clogging of due to fine sediment bedload may pose a potentially unresolvable maintenance challenge to the function of the gallery. → Technologically impracticable	It is assumed that the bed would be graded down to the estimated post-scour profile before the placement of the infiltration gallery; therefore, the facility would be designed to withstand debris mobilized by high flows. → Technologically practicable	Because the infiltration gallery would be located entirely within the main channel, should major maintenance/repair be needed, it would need to wait for low-flow conditions or the dry season, and the water diversion facility could be nonfunctional for extended periods of time. → Technologically impracticable	This design does not include fish monitoring facilities. Monitoring for upstream and downstream migrants would only be possible during low flows (e.g., PIT tagging, trapping, or DIDSON); would be impossible during high flows → Technologically impracticable	Construction would likely be limited to the dry season, limiting risk of damage to equipment and of delays to the construction timeline. Infiltration gallery of necessary size has never been successfully implemented. Therefore, there is high risk that the construction of such a facility would not be possible technologically. → Technologically impracticable	Reduced 100-year flood elevation compared to current conditions. → Technologically practicable	Infiltration gallery facilities would not pose a safety hazard to United's staff or to people in the river downstream of the diversion. → Technologically practicable
G – Remove Structure and Cease Diversions	Project footprint would be accessible from United's property primarily on south bank. Some new temporary access roads would likely be needed for demolition. → Logistically practicable	Standard construction and dewatering/diversion equipment can be used for demolition. Resources necessary for operation and maintenance would not be needed once the structure was removed. → Logistically practicable	Project footprint is entirely within United's property. No new construction, so no additional land needed. → Logistically practicable	Once structure was removed, no maintenance would be necessary over the permit term. → Technologically practicable	Structure would be removed, so no durability concerns would exist. → Technologically practicable	Structure would be removed, so no repair concerns would exist. → Technologically practicable	Monitoring for upstream and downstream migrants would only be possible during low flows (e.g., PIT tagging, trapping, or DIDSON); would be impossible during moderate to high flows → Technologically impracticable	Demolition would occur over a similar duration as the Proposed MSHCP. High/flood flows during the wet season pose risks of damage and delays. Demolition activities would include use of protection levees for in-channel work. In-channel demolition during the wet season would be minimized to maximum extent practicable. → Technologically practicable	Reduced 100-year flood elevation compared to current conditions. → Technologically practicable	Removal of existing facilities would not pose a safety hazard to United's staff or to people in the river downstream of the diversion. → Technologically practicable

*See definitions from Section 10.4, Methods Used to Evaluate Alternatives to Take.

[1] United has made an attempt to acquire neighboring property in the past without success.

[2] Engineering design modeling is ongoing; however, modeling is limited in ways to validate these uncertainties.

10.4.4 OTHER ENVIRONMENTAL CONSEQUENCES

To determine feasibility, it is important to assess whether take alternatives may have unacceptable effects on the environment other than on biological resources. For example, alternatives that entail larger areas of construction-related disturbance may reduce impacts on the covered species (i.e., may reduce take) but may significantly increase adverse effects on air quality and greenhouse gases associated with the greater use of construction materials.

The resources listed below were evaluated for significant and unavoidable effects that could occur under the take alternatives. Table 10-10 summarizes other environmental consequences evaluated for the alternatives; refer to Section 10.5, *Assessment of Take Alternatives*, for the detailed evaluations.

- Agricultural Resources
- Air Quality/Greenhouse Gas Emissions
- Archaeological/Cultural/Tribal Resources
- Biological Resources (excluding covered species)
- Hydrology/Water Quality
- Noise
- Transportation/Traffic

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Table 10-10 Summary of Take Alternatives' Other Environmental Consequences, Compared to Proposed MSHCP

Alternative	Agricultural Resources	Air Quality/Greenhouse Gas Emissions	Archaeological/Cultural/Tribal Resources	Biological Resources (not covered species)	Hydrology/Water Quality	Noise	Transportation/Traffic
Proposed MSHCP with Vertical Slot Fish Passage Facility	No significant impacts anticipated. The Proposed MSHCP would continue diverting surface water for groundwater replenishment in the Oxnard Plain, thereby preventing further seawater intrusion and negative impacts on farmland of the Oxnard Plain.	No significant impacts anticipated. Amount of air quality pollutants/greenhouse gas emissions mostly tied to construction duration (2 years) and footprint.	No significant impacts anticipated; however, potential for impacts varies by size of project footprint.	Most impacts on noncovered species would be on riparian birds and aquatic herps, associated with the construction footprint (approximately 3 acres of which could affect riparian and streambed habitats)	No significant impacts anticipated. Amount of surface water diverted to groundwater storage would affect groundwater levels and seawater intrusion, thereby affecting groundwater quality.	No significant impacts anticipated. Amount of noise impacts mostly tied to construction duration (2 years) and footprint.	No significant impacts anticipated. Amount of traffic impacts mostly associated with truck traffic from construction; varies by duration of construction (2 years) and size of project.
A – Wishtoyo Operational Remedies + Santa Felicia Project	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and substantial negative impacts on farmland. →More impact than Proposed MSHCP.	No new construction would occur; therefore, fewer air quality pollutants/greenhouse gas emissions would occur. →Less impact than Proposed MSHCP.	No new construction would occur; therefore, lower potential for cultural resource impacts to occur. →Less impact than Proposed MSHCP.	No new construction would occur; therefore, no direct impacts on biological resources from construction would occur. Less surface water diversions would allow for more instream flow; therefore, aquatic habitat may improve/extend downstream of the diversion structure in some months. No substantial change would be expected to riparian habitats as a result of water operations due to the hydrologically losing nature of the reach. →Less impact than Proposed MSHCP.	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and substantial negative impacts on groundwater quality. →More impact than Proposed MSHCP.	No new construction would occur; therefore, less noise associated with construction would occur. →Less impact than Proposed MSHCP.	No new construction would occur; therefore, less traffic associated with construction would occur. →Less impact than Proposed MSHCP.
B – Notch Structure	Reduced surface water diversion to supplement groundwater storage when compared to Proposed MSHCP; therefore, greater seawater intrusion and negative impacts on farmland of Oxnard Plain. →More impact than Proposed MSHCP.	New construction would occur, would have larger footprint, and would require more concrete than Proposed MSHCP; therefore, larger amount of air quality pollutants/greenhouse gas emissions would occur. →More impact than Proposed MSHCP.	Larger construction footprint could have higher potential for impacts on cultural resources. →More impact than Proposed MSHCP.	Larger construction footprint could have higher potential for direct impacts on noncovered species (approximately 18 acres of direct impacts on riparian and streambed habitats). Less surface water diversion than Proposed MSHCP could allow for more instream flow and aquatic habitat may improve/extend downstream of the diversion structure in some months; however, diversions would primarily occur during relatively lower flows than the Proposed MSHCP and have a larger impact on aquatic habitats. No substantial change would be expected to downstream riparian habitats as a result of water operations due to the hydrologically losing nature of the reach. However, over forecasted 15-year and 70-year periods, 200 and 400 acres (respectively) of riparian and streambed habitats would be disturbed by aggradation and degradation as a result of the change in bed elevation. →More impact than Proposed MSHCP.	Less surface water diversion to groundwater storage compared with Proposed MSHCP; therefore, greater seawater intrusion and impacts on groundwater quality. →More impact than Proposed MSHCP.	Larger construction footprint would have more noise associated with larger extent of construction. →More impact than Proposed MSHCP.	New construction would occur, would have larger footprint, and would require more concrete than Proposed MSHCP; therefore, more traffic impacts from increased truck traffic would occur. →More impact than Proposed MSHCP.
C – Hardened Ramp Structure	Same surface water diversion to supplement groundwater storage as Proposed MSHCP; therefore, same potential for seawater intrusion and prevention of further negative impacts on farmland of Oxnard Plain. →Similar impact to Proposed MSHCP.	New construction would occur, would have larger footprint, and would require much more concrete than Proposed MSHCP; therefore, larger amount of air quality pollutants/greenhouse gas emissions would occur. →More impact than Proposed MSHCP.	Larger construction footprint could have higher potential for impacts on cultural resources. →More impact than Proposed MSHCP.	Larger construction footprint could have higher potential for direct impacts on noncovered species (approximately 5.5 acres of impacts on riparian and streambed habitats). Same surface water diversion as Proposed MSHCP; therefore, same anticipated impacts on aquatic habitat. No substantial change would be expected to downstream riparian habitats as a result of water operations due to the hydrologically losing nature of the reach. →More impact than Proposed MSHCP.	Same surface water diversion to groundwater storage as Proposed MSHCP; therefore, same potential for seawater intrusion and impacts/ prevention of impacts on water quality. →Similar impact to Proposed MSHCP.	Larger construction footprint would have more noise associated with larger extent of construction. →More impact than Proposed MSHCP.	New construction would occur, would have larger footprint, and would require much more concrete than Proposed MSHCP; therefore, more traffic impacts from increased truck traffic would occur. →More impact than Proposed MSHCP.
D – Vertical slot + 2008 BO	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and negative impacts on farmland. →More impact than Proposed MSHCP.	No significant impacts anticipated. Amount of air quality pollutants/greenhouse gas emissions mostly tied to construction duration (2 years) and footprint. →Similar impact to Proposed MSHCP.	No significant impacts anticipated; however, potential for impacts varies by size of project footprint. →Similar impact to Proposed MSHCP.	Most impacts on noncovered species would be on riparian birds and pond turtles, associated with the construction footprint (approximately 3 acres of which could affect riparian and streambed habitats). Less surface water diversions than the Proposed MSHCP would allow for more instream flow; therefore, aquatic habitat may improve/extend downstream of the diversion structure in some months. No substantial change would be expected to downstream riparian habitats as a result of water operations due to the hydrologically losing nature of the reach. →Less impact than Proposed MSHCP.	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and negative impacts on groundwater quality. →More impact than Proposed MSHCP.	No significant impacts anticipated. Amount of air quality pollutants/greenhouse gas emissions mostly tied to construction duration (2 years) and footprint. →Similar impact to Proposed MSHCP.	No significant impacts anticipated; however, potential for impacts varies by size of project footprint. →Similar impact to Proposed MSHCP.

Table 10-10 Summary of Take Alternatives' Other Environmental Consequences, Compared to Proposed MSHCP

Alternative	Agricultural Resources	Air Quality/Greenhouse Gas Emissions	Archaeological/Cultural/Tribal Resources	Biological Resources (not covered species)	Hydrology/Water Quality	Noise	Transportation/Traffic
E – Hardened ramp + 2008 BO	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and negative impacts on farmland. →More impact than Proposed MSHCP.	New construction would occur, would have larger footprint, and would require much more concrete than Proposed MSHCP; therefore, larger amount of air quality pollutants/greenhouse gas emissions would occur. →More impact than Proposed MSHCP.	Larger construction footprint could have higher potential for impacts on cultural resources. →More impact than Proposed MSHCP.	Less surface water diversions than the Proposed MSHCP would allow for more instream flow; therefore, aquatic habitat may improve/extend downstream of the diversion structure in some months. However, larger construction footprint could have higher potential for direct impacts on noncovered species (approximately 5.5 acres of impacts on riparian and streambed habitats). No substantial change would be expected to downstream riparian habitats as a result of water operations due to the hydrologically losing nature of the reach. →More impact than Proposed MSHCP.	Reduced surface water diversions would reduce groundwater replenishment, resulting in increased seawater intrusion in the Oxnard Plain and negative impacts on groundwater quality. →More impact than Proposed MSHCP.	Larger construction footprint would have more noise associated with larger extent of construction. →More impact than Proposed MSHCP.	New construction would occur, would have larger footprint, and would require much more concrete than Proposed MSHCP; therefore, more traffic impacts from increased truck traffic would occur. →More impact than Proposed MSHCP.
F – Infiltration Gallery	Assuming an infiltration gallery of adequate size could be constructed, same surface water diversion to supplement groundwater storage as Proposed MSHCP; therefore, same potential for seawater intrusion and prevention of further negative impacts on farmland of Oxnard Plain. →Similar impact to Proposed MSHCP.	Construction would have a larger footprint than Proposed MSHCP and construction duration would last longer to Proposed MSHCP; also, large energy requirements to run the pumps resulting in more release of air quality pollutants/greenhouse gas emissions. →More impact than Proposed MSHCP.	Construction would have a larger footprint than Proposed MSHCP; therefore, higher potential for cultural resource impacts. →More impact than Proposed MSHCP.	Larger construction footprint (with a total impact footprint of 40 acres of riparian and streambed habitats) could have higher potential for direct impacts on noncovered species. Removal of structure would remove the water impoundment and the system would return to intermittent stream habitat similar to historical conditions, and greatly reduce riparian habitat in vicinity of the diversion. →More impact than Proposed MSHCP.	Assuming an infiltration gallery of adequate size could be constructed, same surface water diversion to groundwater storage as Proposed MSHCP; therefore, same potential for seawater intrusion and impacts/prevention of impacts on water quality. →Similar impact to Proposed MSHCP.	Construction would have a larger footprint than Proposed MSHCP; therefore, more noise impacts would be anticipated with larger extent of construction activities. →More impact than Proposed MSHCP.	Construction would have a larger footprint than Proposed MSHCP and construction duration would last longer to Proposed MSHCP, resulting in more truck traffic. →More impact than Proposed MSHCP.
G – Remove Structure and Cease Diversions	Cessation of surface water diversions would cease supplemental groundwater replenishment, allowing for increased seawater intrusion in the Oxnard Plain and substantial negative impacts on farmland. →More impact than Proposed MSHCP.	Demolition would have a similar footprint to Proposed MSHCP and construction duration would last a similar length to the Proposed MSHCP, resulting in similar release of air quality pollutants/greenhouse gas emissions. →Similar impact to Proposed MSHCP.	Demolition would have a similar footprint to Proposed MSHCP; therefore, similar potential for cultural resource impacts. →Similar impact to Proposed MSHCP.	Demolition would have a similar footprint to Proposed MSHCP and similar construction duration; therefore, similar potential for direct impacts on noncovered species. Removal of structure would cease water impoundment and the system would return to intermittent stream similar to historical conditions; therefore, riparian habitat and instream habitat would reduce in extent in the vicinity of the former diversion structure. →More impact than Proposed MSHCP.	Cessation of surface water diversions would cease groundwater replenishment, allowing for increased seawater intrusion in the Oxnard Plain and substantial negative impacts on water quality. →More impact than Proposed MSHCP.	Demolition would have a similar footprint to Proposed MSHCP and is assumed to be of similar construction duration; therefore, similar noise associated with construction would occur. →Similar impact to Proposed MSHCP.	Demolition would have a similar footprint to Proposed MSHCP and similar duration; therefore, similar traffic associated with construction would occur. →Similar impact to Proposed MSHCP.

10.5 ASSESSMENT OF TAKE ALTERNATIVES

Take alternative assessment sections are structured in the following fashion. Sections begin with a summary of incidental take and conservation benefits relative to the Proposed MSHCP. This is followed by detailed discussions of effects on covered species, with fish covered discussed separately from other vertebrate species. Each of the effects sections discuss effects from construction, maintenance, and operations. Then the alternative is reviewed for consistency with United's goals, the goals of the MSHCP, and fish passage criteria. Practicability, including cost, logistical, and technological constraints, is discussed next. Following this is a discussion of other environmental consequences associated with the take alternative. Finally, the take alternative assessment is summarized in a concluding statement regarding its status relative to the Proposed MSHCP. Section 10.6 provides a comparative summary of this analysis for all take alternatives, followed by general conclusions of this analysis.

10.5.1 ALTERNATIVE A – WISHTOYO OPERATIONAL REMEDIES PLUS SANTA FELICIA PROJECT

Incidental Take and Conservation Benefits

Relative to the Proposed MSHCP, **Take Alternative A** would avoid or reduce some types of negative effects and take for some covered wildlife species, such as western pond turtle, least Bell's vireo, southwestern willow flycatcher, and yellow-billed cuckoo, by not implementing CMs 1.1.1 and 1.1.2 and substantively modifying CMs 1.2.1–1.2.4 of the Proposed MSHCP.

While United can implement operation and maintenance actions to reduce potential for take of steelhead, United has determined that no actions would preclude all take of steelhead from occurring. Furthermore, the physical structure of Freeman Diversion would remain, and United would still need to operate the existing fish ladder. Fish passage characteristics for Freeman Diversion would remain unchanged and operating the fish ladder may result in take of steelhead during fish passage events; therefore, **Take Alternative A** would provide less overall conservation benefit than the Proposed MSHCP. The existence of the current diversion facility and Denil fish ladder creates a partial barrier, delaying the migration of adult steelhead upstream, and poses a risk to juvenile steelhead migrating downstream. In addition, even minimal maintenance of the existing facility may result in take of steelhead in some circumstances.

Effects on Covered Fishes

Construction

Construction of the vertical slot fishway at Freeman Diversion under the Proposed MSHCP may result in a number of adverse effects on covered fish species (southern California steelhead and Pacific lamprey), including disturbance from in-water construction activities and reduced passage opportunities during construction. **Take Alternative A** would avoid adverse effects on steelhead and lamprey from construction because no new construction would take place. Under both the Proposed MSHCP and **Take Alternative B**, there would be no effect on tidewater goby (*Eucyclogobius newberryi*) from construction activities.

Maintenance

Maintenance activities under **Take Alternative A** would be similar to those under the Proposed MSHCP. Standard routine maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road maintenance) would be necessary under both **Take Alternative A** and the Proposed MSHCP, and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs{ TC "Best Management Practice (BMP" \f A \l "1" }]

- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP{ TC "Capture and Relocation Plan (CRP" \f A \l "1" }]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events

Most of the potential effects on covered steelhead and lamprey from maintenance would be associated with periodic sediment sluicing activities at the diversion facility. Both the Proposed MSHCP and **Take Alternative A** would require similar sluicing flows when sediment accumulation at the diversion intake occurs during normal operations. Neither alternative negates the potential requirement for sediment sluicing to take place during the fish passage window; however, sediment sluicing operations outlined in CM 1.2.6 would be conducted in a way to minimize take. Under both the Proposed MSHCP and **Take Alternative B**, there would be no effect on tidewater goby from maintenance activities. Therefore, effects on covered fishes due to maintenance activities under **Take Alternative A** would be similar to those under the Proposed MSHCP.

Operations

Overall, implementation of **Take Alternative A** would have more negative effects on covered fishes than the Proposed MSHCP. As described below, improved habitat and migration conditions downstream of Freeman Diversion for covered fishes would result from increased instream flows (and decreased diversions). However, anadromous fish migration upstream past Freeman Diversion would be reduced and downstream juvenile migrants would have higher risk of harm when passing the diversion under **Take Alternative A** compared to the Proposed MSHCP because of the continued use of the existing fish passage facility instead of implementation of CMs 1.1.1 and 1.1.2. Therefore, take of covered fishes due to physical harm of juveniles, passage delays, and lessened adult passage opportunities would be greater under **Take Alternative A** compared to the Proposed MSHCP.

Take Alternative A would not implement CMs 1.1.1 and 1.1.2 and would substantively modify CMs 1.2.1–1.2.4, which would alter operations and affect steelhead in the following manner. Because CM 1.1.1 and 1.1.2 would not be implemented, the existing fish screens would remain in place. The existing screens are considered to be less protective than NMFS current criteria for facility design, which would result in more take of steelhead than the fish screen structure specified in the Proposed MSHCP.

The modification of CMs 1.2.1/1.2.3 would result in enhanced adult passage opportunities from the ocean to the estuary by increasing the percent of time the estuary mouth is predicted to remain open during the steelhead migration window (Nov 1 – May 31) in dry and normal Water Year types (Stillwater Sciences 2016a). Increased connectivity with the ocean would be promoted by increased discharge and reduced water diversion into the diversion facility relative to the Proposed MSHCP (This operational scenario is similar to the “No Diversion” scenario evaluated in Stillwater Sciences 2016a). Modification of CMs 1.2.1/1.2.3 would result in enhanced adult passage opportunities through the critical riffle during the steelhead migration window in normal and wet Water Year types (Stillwater Sciences 2016a). Again, this would take place through increased discharge past the diversion facility relative to the Proposed MSHCP (This operational scenario is similar to the “No Diversion” scenario evaluated in R2 Resources [2016]).

The primary difference between the Proposed MSHCP and **Take Alternative A** regarding adult passage opportunities at the diversion is the potential take associated with the existing fish ladder. CM 1.1.1 proposes to replace the existing structure with a new structure that would improve adult passage opportunities. **Take Alternative A** would leave the existing structure in place but modify diversion protocols. The flow modification proposed in **Take Alternative A** may result in reduced adult passage opportunities at the diversion by increasing the amount of time when nuisance flows over the spillway are greater than 80 percent of the 120 cfs attraction flow emanating from the Denil fish ladder. It is assumed that when nuisance flows are greater than 80 percent of attraction flows, no fish passage is possible through the existing fish ladder (Chapter 7: Section 7.2.2). Adult passage opportunities at the diversion would be worse than under the Proposed MSHCP because the existing structure would remain in place and would experience greater bypass flows.

The modification of CMs 1.2.2/1.2.4 would result in enhanced smolt passage opportunities in the estuary and critical riffle for the reasons listed above for adult passage.

The primary difference between the Proposed MSHCP and **Take Alternative A** regarding smolt passage opportunities is the potential take associated with the existing diversion structure. CM 1.1.1 proposes to replace the existing structure with a new structure that would reduce the risk of take to out-migrating smolts. Juvenile passage over the elements of the existing structure, including the diversion crest, bypass channel, trash rack, smolt bypass, and fish ladder poses a number of risks. Passage over the diversion crest is considered to pose an injury or disorientation risk to out-migrating smolts that can tumble onto the exposed apron below. Increased conveyance over the crest associated with **Take Alternative A** would result in some larger fraction of smolts passing over the diversion crest. Juvenile passage opportunities at the diversion would be worse than under the Proposed MSHCP because the existing structure would remain in place and would experience greater bypass flows, particularly more flow over the crest of the diversion.

Reduced water diversion would increase water conveyance past the diversion structure and into the downstream channel. This increased water conveyance would result in either no change or a slight decrease in wetted habitat in the estuary by potentially increasing connectivity between the ocean and estuary during dry and normal years (Stillwater Sciences 2016a). Increased open time would mean that, on average, the estuary would occupy a slightly smaller wetted area relative to behavior under the Proposed MSHCP where the estuary would be closed more often and remain fuller, potentially providing more steelhead rearing habitat in the estuary; however, it is unknown to what extent Santa Clara River steelhead rear in the estuary.

Take Alternative A would not implement CMs 1.1.1 and 1.1.2 and would substantively modify CMs 1.2.1–1.2.4, which would alter operations and affect lamprey in the following manner.

Because CM 1.1.1 and 1.1.2 would not be implemented, the existing fish screens would remain in place. The existing screens are considered to be less protective than NMFS current criteria for facility design, which would result in more take of lamprey ammocoetes than the structure specified in the Proposed MSHCP.

The modification of CMs 1.2.1/1.2.3 would result in enhanced adult lamprey passage opportunities in the estuary in a fashion identical to that given for adult steelhead.

The primary difference between the Proposed MSHCP and **Take Alternative A** regarding adult lamprey passage opportunities at the diversion is the potential take associated with the existing diversion structure. CM 1.1.2 proposes to replace the existing structure with a new structure that would improve adult lamprey passage opportunities. **Take Alternative A** would leave the existing structure in place but modify diversion protocols. Modification is expected to result in reduced passage opportunities in a fashion identical to that given for steelhead adults. Adult lamprey passage opportunities at the diversion would be worse than under the Proposed MSHCP because the existing structure would remain in place and would experience greater bypass flows.

The modification of CMs 1.2.2/1.2.4 would result in enhanced juvenile lamprey passage opportunities in the estuary and critical riffle for the reasons listed above for adult steelhead passage.

The primary difference between the Proposed MSHCP and **Take Alternative A** regarding juvenile lamprey passage opportunities is the potential take associated with the existing diversion structure. The risk of adverse effects on juvenile lamprey migrating past the existing diversion is currently unknown. The Proposed MSHCP is likely to represent a similar or reduced risk to juvenile lamprey as that of the existing diversion.

Under both the Proposed MSHCP and **Take Alternative A**, there is potential for negative effects on tidewater goby to occur during fisheries monitoring activities in the estuary; however, conservation measures would be implemented to avoid take of tidewater goby under both scenarios. Thus, take of tidewater goby due to fisheries monitoring activities would be identical under the Proposed MSHCP and **Take Alternative A**.

The primary difference between the Proposed MSHCP and **Take Alternative A** regarding effects to tidewater goby is similar to the effect on steelhead smolts. Under **Take Alternative A**, increased water conveyance would result in either no change or a slight decrease in wetted habitat in the estuary compared to the Proposed MSHCP by potentially increasing the connectivity between the ocean and estuary during dry and normal years (Stillwater Sciences 2016a). Increased open time would mean that, on average, the estuary would occupy a slightly smaller wetted area relative to behavior under the Proposed MSHCP where the estuary would be closed more often and remain fuller, potentially providing more tidewater goby habitat in the estuary. Thus, **Take Alternative A** would provide slightly less estuary habitat for tidewater goby than the Proposed MSHCP due to differences in water release operations.

Effects on Covered Birds and Western Pond Turtle

Take of covered birds and negative effects on pond turtle would be lower under **Take Alternative A** compared to the Proposed MSHCP because no construction activities would occur under **Take Alternative A**, thus no construction-related take would occur. Under **Take Alternative A**, take of covered birds and pond turtle due to maintenance and operational activities would be similar to take expected under the Proposed MSHCP.

Construction

Take Alternative A is expected to result in less negative effects on covered birds and pond turtles than the Proposed MSHCP. Under **Take Alternative A**, CMs 1.1.1 and 1.1.2 would not be implemented and no construction would occur. Therefore, temporary and permanent impacts on approximately 3 acres of riparian habitat included under the Proposed MSHCP would not occur, and there would be no take of covered birds and no direct impact on pond turtle under **Take Alternative A** as a result of construction activities.

Maintenance

Standard routine maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road control maintenance) would be necessary under both **Take Alternative A** and the Proposed MSHCP and would include implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.1.7 Avoidance of Nests of Covered Species of Birds During Nesting Bird Season
- CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events

Both under **Take Alternative A** and the Proposed MSHCP, take of covered avian species is reasonably certain to occur due to temporary removal of riparian vegetation during maintenance covered activities. Implementation of CMs 2.1.1–2.18 and CM 2.2.2 would reduce the potential for effects on covered birds from maintenance activities under both the Proposed MSHCP and **Take Alternative A**, and similar levels of take are expected under both alternatives.

Maintenance activities occur within riparian areas that have been routinely maintained since construction of the Freeman Diversion (e.g., vegetation management zones, hardscape earth/structure) and generally lack suitable habitat for pond turtle. Therefore, adverse effects to pond turtle would be relatively low; however, some work will be required in the river channel in areas of currently occupied pond turtle habitat. Maintenance activities would also include inspection and sediment management of the fishway and baffles and annual dewatering, which could negatively affect pond turtles. These activities would be required for maintenance under the Proposed MSHCP and under **Take Alternative A** (e.g., to ensure the facility is functioning properly, gates are calibrated and running smoothly). Under both alternatives, United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize negative effects covered pond turtles due to dewatering and rescue activities (e.g., stranding, stress from handling). Therefore, negative effects on covered pond turtles due to maintenance activities are anticipated to be identical under **Take Alternative A** to that of the Proposed MSHCP.

Operations

Riparian Habitat and Aquatic Habitat

As described in Chapter 7, *Effects Analysis*, and in the Stillwater Sciences (2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }) *Effects of Freeman Diversion on Riparian Vegetation in the Santa Clara River*, the Freeman Diversion supports more extensive riparian vegetation establishment immediately upstream and downstream of the diversion compared to historical conditions (pre-diversion structure) and compared to areas outside of the influence of the diversion and grade control structure, likely as a result of under-seepage and subsurface water backing up behind the diversion and grade control structure. The stream reach in the vicinity of the Freeman Diversion was historically a losing hydrological reach and would likely have less dry-season flow than occurs under current conditions with the presence of the Freeman Diversion and water bypass operations.

Analysis by Stillwater Sciences (2016b) indicated that hydrologic alterations between water operation scenarios would have little to no effect on hydrologic parameters most critical to riparian vegetation recruitment and growth. Operations under **Take Alternative A** were not analyzed in the Stillwater Sciences (2016b) study; however, similar conclusions about riparian habitats are expected. It is anticipated that the ongoing impoundment of water behind the Freeman Diversion and seepage through pipes built into the base of the diversion would continue to support similar levels of riparian habitat in the vicinity of the structure. The impoundment and downstream pool would continue to support habitat suitable for a population of pond turtles.

Take Alternative A would result in increased instream flows downstream of Freeman Diversion compared to the Proposed MSHCP, which could allow for improved or increased extent of aquatic habitat in some months, further benefitting pond turtle. Therefore, overall, impacts on covered riparian birds and pond turtles from water operations under **Take Alternative A** would be slightly less than under the Proposed MSHCP.

Covered Birds

No take of covered birds is expected to result from operations under the Proposed MSHCP or **Take Alternative A**.

Western Pond Turtles

As described in Chapter 7, *Effects Analysis*, no take of pond turtles is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative A**. Under operation of the fish passage facilities included in both **Take Alternative A** and the Proposed MSHCP, pond turtles could enter the fish passage facility and be negatively affected if they become trapped in the facility, resulting in take of these species, though the potential for injury or mortality is low. Additional sources of take under the Proposed MSHCP and **Take Alternative A** include covered aquatic species rescue and relocation, sediment sluicing, crest gate operations, and monitoring activities, though the potential for take during these activities would be similar under both alternatives. Therefore, negative effects on covered pond turtles due to operations would be similar under **Take Alternative A** to that of the Proposed MSHCP.

Consistency with Goals

Take Alternative A would eliminate the underlying lawful activity for which a permit is being sought and thus be inconsistent with United's purposes and prevent accomplishment of the activity for which ITPs are being requested. Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative A** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

Due to greatly reduced water diversions, implementation of **Take Alternative A** would be inconsistent with the following goals to achieve United's mission:

- Goal 1 – Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
- Goal 2 – Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.

Due to greatly reduced water diversions, implementation of **Take Alternative A** would reduce the need for sediment management, and it would be more consistent with the following goal to achieve United's mission:

- Goal 4 – Allow United to manage sediment deposition in the desilting basin or other settling basin in a sustainable manner.

Take Alternative A would be less consistent with the following MSHCP covered species goals than the Proposed MSHCP because the existing fish passage facility would remain in place and not be modified to improve fish passage[10]:

- Goal 1 – Improve migration of steelhead through the diversion.
- Goal 4 – Promote migration of lamprey through the diversion.

Due to greatly reduced water diversions, implementation of **Take Alternative A** would be inconsistent with the following MSHCP covered species goal:

- Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose.

[10] The Proposed MSHCP includes replacement of the existing fishway with a vertical slot fishway and diversion grade control structure modifications to improve adult and juvenile fish passage past the diversion relative to existing conditions, thereby improving access between upstream spawning grounds and estuarine/marine areas.

Take Alternative A would provide increased flows and approximate an unimpeded hydrograph downstream of the diversion most of the year (during wettest months and the shoulder seasons); therefore, it would have greater consistency with the following MSHCP covered species goals compared to the Proposed MSHCP:

- Goal 2 – Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31).
- Goal 3 – Improve upstream migration of adult steelhead and downstream migration of smolts before and after the primary migration periods (e.g., November, December, and June) when sufficient rainfall could also allow passage in the Santa Clara River downstream of the Freeman Diversion.
- Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.
- Goal 7 – Minimize impacts on riparian habitat and other covered species.
- Goal 8 – Minimize operational complexity including operational transitions between different fish passage systems.

Due to continued use of the existing fish passage facility, **Take Alternative A** would be inconsistent with the following fish passage facility criteria:

- Criterion 1 – Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs.
- Criterion 2 – Minimize interruptions to passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 4 – Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows.
- Criterion 5 – Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.
- Criterion 6 – Ensure hydraulic conditions meet the needs of all steelhead life stages expected to pass through the facility.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.
- Criterion 8 – Preclude nuisance attraction flows across the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.
- Criterion 9 – Preclude fish passage through partially open gates or weirs.
- Criterion 10 – Ensure fish screens are protective of all life stages of covered aquatic species from impingement and entrainment.

Because no new construction would take place, **Take Alternative A** would be more consistent with the following fish passage facility criteria:

- Criterion 11 – Ensure that instream project work be completed within 2 years of permitting, as required by Court Order

Therefore, **Take Alternative A** is not considered consistent with the purpose of activity for which ITPs are requested or the goals and fish passage criteria of the MSHCP.

Practicability

Take Alternative A was found to be both logistically and technologically practicable. However, **Take Alternative A** was deemed impracticable because it would not be economically feasible for United to implement and it would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested.

Cost

Take Alternative A would lead to a reduction in diversions which in turn would lead to a reduction in available water supplies to customers and a commensurate increase in rates. This would lead to substantial impacts on the local economy, both through rate increases of 48% and reduced agricultural production due to a 35% reduction in agricultural pumping. Regional net income losses could approach and exceed $100 million per year.

Logistics

New construction would not occur under **Take Alternative A**. Access to existing facilities would remain unchanged and the current availability of resources would remain sufficient for maintenance and operation activities. No additional land beyond the existing project site would be needed because no new construction would occur. Therefore, **Take Alternative A** would be logistically practicable.

Technology

The existing facility would continue to be operated under **Take Alternative A**. It is capable of being maintained over the permit term with reasonable maintenance costs, is durable enough to withstand debris loads from high storm flows, and can be repaired in a timely manner should major damage shut down the facility temporarily. Fish monitoring would continue with the existing facility; upstream migrant monitoring would be accomplished with an existing false weir and camera equipment, and downstream migrant monitoring could be accomplished using an existing downstream migrant trap. There would be no construction risks from flood damage or delay because no new construction would occur, and the 100-year flood elevation would remain unchanged. The existing facility does not pose a safety hazard to United's staff or to people in the river downstream of the diversion. Therefore, considering maintenance, durability, timeliness of repairs, fish monitoring, construction risk, 100-year flood elevation, and safety concerns, **Take Alternative A** is considered technologically practicable.

Other Environmental Consequences

Under **Take Alternative A**, more negative impacts would be anticipated on agricultural resources and water quality of the Oxnard Plain. Reduced surface water diversions at Freeman Diversion would reduce supplies for groundwater replenishment in the Oxnard Plain, allowing for increased seawater intrusion, which would negatively affect farmland and groundwater quality (see Section 10.4 and Appendix B). In an analysis of the interaction between groundwater and surface water of the Oxnard Plain and the Santa Clara River below the Freeman Diversion, it was found that United's pumping activities did not have a significant effect on surface water presentation. Therefore, United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D).

Implementation of **Take Alternative A** would have less negative impact than the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic. No new construction would occur, resulting in less release of emissions, less noise, and less traffic related to construction activities than would occur under the Proposed MSHCP. Without new construction, there would be no potential for impacts on previously undisturbed archaeological/cultural/tribal resources. Negative effects on biological resources (noncovered species), such as California Species of Special Concern (e.g., yellow-breasted chat (*Icteria virens*), yellow warbler (*Dendroica petechia*), and two-striped gartersnake (*Thamnophis hammondii*)), would be less under **Take**

Alternative A compared to the Proposed MSHCP because there would be no new disturbance to riparian or stream habitats from construction. Additionally, increased water releases downstream would likely benefit noncovered aquatic species by providing more instream flows and potentially improving and/or expanding available aquatic habitat in some months.

In summary, in spite of reduced impacts on several resources because of no construction footprint, **Take Alternative A** would result in substantial negative impacts on agricultural resources through increased seawater intrusion into the Oxnard Plain.

Conclusions

Despite the reduced take on some covered wildlife species, **Take Alternative A** would provide less overall conservation benefit than the Proposed MSHCP primarily because fish passage characteristics for Freeman Diversion would remain unchanged. Furthermore, upstream anadromous fish migration opportunities would be reduced under **Take Alternative A** compared to the Proposed MSHCP because modifying diversion protocols would increase the amount of time when nuisance flows over the diversion crest are too high relative to attraction flow emanating from the Denil fish ladder, thereby increasing passage delay associated with fish having difficulty in locating the fishway. Therefore, **Take Alternative A** would be inconsistent with many of the goals and criteria of the MSHCP and United. **Take Alternative A** would also be inconsistent with the primary purpose of this project to obtain incidental take authorization that would enable United to continue to operate Freeman Diversion consistent with the requirements of the ESA. **Take Alternative A** is therefore not practicable and was eliminated from further consideration.

10.5.2 ALTERNATIVE B – NOTCH STRUCTURE

Incidental Take and Conservation Benefits Summary

Take Alternative B would modify CMs 1.1.1 and 1.1.2 by replacing the proposed vertical slot with a gated notch design. Relative to the Proposed MSHCP, **Take Alternative B** would have similar levels of take for most covered wildlife species and would implement the remainder of the conservation measures unmodified and as proposed in the MSHCP.

Both **Take Alternative B** and the Proposed MSHCP would implement CMs 1.1.1 and 1.1.2 to improve fish passage past Freeman Diversion; however, **Take Alternative B** would have a similar or potentially greater probability of take for covered fish species because of design requirements separating flows into high- and low-flow fishways. The notch structure reduces the drop height fish must ascend at Freeman Diversion during high flows (greater than 2,375 cfs), provides a wide passage area on a ramp HFF structure during those high flows, and provides passage during low flows and diversion operations in an LFF (less than 2,375 cfs).

However, as described below in more detail, United eliminated this alternative from consideration because the structure does not meet the MSHCP's fish passage facility criterion of minimizing interruptions to passage opportunities for listed fish species through the stipulated flow range of 45–6,000 cfs. Note that the Proposed MSHCP would have occasional interruptions to fish passage within this flow range when sediment management requires use of the bypass channel; however, the frequency and duration of interruptions expected under **Take Alternative B** would be much more extensive compared to the Proposed MSHCP. The notch design as currently proposed consists of two fishways where flow would be transferred at a threshold of 2,375 cfs. This transfer may result in periods when flow through the fishways would be interrupted, resulting in passage delays to covered fish species. In addition, the alternative did not meet United's diversion criterion because water diversions can only be made when the LFF is in use but cannot be made when the HFF is in use (above the 2,375 cfs threshold). This is due to a technical limitation of the design where the water surface elevation upstream of the diversion structure would be too low to route through the diversion canal when the notch crest gates (Obermeyer gates) are open.

Effects on Covered Fishes

Under **Take Alternative B**, effects on covered fishes as a result of maintenance of the notch structure are expected to be similar to those of the Proposed MSHCP. Potential for take of steelhead and lamprey due to construction would be higher under **Take Alternative B** compared to the Proposed MSHCP due to a larger project footprint. Operations would cause risk of passage delays and stranding of steelhead and lamprey at the facility by switching flows between the high- and low-flow fishways. The alternative would reduce aquatic habitat for all covered fish species and passage opportunities downstream for steelhead and lamprey through greater diversions at lower flows because diversion cannot take place at high flows. **Take Alternative B** would present reduced risk of take associated with operations at high flows through the HFF by reducing the barrier to passage that the Freeman Diversion structure poses to steelhead and lamprey as compared to the vertical slot fishway included in the Proposed MSHCP. It would do this through the presentation of a roughened channel that conveys the flow of the entire river while operating at flows greater than 2,375 cfs; however, it is unlikely that adult steelhead would be actively swimming in an upstream direction and ascending any fish passage system at these flows (>1,200 cfs on average) (Appendix E). **Take Alternative B** would present a similar risk of take for steelhead and lamprey associated with operations at low flows through the LFF by presenting a similar fish ladder to that in the Proposed MSHCP. Therefore, overall, take of covered fishes under **Take Alternative B** is anticipated to be similar to or greater than that of the Proposed MSHCP.

Construction

Overall, take of steelhead and lamprey due to construction activities is anticipated to be greater under **Take Alternative B** compared to the Proposed MSHCP. Effects on steelhead and lamprey resulting from demolition activities to replace the existing fish ladder and modify the diversion facility could include disturbance/harm/mortality from in-water construction activities, rescue and relocation activities, and dewatering activities; reduced passage opportunities during construction windows; and loss of ecological service to fishes during temporary loss of aquatic habitat due to dewatering.

Impacts on steelhead and lamprey from in-water construction activities would be greater under **Take Alternative B** than under the Proposed MSHCP because of a larger construction footprint. In-water construction activities, such as demolition and removal of existing structure or construction of temporary falsework structures, have the potential to disturb, stress, or harm fishes by increasing noise and vibration within the water, causing physical contact of fishes with equipment or materials, and decreasing water quality due to sediment releases or increased turbidity. BMPs would be followed to minimize the risk of these impacts, though the risk of disturbance to fishes during in-water construction activities cannot be fully avoided.

Impacts on steelhead and lamprey from dewatering activities during construction would be greater under **Take Alternative B** than the Proposed MSHCP because of a greater construction footprint. If dewatering is needed during replacement of the fish ladder and diversion facility, this activity has the potential to disturb, stress, or harm fishes due to decreased water quality (such as increased water temperature and turbidity), intake of fishes into dewatering pumps or impingement on pump screens, and handling or crowding effects associated with rescue and relocation. To minimize the risk of these impacts, BMPs would be followed and dewatering and fish rescue plans would be written and implemented; however, the risk of harm to fishes during dewatering activities could not be fully avoided.

Impacts on steelhead and lamprey from reduced passage opportunities during construction windows would be similar under **Take Alternative B** to those under the Proposed MSHCP. As described above, the construction work window for removal of the diversion structure would need to be timed around prevailing weather and river flows; active demolition activities in the wetted channel would likely be restricted to the dry season and may require multiple years to complete. If work in the wetted channel were to occur within the downstream migration period (March 15 through May 31), passage of fishes moving downstream during this time, such as steelhead smolts or lamprey macropthalmia, could be delayed or blocked.

Impacts on steelhead and lamprey from loss of ecological service during temporary loss of aquatic habitat, such as due to dewatering, would be greater under **Take Alternative B** than the Proposed MSHCP because of a greater construction footprint. Dewatering of portions of or all of the river in the vicinity of Freeman Diversion may be required for notching of the diversion structure. This temporary loss of aquatic habitat could result in negative effects on steelhead and lamprey through a direct reduction in habitat availability and loss of food sources/reduction of food availability. Relative to the extent of existing habitat within the Santa Clara River, this small, temporary loss of aquatic habitat would result in minor effects on covered fish species.

Under both the Proposed MSHCP and **Take Alternative B**, there would be no effect on tidewater goby from construction activities.

Maintenance

Maintenance activities under **Take Alternative B** would be similar to those under the Proposed MSHCP; however, **Take Alternative B** may require more frequent dry-season in-channel sediment maintenance. Due to the location of the fishway structure across the main river channel, nonroutine repairs are anticipated to be necessary following flood flows that are capable of transporting large debris, which could damage the HFF facility. Additionally, the 20 Obermeyer crest gates require bladder replacement at approximately 30 years of service life, and, in addition, may require maintenance due to damage sustained during flood flows or component malfunction. These potential maintenance events are anticipated to be nonroutine and their frequency cannot be estimated with any accuracy but would result in higher take compared to maintenance activities under the Proposed MSHCP.

Standard maintenance activities (e.g., facility maintenance, vegetation control, and access road maintenance) would be necessary under both **Take Alternative B** and the Proposed MSHCP, and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events

As also described below in the practicability section and mentioned above, channel maintenance may be required to restore diversion and fish passage operations. In addition to standard annual maintenance, repair of the notch is anticipated to be necessary following most flood events that are capable of transporting large boulders and debris. These additional repairs are not expected to occur under the Proposed MSHCP because the vertical slot fish ladder would be located off-channel and would not be directly subjected to high debris and bed-loads. Take of covered fish species may occur during repair activities primarily due to reduction in fish passage opportunities at the diversion structure if the facility is inoperable, which could last until the end of the migration season if flows are too high to allow for construction equipment to access the ramp. Take could also occur due to handling during rescue and relocation associated with dewatering for repairs. Therefore, take of steelhead and lamprey due to fish passage facility emergency repairs would be higher under **Take Alternative B** compared to the Proposed MSHCP. Under both the Proposed MSHCP and **Take Alternative B**, there would be no effect on tidewater goby from maintenance activities.

Therefore, overall, take of covered fishes due to maintenance activities would be higher under **Take Alternative B** compared to the Proposed MSHCP.

Operations

Overall, operations under **Take Alternative B** are expected to result in similar take of covered fishes to that under the Proposed MSHCP. CMs 1.2.1 through 1.2.4 would be implemented under both the Proposed MSHCP and **Take Alternative B**.

The notch structure ultimately reduces the drop height fish must ascend at Freeman Diversion, provides a wide passage area on a HFF structure during high flows (although adult steelhead actively swimming in an upstream direction at high flows is unlikely), and provides passage during low flows and diversion operations in an LFF (when active upstream movement by adult steelhead is more likely). Many of the negative effects on steelhead and lamprey are expected to be similar between **Take Alternative B** and the Proposed MSHCP. However, collective operations of the notch crest gates, HFF, LFF, and diversion canal have the potential to cause fish migration delays and disruptions at a level beyond those expected under the Proposed MSHCP. Thus, the benefits of improved upstream passage are negatively offset by detrimental higher level of migration delays and disruptions expected under **Take Alternative B** compared to the Proposed MSHCP; therefore, the overall level of take of steelhead and lamprey is expected to be higher than that under the Proposed MSHCP.

Potential negative effects from operations under both the Proposed MSHCP and **Take Alternative B** that could result in take of steelhead and lamprey include:

- Timing and magnitude of flow diversions delaying adult upstream migration timing, reducing the number of adult migration opportunities, and reducing the duration of adult migration
- Reduced flow fluctuations delaying adult migration
- Increasing risk of stranding
- Timing of flow diversions reducing steelhead smolt and juvenile lamprey out-migration opportunities, delaying out-migration, and increasing risk of juvenile stranding during out-migration
- Access upstream past Freeman Diversion being affected due to adult fishes having to migrate through the fish passage facility, resulting in some delay of upstream adult migrants
- Access downstream past Freeman Diversion being affected due to some juvenile fishes having to migrate through the fish bypass facility or going over the diversion structure crest (at spill flows), resulting in some mortality/injury/delay of downstream juvenile migrants
- Transportation of steelhead and lamprey downstream during relocation activities, resulting in injury and mortality of fishes due to handling- and transportation-associated impacts

Operational decisions would attempt to minimize these negative effects; however, the following operational scenarios would likely result in additional migration delays and disruptions under **Take Alternative B**. Additional negative effects to steelhead and lamprey that would result from operation of Take Alternative B compared to the Proposed MSHCP are described below.

The notch's Obermeyer crest gates would be operated in the closed position to allow for diversion and use of the LFF until an opening threshold of 2,375 cfs. As flows increased above the capacity of the diversion and the LFF but prior to HFF opening, flow would spill over the closed notch Obermeyer gates onto the HFF section. Thus, **Take Alternative B** does not provide 100 percent attraction flows at 45–6,000 cfs. The design provides 100 percent attraction flow above the 2,375 cfs flow threshold when the notch crest gates would be open, but adults are unlikely to be actively swimming in an upstream direction at that time.

The LFF would have a capacity of 400 cfs and, combined with a diversion capacity of 750 cfs, would be used at river flows up to 1,150 cfs. However, fish would not be able to fully use the HFF until the crest gate opens at 2,375 cfs. Passage delays could occur at these flows. Between river flows of 1,150 cfs and 2,375 cfs, upstream migrants would need to either use the LFF or ascend the HFF and move laterally across the expanded passage corridor of the fishway's low-flow channel to river left (toward the south bank) to find the transition into the LFF. Before the HFF is activated, but at flows between 1,150 cfs and 2,375 cfs (when flow capacity exceeds the LFF plus diversion but has not reached the notch crest gate opening threshold), upstream-migrating fish could be distracted by the presence of nuisance attraction flows spilling over the Obermeyer crest gates and delayed in locating the LFF.

When the hydrograph rises rapidly, delayed fish passage through the HFF could result due to flow in the HFF being too high for fish passage before unimpeded conditions would have reached that level. Drawdown of the upstream impoundment would occur as the notch crest gates are opened, adding water released to unimpeded inflow, which at times would cause flow in the HFF to exceed the upper passage design flow (6,000 cfs) before unimpeded inflows would have become impassible.

At flow levels when water spreads across the HFF, shallow sheet flow hydraulics may inhibit downstream passage. The passage facilities are designed to be free-draining to allow escape during decreasing flow transitions, such as with the use of slush grouting to minimize stranding risk; however, monitoring of such flow transitions to further minimize stranding would be challenging due to the size of the HFF structure and potential for transition periods to occur at night posing a safety risk to monitoring staff. Under **Take Alternative B**, diversion of water at lower flows than under the Proposed MSHCP (only during LFF operations) would cause a larger relative reduction in downstream flows, negatively affecting passage at the critical riffle and estuary during diversion operations.

Therefore, take of steelhead and lamprey due to operations would be higher under **Take Alternative B** than under the Proposed MSHCP.

Both the Proposed MSHCP and **Take Alternative B** would implement conservation measures to avoid potential take of tidewater goby during fishery monitoring activities in the estuary. There would be no take of tidewater goby due to water operations under the Proposed MSHCP or **Take Alternative B**.

Effects on Covered Birds and Western Pond Turtles

Take of covered birds and negative effects on pond turtle would be higher under **Take Alternative B** compared to the Proposed MSHCP primarily due to take associated with construction (a larger project footprint) and operations (greatly reduced riparian habitat upstream resulting from mid- to long-term channel degradation). Under **Take Alternative A**, take of covered birds due to maintenance activities would be similar to take expected under the Proposed MSHCP. Negative effects to pond turtle due to maintenance activities would be higher than expected under the Proposed MSHCP due to anticipated more frequent, large-scale maintenance needs of the in-channel HFF. Therefore, take of covered birds and negative effects on pond turtle under **Take Alternative B** are anticipated to be higher than under the Proposed MSHCP.

Construction

Under **Take Alternative B**, negative effects on covered birds and pond turtle could result from construction activities to replace the existing fish passage facility with the notch structure and associated facilities. Negative effects on covered riparian birds and pond turtle could include disturbance/harm/mortality resulting from vegetation clearing, terrestrial ground disturbance, in-water construction, rescue and relocation, and dewatering activities. These effects would primarily occur in areas directly upstream and downstream of the current diversion structure. Implementation of BMPs (CM 2.1.1), a dewatering plan, a CRP (CM 2.1.4), and a nesting bird monitoring and avoidance plan (CM 2.1.7), western pond turtle avoidance (CM 2.1.8), and avoidance of riparian and aquatic habitats during rainfall events (CM 2.2.2) would minimize the risks of take of covered birds and pond turtle; however, the risks of take associated with construction could not be eliminated.

Because the notch structure and HFF would have a larger footprint than the vertical slot design included in the Proposed MSHCP, more riparian habitat would be affected by construction activities. Therefore, take of covered birds and negative effects on pond turtle due to construction activities are anticipated to be higher under **Take Alternative B** compared to the Proposed MSHCP.

Maintenance

Standard maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road maintenance) would be necessary under both **Take Alternative B** and the Proposed MSHCP and would include implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.1.7 Avoidance of Nests of Covered Species of Birds During Nesting Bird Season
- CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
- CM 2.2.2 Avoid Riparian and Aquatic Habitat During Rainfall Events

Under **Take Alternative B** and the Proposed MSHCP, take of covered avian species is reasonably certain to occur due to temporary removal of riparian vegetation during maintenance covered activities. Implementation of CMs 2.1.1–2.18 and CM 2.2.2 would reduce the potential for effects on covered birds from maintenance activities under both the Proposed MSHCP and **Take Alternative B**, and similar levels of take are expected under both alternatives.

As described above, most routine maintenance activities would be similar under **Take Alternative B** and the Proposed MSHCP, including vegetation control in upland and riparian areas, dewatering for maintenance inspection and sediment management purposes, which could negatively affect and result in take of covered pond turtle. Under both alternatives, United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize negative effects on pond turtle due to dewatering and rescue activities (e.g., stranding, stress from handling). However, as also described in the practicability section below, channel maintenance may be required to restore diversion and fish passage operations under **Take Alternative B**, and repair of the HFF is anticipated to be necessary following most flood events that are capable of transporting large boulders and debris. These additional repairs are not expected to occur under the Proposed MSHCP because the vertical slot fish ladder would be located off-channel and would not be directly subjected to high debris and bed-loads. Negative effects on covered pond turtle may occur during repair activities primarily due to handling during rescue and relocation associated with dewatering. Therefore, negative effects on covered pond turtle due to fish passage facility emergency repairs would be higher under **Take Alternative B** compared to the Proposed MSHCP.

Operations

Riparian Habitat and Aquatic Habitat

As described above in Section 10.5.1 and in Chapter 7, *Effects Analysis*, the Freeman Diversion functions as a grade stabilization structure and the water impoundment behind the structure has promoted significant growth of riparian habitat in the vicinity upstream and downstream of the diversion following its construction in 1991 (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }). The notch would remove a portion of the grade stabilization functionality from Freeman Diversion. Notching the structure would severely aggrade the riverbed downstream and degrade the riverbed upstream of the diversion over time, resulting in widespread reduction in upstream riparian habitat (Stillwater Sciences 2019{ TC "Stillwater Sciences 2019" \f C \l "1" }, Appendix H). Over 15 years, approximately 200 acres of riparian and stream habitats would be affected by aggradation and degradation; over a 70-year period, approximately 400 acres of riparian and stream habitats would be affected (Stillwater Sciences 2019{ TC "Stillwater Sciences 2019" \f C \l "1" }). Specifically, upstream degradation would result in the reduction of a large amount of mature riparian habitat that would remain intact under the Proposed MSHCP. As such, negative effects on riparian habitat from operations under **Take Alternative B** are anticipated to be much larger to those under the Proposed MSHCP.

There would be reduction in total water diversion under **Take Alternative B** compared to the Proposed MSHCP; thus, more instream flow could result in improvement and/or extension of aquatic habitat in some months. The project would also implement CMs 1.2.1 through 1.2.4 to provide flows downstream. However, operations would differ from those of the Proposed MSHCP such that water diversions would be made primarily at relatively lower river flows which would have a greater impact on aquatic habitats than diversions at relatively high flows. Therefore, effects on the quantity and/or quality of aquatic habitat from operations under **Take Alternative B** are anticipated to be greater than those under the Proposed MSHCP at low flows, but similar to those of the Proposed MSHCP in relation to fish passage characteristics downstream of the diversion.

Covered Birds

As described in Chapter 7, *Effects Analysis*, no take of covered avian species is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative B.** Similar levels of take would be expected due to sediment management and monitoring operations under both alternatives. However, due to operation of the notch facility over time, widespread degradation of the upstream channel and subsequent reduction in riparian habitat would occur, resulting in additional take of covered birds due to operations under **Take Alternative B**. Therefore, there would be more take of covered birds as a result of operations under **Take Alternative B** compared to the Proposed MSHCP.

Western Pond Turtle

As described in Chapter 7, *Effects Analysis*, no take of pond turtles is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative B**. Under operations of both **Take Alternative B** and the Proposed MSHCP, pond turtles could enter the fish passage facility and be negatively affected if they become trapped in the facility, resulting in take of these species, though the potential for injury or mortality is low. Additional sources of take under the Proposed MSHCP and **Take Alternative B** include covered aquatic species rescue and relocation, sediment sluicing, crest gate operations, and monitoring activities, though the potential for take would be similar under both alternatives. However, additional take of pond turtle is expected due to operations under **Take Alternative B** resulting from degradation of the upstream channel and subsequent reduction in riparian habitat. Therefore, there would be more take of pond turtle due to operations under **Take Alternative B** compared to the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative B** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

Operationally, under **Take Alternative B**, once the notch Obermeyer gates were open, United would be unable to divert river flows until the notch gates closed. That would significantly reduce the yield of Freeman Diversion below what is practicable (Appendix B). The notch is not a practicable alternative because it would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested. Additionally, a larger proportion of the yield would come from lower flows, potentially increasing negative effects on covered species downstream of the diversion during low-flow conditions.

The footprint of the notch project would extend downstream of United's current property line and require that United acquire additional land. Therefore, **Take Alternative B** would be inconsistent with the following goals to achieve United's mission:

- Goal 1 – Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
- Goal 3 – Implement actions on land that United owns or can feasibly acquire.

Take Alternative B would be inconsistent with the following MSHCP covered species goal:

- Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose.

As described above, under **Take Alternative B**, lack of diversion at high flows would mean increased diversion at lower flows, which may interfere with providing bypass flows that mimic unimpeded recession. In addition, transitions between use of the LFF and HFF as streamflow increases or decreases past the notch crest gate's operational threshold would result in flow interruptions and fish passage delays. Some riparian habitat upstream of the diversion would be lost due to channel degradation from removal of some of the grade control function of the structure as a result of notching and some riparian habitat downstream would be lost to aggradation. Therefore, **Take Alternative B** would be less consistent with the following MSHCP covered species goals than the Proposed MSHCP:

- Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.
- Goal 7 – Minimize impacts on riparian habitat and other covered species.
- Goal 8 – Minimize operational complexity including operational transitions between different fish passage systems.
- Goal 10 – Do not pose a significant stranding risk to steelhead.

The design of **Take Alternative B** includes a sediment sluicing channel that would preclude function of the LFF when sluicing activities were occurring. The notch design's LFF has a capacity of 400 cfs. At flows above 1,150 cfs (when a maximum of 750 cfs are being diverted) but below the gate opening threshold of 2,375 cfs, flow would spill over the notch crest gates and not be directed through a functional fishway, causing nuisance attraction flows and allowing downstream migrants to pass over the crest gates. Additionally, depending on operations for impoundment drawdown, fish might pass through partially open notch crest gates. Therefore, **Take Alternative B** would be inconsistent with the following fish passage facility criteria:

- Criterion 1 – Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs.
- Criterion 2 – Minimize passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 8 – Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.

- Criterion 9 – Preclude fish passage through partially open gates or weirs.

Operations under **Take Alternative B** would not meet the flow range for fish passage operations set by NMFS and described in Section 10.4.2, *Consistency with Goals of United and MSHCP*. Therefore, **Take Alternative B** would be less consistent with the following fish passage facility criteria than the Proposed MSHCP:

- Criterion 4 – Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.

Therefore, **Take Alternative B** is not considered consistent with the purpose of activity for which ITPs are requested or the goals and fish passage criteria of the MSHCP.

Practicability

Take Alternative B was deemed not practicable, because it would be logistically and technologically impracticable, and it would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested.

Cost

Take Alternative B would lead to rate increases slightly more than the Proposed action at 88 percent above current levels and 7 percent more than the Proposed MSHCP. The impacts on agriculture would be similar to the Proposed MSHCP within a band of uncertainty.

Logistics

Access to the necessary construction and restoration sites would be mostly accomplished from United’s property, primarily on the south bank. Some new temporary access roads would likely be needed for construction. Concerns include access to LFF (riverside of structure) if a bypass channel were included, and to the upstream end of a ramp-style HFF; however, these could be further evaluated in design process. Standard construction and dewatering/diversion equipment would be used to construct the fish passage facilities and associated infrastructure. A portion of the fish passage facility (HFF structure) extends downstream beyond United’s property line and the construction footprint (due to significant restructuring of the forebay) extends upstream beyond United’s property line. Therefore, United does not have sufficient land suitable for the new fish passage facility and **Take Alternative B** is considered logistically impracticable.

Technology

Under **Take Alternative B**, a 400-foot-wide section of the diversion structure crest would be notched to accommodate installation of a ramp-style HFF, and an LFF and new diversion infrastructure would be constructed. There is concern that the ramp-style HFF would not be capable of being maintained over the term of the permit to its intended design standards and with reasonable maintenance costs. Emergency maintenance activities are anticipated to be necessary following large flow events. The HFF is located within the main river channel and would be subjected to large debris and bedload mobilized by high flows. Should repairs to the fishway be necessary, they would have to wait until high flows had subsided to allow equipment into the channel, possibly rendering the facility inoperable until the dry season losing significant fish passage opportunity that occurs in wet years. Failure of 1 of the 20 Obermeyer gates, which are expected to have a 30-year service life outside of catastrophic events, would result in an inability to control flows, divert water, or provide safe fish passage. Additionally, the proposed ramp-style HFF with roughened channel as a fish passage structure is considered experimental and there are no set standards or working examples for construction or maintenance guidance.

Monitoring of downstream migrants under **Take Alternative B** and the Proposed MSHCP would be possible through a fish bypass pipe and evaluation station. At low flow conditions, a higher proportion of total river flow is monitored for downstream migrants under the Proposed MSHCP compared to under **Take Alternative B**. Upstream migrant monitoring across the HFF may not be technologically feasible; the primary challenge is that the wide HFF could not be monitored by a visual detection system (e.g., DIDSON or Vaki River Watcher) at moderate to high flows due to elevated turbidity and installing a PIT tag antenna would be challenging.

Construction activities would be similar under the Proposed MSHCP and **Take Alternative B**. The 100-year flood elevation would be reduced under **Take Alternative B** compared to the Proposed MSHCP and the notch would remove a portion of the grade stabilization functionality from Freeman Diversion. Notching the diversion structure would aggrade the riverbed downstream and degrade the riverbed upstream of the diversion. This shift in river grade could prove problematic to current land users upstream and downstream of the diversion. Additionally, the aggradation of the riverbed downstream of the diversion creates a problem when designing the entrance to a low-flow fish bypass facility because it would require designing an entrance to the facility that would be viable at multiple invert elevations.

Therefore, considering issues discussed for durability, timeliness of repairs, and fish monitoring, **Take Alternative B** is considered technologically impracticable.

Other Environmental Consequences

Under **Take Alternative B**, more negative impacts would be anticipated on agricultural resources and water quality of the Oxnard Plain. United would not be able to achieve the same annual yield because diversion could not occur at high flows. Reduced surface water diversions at Freeman Diversion would reduce supplies for groundwater replenishment in the Oxnard Plain allowing for increased groundwater degradation such as seawater intrusion and nitrate concentrations, which would negatively affect farmland and some municipal water users (see Section 10.4 and Appendix B). As stated in in the analysis for Take Alternative A, United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D).

Implementation of **Take Alternative B** would have more negative impact than the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic. Construction would occur on a larger footprint involving more concrete compared to the Proposed MSHCP, resulting in more release of emissions, more noise, and more traffic related to construction activities than would occur under the Proposed MSHCP. With a larger construction footprint, there would be more potential for impacts on previously undisturbed archaeological/cultural/tribal resources. Negative effects on biological resources (noncovered species), such as California Species of Special Concern (e.g., yellow-breasted chat, yellow warbler, and two-striped gartersnake) would be increased under **Take Alternative B** compared to the Proposed MSHCP because more riparian or stream habitats would be affected from the larger construction footprint. Diversion of surface water at relatively lower flows than the Proposed MSHCP would have a larger impact on aquatic habitats than the Proposed MSHCP's diversions at relatively higher flows. Additionally, over forecasted 15-year and 70-year periods, 200 and 400 acres, respectively, of riparian and streambed habitats would be disturbed by aggradation and degradation as a result of the notch structure (Stillwater Sciences 2019{ TC "Stillwater Sciences 2019" \f C \l "1" }).

In summary, **Take Alternative B** would result in substantially greater negative impacts on all resources currently being considered when compared to the Proposed MSHCP.

Conclusions

Take Alternative B would be inconsistent with many of the goals and criteria of the MSHCP. The notch structure does not meet the MSHCP's fish passage facility criterion of providing uninterrupted passage opportunities for listed fish species through the stipulated flow range (45–6000 cfs), and upstream anadromous fish migration opportunities would be reduced under **Take Alternative B** compared to the Proposed MSHCP. Additionally, water diversions can only be made at relatively low flows when the notch crest gates are closed and not at high flows when the HFF is in use and when adult steelhead are unlikely to ascend a fish passage system anyway, thereby preventing United from achieving the total annual yield of the Proposed MSHCP with little to no added benefit to biological resources. As a result of decreased yield, reduced groundwater replenishment in the Oxnard Plain could allow for increased seawater intrusion and associated impacts on farmland as well as other water quality degradation affecting some municipal water users. Therefore, **Take Alternative B** is considered not practicable and was eliminated from further consideration.

10.5.3 ALTERNATIVE C – HARDENED RAMP STRUCTURE

Incidental Take and Conservation Benefits

Both **Take Alternative C** and the Proposed MSHCP would implement CMs 1.1.1 and 1.1.2 to improve fish passage past Freeman Diversion; however, **Take Alternative C** would avoid or reduce some types of take for covered fish species by reducing the barrier to passage that the Freeman Diversion structure poses to steelhead and Pacific lamprey as compared to the vertical slot fishway included in the Proposed MSHCP.

As described below, United eliminated this alternative from consideration because the structure is experimental with no set standards or design parameters, and because there is a high risk of damage to the structure during debris-transporting and bedload-mobilizing high-flow events, which could render the passage facility inoperable during the anadromous fish migration season, potentially losing significant fish passage opportunity in wet years.

Additionally, the hardened ramp may not be durable enough to withstand winter debris flows and bedload mobilization and physical modeling is limited on ways to validate these uncertainties. Also, **Take Alternative C** only presents options for monitoring anadromous fish migrating downstream, with no means of effectively monitoring anadromous fish migrating upstream through the structure, especially at high flows. Therefore, **Take Alternative C** poses a significant operational risk in comparison to the Proposed MSHCP and would not allow the same kinds of options for scientific studies or monitoring to contribute to recovery efforts as the vertical slot fishway of the Proposed MSHCP.

Effects on Covered Fishes

Relative to the Proposed MSHCP, **Take Alternative C** would reduce take for steelhead and lamprey once the fish passage facility and diversion facility were renovated and operations activities were underway. Construction activities would result in potential take of steelhead and lamprey that may occur within the project footprint during renovation at levels similar to those of the Proposed MSHCP. Standard maintenance activities would also result in similar levels of take for all covered species compared to the Proposed MSHCP.

Construction

Overall, the types of construction activities used and associated effects causing take are anticipated to be similar under **Take Alternative C** compared to the Proposed MSHCP, and are anticipated to be similar under all take alternatives involving renovation or removal of the existing fish passage facility. Refer to Section 10.5.4, *Alternative B – Notch Structure*, for discussion of take anticipated as a result of general construction activities. Because the hardened ramp's footprint of construction would be larger than that of the vertical slot, there could be higher take of steelhead and lamprey due to construction under **Take Alternative C** compared to the Proposed MSHCP. Under both the Proposed MSHCP and **Take Alternative C**, there would be no effect on tidewater goby from construction activities.

Maintenance

Maintenance activities under **Take Alternative C** would be similar to those under the Proposed MSHCP. Standard maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road maintenance) would be necessary under both **Take Alternative C** and the Proposed MSHCP, and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Take of covered fish species due to routine maintenance activities is anticipated to be similar under **Take Alternative C** to that of the Proposed MSHCP. However, as described under the practicability assessment section and detailed below, emergency repairs necessary to fix damage from high-flow events are expected to be increased under **Take Alternative C** compared to the Proposed MSHCP, resulting in increased take of covered fishes due to decreased fish passage opportunities if the fishway is damaged and rendered inoperable.

Annual dewatering required for maintenance activities under the Proposed MSHCP would likely also be necessary under **Take Alternative C** (e.g., to ensure the facility is functioning properly, gates are calibrated and running smoothly). Maintenance would include inspection of the ramp and baffles and removal of debris, sediment, and boulders. Due to the width of the ramp, some sediment and debris accumulation may be tolerable, and debris removal might be required on an annual basis as well as after very large events (discussed below and in the practicability section), depending on the success of the ramp design in shedding debris. Take of covered fish species may occur during annual dewatering required for maintenance activities under all fish passage facility alternatives. Additionally, due to the ability of debris to accumulate in the fishway, rescue of stranded fish within the hardened ramp fishway when dewatered would likely be more difficult compared to rescue from the vertical slot fishway of the Proposed MSHCP. United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize take of steelhead and lamprey due to dewatering and rescue activities (e.g., stranding, stress from handling).

Some of the potential effects on steelhead and lamprey associated with standard maintenance activities would be due to periodic sediment sluicing activities at the diversion facility. The Proposed MSHCP and **Take Alternative C** would require sluicing flows when sediment accumulation occurred during normal operations. However, the hardened ramp design may be able to shed sediment more effectively and require less frequent sluicing flows. Neither design negates the potential requirement for sediment sluicing to take place during the fish passage window. Therefore, take associated with sediment sluicing activities could occur due to fish passage interruptions (e.g., fall-back of upstream migrants) and handling if rescue and relocation is required (e.g., due to dewatering of portions of passage facilities or upstream areas) would occur under both **Take Alternative C** and the Proposed MSHCP.

As also described below in the practicability section, channel maintenance may be required to restore diversion and fish passage operations. In addition to standard annual maintenance, repair of the hardened ramp is anticipated to be necessary following most flood events that are capable of transporting large boulders and debris. These additional repairs are not expected to occur under the Proposed MSHCP because the vertical slot fish ladder would be located off-channel and would not be directly subjected to high debris and bed-loads. Take of covered fish species may occur during repair activities primarily due to reduction in fish passage opportunities at the diversion structure if the facility is inoperable, which could last until the end of the migration season if flows are too high to allow for construction equipment to access the ramp. Take could also occur due to handling during rescue and relocation associated with dewatering for repairs. Therefore, take of steelhead and lamprey due to fish passage facility emergency repairs would be higher under **Take Alternative C** compared to the Proposed MSHCP.

Consequently, take of steelhead and lamprey during maintenance activities, primarily in the form of reduced fish passage opportunities due to facility maintenance necessary to fix damage from large flow events, is expected to be higher under **Take Alternative C** compared to the Proposed MSHCP. Under both the Proposed MSHCP and **Take Alternative C**, there would be no effect on tidewater goby from maintenance activities.

Operations

In summary, operations activities under **Take Alternative C** would be similar to operations under the Proposed MSHCP. The primary difference between operations under the two alternatives is that, below discharges that spill over the diversion crest, the hardened ramp fishway is operated such that all water not diverted or sent through the fish bypass from the diversion intake's fish screens passes through the fishway, unless United would be conducting sediment sluicing, then water is also sent through the bypass channel. The vertical slot fishway in the Proposed MSHCP is operated such that, below discharges that spill over the dam, water not diverted is sent through the fish ladder, Auxiliary Water Supply, and fish bypass, and excess water is sent through the crest gates unless United would be conducting sediment sluicing, then flows would go through the bypass channel and the crest gates. Because of the difference in attraction flow and sediment management operations, there would be lower potential for negative effects, and take of covered fish species associated with operations under **Take Alternative C** is expected to be lower compared to the Proposed MSHCP.

Operations associated with water diversion and instream flow management are expected to be similar between **Take Alternative C** and the Proposed MSHCP. Many of the anticipated negative effects on steelhead and lamprey resulting from water diversion and instream flow management are expected to be similar and associated take of covered fishes are expected to be similar between **Take Alternative C** and the Proposed MSHCP. These effects are also anticipated under Take Alternative B and are discussed above; refer to Section 10.5.4, *Alternative B – Notch Structure*, for discussion of operational effects on covered fishes under the Proposed MSHCP.

Fish passage facility operations would differ between **Take Alternative C**, which includes operation of a hardened ramp fishway, and the Proposed MSHCP, which includes operation of a vertical slot fishway. As described above, both fish passage facilities would be dewatered for maintenance activities. Fish passage facility dewatering due to operational conditions under both **Take Alternative C** and the Proposed MSHCP would also occur when adequate flows cannot be maintained at the critical riffle. Under these conditions, take of covered fish species may occur under either **Take Alternative C** or the Proposed MSHCP. As noted in the maintenance discussion above, rescue of stranded fish within the hardened ramp fishway when dewatered would likely be more difficult compared to rescue from the vertical slot fishway of the Proposed MSHCP due to the ability of debris to accumulate in the hardened ramp fishway. Consistent with dewatering for maintenance, take would be minimized through the development and implementation of the dewatering and diversion plan and a CRP (CM 2.1.4). Additionally, under specific operational conditions **Take Alternative C** may necessitate the use of the crest gates to protect the hardened ramp from bedload and debris during high flow events. The use of the crest gates would cause the hardened ramp fishway to dewater while the gates are engaged, potentially resulting in stranding of covered fish. Under these specific operational conditions, stranding surveys would likely be infeasible due to safety concerns.

Under **Take Alternative C**, downstream fish passage may occur through four pathways: down the hardened ramp fishway, over the diversion crest, through the screen bay of the canal to the fish bypass, or through the bypass channel, though the preferred pathway at flows within the fish passage design flow range (less than 6,000 cfs) is down the hardened ramp. Note, however, that during the 3-day flow ramp down period, when total river flow is not sufficient to maintain 80 cfs at the critical riffle and also divert 40 cfs, the flows going down the hardened ramp would be unscreened, leading to potential stranding or isolation of migrants that may have recently travelled downstream of the Freeman into the critical reach. Under the Proposed MSHCP, downstream fish passage could occur through similar pathways with some differences. The ramp is replaced with the vertical slot ladder, and the primary pathway within the design flow range (less than 6,000 cfs) is through the vertical slot, through screened pathways that lead to fish bypass pipes or the crest gates. Therefore, the hardened ramp would provide better downstream fish passage compared to the vertical slot and its associated facilities; as such, take of juvenile downstream migrants of covered fish species associated with operations of the fish passage facility may be lower under **Take Alternative C** compared to the Proposed MSHCP.

Under **Take Alternative C**, all upstream fish passage is provided at the hardened ramp, where most of the water not diverted would be preferentially routed, up to a capacity of at least 2,000 cfs; therefore, attraction flow of the ramp is 100 percent up to 2,000 cfs river flow (or 2,750 cfs river flow if maximum diversions are occurring). At river flows beyond the capacity of the hardened ramp, spill over the diversion structure crest would reduce the attraction flow percentage of the ramp, reaching approximately 30 percent at 6,000 cfs river flow (or at 6,750 cfs river flow if maximum diversions are occurring), which differs from the Proposed MSHCP. However, adult steelhead are unlikely to actively swim in an upstream direction above 1,200 cfs and are very unlikely to actively swim in an upstream direction above 4,500 cfs on average (Appendix E). Under both the Proposed MSHCP and **Take Alternative C**, use of the sluicing channel to bypass water would allow for adjustment of these flow values higher by delaying spill over the diversion crest.

In summary, due to higher attraction flow percentages attained at flows over 600 cfs, the hardened ramp would provide better upstream fish passage compared to the Proposed MSHCP, albeit at flows where adult fish are not likely to be actively swimming in an upstream direction and at significant risk for damage in high flow events that could result in little to no upstream fish passage in an unknown amount of time. Therefore, take of adult upstream migrants of covered fish species associated with operations of the fish passage facility would be lower or similar under **Take Alternative C** compared to the Proposed MSHCP.

Both the Proposed MSHCP and **Take Alternative C** would implement conservation measures to avoid potential take of tidewater goby during fishery monitoring activities in the estuary. There would be no take of tidewater goby due to water operations under the Proposed MSHCP or **Take Alternative C**.

Effects on Covered Birds and Western Pond Turtle

Under **Take Alternative C**, higher levels of take of covered birds and pond turtle would be expected compared to under the Proposed MSHCP. Take of covered birds and negative effects on pond turtle would be higher under **Take Alternative C** compared to the Proposed MSHCP due to a larger construction footprint. Take of covered birds as a result of maintenance of the hardened ramp structure under **Take Alternative C** is anticipated to be similar to that of the vertical slot under the Proposed MSHCP; however, negative effects on covered pond turtle as a result of maintenance is anticipated to be higher under **Take Alternative C** compared to the Proposed MSHCP. Similar negative effects on covered birds and pond turtle would be expected due to operation of **Take Alternative C** as compared to operation of the Proposed MSHCP. Construction

Under **Take Alternative C**, negative effects on covered birds and pond turtle could result from construction activities to replace the existing fish passage facility with the hardened ramp structure and associated facilities. The types of negative effects on covered riparian birds and pond turtle resulting from construction would be similar to those of the Proposed MSHCP; refer to Section 10.5.4, *Alternative B – Notch Structure*, for description of take of covered riparian birds and negative effects on pond turtle due to construction activities. However, because the hardened ramp would have a larger footprint than the vertical slot design included in the Proposed MSHCP, more riparian habitat would be affected by construction activities. Therefore, take of covered bird and negative effects on pond turtle species due to construction activities is anticipated to be higher under **Take Alternative C** compared to the Proposed MSHCP.

Maintenance

Standard maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road maintenance) would be necessary under both **Take Alternative C** and the Proposed MSHCP and would include implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.1.7 Avoidance of Nests of Covered Species of Birds During Nesting Bird Season
- CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Under **Take Alternative C** and the Proposed MSHCP, take of covered avian species is reasonably certain to occur due to temporary removal of riparian vegetation during maintenance covered activities. Implementation of CMs 2.1.1–2.18 and CM 2.2.2 would reduce the potential for effects on covered birds from maintenance activities under both the Proposed MSHCP and **Take Alternative C**, and similar levels of take are expected under both alternatives.

As described above, most routine maintenance activities would be similar under **Take Alternative C** and the Proposed MSHCP. Under both alternatives, United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize take of covered pond turtle due to dewatering and rescue activities (e.g., stranding, stress from handling). However, as also described below in the practicability section below, channel maintenance may be required to restore diversion and fish passage operations and repair of the hardened ramp is anticipated to be necessary following most flood events that are capable of transporting large boulders and debris. These additional repairs are not expected to occur under the Proposed MSHCP because the vertical slot fish ladder would be located off-channel and would not be directly subjected to high debris and bed-loads. Negative effects on pond turtle may occur during repair activities primarily due to handling during rescue and relocation associated with dewatering. Therefore, negative effects on covered pond turtle due to fish passage facility emergency repairs would be higher under **Take Alternative C** compared to the Proposed MSHCP.

Operations

Riparian Habitat and Aquatic Habitat

As described in Section 10.5.1 above and in Chapter 7, *Effects Analysis*, the Freeman Diversion functions as a grade stabilization structure and the water impoundment behind the structure has promoted significant growth of riparian habitat in the vicinity upstream and downstream of the diversion following its construction in 1991 (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }). No substantial change would be expected to further downstream riparian habitats as a result of water operations under **Take Alternative C** due to the hydrologically losing nature of the reach. Like the Proposed MSHCP, operations under **Take Alternative C** would be conducted in accordance with CM 1.2.1 through CM 1.2.4 to provide flows downstream. Therefore, negative effects on riparian and aquatic habitats due to operations under **Take Alternative C** are anticipated to be similar to those under the Proposed MSHCP.

Covered Birds

As described in Chapter 7, *Effects Analysis*, no take of covered birds is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative C**. Potential negative effects from sediment management (such as a small amount of vegetation removal and riparian habitat inundation) and monitoring activities (such as disturbance from playback of calls) would be similar under the Proposed MSHCP and **Take Alternative C**. Therefore, take of covered avian species due to operational activities under **Take Alternative C** is anticipated to be similar to that of the Proposed MSHCP.

Western Pond Turtle

As described in Chapter 7, *Effects Analysis*, no take of pond turtles is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative C**. Under operation of both **Take Alternative C** and the Proposed MSHCP, pond turtles could enter the fish passage facility and be negatively affected if they become trapped in the facility, resulting in take, though the potential for injury or mortality is low. Additional sources of take under the Proposed MSHCP and **Take Alternative C** include covered aquatic species rescue and relocation, sediment sluicing, crest gate operations, and monitoring activities, and the potential for take during these activities would be similar under both alternatives. Therefore, negative effects on covered pond turtle due to operations would be similar under **Take Alternative C** to that of the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative C** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

The footprint of the hardened ramp project, assuming a 5 percent ramp slope, would extend beyond United's current property line and require that United acquire additional land. Therefore, **Take Alternative C** would be inconsistent with the following goal to achieve United's mission:

- Goal 3 – Implement actions on land that United owns or can feasibly acquire.

Under **Take Alternative C**, a higher amount of riparian habitat would be affected due to a larger construction footprint compared to that of the Proposed MSHCP. Therefore, **Take Alternative C** would be less consistent with the following goal than the Proposed MSHCP:

- Goal 7 – Minimize impacts on riparian habitat and other covered species.

As described above, when functional, the ramp structure included in **Take Alternative C** would provide improved migratory fish passage at Freeman Diversion compared to the vertical slot included in the Proposed MSHCP; therefore, **Take Alternative C** would have greater consistency with the following goals compared to the Proposed MSHCP:

- Goal 4 – Promote migration of lamprey through the diversion.

Under **Take Alternative C**, the hardened ramp fishway is designed for a capacity of approximately 2,000 cfs, which added to maximum diversions allows for approximately 2,750 cfs of river flow to pass the diversion structure before flow spills over the diversion structure crest. This value is higher than the approximately 600 cfs that can be passed by the fishway and associated facilities under the Proposed MSHCP, or 1,150 cfs accounting for maximum diversions. Additional flows could be bypassed through the sluicing channel; it is assumed these capacities would be the same under **Take Alternative C** and the Proposed MSHCP. Therefore, **Take Alternative C** would be more consistent with the following fish passage facility criteria than the Proposed MSHCP:

- Criterion 2 – Minimize passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 5 - Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.
- Criterion 8 – Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.

Therefore, **Take Alternative C** is not considered consistent with the goals of the MSHCP.

Practicability

Take Alternative C was deemed not practicable because it would be logistically and technologically impracticable and would have larger economic impacts than the Proposed MSHCP.

Cost

Take Alternative C would lead to rate increases more than the Proposed MSHCP at 107 percent above current levels, and 25 percent more than the Proposed MSHCP. Because the diversions would be the same as the Proposed MSHCP, the impacts on agriculture similarly would be the same within a band of uncertainty. In addition, the initial capital cost would exceed United's debt ceiling as described in Chapter 9.

Logistics

Access to the necessary construction and restoration sites would be mostly accomplished from United's property, primarily on the south bank. Some new temporary access roads would likely be needed for construction. Concerns include access to ramp which could be further evaluated in design process. Standard construction and dewatering/diversion equipment would be used to construct the fish passage facilities and associated infrastructure. The hardened ramp project footprint would be located mostly within United's property; however, assuming a ramp slope of 5 percent is included, the structure would extend beyond United's property and some property acquisition would be required. Therefore, United does not have sufficient land suitable for the new fish passage facility and **Take Alternative C** is considered logistically impracticable.

Technology

Construction activities and the 100-year flood elevation would be similar under the Proposed MSHCP and **Take Alternative C**, and neither project presents a safety risk to United or people downstream. However, United eliminated this alternative from consideration because the hardened ramp structure is experimental with no set standards or design parameters and because it was determined to not be durable enough. The structure is located in-channel and occupies a greater extent of the riverbed, including property to which United does not currently hold rights. Therefore, the structure would likely be damaged by rock and debris during high-flow events. Damage to the structure would require large-scale maintenance to the structure, likely at unreasonable frequencies and costs compared to the fish passage facility design included in the Proposed MSHCP. Furthermore, to substantially minimize passage delays of covered fish, in the event of damage that shuts down the fish passage facility, the facility should be capable of being repaired and restored to service within the same migration season and with reasonable and expected maintenance costs. Due to the in-channel location of the hardened ramp structure, repair of the structure would not be possible during the same migration season of most water years because flow in the river channel would preclude in-channel construction.

Damage to the passage structure by debris transported during high-flow events would reduce the structure's reliability during important times when steelhead are likely to be actively swimming upstream (see Appendix E). Reliability of a fish passage facility is a critical consideration when determining the operational window of the system. Approximately 20 percent of all passage days occur in years where a peak flow following a storm event exceeded 100,000 cfs, which is a strong flow event likely to transport large debris capable of damaging the hardened ramp fish passage structure.

In 2017, piles of debris and boulders larger than 1 foot were deposited downstream of the diversion during a storm that peaked at less than 30,000 cfs (Figure 10-4). Exposing a fish passage system to such peaks would potentially risk damage and subsequent operations of the ladder when turbidity and turbulence have subsided and steelhead are expected to be at the diversion, ready to ascend the fish passage structure. Also, given the experimental nature of this alternative, it would require additional physical modeling that would be costly and extend the timeline for constructing a new fish passage with no guarantee that the physical model would show that the structure would be effective in this watershed.

The hardened ramp provides little reliability or options for monitoring upstream anadromous fish migration. Monitoring is essential to the evaluation of effectiveness of the conservation program and to providing the best available science to support species recovery. Similar to the challenges posed by Take Alternative B, the high levels of suspended sediment in the river and resulting turbidity make traditional monitoring methods (e.g., DIDSON, Vaki River Watcher) difficult and ineffective across the wide ramp fishway. Monitoring for upstream migrants could be achieved at low flows with the installation of a separate instream fish trap (a source of delay) or DIDSON but upstream monitoring would be impossible at high flows. Some monitoring of downstream migrants through the fish bypass could be accomplished, but the majority of downstream migrants would likely pass over the ramp and could not be monitored for. The vertical slot alternative allows more reliable monitoring of both upstream and downstream migration. Monitoring of downstream migrants under **Take Alternative C** and the Proposed MSHCP would be possible through a fish bypass pipe and evaluation station. At low flow conditions, a higher proportion of total river flow is monitored for downstream migrants under the Proposed MSHCP compared to under **Take Alternative C**.

Therefore, considering the concerns about land rights, standard maintenance and durability due to risk of damage from large debris load, difficulty to repair in a timely manner, and the inability to monitor upstream anadromous migrants, **Take Alternative C** is considered logistically and technologically impracticable.

**Figure 10-4 Example Large Debris and Drop Out of Bedload following Storm Flow, 2017{ TC "Figure 10-4. Example Large Debris and Drop Out of Bedload following Storm Flow, 2017
" \f F \l "1" }**

Other Environmental Consequences

Under **Take Alternative C**, similar benefits would be anticipated to agricultural resources and water quality of the Oxnard Plain as those under the Proposed MSHCP. United would achieve the same annual yield to use surface water supplies for groundwater replenishment in the Oxnard Plain, preventing additional seawater intrusion that negatively affects farmland (see Section 10.4 and Appendix B) and other water quality degradation. As stated in in the analysis for Take Alternative A, United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D).

Implementation of **Take Alternative C** would have more negative impact than the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic. Construction would occur on a slightly larger footprint and involve a larger amount of concrete compared to the Proposed MSHCP, resulting in more release of emissions, more noise, and more traffic related to construction activities than would occur under the Proposed MSHCP. With a larger construction footprint, there would be slightly more potential for impacts on previously undisturbed archaeological/cultural/tribal resources. Negative effects on biological resources (noncovered species), such as California Species of Special Concern (e.g., yellow-breasted chat, yellow warbler, and two-striped gartersnake), would be increased under **Take Alternative C** compared to the Proposed MSHCP because more riparian and stream habitats would be affected from the larger construction footprint.

In summary, **Take Alternative C** would result in more negative impacts on air quality, archaeological/ cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic when compared with the Proposed MSHCP. Implementation of **Take Alternative C** would have a similar impact to that of the Proposed MSHCP on groundwater replenishment, seawater intrusion and groundwater quality, and farmland in the Oxnard Plain.

Conclusions

Despite the reduced take on some covered wildlife species and higher conservation benefit for anadromous fishes compared to the Proposed MSHCP, **Take Alternative C** was eliminated from further consideration because it is considered technologically and logistically impracticable. As described above, the structure is experimental with no set standards or design parameters, and there is a high risk of damage to the structure during debris-transporting high-flow events, which could render the passage facility inoperable during the anadromous fish migration season, making it inconsistent with some goals and criteria of the MSHCP. Additionally, the hardened ramp provides little reliability or options for monitoring anadromous fish upstream migration and would contribute less data to recovery efforts than the vertical slot fishway of the Proposed MSHCP. Therefore, **Take Alternative C** is considered infeasible and was eliminated from further consideration.

10.5.4 ALTERNATIVE D – VERTICAL SLOT STRUCTURE PLUS WATER DIVERSION CONSISTENT WITH 2008 BIOLOGICAL OPINION

Incidental Take and Conservation Benefits

Relative to the Proposed MSHCP, **Take Alternative D** would avoid or reduce take for some covered wildlife species by substantively modifying CMs 1.2.1–1.2.4 of the Proposed MSHCP. All other conservation measures would be implemented as in the Proposed MSHCP.

Although some elements of the proposed diversion protocols covered in CMs 1.2.1–1.2.4 would remain in place, the net effect of implementing **Take Alternative D** would be a substantive reduction in the amount of water being diverted at Freeman Diversion relative to the Proposed MSHCP. This reduction in diversion is likely to have a similar effect to that of Take Alternative A's modification of the conservation measures, in that it would result in enhanced adult passage opportunities in the estuary by increasing the period of time the estuary was open to the ocean. However, this alternative is unlikely to increase adult passage opportunities through the critical riffle relative to the Proposed MSHCP.

Take Alternative D would result in similar effects on covered species, including covered fish species, to the Proposed MSHCP. In addition to more instream flow being released past Freeman Diversion, fish passage characteristics for Freeman Diversion would be improved through the replacement of the Denil fish ladder with a vertical slot fish ladder; therefore, passage opportunities at the diversion would be similar under **Take Alternative D** when compared to the Proposed MSHCP.

Overall, because of the reduced take on covered wildlife species, **Take Alternative D** would provide greater overall conservation benefit because of the positive effects on migration of covered fishes downstream of Freeman Diversion.

Effects on Covered Fishes

Relative to the Proposed MSHCP, **Take Alternative D** would have similar take for steelhead and lamprey once the fish passage facility and diversion facility were renovated and operations activities were underway. Construction activities would result in potential take of all covered species that may occur within the project footprint during renovation at levels identical to those of the Proposed MSHCP. Standard maintenance activities would also result in identical levels of take for all covered species compared to the Proposed MSHCP.

Construction

Overall, the types of construction activities used and associated effects causing take are anticipated to be identical under **Take Alternative D** compared to the Proposed MSHCP, and are anticipated to be similar under all take alternatives involving renovation or removal of the existing fish passage facility. Refer to Section 10.5.4, *Alternative B – Notch Structure*, for discussion of take anticipated as a result of general construction activities.

Maintenance

Maintenance activities under **Take Alternative D** would be identical to those under the Proposed MSHCP. Standard maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road control maintenance) would be necessary under both **Take Alternative D** and the Proposed MSHCP, and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Take of steelhead and lamprey due to maintenance activities is anticipated to be identical under **Take Alternative D** to that of the Proposed MSHCP. Annual dewatering required for maintenance activities under the Proposed MSHCP would also be necessary under **Take Alternative D** (e.g., to ensure the facility is functioning properly, gates are calibrated and running smoothly). Maintenance would include inspection and sediment management of the fishway and baffles. Take of covered steelhead and lamprey may occur during annual dewatering required for maintenance activities under all fish passage facility alternatives. United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize take of steelhead and lamprey due to dewatering and rescue activities (e.g., stranding, stress from handling).

Some of the potential effects on steelhead and lamprey associated with standard maintenance activities would be due to periodic sediment sluicing activities at the diversion facility. Both the Proposed MSHCP and **Take Alternative D** would require identical sluicing flows when sediment accumulation occurred during normal operations. like the Proposed MSHCP, **Take Alternative D** requires sediment sluicing to take place during the fish passage window. Therefore, take associated with sediment sluicing activities could occur due to fish passage interruptions (e.g., fall-back of upstream migrants) and handling if rescue and relocation is required (e.g., due to dewatering of portions of passage facilities or upstream areas) would occur under both **Take Alternative D** and the Proposed MSHCP.

As also described below in the practicability section, channel maintenance may be required to restore diversion and fish passage operations. Take of covered fish species may occur during repair activities primarily due to reduction in fish passage opportunities at the diversion structure if the facility is inoperable, which could last until the end of the migration season if flows are too high to allow for construction equipment to access the ramp. Take could also occur due to handling during rescue and relocation associated with dewatering for repairs. Therefore, take of steelhead and lamprey due to fish passage facility emergency repairs would be identical under **Take Alternative D** compared to the Proposed MSHCP.

Under both the Proposed MSHCP and **Take Alternative D**, there would be no effect on tidewater goby from maintenance activities.

Consequently, take of covered fishes during maintenance activities is expected to be identical under **Take Alternative D** compared to the Proposed MSHCP.

Operations

In summary, operations activities under **Take Alternative D** would be similar to operations under the Proposed MSHCP. The vertical slot fishway is operated such that, above the fishway, auxiliary water supply, and diversion capacity, a portion of water not diverted is sent through the fishway and a portion is sent through the crest gates and smolt bypass unless United would be conducting sediment sluicing, then flows would go through the bypass channel and the crest gates. Therefore, overall, take of covered fishes associated with operations under **Take Alternative D** is expected to be similar compared to the Proposed MSHCP.

Many of the anticipated effects on covered fishes resulting from reduced water diversion and associated take of covered fishes are expected to be similar between **Take Alternative D** and **Take Alternative A** – Wishtoyo Operational Remedies Plus Santa Felicia Project.

Fish passage facility operations under **Take Alternative D** and the Proposed MSHCP, which includes operation of a vertical slot fishway, would be identical. In summary, due to reduced diversion, **Take Alternative D** would provide improved fish passage opportunities below the diversion during normal Water Year types when compared to the Proposed MSHCP. Therefore, take of steelhead and lamprey associated with operations of the fish passage facility would be lower under **Take Alternative D** compared to the Proposed MSHCP.

Under both the Proposed MSHCP and **Take Alternative D**, there is potential for negative effects on tidewater goby to occur during fisheries monitoring activities in the estuary; however, conservation measures would be implemented to avoid take of tidewater goby under both scenarios. Thus, take of tidewater goby due to fisheries monitoring activities would be identical under the Proposed MSHCP and **Take Alternative D**. The primary difference between the Proposed MSHCP and **Take Alternative D** regarding effects to tidewater goby is that under **Take Alternative D**, increased water conveyance would result in either no change or a slight decrease in wetted habitat in the estuary compared to the Proposed MSHCP by potentially increasing the connectivity between the ocean and estuary during dry and normal years (Stillwater Sciences 2016a). Increased open time would mean that, on average, the estuary would occupy a slightly smaller wetted area relative to behavior under the Proposed MSHCP where the estuary would be closed more often and remain fuller, potentially providing more tidewater goby habitat in the estuary. Thus, **Take Alternative D** would provide slightly less estuary habitat for tidewater goby than the Proposed MSHCP due to differences in water release operations.

Overall, **Take Alternative D** would have lower take of steelhead and lamprey (due to increased passage opportunities downstream of the diversion in normal Water Year types) but potentially slightly higher take of tidewater goby (due to potential for slight estuary habitat area reductions) compared to the Proposed MSHCP.

Effects on Covered Birds and Western Pond Turtle

Take of covered birds and negative effects on pond turtle would be identical under **Take Alternative D** compared to the Proposed MSHCP due to construction and maintenance activities. Under **Take Alternative D**, operations would result in slightly less impact to aquatic habitats due to decreased diversions and increased instream flows that would improve and/or extend aquatic habitat in some months, benefitting pond turtle. Therefore, take of covered birds would be identical under **Take Alternative D** and the Proposed MSHCP, but negative effects on pond turtle under **Take Alternative D** are anticipated to be slightly lower than under the Proposed MSHCP.

Construction

Under **Take Alternative D**, negative effects on covered bird species and pond turtle could result from construction activities to replace the existing fish passage facility with the vertical slot structure and associated facilities. Take of covered riparian birds and negative effects on pond turtle resulting from construction would be identical to those of the Proposed MSHCP; refer to Chapter 7 for description of take of covered riparian birds and pond turtle due to construction activities.

Maintenance

Under **Take Alternative D**, negative effects on covered bird species and pond turtle could result from maintenance activities including vegetation removal, temporary dewatering, and rescues and relocations. Take of covered riparian birds and negative effects on pond turtle resulting from construction would be identical to those of the Proposed MSHCP; refer to Chapter 7 for description of take of covered riparian birds and pond turtle due to construction activities.

Operations

Riparian Habitat and Aquatic Habitat

Refer to Chapter 7, *Effects Analysis*, for description of effects on riparian and aquatic habitat due to operational activities under the Proposed MSHCP, which would be identical under Alternative D but for instream flows released. As described in Section 10.5.1 above and in Chapter 7, *Effects Analysis*, the Freeman Diversion functions as a grade stabilization structure and the water impoundment behind the structure has promoted significant growth of riparian habitat in the vicinity upstream and downstream of the diversion following its construction in 1991 (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }). Operations under **Take Alternative D** would be modified to provide additional flows downstream compared to the Proposed MSHCP. However, no substantial change would be expected to further downstream riparian habitats as a result of water operations under **Take Alternative D** due to the hydrologically losing nature of the reach. In some months, the additional instream flows would result in improved and/or extended aquatic habitats downstream of the diversion which could benefit pond turtle. Therefore, overall, negative effects on riparian and aquatic habitats due to operations under **Take Alternative D** are anticipated to be slightly less than those under the Proposed MSHCP.

Covered Birds

Potential negative effects from operational sediment management (such as a small amount of vegetation removal and riparian habitat inundation) and monitoring activities (such as disturbance from playback of calls) would be similar under the Proposed MSHCP and **Take Alternative D**. No take of covered birds is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative D**. Therefore, take of covered avian species due to operational activities under **Take Alternative D** is anticipated to be similar to that of the Proposed MSHCP.

Western Pond Turtle

As described in Chapter 7, *Effects Analysis*, no take of pond turtles is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative D**. Under operation of both **Take Alternative D** and the Proposed MSHCP, pond turtle could enter the fish passage facility and be negatively affected if they become trapped in the facility, resulting in take, though the potential for injury or mortality is low. Additional sources of take under the Proposed MSHCP and **Take Alternative D** include covered aquatic species rescue and relocation, sediment sluicing, crest gate operations, and monitoring activities, and the potential for take during these activities would be similar under both alternatives. Therefore, negative effects on covered pond turtle due to operations would be identical under **Take Alternative D** to that of the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative D** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

This alternative would eliminate the underlying lawful activity for which a permit is being sought and thus be inconsistent with United's purposes and prevent accomplishment of the activity for which ITPs are being requested. Due to reduced water diversions, **Take Alternative D** would be inconsistent with the following goal to achieve United's mission:

- Goal 1 - Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
- Goal 2 – Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.

Modified operations included in **Take Alternative D** would continue to allow an instantaneous 750 cfs diversion but would result in curtailment of the annual diversion yield. Because of this, **Take Alternative D** would be less consistent with the following covered species goal of the MSHCP compared to the Proposed MSHCP:

- Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose.

As described above, overall, the modified operations included in **Take Alternative D** would provide enhanced migratory fish passage below Freeman Diversion compared to the Proposed MSHCP; therefore, **Take Alternative D** would have greater consistency with the following covered species goals compared to the Proposed MSHCP:

- Goal 2 – Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31).

- Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.
- Goal 7 – Minimize impacts on riparian habitat and other covered species.

Under **Take Alternative D**, the vertical slot fish passage is identical to the Proposed MSHCP; therefore, **Take Alternative D** would be consistent with all fish passage facility criteria associated with the Proposed MSHCP.

For the reasons listed above, **Take Alternative D** is not considered consistent with the goals of the MSHCP.

Practicability

Take Alternative D was deemed logistically and technologically practicable, because it would be identical in practicability to the Proposed MSHCP. However, **Take Alternative D** was deemed impracticable because it would not be economically feasible for United to implement.

Cost

Take Alternative D would lead to rate increases significantly more than the Proposed action at 116 percent above current levels, and 36 percent more than the Proposed MSHCP. It also would lead to significant losses to agricultural operations. Annual lost income for the Ventura County agricultural economy would amount to $15 million and 230 jobs.

Logistics

Access to the necessary construction and restoration sites would be mostly accomplished from United's property, primarily on the south bank. Standard construction and dewatering/diversion equipment would be used to construct the fish passage facilities and associated infrastructure. The project footprint would be located mostly within United's property; therefore, United has sufficient land suitable for the new fish passage facility and **Take Alternative D** is considered logistically practicable.

Technology

All technology aspects evaluated would be identical under the Proposed MSHCP and **Take Alternative D**. Most components of the fish ladder included in **Take Alternative D** could be accessed and isolated for major repairs during high flows. The Obermeyer inflatable bladder/steel gate plates and the north fish entrance gates would not be accessible at high flows for major maintenance, and maintenance would need to occur at low flows, but these facilities are accessible by walkways for minor maintenance. **Take Alternative D** includes an evaluation station through which bypass flow would be routed, allowing for monitoring of juvenile downstream migrants and trap and haul. The evaluation station coupled with the capacity of the auxiliary water system gives the vertical slot structure the greatest capability for monitoring downstream migrants of all evaluated design alternatives. **Take Alternative D** also includes an upstream trap within or at the exit of the vertical slot fish ladder, DIDSON, PIT tag and radio-telemetry antenna arrays, allowing for monitoring of adult upstream migration at high and low flows. High flood flows during the wet season pose risks of damage and delays; however, the fishway is located off-channel and is at much lower risk of damage compared to other alternatives. Construction risk would be minimized through use of protection levees for in-channel work, and the in-channel footprint of construction, complexity of activities, and duration of construction during the wet season would be minimized to maximum extent practicable. The 100-year flood elevation would be unchanged from current conditions and the alternative does not present a safety risk to United or people downstream Therefore, **Take Alternative D** is considered technologically practicable.

Other Environmental Consequences

Take Alternative D would result in reduced surface water diversions and increased instream flows relative to the Proposed MSHCP. United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative. Like Take Alternative A which has reduced water diversions due to implementation of bypass flows in accordance with the 2008 BO, **Take Alternative D** would result in substantial negative impacts on agricultural resources and water quality of the Oxnard Plain. Implementation of **Take Alternative D** would have identical impacts to that of the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, noise, and transportation/traffic. It would have less impact on biological resources (noncovered species) through increased water releases which would provide more instream flows and potentially improve and/or expand available aquatic habitat in some months when compared with the Proposed MSHCP.

Conclusions

Despite the reduced take on some covered wildlife species and higher conservation benefit for anadromous fishes compared to the Proposed MSHCP, **Take Alternative D** was eliminated from further consideration because it would eliminate the underlying lawful activity for which a permit is being sought and thus be inconsistent with United's purposes and prevent accomplishment of the activity for which ITPs are being requested. Therefore, **Take Alternative D** is considered infeasible and was eliminated from further consideration.

10.5.5 ALTERNATIVE E – HARDENED RAMP STRUCTURE PLUS WATER DIVERSION CONSISTENT WITH 2008 BO

Incidental Take and Conservation Benefits

Take Alternative E would implement CMs 1.1.1 and 1.1.2 to improve fish passage past Freeman Diversion in the same manner described for Take Alternative C. However, **Take Alternative E** would reduce some types of take for covered fish species by substantively modifying CMs 1.2.1–1.2.4 of the Proposed MSHCP as specified in the 2008 BO and described in **Take Alternative D**.

As described below, United eliminated this alternative from consideration because the structure is experimental with no set standards or design parameters, with a high risk of damage to the structure during debris-transporting and bedload-mobilizing high-flow events. Furthermore, these risks are not reduced by the proposed reductions in surface water diversions.

Therefore, **Take Alternative E** poses a significant operational risk in comparison to the Proposed MSHCP in a fashion identical to **Take Alternative C**. In addition, it would not allow the same kinds of options for scientific studies or monitoring to contribute to recovery efforts as the vertical slot fishway of the Proposed MSHCP.

Effects on Covered Fishes

Relative to the Proposed MSHCP, **Take Alternative E** would reduce take for steelhead and lamprey once the fish passage facility and diversion facility were renovated and operations activities were underway. Construction activities would result in potential take of all covered species that may occur within the project footprint during renovation at levels similar to those of the Proposed MSHCP. Standard maintenance activities would also result in similar levels of take for all covered species compared to the Proposed MSHCP.

Construction

Overall, the types of construction activities used and associated effects causing take are anticipated to be similar under **Take Alternative E** compared to the Proposed MSHCP, and are anticipated to be similar under all take alternatives involving renovation or removal of the existing fish passage facility. Refer to Section

10.5.4, *Alternative C – Hardened Ramp Structure*, for discussion of take anticipated as a result of general construction activities. Because construction of this alternative is identical to Alternative C, there could be higher take of covered fishes due to construction under **Take Alternative E** compared to the Proposed MSHCP.

Maintenance

Maintenance activities under **Take Alternative E** would be similar to those under the Proposed MSHCP and to those detailed under *Alternative C – Hardened Ramp Structure* listed above. Standard maintenance activities (e.g., dry-season in-channel maintenance, facility maintenance, vegetation control, and access road control maintenance) would be necessary under both **Take Alternative E** and the Proposed MSHCP, and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Take of covered fish species due to maintenance activities under **Take Alternative E** is expected to be identical to that of Take Alternative C, described above and would not be substantively modified by the change in operations specified under the 2008 BO. Under both the Proposed MSHCP and **Take Alternative D**, there would be no effect on tidewater goby from maintenance activities. Annual dewatering in the vicinity of the diversion required for maintenance activities would likely be necessary under **Take Alternative E** in the same fashion as that of Alternative C. Consequently, take of steelhead and lamprey during maintenance activities, primarily in the form of reduced fish passage opportunities due to facility maintenance necessary to fix damage from large flow events, is expected to be higher under **Take Alternative E** compared to the Proposed MSHCP and identical to that of Take Alternative C. Additionally, due to the ability of debris to accumulate in the fishway, rescue of stranded fish within the hardened ramp fishway when dewatered would likely be more difficult compared to rescue from the vertical slot fishway of the Proposed MSHCP.

Operations

In summary, operations activities under **Take Alternative E** would be similar to operations under Take Alternative D and specified in the 2008 BO. Overall, there would be lower potential for negative effects on steelhead and lamprey due to operations activities, and take of steelhead and lamprey associated with operations under **Take Alternative E** is expected to be lower compared to Take Alternative C because of reduced water diversion.

Operations associated with water diversion and instream flow management are expected to be similar between **Take Alternative E** and Take Alternative D. Many of the anticipated negative effects on steelhead and lamprey resulting from water diversion and instream flow management are expected to be lower and associated take of steelhead and lamprey are expected to be lower between **Take Alternative E** and the Proposed MSHCP.

Fish passage facility operations would differ between **Take Alternative E**, which includes operation of a hardened ramp fishway, and the Proposed MSHCP, which includes operation of a vertical slot fishway. These effects are also anticipated under Take Alternative C and are discussed above; refer to Section 10.5.3, *Alternative C – Hardened Ramp Structure*, for discussion of operational effects on covered fishes under the Proposed MSHCP.

Under **Take Alternative E**, downstream fish passage would occur in a fashion similar to Take Alternative C described above but would be augmented by additional flows resulting from reduced diversion. Therefore, Alternative E would provide better downstream fish passage compared to the Proposed MSHCP. Take of juvenile downstream migrants of covered fish species associated with operations of the fish passage facility would be lower under **Take Alternative E** compared to the Proposed MSHCP.

In summary, due to higher attraction flows as described for **Take Alternative C**, the hardened ramp would provide better upstream fish passage compared to the Proposed MSHCP, albeit at flows where adult fish are not likely to be actively swimming in an upstream direction and at significant risk for damage in high flow events that could result in little to no upstream fish passage in an unknown amount of time. Therefore, take of adult upstream migrants of steelhead and lamprey associated with operations of the fish passage facility would be lower under **Take Alternative E** compared to the Proposed MSHCP.

Under both the Proposed MSHCP and **Take Alternative E**, there is potential for negative effects on tidewater goby to occur during fisheries monitoring activities in the estuary; however, conservation measures would be implemented to avoid take of tidewater goby under both scenarios. Thus, take of tidewater goby due to fisheries monitoring activities would be identical under the Proposed MSHCP and **Take Alternative D**. The primary difference between the Proposed MSHCP and **Take Alternative E** regarding effects to tidewater goby is that under **Take Alternative E**, increased water conveyance would result in either no change or a slight decrease in wetted habitat in the estuary compared to the Proposed MSHCP by potentially increasing the connectivity between the ocean and estuary during dry and normal years (Stillwater Sciences 2016a). Increased open time would mean that, on average, the estuary would occupy a slightly smaller wetted area relative to behavior under the Proposed MSHCP where the estuary would be closed more often and remain fuller, potentially providing more tidewater goby habitat in the estuary. Thus, **Take Alternative D** would provide slightly less estuary habitat for tidewater goby than the Proposed MSHCP due to differences in water release operations.

Effects on Covered Birds and Western Pond Turtle

Under **Take Alternative E**, similar levels of take of covered birds is anticipated as a result of maintenance of the hardened ramp structure and operations as compared to the Proposed MSHCP. Water operations under **Take Alternative** E would increase instream flows and result in less negative effects on aquatic habitats than the Proposed MSHCP in some months. However, take of covered birds and negative effects on pond turtle would be higher under **Take Alternative E** compared to the Proposed MSHCP due to a larger construction footprint. Additionally, take of covered pond turtle due to maintenance activities would be expected to be higher due to greater repair needs of the in-channel fishway compared to that of the Proposed MSHCP that is off-channel and would be subject to less damage. Therefore, overall, take of covered birds and negative effects on pond turtle under **Take Alternative E** are anticipated to be higher than under the Proposed MSHCP.

Construction

Negative effects on covered riparian birds and pond turtle and take resulting from construction would be greater than those of the Proposed MSHCP; refer to Section 10.5.4, *Alternative C – Hardened Ramp Structure*, for description of take of covered riparian birds and negative effects on pond turtle due to construction activities of the hardened ramp.

Maintenance

Take of covered birds as a result of maintenance activities would be similar to take under the Proposed MSHCP but negative effects on covered pond turtle resulting from maintenance would be greater than those under the Proposed MSHCP; refer to Section 10.5.3, *Alternative C – Hardened Ramp Structure*, for description of negative effects on covered pond turtle due to maintenance activities.

Operations

Riparian Habitat and Aquatic Habitat

As described in Section 10.5.1 above and in Chapter 7, *Effects Analysis*, the Freeman Diversion functions as a grade stabilization structure and the water impoundment behind the structure has promoted significant growth of riparian habitat in the vicinity upstream and downstream of the diversion following its construction in 1991 (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }). No substantial change would be expected to further downstream riparian habitats as a result of water operations under **Take Alternative D** due to the hydrologically losing nature of the reach. Operations under **Take Alternative E** would modify CM 1.2.1 through CM 1.2.4 to provide increased flows downstream, allowing for improvement and/or expansion of downstream aquatic habitat in some months, benefitting pond turtle. Therefore, negative effects on aquatic habitats due to operations under **Take Alternative E** are anticipated to be less than those under the Proposed MSHCP.

Covered Birds

No take of covered birds is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative E**. Potential negative effects from operational sediment management (such as a small amount of vegetation removal and riparian habitat inundation) and monitoring activities (such as disturbance from playback of calls) would be similar under the Proposed MSHCP and **Take Alternative E**. Therefore, take of covered avian species due to operational activities under **Take Alternative E** is anticipated to be similar to that of the Proposed MSHCP.

Western Pond Turtle

As described in Chapter 7, *Effects Analysis*, no take of pond turtles is expected as a result of instream flow operations under the Proposed MSHCP, and the same would be expected under **Take Alternative E**. Under operation of both **Take Alternative E** and the Proposed MSHCP, pond turtle could enter the fish passage facility and be negatively affected if they become trapped in the facility, resulting in take, though the potential for injury or mortality is low. Additional sources of take under the Proposed MSHCP and **Take Alternative E** include covered aquatic species rescue and relocation, sediment sluicing, crest gate operations, and monitoring activities, and the potential for take during these activities would be similar under both alternatives. Therefore, negative effects on covered pond turtle due to operations would be similar under **Take Alternative E** to that of the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative E** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

This alternative would eliminate the underlying lawful activity for which a permit is being sought and thus be inconsistent with United's purposes and prevent accomplishment of the activity for which ITPs are being requested. Due to reduced annual water diversion yield and the footprint of the hardened ramp project extending beyond United's current property line, **Take Alternative E** would be inconsistent with the following goals to achieve United's mission:

- Goal 1 - Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
- Goal 2 – Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.

- Goal 3 – Implement actions on land that United owns or can feasibly acquire.

Under **Take Alternative E**, operational constraints on annual diversion yield would not allow United to achieve their mission. Additionally, a higher amount of riparian habitat would be affected due to a larger construction footprint compared to that of the Proposed MSHCP. Therefore, **Take Alternative E** would be less consistent with the following goal than the Proposed MSHCP:

- Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose.
- Goal 7 – Minimize impacts on riparian habitat and other covered species.

The ramp structure included in **Take Alternative E** would provide improved migratory fish passage at Freeman Diversion compared to the vertical slot included in the Proposed MSHCP; therefore, **Take Alternative E** would have greater consistency with the following MSHCP covered species goals compared to the Proposed MSHCP:

- Goal 2 – Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31).
- Goal 4 – Promote migration of lamprey through the diversion.
- Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.

Under **Take Alternative E**, the hardened ramp fishway is designed for a capacity of approximately 2,000 cfs, which added to maximum diversions allows for approximately 2,750 cfs of river flow to pass the diversion structure before flow spills over the diversion structure crest. This value is higher than the approximately 600 cfs that can be passed by the fishway and associated facilities under the Proposed MSHCP, or 1,150 cfs accounting for maximum diversions. Additional flows could be bypassed through the sluicing channel; it is assumed these capacities would be the same under **Take Alternative E** and the Proposed MSHCP. Therefore, **Take Alternative E** would be more consistent with the following fish passage facility criteria than the Proposed MSHCP:

- Criterion 2 – Minimize passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 5 - Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.
- Criterion 8 – Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.

Therefore, **Take Alternative E** is not considered consistent with the goals of the MSHCP.

Practicability

Take Alternative E was deemed not practicable because it would be logistically and technologically impracticable, would result in substantially more economic impacts than the Proposed MSHCP, and would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested.

Cost

Take Alternative E would lead to rate increases significantly more than the Proposed action at 154 percent above current levels, and 73 percent more than the Proposed MSHCP, and it would lead to significant losses to agricultural operations. Annual lost income for the Ventura County agricultural economy would amount to $16 million and 235 jobs.

Logistics

Take Alternative E is logistically identical to Take Alternative C; refer to Section 10.5.3 for the evaluation of logistics. Thus, **Take Alternative E** is considered logistically impracticable.

Technology

Take Alternative E is technologically identical to Take Alternative C; refer to Section 10.5.3 for the evaluation of technology. Thus, **Take Alternative E** is considered technologically impracticable.

Other Environmental Consequences

Take Alternative E would result in substantial negative impacts on agricultural resources and water quality of the Oxnard Plain (see Section 10.4 and Appendix B). United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D). Implementation of **Take Alternative E** would have more negative impacts than the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic. Construction would occur on a slightly larger footprint and involve a larger amount of concrete compared to the Proposed MSHCP, resulting in more release of emissions, more noise, and more traffic related to construction activities than would occur under the Proposed MSHCP. With a slightly larger construction footprint, there would be slightly more potential for impacts on previously undisturbed archaeological/cultural/tribal resources. Increased water releases downstream would likely benefit noncovered species by providing more instream flows and potentially improving and/or expanding available aquatic habitat in some months. However, negative effects on biological resources (noncovered species), such as California Species of Special Concern (e.g., yellow-breasted chat, yellow warbler, and two-striped gartersnake), would be increased during construction activities under **Take Alternative E** compared to the Proposed MSHCP, primarily because more riparian and stream habitats would be affected from the larger construction footprint.

In summary, **Take Alternative E** would result in more negative impacts on groundwater quality, air quality, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic when compared with the Proposed MSHCP.

Conclusions

Despite the reduced take on some covered wildlife species and higher conservation benefit for anadromous fishes compared to the Proposed MSHCP, **Take Alternative E** was eliminated from further consideration because it is considered technologically and logistically impracticable. As described above, the structure is experimental with no set standards or design parameters, and there is a high risk of damage to the structure during debris-transporting and bedload-mobilizing high-flow events, which could render the passage facility inoperable during the anadromous fish migration season, making it inconsistent with some goals and criteria of the MSHCP. Additionally, the operations specified in the 2008 BO would result in reduced agricultural benefit and increased seawater intrusion when compared with the Proposed MSHCP. Therefore, **Take Alternative E** is considered infeasible and was eliminated from further consideration.

10.5.6 ALTERNATIVE F – INFILTRATION GALLERY

Incidental Take and Conservation Benefits Summary

Take Alternative F would remove any barrier to passage that Freeman Diversion poses to steelhead and Pacific lamprey, replacing the diversion structure with a series of infiltration galleries buried in the main channel of the riverbed at the approximate location of the current facility.

Relative to the Proposed MSHCP, **Take Alternative F** would reduce take for covered fish species once the diversion facility was removed by eliminating any physical structures that might affect fish passage characteristics through the diversion. While the replacement of the diversion facility with **Take Alternative F** would eliminate this source of potential take of listed species, the removal process would result in potential take of all covered species that may occur within the project footprint during demolition activities. Additionally, as discussed below, the infiltration gallery is expected to cost significantly more (approximately $304 million more) than the Proposed MSHCP, would require acquisition of a large tract of additional land upstream and outside of United's property rights, and would require a significant increase in electricity usage associated with pumping. Furthermore, the infiltration gallery may be prone to clogging due to high sediment loads in the Santa Clara River, representing an unknown risk to the function of the gallery.

Effects on Covered Fishes

Construction

Overall, take of steelhead and lamprey during construction activities is anticipated to be greater under **Take Alternative F** compared to the Proposed MSHCP due to temporary and permanent impact footprint on approximately 40 acres of riparian and streambed habitats, which are much larger than that of the Proposed MSHCP. Effects on steelhead and lamprey resulting from demolition activities to remove the diversion facility could include disturbance/harm/mortality from in-water construction activities, rescue and relocation activities, and dewatering activities; reduced passage opportunities during construction windows; and loss of ecological service to fishes during temporary loss of aquatic habitat due to dewatering.

Impacts on steelhead and lamprey from in-water construction activities would be greater under **Take Alternative F** compared to those under the Proposed MSHCP. In-water construction activities, such as demolition and removal of the existing structure or construction of temporary falsework structures, have the potential to disturb, stress, or harm fishes by increasing noise and vibration within the water, resulting in physical contact of fishes with equipment or materials, and decreasing water quality due to sediment releases or increased turbidity. BMPs would be followed to minimize the risk of these impacts, though the risk of disturbance to fishes during in-water construction activities cannot be fully avoided.

Impacts on steelhead and lamprey from dewatering activities during construction would be greater under **Take Alternative F** compared to those under the Proposed MSHCP. Dewatering is likely to be required during installation of the gallery upstream of the current structure and during removal of the diversion facility. This activity has the potential to disturb, stress, or harm fishes due to decreased water quality (such as increased water temperature and turbidity), intake of fishes into dewatering pumps or impingement on pump screens, and handling or crowding effects associated with rescue and relocation. To minimize the risk of these impacts, BMPs would be followed and dewatering and fish rescue plans would be written and implemented; however, the risk of harm to fishes during dewatering activities cannot be fully avoided.

Impacts on steelhead and lamprey from reduced passage opportunities during construction windows would be greater under **Take Alternative F** compared to those under the Proposed MSHCP. As described in Section 10.3.8, *Alternative B – Notch Structure*, above, the construction work window for removal of the diversion structure would need to be timed around prevailing weather and river flows; active demolition activities in the wetted channel would likely be restricted to the dry season and may require multiple years to complete. If work in the wetted channel were to occur within the downstream migration period (March 15 through May 31), passage of fishes moving downstream during this time, such as steelhead smolts or lamprey macropthalmia, could be delayed or blocked. Construction of the infiltration gallery would require dewatering and excavation of approximately 40 acres of riparian and stream channel / open water habitat within and adjacent to the current structure and would have similar restrictions regarding weather and river flows to the demolition of the existing structure but result in a larger impact footprint relative to the Proposed MSHCP.

Impacts on steelhead and lamprey from loss of ecological service during temporary loss of aquatic habitat, such as due to dewatering, would be greater under **Take Alternative F** compared to those under the Proposed MSHCP. Dewatering of portions or all of the river in the vicinity of Freeman Diversion may be required for full removal of the diversion structure and installation of the infiltration gallery. This temporary loss of aquatic habitat could result in negative effects on covered fishes such as direct reduction in habitat availability and loss of food sources/reduction of food availability. Relative to the extent of existing habitat within the Santa Clara River, this significant loss of aquatic habitat would result in effects on covered fish species.

Under both the Proposed MSHCP and **Take Alternative F**, there would be no effect on tidewater goby from construction activities.

Maintenance

Some standard maintenance activities would be necessary under both **Take Alternative F** and the Proposed MSHCP (e.g., vegetation control, and access road control maintenance), and would have little to no potential for effects on covered fishes due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Most maintenance activities under **Take Alternative F** would differ substantially from those under the Proposed MSHCP. Because the diversion structure would be removed, no maintenance activities related to it would be conducted under **Take Alternative F**. Maintenance of pumps and machinery would take place on a daily or monthly basis, but would not require in-channel work and is expected to have no effect on covered fish. However, there would be additional maintenance activities associated with sediment management within the infiltration galleries that would occur on an as-needed basis. The effect of these activities could range from temporary increased sediment discharge downstream of the gallery to extensive dewatering and excavation of the riverbed to replace clogged filter media. These effects may offset the reduction in maintenance activities from not needing to maintain fish passage or diversion facilities. Therefore, there would be a similar potential for negative effects on steelhead and lamprey due to maintenance activities under **Take Alternative F**; as such, effects due to maintenance would be similar compared to the Proposed MSHCP. Under both the Proposed MSHCP and **Take Alternative F**, there would be no effect on tidewater goby from maintenance activities.

Operations

Operations activities under **Take Alternative F** would differ substantially from those of the Proposed MSHCP. Because the diversion structure would be removed and replaced with an infiltration gallery, diversion operations would be modified under **Take Alternative F**. All water not extracted via pumping would remain in the river to fulfill bypass flow requirements, though variable pumping would affect flows through the critical riffle downstream of the infiltration gallery. Assuming variable pumping would allow for implementation of CMs 1.2.1 through 1.2.4, negative effects on downstream flows and aquatic habitat resulting from reduced surface flows caused by water diversions would be similar to effects described under the Proposed MSHCP. Additionally, because no headworks would exist for a fish passage facility or diversion canals and surface water diversions would be extracted from below the streambed, flows downstream would more closely mimic an unimpeded hydrograph compared to flows under the Proposed MSHCP. Therefore, there would be a similar potential for negative effects on covered fish species due to water operations activities under **Take Alternative F** compared to the Proposed MSHCP.

Without the instream diversion facility, there would be no physical barrier to steelhead upstream or downstream passage; therefore, adult and juvenile steelhead and lamprey passage would be improved under **Take Alternative F** compared to the Proposed MSHCP. **Take Alternative F** would not implement CMs 1.1.1 and 1.1.2, and flows downstream of the former diversion site would be unimpeded by a structural barrier. The presence of unimpeded flows would provide improved passage opportunities for adult and juvenile steelhead and lamprey compared to the Proposed MSHCP. Without the passage facility, fishes would be able to navigate within the river past the previous facility's location without having to enter and exit a fish ladder or other passage structure; therefore, there would be no potential for take associated with a passage facility. Take of steelhead and lamprey associated with operation of a passage facility would be reduced (i.e., eliminated) compared to the Proposed MSHCP, which has a potential for take at the diversion structure's passage facility.

Both the Proposed MSHCP and **Take Alternative F** would implement conservation measures to avoid potential take of tidewater goby during fishery monitoring activities in the estuary. There would be no take of tidewater goby due to water operations under the Proposed MSHCP or **Take Alternative F**.

Overall, take of covered fishes associated with operations of the infiltration gallery under **Take Alternative F** would be less than under the Proposed MSHCP.

Effects on Covered Birds and Western Pond Turtle

Relative to the Proposed MSHCP, **Take Alternative F** would increase take of covered birds and negative effects on pond turtle during construction activities due to a much larger construction footprint and due to an expected large reduction in riparian and aquatic habitats in the vicinity of the Freeman Diversion as a result of removal of the grade control structure and water impoundment. Maintenance- and operations-related take of covered birds under **Take Alternative F** would be similar to that of the Proposed MSHCP. Operations under **Take Alternative F** may result in reduced take of covered pond turtle compared to the Proposed MSHCP. However, maintenance activities to keep the gallery intakes functioning and clear of sediment may require wider-scale dewatering and sediment management than maintenance activities of the Proposed MSHCP, resulting in larger effects on pond turtle. Overall, under **Take Alternative F**, there would be greater take of covered bird and negative effects on pond turtle compared to the Proposed MSHCP.

Construction

The types of construction activities used and associated effects causing take would be greater under **Take Alternative F** compared to the Proposed MSHCP for the infiltration gallery itself, and are anticipated to be similar under all take alternatives involving removal of the existing fish passage facility. Refer to Section 10.5.7, *Alternative G – Remove Structure and Cease Diversions*, for discussion of take anticipated as a result of general construction activities associated with removal of the existing structure.

Overall, take of covered bird species and negative effects on pond turtle due to construction activities is anticipated to be greater under **Take Alternative F** compared to the Proposed MSHCP because of the approximately 40-acre temporary and permanent impact area on riparian and streambed habitats. Removal of the grade control and diversion structure would eliminate the water impoundment and downstream seepage pool at the structure which supports a population of pond turtles, resulting in a large negative impact on pond turtle. **Take Alternative F** would result in much larger direct impacts on riparian and stream habitats and negative effects on pond turtles than those of the Proposed MSHCP.

Maintenance

Some standard maintenance activities would be necessary under both **Take Alternative F** and the Proposed MSHCP (e.g., vegetation control and access road maintenance), and would have little to no potential for effects on covered birds and pond turtle due to implementation of the following conservation measures described in Chapter 5:

- CM 2.1.1 Best Management Practices [BMPs]
- CM 2.1.2 Worker Environmental Awareness Training [WEAT]
- CM 2.1.3 Pre-activity Surveys
- CM 2.1.4 Covered Species Capture and Relocation Plan [CRP]
- CM 2.1.5 Noise Abatement Protocol
- CM 2.1.6 Biological Monitoring
- CM 2.1.7 Avoid Nests of Covered Species of Birds During Nesting Bird Season
- CM 2.1.8 Avoid Western Pond Turtle During In-Water Work and Work in Riparian Zones
- CM 2.2.2 Avoid Riparian and Aquatic Habitats During Rainfall Events

Most maintenance activities under **Take Alternative F** would differ substantially from the Proposed MSHCP. Because the diversion structure would be removed, no maintenance activities related to it would be conducted under **Take Alternative F**. Maintenance of pumps and machinery would take place on a daily or monthly basis, but it is assumed they would not require work activities in-channel or within riparian areas and is expected to have no effect on covered pond turtle or bird species. However, there would be additional maintenance activities associated with sediment management within the infiltration galleries that would occur on an as-needed basis. The effect of these activities could range from temporary increased sediment discharge downstream of the gallery to extensive dewatering and excavation of the riverbed to replace clogged filter media, negatively affecting downstream aquatic habitat quality. United would develop and implement a dewatering and diversion plan and a CRP (CM 2.1.4) to minimize take of pond turtle due to dewatering and rescue activities (e.g., stranding, stress from handling). The additional negative effects described may beyond offset the reduction in maintenance activities from not needing to maintain fish passage or diversion facilities. Therefore, there would be greater potential for negative effects on pond turtle due to maintenance activities under **Take Alternative F** compared to that of the Proposed MSHCP. Take of covered bird species due to maintenance would be similar to that of the Proposed MSHCP.

Operations

Riparian Habitat and Aquatic Habitat

As described above in Section 10.5.1 and in Chapter 7, *Effects Analysis*, the Riparian Habitat Study (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }) found that the amount of riparian vegetation in the immediate vicinity of Freeman Diversion increased as a result of Freeman Diversion presence and operations compared to historical conditions, and that operations promote recruitment and development of riparian vegetation in the immediate area. Removal of the diversion structure under **Take Alternative F** would result in decreased riparian vegetation in the vicinity, thereby reducing the quantity and/or quality of riparian habitat for pond turtle and birds and reducing the quality of habitat for pond turtle (e.g., due to reduced shading). Additionally, similar to Take Alternative B, after removal of the grade control structure, over time, destabilization of the riverbed would allow degradation upstream affecting well-established riparian habitat that has grown since construction of the Freeman diversion including mitigation areas on The Nature Conservancy's property. The true extent of degradation that would occur under **Take Alternative F** has not been evaluated, though it is expected to be greater than that of Take Alternative B and similar to that of Take Alternative G. Removal of the structure would eliminate the water impoundment and downstream seepage pool that also provides aquatic pool habitat for a population of pond turtles.

Covered Birds

The reduction in riparian habitat as a result of removal of the grade control structure and water impoundment would cause take of covered bird species as a result of operations under **Take Alternative F**; therefore, there would be the higher take of covered bird species under **Take Alternative F** and the Proposed MSHCP.

Western Pond Turtle

As described above for effects of operations on covered fishes, variable pumping at the infiltration gallery could allow for implementation of CMs 1.2.1 through 1.2.4 to minimize negative effects on downstream aquatic habitat resulting from reduced flow due to surface water diversions to levels similar to those under the Proposed MSHCP. Therefore, take of pond turtle due to water operations would be similar under **Take Alternative F** to that under the Proposed MSHCP, which would primarily be due to rescue and relocations. Operation of the Proposed MSHCP could allow pond turtle to enter the fish passage facility and be negatively affected if they become trapped in the facility, and they could be negatively affected during sediment sluicing, crest gate operations, and monitoring activities, though the potential for injury or mortality is low. Because the diversion structure would be removed and replaced with an infiltration gallery, and no passage facility or diversion facilities would exist, there would be no potential for negative effects on pond turtle due to facility operations activities under **Take Alternative F**. However, removal of the grade control and diversion structure would result in riverbed destabilization and degrade upstream habitats overtime, potentially negatively affecting pond turtle habitat in the vicinity. Additionally, removal of the diversion structure would eliminate the water impoundment and downstream seepage pool that provide aquatic pool habitat for a population of pond turtles and the reduction in riparian habitat would result in a loss of quantity and quality habitat for pond turtles. Therefore, overall, there would be more negative effects on covered pond turtle due to operations under **Take Alternative F** compared to the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative F** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

In order to sustain a rate of 750 cfs diversion, the infiltration gallery would need a footprint of approximately 21 acres within the river channel upstream of the current diversion facility, which would have large negative impacts on existing riparian and stream habitats. In addition, United would need to acquire most of the footprint on land upstream of the current property boundary. Therefore, **Take Alternative F** would be inconsistent with the following goal to achieve United's mission:

- Goal 3 – Implement actions on land that United owns or can feasibly acquire.

Because of the nature of the diversion, with no impoundments in the channel, sediment management would no longer be necessary and **Take Alternative F** would be more consistent with the following goal to achieve United's mission:

- Goal 4 – Allow United to manage sediment deposition in the desilting basin or other settling basin in a sustainable manner.

Because of the increased construction footprint, **Take Alternative F** would be less consistent with the following MSHCP covered species goal:

- Goal 7 – Minimize impacts on riparian habitat.

Take Alternative F would provide improved migratory fish passage at Freeman Diversion compared to the vertical slot included in the Proposed MSHCP because the diversion would be removed, resulting in no fish passage barrier at the location. Because no headworks would exist for a fish passage facility or diversion canals and surface water diversions would be extracted from below the streambed, flows downstream would more closely mimic an unimpeded hydrograph compared to flows under the Proposed MSHCP. Additionally, because no fish passage facility would exist, there would be no transitions between fish passage systems. Therefore, **Take Alternative F** would have greater consistency with the following MSHCP covered species goals compared to the Proposed MSHCP:

- Goal 1 – Improve migration of steelhead through the diversion.
- Goal 4 – Promote migration of lamprey through the diversion.
- Goal 8 – Minimize operational complexity including operational transitions between different fish passage systems.
- Goal 10 – Do not pose a significant stranding risk to steelhead.

Replacement of the diversion facility with an infiltration gallery would completely remove the fish passage facility and its associated infrastructure, and no fish passage barrier would remain. All river flows not diverted would remain in the channel. Therefore, **Take Alternative F** would be more consistent with the following fish passage facility criteria than the Proposed MSHCP:

- Criterion 1 – Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs.
- Criterion 2 – Minimize passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 4 – Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows.
- Criterion 5 – Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.
- Criterion 8 – Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.
- Criterion 9 – Preclude fish passage through partially open gates or weirs.
- Criterion 10 – Ensure fish screens are protective of all life stages of covered aquatic species from impingement and entrainment.

Therefore, **Take Alternative F** is not considered consistent with the purpose of the activity for which ITPs are requested or the goals and fish passage criteria of the MSHCP.

Practicability

United commissioned a study of how an infiltration gallery could be used to supplement the diversions lost with the removal of Freeman Diversion (NHC 2016{ TC "NHC 2016" \f C \l "1" }). The study concluded that pumping water out of the diversion would require significant amounts of electrical energy to run the pumps at the needed rate. In addition, the infiltration gallery would require approximately 40 acres of land to which United does not currently have the rights. For these reasons, **Take Alternative F** is not considered to be logistically practicable.

In addition, there are uncertainties regarding the effects of fine sediment on the porosity of the gallery over the course of operation. Repair of the facility may require complete re-excavation of the gallery. Construction of an infiltration gallery on the scale proposed has not been done before, and construction may require in-channel work over the course of multiple seasons, exposing the project to risk of storm-related damage during construction. For these reasons, this alternative was deemed not technologically practicable. **Take Alternative F** would be economically infeasible with much larger economic impacts than the Proposed MSHCP.

Cost

Take Alternative F would lead to substantial rate increases of 317 percent above current levels, and 236 percent more than the Proposed MSHCP. For municipal and industrial customers, other alternative sources would be more cost effective and these customers could leave the District, thus leading to further rate increases. Annual lost income for the Ventura County agricultural economy would amount to $7 million and 100 jobs.

Logistics

It is unlikely that United has the necessary resources to acquire land rights, conduct permitting activities, and operate an infiltration gallery of the size that would be required to achieve annual diversion yields commensurate with those of the Proposed MSHCP. The 750 cfs gallery would require the acquisition of an additional 40 acres of property mostly upstream and outside of United's current property boundaries.

Because the infiltration gallery to be implemented under **Take Alternative F** is proposed to be constructed mostly on land upstream of the current diversion, access to the necessary construction site would require the construction of many new access routes. United does not currently have access or land rights to the portions of the Santa Clara River required to construct, operate, and maintain the infiltration gallery. Acquisition of the necessary land rights poses a logistical constraint based on the absence of roads or infrastructure adjacent to the river upstream of the current facility.

Operation of the infiltration gallery would require the use of large pumps to transfer water to United's existing fixed elevation diversion canal. The pumps associated with water transfer from the infiltration gallery into the diversion canal would require more electricity than is consumed by the existing facility or the Proposed MSHCP. Operating costs associated with this increased electricity consumption would be prohibitively high relative to the Proposed MSHCP; thus, availability of resources is considered a constraint under **Take Alternative F**.

Therefore, considering constraints due to access, availability of resources, and land acquisition, **Take Alternative F** is considered logistically impracticable.

Technology

A technological constraint associated with the infiltration gallery is the proposed facility's operational reliability. There are no currently known examples of a functional infiltration gallery of the size proposed in this alternative. Additionally, bedload in the Santa Clara River at the proposed site is dominated by fines and sand, which may pose a potentially unresolvable challenge to the function of the gallery. As a result, the infiltration gallery may be prone to clogging due to high sediment loads, representing an unknown risk to the long-term maintenance of the diversion. The unknown risks associated with managing sedimentation of the infiltration gallery under **Take Alternative F** potentially involve a significantly greater effort and much higher costs than under the Proposed MSHCP.

The Santa Clara River is challenging for fish monitoring activities due to high storm flows with high suspended sediment. Without a fish passage facility, fish monitoring at anything but low flows would be technologically infeasible due to high sediment loads that would preclude use of trapping methods, and high turbidity that would preclude use of visual monitoring methods.

Implementation of the infiltration gallery would require substantial in-water construction, which entails significant risk of damage and delays from flood events considering the size of the in-river construction footprint. The feasibility study could not show where an infiltration gallery of necessary size has ever been successfully implemented, and the infiltration gallery to be implemented under **Take Alternative F** would be considered experimental.

Under implementation of the infiltration gallery, the diversion structure would be removed and there would be no above-channel structures; therefore, there would be no risk to damage of the completed facility due to high debris loads during storm events. Re-grading of the river channel would reduce the 100-year flood line and there would be no safety concerns to United staff or downstream river users/landowners. However, the current locations of armoring against floods may need to be reevaluated and relocated as flood zones and risk may change.

Therefore, overall, **Take Alternative F** is considered technologically impracticable.

Other Environmental Consequences

Under **Take Alternative F**, assuming an infiltration gallery capable of allowing 750 cfs diversions would be built, similar benefits would be anticipated to agricultural resources and water quality of the Oxnard Plain as those under the Proposed MSHCP. United would achieve the same annual yield to use surface water supplies for groundwater replenishment in the Oxnard Plain, preventing additional seawater intrusion that negatively affects farmland (see Section 10.4 and Appendix B). United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D).

Implementation of **Take Alternative F** would have more negative impact than the Proposed MSHCP on air quality/greenhouse emissions, archaeological/cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic. Construction would occur on a much larger footprint compared to the Proposed MSHCP, resulting in more release of emissions, more noise, and more traffic related to construction activities than would occur under the Proposed MSHCP. Additionally, the energy needed to run the pumps for this alternative would result in higher energy use per AF of water recharge, which would mean higher greenhouse gas emissions associated with United's operations if the energy source came from a nonrenewable resource. Currently, the gravity-fed canal system requires minimal energy to operate, resulting in relatively low greenhouse gas emissions per AF of water recharge. With a much larger construction footprint upstream of the diversion, there would be more potential for impacts on previously undisturbed archaeological/cultural/tribal resources. Negative effects on biological resources (noncovered species), such as California Species of Special Concern (e.g., yellow-breasted chat, yellow warbler, and two-striped gartersnake), would be increased under **Take Alternative F** compared to the Proposed MSHCP. More riparian and stream habitats would be affected from the much larger construction footprint, elimination of the water impoundment would negatively affect localized riparian habitat which would likely revert toward historical conditions, and destabilization of the river bed would allow degradation upstream affecting well established riparian habitat that has grown since construction of the Freeman diversion. Additionally, swallows nest on the current structure and removal of the structure would reduce the amount of available hard-surfaces for swallow nesting.

In summary, **Take Alternative F** would result in more negative impacts on air quality, archaeological/ cultural/tribal resources, biological resources (noncovered species), noise, and transportation/traffic when compared with the Proposed MSHCP. Implementation of **Take Alternative F** would have a similar impact to that of the Proposed MSHCP on groundwater replenishment in the Oxnard Plain.

Conclusions

Despite the improved fish passage characteristics, **Take Alternative F** would be inconsistent with many of the goals and criteria of the MSHCP. The infiltration gallery does not meet the MSHCP's criterion of being an action that can be implemented on land that United owns or can feasibly acquire. In addition, the alternative would require a significant disturbance of the channel and riparian bank upstream of the current diversion. Finally, the proposed design is untested and represents an unknown risk associated with clogging of the gallery by fine sediment. Therefore, **Take Alternative F** is considered infeasible and was eliminated from further consideration.

10.5.7 ALTERNATIVE G – REMOVE STRUCTURE AND CEASE DIVERSIONS

Incidental Take and Conservation Benefits Summary

Take Alternative G would remove any barrier to passage that the Freeman Diversion structure poses to steelhead and Pacific lamprey. Relative to the Proposed MSHCP, **Take Alternative G** would reduce take for all covered species once the diversion facility was removed. While the removal of the diversion facility would eliminate this source of potential take of listed species, the removal process would result in potential take of all covered species that may occur within the project footprint during demolition activities.

Effects on Covered Fishes

Demolition

Demolition under **Take Alternative G** would result in similar types of impacts as those under the Proposed MSHCP, resulting in a number of adverse effects on steelhead and lamprey, including disturbance from in-water demolition activities and reduced passage opportunities. Refer to Section 10.5.4, *Alternative B – Notch Structure*, for discussion of take anticipated as a result of general demolition activities. Because the footprint of demolition would be similar, but would require less time (no construction following removal), there would be less take of steelhead and lamprey due to removal of the structure under **Take Alternative G** compared to the Proposed MSHCP. Under both the Proposed MSHCP and **Take Alternative G**, there would be no effect on tidewater goby from construction or demolition activities, respectively.

Maintenance

Maintenance activities under **Take Alternative G** would differ substantially from those of the Proposed MSHCP. Because the diversion structure would be removed, no maintenance activities would be conducted under **Take Alternative G**. Therefore, there would be no potential for negative effects on covered fish species due to maintenance activities under **Take Alternative G**; as such, take of covered fish species due to maintenance would be reduced (i.e., eliminated) compared to the Proposed MSHCP.

Operations

Operations activities under **Take Alternative G** would differ substantially from those of the Proposed MSHCP. Because the diversion structure would be removed, no diversions would occur under **Take Alternative G**, all water would remain in the river (unimpeded flows), and no passage facility would exist. Therefore, there would be no potential for negative effects on covered fish species due to operations activities under **Take Alternative G**.

Without the instream diversion facility, there would be no physical barrier to steelhead upstream or downstream passage; therefore, adult and juvenile steelhead and lamprey passage would be improved under **Take Alternative G** compared to the Proposed MSHCP.

Take Alternative G would not implement CMs 1.1.1, 1.1.2, or 1.2.1–1.2.4 and flows downstream of the former diversion site would be unimpeded. The presence of unimpeded flows would provide improved passage opportunities for adult and juvenile steelhead and lamprey compared to the Proposed MSHCP. Without the passage facility, fishes would be able to navigate within the river past the previous facility's location without having to enter and exit a fish ladder or other passage structure; therefore, there would be no potential for take associated with a passage facility. Take associated with operation of a passage facility would be reduced (i.e., eliminated) compared to the Proposed MSHCP, which has a potential for take at the diversion structure's passage facility.

Fisheries monitoring activities in the estuary would be discontinued under **Take Alternative G,** resulting in less potential for effects when compared with the Proposed MSHCP, though the Proposed MSHCP would implement conservation measures to avoid potential take of tidewater goby; thus, take of goby associated with fisheries monitoring activities would be zero or avoided under both scenarios.

Effects on tidewater goby from operations under **Take Alternative G** would differ substantially from the Proposed MSHCP. Diversion of water at Freeman Diversion influences the dynamics of the Santa Clara River estuary compared to a scenario of no water diversion. Based on the Santa Clara River estuary study report (Stillwater Sciences 2016a{ TC "Stillwater Sciences 2016a" \f C \l "1" }), overall, in dry and normal Water Year types, increased river discharge (as analyzed under a no-diversion scenario) would result in increased connectivity between the ocean and the estuary, and a smaller estuary surface area, compared to a scenario of increased diversion (similar to that of the Proposed MSHCP). For the purposes of comparison under the take alternatives, these relative effects could also be expected under **Take Alternative G** compared to the Proposed MSHCP because the facilities would be removed, and the river flow would be unimpeded. The more natural estuary processes described above could result in a net benefit to steelhead due to increased passage opportunities, though decreased estuary size may reduce rearing habitat availability. The net effects of more natural estuary processes on tidewater goby are unknown, though connectivity between the ocean and estuary during the incubation period (summer/fall) and decreased habitat availability could be detrimental in dry and normal Water Years.

Effects on Covered Birds and Western Pond Turtle

Relative to the Proposed MSHCP, **Take Alternative G** would increase take of covered birds and negative effects on pond turtle during construction activities due to a much larger construction and impacts footprint, as well as during operations activities due to reductions in quantity and/or quality of riparian and aquatic habitats (as a result of removal of the grade control structure and water impoundment which provide aquatic pool habitat and maintain downstream riparian areas). Maintenance and operations would result in reduced take of covered birds and pond turtle compared to the Proposed MSHCP. Overall, under **Take Alternative G**, there would be greater take of covered birds and pond turtle compared to the Proposed MSHCP.

Demolition

Negative effects on covered bird species and pond turtle resulting from demolition activities to remove the diversion facility could include disturbance/harm/mortality resulting from vegetation clearing, terrestrial ground disturbance, in-water demolition, rescue and relocation, and dewatering activities. These effects would primarily occur in areas directly upstream and downstream of the current diversion structure. Implementation of BMPs (CM 2.1.1), a dewatering plan, a CRP (CM 2.1.4), and a nesting bird monitoring and avoidance plan (CM 2.1.7), western pond turtle avoidance (CM 2.1.8), and avoiding riparian and aquatic habitats during rainfall events (CM 2.2.2) would minimize the risks of take of covered bird species and negative effects on pond turtle; however, the risks of take associated with demolition could not be eliminated. The demolition footprint and associated impact areas under **Take Alternative G** would be larger than those of the vertical slot under the Proposed MSHCP. Additionally, removal of the grade control and diversion structure would eliminate the water impoundment at the structure which supports a population of pond turtles. Overall, take of covered bird species and negative effects on pond turtle due to demolition activities are anticipated to be higher under **Take Alternative G** compared to that of the take anticipated under construction of the Proposed MSHCP.

Maintenance

Maintenance activities under **Take Alternative G** would differ substantially from those under the Proposed MSHCP. Because the diversion structure would be removed, no maintenance activities would be conducted under **Take Alternative G**. Therefore, there would be no potential for negative effects on covered birds and pond turtle due to maintenance activities; as such, take of covered bird species and negative effects pond turtle due to maintenance would be reduced (i.e., eliminated) under **Take Alternative G** compared to the Proposed MSHCP.

Operations

Riparian Habitat and Aquatic Habitat

As described above in Section 10.5.1 and in Chapter 7, *Effects Analysis*, the Riparian Habitat Study (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }) found that the amount of riparian vegetation in the vicinity of Freeman Diversion increased as a result of Freeman Diversion operations compared to historical conditions, and that operations promote recruitment and development of riparian vegetation in the immediate area. Removal of the diversion structure under **Take Alternative G** would result in decreased riparian vegetation in the immediate vicinity, thereby reducing the quantity and/or quality of riparian habitat for pond turtle and birds and reducing the quality of aquatic habitat for pond turtle (e.g., due to reduced shading). Additionally, and similar to Take Alternatives B and F, after removal of the grade control structure, destabilization of the riverbed would allow degradation upstream affecting well-established riparian habitat that has grown since construction of the Freeman diversion including mitigation areas on The Nature Conservancy's property. The true extent of degradation that would occur under **Take Alternative G** has not been evaluated, though it is expected to be greater than that of Take Alternative B and the same as Take Alternative F. Removal of the structure would also eliminate the water impoundment that also provides aquatic pool habitat for a population of pond turtles.

Covered Birds

The reduction in riparian habitat as a result of removal of the grade control structure and water impoundment would cause take of covered bird species as a result of operations under **Take Alternative G**; therefore, there would be the higher take of covered bird species under **Take Alternative G** and the Proposed MSHCP.

Western Pond Turtle

Operations activities under **Take Alternative G** would differ substantially from those of the Proposed MSHCP. Because the diversion structure would be removed, no diversions would occur under **Take Alternative G**, all water would remain in the river (unimpeded flows), and no passage facility would exist. Under current operations and the Proposed MSHCP, pond turtles could enter the fish passage facility and be negatively affected if they become trapped in the facility, and they could be negatively affected during sediment sluicing, crest gate operations, and monitoring activities, resulting in take of these species, though the potential for injury or mortality is low. There would be no potential for negative effects on covered pond turtle due to facilities operations activities under **Take Alternative G**. However, as described above, removal of the grade control and diversion structure would result in riverbed destabilization and degrade upstream habitats overtime, potentially negatively affecting riparian and aquatic pond turtle habitat in the vicinity. Additionally, removal of the diversion structure would eliminate the water impoundment and downstream seepage pool that provide aquatic pool habitat for a population of pond turtles and the reduction in riparian habitat would result in a loss of quantity and quality habitat for pond turtles. Therefore, overall, there would be more negative effects on covered pond turtle due to operations under **Take Alternative F** compared to the Proposed MSHCP.

Consistency with Goals

Consistencies with goals and criteria of the MSHCP that differ between **Take Alternative G** and the Proposed MSHCP are described below; consistencies that do not differ are not discussed below. Refer to Section 10.4.2, *Consistency with Goals of United and MSHCP*, for the full list of goals and criteria.

Full removal of the facilities would cease water diversion, and United would not be able to attain annual diversion yields. Therefore, **Take Alternative G** would be inconsistent with the following goals to achieve United's mission:

- Goal 1 – Ensure an average annual water diversion yield of 71,800 AF at Freeman Diversion.
- Goal 2 – Provide a minimum of 40 cfs supply of surface water to abate water quality degradation (high nitrates and sea water intrusion) in the Oxnard Plain.

No diversions would occur and all flows in the river would be unimpeded flows. No maintenance activities or operations would occur because all facilities would be removed. Therefore, **Take Alternative G** would have greater consistency with the following goal to achieve United's mission compared to the Proposed MSHCP:

- Goal 4 – Allow United to manage sediment deposition in the desilting basin or other settling basin in a sustainable manner.

Take Alternative G would be inconsistent with the following MSHCP covered species goal:

- Goal 6 – Maximize diversion yield during high flows in order to avoid and minimize impacts on covered fish species while achieving the average annual diversion yield that is needed to meet United's mission and purpose.

Take Alternative G would provide improved migratory fish passage at Freeman Diversion compared to the vertical slot included in the Proposed MSHCP because the diversion would be removed, resulting in no fish passage barrier at the location. Because no fish passage facility would exist, there would be no transitions between fish passage systems. With no diversion structure in place, head cutting would take place upstream of the diversion, resulting in loss of riparian habitat as the river channel was re-configured. Elimination of the water impoundment at the grade control structure would result in reversion of the system toward historical conditions, causing reduction in riparian and aquatic habitats. Because of this, **Take Alternative G** would be less consistent with the following MSHCP covered species goal:

- Goal 7 – Minimize impacts on riparian habitat and other covered species.

Take Alternative G would have greater consistency with the following MSHCP covered species goals compared to the Proposed MSHCP:

- Goal 1 – Improve migration of steelhead through the diversion.
- Goal 2 – Improve migration of steelhead in the Santa Clara River downstream of the Freeman Diversion; specifically, upstream adult migration throughout the primary adult migration period (January 1 through May 31) and downstream juvenile migration throughout the primary smolt migration period (March 15 through May 31).
- Goal 3 – Improve upstream migration of adult steelhead and downstream migration of smolts before and after the primary migration periods (e.g., November, December, and June) when sufficient rainfall could also allow passage in the Santa Clara River downstream of the Freeman Diversion.
- Goal 4 – Promote migration of lamprey through the diversion.
- Goal 5 – Following peak flow of storm events during the primary migration period, provide bypass flows downstream of Freeman Diversion that are intended to minimize alteration of the components

of the hydrograph that support unimpeded migration of adult and juvenile steelhead and lamprey (i.e., timing, frequency, duration, rate-of-change, and magnitude of flows) between the estuary and the Freeman Diversion.

- Goal 8 – Minimize operational complexity including operational transitions between different fish passage systems.
- Goal 9 – Minimize impacts on nesting riparian birds from maintenance activities by ensuring feasibility of conducting annual maintenance in the period between the nesting bird season (March 15 to September 15) and the rainy season (November 1).
- Goal 10 – Do not pose a significant stranding risk to steelhead.

Removal of the diversion, fish passage facility, and associated infrastructure would completely remove the fish passage barrier. All river flow would be an unimpeded hydrograph. Therefore, **Take Alternative G** would be more consistent with the following fish passage facility criteria than the Proposed MSHCP:

- Criterion 1 – Operate in river flows from a range of approximately 45 cfs up to 6,000 cfs.
- Criterion 2 – Minimize passage opportunities for necessary sediment management and other maintenance activities.
- Criterion 4 – Ensure that fish passage entrances and channel forcing/training features are arranged and operated in a way to minimize delay in detecting fish passage entrances by upstream migrating steelhead and lamprey (i.e., minimize nuisance attraction flows) at discharges less than spill flows.
- Criterion 5 – Provide discharge attraction flows of at least 5–10 percent of river discharge at each fish passage location.
- Criterion 6 – Ensure hydraulic conditions meet the needs of all steelhead life stages expected to pass through the facility.
- Criterion 7 – Prevent passage over diversion structure crest and under sluice gates.
- Criterion 8 – Preclude nuisance attraction flows over the prescribed flow range, which can be accomplished by conveying all flows less than 1,200 cfs within the fishway.
- Criterion 9 – Preclude fish passage through partially open gates or weirs.
- Criterion 10 – Ensure fish screens are protective of all life stages of covered aquatic species from impingement and entrainment.
- Criterion 11 – Ensure that project construction be completed within 2 years of permitting, as required by Court Order

Overall, **Take Alternative G** would be more consistent with many of the goals and criteria of the MSHCP than the Proposed MSHCP. However, this alternative would eliminate the underlying lawful activity for which a permit is being sought and thus be inconsistent with United's purposes and prevent accomplishment of the activity for which ITPs are being requested. Therefore, **Take Alternative G** is not considered consistent with the purpose of the activity for which ITPs are requested.

Practicability

As discussed below, **Take Alternative G** is considered logistically practicable but technologically impracticable because it would not provide any options for monitoring upstream steelhead migration within the Santa Clara River. **Take Alternative G** would be financially impracticable, would result in the largest economic impacts of all the alternatives, and would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested. In addition, regional economic impacts would be substantial, particularly to agricultural water users.

Cost

Take Alternative G would eliminate Zone B as separate rate area and most of the agricultural customers, leading to Zone A rates increasing 89 percent as they would bear a much larger share of District costs. (Zone A rates do not increase under the other Alternatives.) Given the significant shrinkage in water users with the loss of Zone B, whether United could continue as a going concern would need further examination under this Alternative. Due to the loss of agricultural operations and with the rate increases in Zone A, the Ventura County economy would lose $149 million in annual economic value and 2,200 jobs.

Logistics

Demolition activities would occur under **Take Alternative G**. Access to existing facilities would remain unchanged and could occur entirely on United's land. Standard construction and dewatering/diversion equipment could be used for demolition. Resources necessary for operation and maintenance would not be needed once the structure was removed. Because no new structure would be constructed, there would be no requirement for additional suitable land. Therefore, **Take Alternative G** would be logistically practicable.

Technology

Under implementation of **Take Alternative G**, the diversion structure would be removed and there would be no above-channel structures; therefore, there would be no risk to damage of the facility due to high debris loads during storm events. Re-grading of the river channel would reduce the 100-year flood line and there would be no safety concerns to United staff or downstream river users/landowners. No maintenance would be required because no facilities would exist. Removal of the diversion and associated structures might require substantial in-water demolition, but it would likely be possible during low-flow or dry season periods, similar to construction activities under the Proposed MSHCP.

The Santa Clara River is challenging for fish monitoring activities due to high storm flows with high suspended sediment. Without a fish passage facility, fish monitoring at anything but low flows would be technologically infeasible due to high flows and high debris loads that would preclude use of trapping methods, and high turbidity that would preclude use of visual monitoring methods. Therefore, **Take Alternative G** is considered technologically impracticable because of inability to monitor for upstream adult migration at anything but low flows.

Other Environmental Consequences

Take Alternative G would have similar impacts as the Proposed MSHCP on air quality, archaeological/ cultural/tribal resources, noise, and transportation/traffic. Eliminated surface water diversions at Freeman Diversion would reduce supplies for groundwater replenishment in the Oxnard Plain, allowing for increased seawater intrusion, which would negatively affect farmland and groundwater quality (see Section 10.4 and Appendix B). Therefore, **Take Alternative G** would result in substantial negative impacts on agricultural resources through increased seawater intrusion into the Oxnard Plain and water quality degradation. United's conjunctive use of groundwater pumping would not alter the analysis of impacts for the current alternative (Appendix D).

Although the environmental consequences of altered geomorphological processes and estuary dynamics would not result in differences in take of covered species directly, these effects are discussed for comparison of **Take Alternative G** with the Proposed MSHCP. Overall, removal of the Freeman Diversion facilities would result in more natural geomorphological processes and estuary dynamics compared to those that would occur under the Proposed MSHCP.

The Freeman Diversion structure affects the geomorphology of the Santa Clara River channel, resulting in incision immediately downstream of the structure and bed aggradation upstream, though the reach was previously altered from historical conditions by long-term instream gravel mining (Stillwater Sciences 2007{ TC "Stillwater Sciences 2007" \f C \l "1" }). Removal of the diversion and grade control structure under **Take Alternative G** would result in head cutting and some short-term and long-term changes in the river character upstream and downstream of the structure in association with the redistribution of trapped sediment. Compared to the Proposed MSHCP, removal of the facilities under **Take Alternative G** would result in significant downcutting, degradation, and recontouring of the channel in the vicinity of the diversion. This channel degradation upstream and aggradation downstream is likely to result in reconfiguration of riparian vegetation throughout the mainstem of the Santa Clara River and loss of riparian cover. Additionally, the impoundment of water behind the grade control and diversion structure has contributed to expansion of riparian habitat in the vicinity of the diversion since its construction compared to historical conditions (Stillwater Sciences 2016b{ TC "Stillwater Sciences 2016b" \f C \l "1" }). Removal of the structure would result in reduction of riparian habitat in the vicinity as the system moves toward historical conditions. Additionally, swallows nest on the current Freeman diversion structure; removal of the structure would reduce the amount of available hard-surfaces for swallow nesting. Therefore, though removal of the structure would return the vicinity to a more natural condition, **Take Alternative G** would result in more impacts on biological resources than the Proposed MSHCP.

Conclusions

Take Alternative G would result in reduced take of covered species and greater overall conservation benefit compared to the Proposed MSHCP, primarily due to the substantial reductions in take associated with full removal of the diversion structure/passage facility and cessation of associated operations; however, this alternative is inconsistent with the goals and purpose of the activity because it would eliminate the underlying lawful activity for which a permit is being sought. This alternative was deemed not practicable, because it would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested.

10.6 SUMMARY AND CONCLUSIONS

This chapter provides an assessment of alternatives to the Proposed MSHCP that may reduce take of the covered fish and wildlife species, and an explanation of why those alternatives were not selected. Seven take alternatives, labeled A through G, were developed to include a range of approaches to advance the MSHCP's overall goal 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." Take alternatives were also evaluated qualitatively against each of the goals of the MSHCP and United's mission. These seven take alternatives vary in terms of the design and capacity of the new water diversion facility, water diversion and release operations, and/or fish passage facility design. The take alternatives were designed to vary in as few ways as possible from the Proposed MSHCP to facilitate comparisons.

The seven take alternatives are evaluated against the following five criteria:

- Does the take alternative reduce take of covered species?
- Does the take alternative increase conservation benefit to covered species?
- Is the take alternative consistent with the goals of United Water Conservation District?
- Is the take alternative practicable in terms of costs, logistics, and technical feasibility?
- Are there additional significant and unavoidable adverse effects on other resources (i.e., besides covered fish and wildlife species and their habitat)?

Details of these criteria are described in Section 10.4, *Methods Used to Evaluate Alternatives to Take*. Summaries of the results of this analysis are presented in Table 10-2, Table 10-5, Table 10-6, Table 10-7, Table 10-8, Table 10-9, and Table 10-10.

Take Assessment. Compared to the Proposed MSHCP, **Take Alternative A** reduces take of covered wildlife species by avoiding construction but does not reduce take of steelhead and lamprey by improving fish passage past the diversion. **Take Alternative B** would have worse fish passage characteristics past the diversion and would increase take of covered wildlife species due to construction and operations compared to the Proposed MSHCP. **Take Alternatives C, D, E, F, and G** result in reduced take of covered fishes through improved fish passage characteristics past the diversion (either through differences in the passage facility design and/or due to enhanced instream flows), though **Take Alternatives C, E, F, and G** would have increased construction-related impacts on all covered species compared to the Proposed MSHCP. **Take Alternatives B, F, and G** would also have large negative effects on riparian and aquatic habitats in the vicinity of the Freeman Diversion due to do widespread degradation and aggradation of the riverbed over time during the operational phase and due to removal of the water impoundment.

Conservation Benefit. **Take Alternative A** would have lower conservation benefit to covered fish species compared to the Proposed MSHCP because it leaves the existing fish passage facility in place. **Take Alternative B** is expected to result in decreased conservation benefit to covered fish species primarily because the fish passage facility would not function as well as that of the Proposed MSHCP; compared to the Proposed MSHCP, the notch operations would result in more passage delays when flow switches must be made between the LFF and HFF. **Take Alternative D** would have more conservation benefit than the Proposed MSHCP; the same fish passage renovations would occur, but additional instream flows would be provided from reduced diversions. **Take Alternatives C, E, F,** and **G** are expected to result in an increased conservation benefit to steelhead and lamprey because they include replacement of the existing fish ladder with a structure, or removal of the structure completely, that would enhance fish passage through the diversion compared to the Proposed MSHCP. **Take Alternatives F** and **G** are likely to have the highest conservation benefit to steelhead and lamprey once demolition or construction is completed because they do not include in-water diversion structures or fish ladders and would offer the best passage characteristics. However, **Take Alternatives B, F, and G** would result in significant impacts to riparian and aquatic habitats because of widespread degradation upstream of the Freeman Diversion location, and aggradation downstream, as a result of modification and/or removal of the grade control structure and water impoundment.

Consistency with MSHCP Goals and United's Mission. **Take Alternatives A**, **B**, **C, D, E, F, and G** are inconsistent with the goals of the MSHCP as well as United's mission. **Take Alternative A** would keep the existing structure, which, even with the operational modifications proposed, would result in more take of covered fish species compared to the Proposed MSHCP and would fail to satisfy a key goal of the MSHCP to improve passage. In addition, proposed operational modifications for **Take Alternatives D** and **E** would substantially affect United's ability to achieve its mission due to greatly reduced water diversions that would prevent attainment of the target annual average diversion yield. **Take Alternative B** is inconsistent with United's mission because the proposed structure is unable to divert at high flows or reach the target annual diversion yield. **Take Alternatives C, D, E,** and **F** are generally consistent with the goals of the MSHCP but vary with regard to achieving United's mission. **Take Alternatives C, E,** and **F** are inconsistent with United's mission because the footprint of the project would extend beyond United's current property line and require that United acquire additional land that United currently does not own or cannot feasibly acquire. Finally, **Take Alternative G** would prevent United from completing its mission by preventing water diversion of any kind.

Practicability. **Take Alternative A** is practicable based on the logistics and technology but was deemed impracticable because it would not be feasible for United to implement due to regional economic impacts. **Take Alternative B** is impracticable due to logistics and technology issues surrounding the use of Obermeyer gates in the configuration specified; the gates and ramp may not be durable enough to be maintained over the project duration and, if repairs are needed, may not be repairable in a timely manner. **Take Alternative C** and **E** are technologically and logistically infeasible due to uncertainty regarding the durability of the hardened ramp structure and the ability to repair it in a timely manner, inadequacy of upstream adult migration monitoring opportunities, and lack of land rights. **Take Alternative F** is technologically and logistically infeasible because of issues associated with availability of resources, land rights, maintenance uncertainties associated with operation of an infiltration gallery in a high-sediment load environment, repairability, lack of monitoring opportunities, and general constructability (no current operational examples exist of a gallery of that size). Finally, **Take Alternative G** is logistically and technologically practicable for most elements;

however, it would eliminate all ability to divert water and would, therefore, be financially and economically impracticable. Due to greatly reduced diversions and/or inability to divert water at high flows, **Take Alternatives A, B, D, E, and G** would prevent accomplishment of the purpose of the underlying activity for which ITPs are being requested.

Other Environmental Consequences. All of the take alternatives have at least one significant and unavoidable adverse effect on other environmental resources compared to the Proposed MSHCP. For example, **Take Alternatives A**, **B**, **D**, **E**, and **G** would have substantial adverse effects on groundwater quality of the Oxnard Plain due to seawater intrusion because of reduced or eliminated average annual diversion yield. Seawater intrusion would reduce or eliminate the economic viability of most farming efforts in the surrounding area. **Take Alternatives C, E** and **F** would have substantial additional adverse effects on air quality, greenhouse gas emissions, and riparian habitats due to greater construction requirements. **Take Alternatives F and G** would have substantial negative effects on non-covered species due to greater impacts on riparian and aquatic habitats from degradation upstream of the Freeman Diversion location, and aggradation downstream, as a result of removal of the grade control structure and water impoundment.

Conclusions. Some of the alternatives would reduce take of covered species and/or increase conservation benefit compared to the MSHCP. However, all seven take alternatives would be impracticable due to technological, logistical, and/or financial and economic constraints. Each of the seven alternatives would have at least one significant and unavoidable adverse effect on other environmental resources. Additionally, the seven alternatives would be inconsistent with goals of the MSHCP and with United's mission.

10.7 LITERATURE CITED

AECOM, Alden Research Laboratory, Inc., and R2 Resources Consultants, Inc. 2016{ TC "AECOM et al. 2016" \f C \l "1" }. Draft Freeman Diversion Fish Passage Hardened Ramp Design: 60% Hydraulic Basis of Design Report. June.

AECOM. 2016. Freeman Diversion Facilities Invasive Species Control Options Assessment and Engineering Feasibility Study, AECOM Project No. 60445564, Prepared for United, September 27, 2016.

Alliance for Water Efficiency. 2015. *Water Conservation Tracking Tool Version 3.0 User Guide*. September. Available with subscription online: https://www.allianceforwaterefficiency.org/resources/topic/water-conservation-tracking-tool.

California Department of Fish and Wildlife (CDFW). 2009. California Salmonid Stream Habitat Restoration Manual, Vol. II, Part XII: Fish Passage Design and Implementation. July 2009.

———. 2020a. Letter from Ed Pert, California Department of Fish and Wildlife, to Mauricio Guardado, United Water Conservation District. Re: United Water District, Vern Freeman Diversion Habitat Conservation Plan/Fish Passage, Ventura, California. Dated March 18, 2020

———. 2020b. Email from Ed Pert, California Department of Fish and Wildlife, to Mauricio Guardado, United Water Conservation District, transmitting word document "CDFW comments on hardened ramp work plan". Sent March 18, 2020.

California Trout v. Bureau of Reclamation, et al., Case No. CV09-0312 GHK-FMOx, C.D. Cal. Dkt. No. 113, August. (2009 Settlement)

California Natural Resources Agency. 2016. *2016 Statewide Crop Mapping*. Available online: https://data.cnra.ca.gov/dataset/statewide-crop-mapping; accessed April 2020.

California Water Service Company. 2015. 2015 Conservation Master Plan. Available online: https://www.calwater.com/conservation/uwmp/.

Cooley, H. and R. Phurisamban. 2016. The Cost of Alternative Water Supply and Efficiency Options in California. Pacific Institute; Oakland, California. October. Available online: https://pacinst.org/wp-content/uploads/2016/10/PI_TheCostofAlternativeWaterSupplyEfficiencyOptionsinCA.pdf.

Department of Water Resources (DWR). 2019. *Management of the California State Water Project Bulletin*: 132-17. January. Available online: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/State-Water-Project/Management/Bulletin-132/Bulletin-132/Files/Bulletin-132-17-r.pdf?la=en&hash=ED141F1E77778255A08BCE4EF20BE94D31007ED0.

Fox Canyon Groundwater Management Agency (FCGMA). 2019. *Groundwater Sustainability Plans*. November 27, 2019. Available online: http://www.fcgma.org/groundwater-sustainability-plan.

Kramer, S. 2017. *Errata Expert Report of Sharon Kramer*. Wishtoyo Foundation, et al., v. United Water Conservation District. Case No. 2:16-cv-03869-DOC-PLA. July 16.

McEachron, M. 2007. Hydrologist, United Water Conservation District. Personal communication on November 21, 2007.

McEachron, M. 2020. Hydrologist, United Water Conservation District. Personal communication on March 12, 2020.

Metropolitan Water District of Southern California (MWDSC). 2017. *Rate Structure Administrative Procedures Handbook FY2017/18*. Available online: http://mwdh2o.com/rsap/rate_admin_proc.pdf.

———. 2020. Metropolitan Water District of Southern California. Website: http://mwdh2o.com/WhoWeAre/Management/Financial-Information; accessed February 2020.

Municipal Water District of Orange County (MWDOC). 2014. *Water Use Efficiency Master Plan*. Presentation presented at the 2014 Water Smart Innovations Conference. Available online: https://ceregportal.com/wsi/documents/sessions/2014/2014-W-1432.pdf.

National Marine Fisheries Service (NMFS). 1997. Southwest Region, *Fish Screening Criteria for Anadromous Salmonids*. January 1997

———. 2008. *Final Biological Opinion*. Agency: U.S. Bureau of Reclamation, Sacramento, California. Action: Approve United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility. Consultation conducted by: National Marine Fisheries Service, Southwest Region. Date issued: July 23, 2008. Administrative Record File #: 151422SWR01PR6149.

———. 2011. *Northwest Region, Anadromous Salmonid Passage Facility Design.* NMFS, Northwest Region, Portland, Oregon. July 2011. Available online: http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_design_criteria.pdf. Accessed August 2018.

———. 2019a. Letter from Alecia Van Atta, National Marine Fisheries Service, to Mauricio Guardado, United Water Conservation District. Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Notch Fish Passage Improvements dated June 21, 2019. Sent July 19, 2019.

———. 2019b. Letter from Alecia Van Atta, National Marine Fisheries Service, to Mauricio Guardado, United Water Conservation District. Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Hardened Ramp Fish Passage Improvements dated August 21, 2019. Sent August 21, 2019.

———. 2019c. Letter from Alecia Van Atta, National Marine Fisheries Service, to Mauricio Guardado, United Water Conservation District. Re: Review of Draft Hydraulic Basis of Design Report for Vern Freeman Diversion Dam Vertical Slot Fish Passage Improvements dated August 15, 2019. Sent September 16, 2019.

———. 2019d. Letter from Alecia Van Atta, National Marine Fisheries Service, to Mauricio Guardado, United Water Conservation District. Re: Summary of NOAA's National Marine Fisheries Service's (NMFS) Review and Recommendation for Three Fish Passage Facility Design Alternatives for Vern Freeman Diversion Dam. Sent September 26, 2019.

Northwest Hydraulic Consultants Inc. (NHC). 2016. *Evaluation of Vern Freeman Diversion Dam Modification Alternatives – Detailed Feasibility Examination*. Final Report. Prepared for United Water Conservation District. October 7.

———. 2019a. Vern Freeman Diversion Dam Notch Fish Passage Improvements – Draft Hydraulic Basis of Design Report. Prepared for United Water Conservation District; Santa Paula, California. June 21.

———. 2019b. Vern Freeman Diversion Hardened Ramp Fish Passage Improvements – Hydraulic Basis of Design Draft Report. Prepared for United Water Conservation District; Santa Paula, California. July 21.

R2 Resource Consultants. 2016. *Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey*. Prepared by R2 Resource Consultants for United Water Conservation District. September.

Stantec Consulting Services Inc. (Stantec). 2019. *Vern Freeman Dam Vertical Slot Fish Ladder – Hydraulic Basis of Design Report*. Prepared for United Water Conservation District. December 6.

Stillwater Sciences. 2007. Santa Clara River Parkway Floodplain Restoration Feasibility Study: Assessment of Geomorphic Processes for the Santa Clara River Watershed, Ventura and Los Angeles counties, California. Prepared for the California Coastal Conservancy. August.

———. 2016a. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Habitat Conditions in the Santa Clara River Estuary. September.

———. 2016b. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Riparian Conditions in the Santa Clara River.

———. 2019. Technical Memorandum: Assessment of Potential Effects to Biological Resources Upstream and Downstream of Freeman Diversion from the Proposed Dam Notch Fish Passage Improvements, Revised Draft. Prepared for United Water Conservation District. August 31.

United Water Conservation District (United). 2016. *Forecasted Water Resource Impacts from Changes In Operation of Freeman Diversion*. Open-File Report 2016-03. October.

———. 2019. FY2019-20 Adopted Budget. June 19.

———. 2020. Letter from Mauricio Guardado, United Water Conservation District, to Alecia Van Atta, National Marine Fisheries Service. Re: Request for NMFS support for focusing efforts and resources on one fish passage alternative for the Habitat Conservation Plan. Sent January 16, 2020.

United States Department of Agriculture (USDA). 2020. *The Fox Canyon Water Market: A Market-Based Tool for Groundwater Conservation Goes Live*. May 11. Available online: https://www.usda.gov/media/blog/2020/05/08/fox-canyon-water-market-market-based-tool-groundwater-conservation-goes-live.

United States Fish and Wildlife Service and National Marine Fisheries Service. 2016. *Habitat Conservation Planning and Incidental Take Permit Processing Handbook*. December 21.

University of California Davis (UCD). Various Years. "Current Cost and Return Studies," various crops. Available online: https://coststudies.ucdavis.edu/en/current/; accessed April 2020.

Ventura County Office of the Agricultural Commissioner. 2019. *2018 Crop and Livestock Report*. Available online: https://vcportal.ventura.org/AgComm/docs/crop-reports/Ag%20Comm%202018%20Crop%20Report%2008-02-19%20web.pdf

Vern Freeman Dam Fish Passage Panel (VFDFPP). 2010. *Vern Freeman Dam Fish Passage Conceptual Design Report*. Final Report prepared for United Water Conservation District. 264 pp.

Appendix A.

Assessment of Covered Species

Freeman Diversion
Multiple Species Habitat Conservation Plan

Prepared by:

United Water
CONSERVATION DISTRICT

"Conserving Water Since 1927"

June 2020

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1 INTRODUCTION

United Water Conservation District (United) is applying for incidental take permits (ITPs) under Section 10(a)(1)(B) of the Endangered Species Act (ESA) and 2081(b) and (c) of the California Endangered Species Act (CESA) for the rehabilitation and expansion of the Freeman Diversion facility and ongoing operations and maintenance of the facility. An initial screening assessment of covered activities and covered species was completed in 2010 to identify potential activities and candidate species for a Multiple Species Habitat Conservation Plan (MSHCP) and associated ITP application package (United and ENTRIX 2010). The covered activities and covered species screening assessment was updated in 2011 (United and Cardno ENTRIX 2011) and 2015 (United et al. 2015), and again in 2016. The most recent update was based on a search of the 2016 California Natural Diversity Database (CNDDB), following refinements in the engineering design and continued consultation with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and California Department of Fish and Wildlife (CDFW) to develop a final list of covered species for the MSHCP. Since the initial screening assessment and screening assessment updates were completed, changes to covered activities and plan and permit areas have occurred; further scientific assessments and biological surveys have been completed; and additional consultation with the resources agencies has occurred. This document represents the most recent update to the species screening assessment, accounting for the proposed project design and the most up to date survey data and status designations of species potentially impacted by the covered activities that are already listed or have a reasonable likelihood of listing during the permit term.

United used the current screening assessment, which takes into account the initial screening assessment and subsequent updates, as a tool throughout the planning, design, and consultation process associated with the MSHCP. Evaluation of covered activities, their location, and their potential for effects to species provided a reasoned and founded process for the selection of covered species. The covered activities under the MSHCP include renovations of the fish passage facility and the Freeman Diversion infrastructure, water diversion operations, facility and property maintenance, habitat restoration and mitigation, monitoring, and adaptive management measures. This appendix provides a synthesis of the evaluation and covered species selection process carried out by United in the development of the MSHCP for the determination of the need for “take” coverage.

The assessment initially developed a list of species based on available existing information on their status, habitat, and distribution in the vicinity of the MSHCP plan area. The overlap of species habitat with the plan area was determined and quantified using a geographic information system (GIS) platform. An initial assessment of effect was then made based on distribution of habitat in the plan area. Each species was then evaluated according to two set of criteria to designate the species as covered species. The identified covered species represent species that are currently listed as threatened or endangered under the state and/or federal ESA for which there is reasonable potential for incidental take from at least one covered activity or species that have a high probability of becoming listed during the permit term and for which incidental take is reasonably certain to occur. Seven covered species (Table 1) out of 121 species (71 wildlife and 50 plants) were identified.

Tidewater goby remains under evaluation as a covered species. Based on effects analyses to date, United and USFWS consider there to be no reasonable potential for take to this species based on any of the current proposed covered activities, conservation measures, or monitoring measures. However, United is in the process of conducting a mitigation working group and there is potential that the group will identify mitigation projects in or around the Santa Clara River estuary. Also, there is potential for monitoring measures in the estuary. Therefore, tidewater goby was retained in this draft for discussion with the agencies pending mitigation and monitoring decisions. If no mitigation or monitoring in the estuary is ultimately proposed, then tidewater goby will not be included as a covered species in the final MSHCP.

Table 1 MSHCP Covered Species			
Species	Federal Status	State Status	Critical Habitat Designated
Fish			
Pacific lamprey (*Entosphenus tridentatus*)	None	SSC	No
Southern California steelhead (*Oncorhynchus mykiss*)	E	None	Yes
Tidewater goby (*Eucyclogobius newberryi*)	E	None	Yes
Reptiles			
Western pond turtle (*Actinemys marmorata*)	None	SSC	No
Birds			
Least Bell's vireo (*Vireo bellii pusillus*)	E	E	Yes
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	E	Yes
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	T	E	No
E = endangered, T = threatened, SSC = California Species of Special Concern			

2 BACKGROUND

2.1 REGULATORY CONTEXT

Covered species in this MSHCP are those species that United is requesting coverage under an ITP issued under the ESA and, for a few of the species, CESA. Under the ESA, NMFS and USFWS provide assurances under the "No Surprises" policy for species not currently listed, but that have the potential to become listed in the life of the HCP. CESA does not include "no surprises" assurances, therefore CDFW can only issue an ITP for currently listed species. The *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* provides the following recommendation for selecting covered species:

> *The Services require applicants to include as HCP covered species all ESA-listed wildlife species for which incidental take is reasonably certain to occur, unless take is addressed through a separate ESA mechanism (e.g., Section 7 consultation with another Federal agency, separate incidental take permit, etc.), or to explain or demonstrate in the HCP why take is not anticipated or will be avoided during implementation of covered activities (e.g., inclusion of measures that will avoid potential for take) (USFWS and NMFS 2016).*

The HCP Handbook also suggests:

> *Species that may be ESA-listed during the permit term and are expected to be taken from proposed activities should be considered for inclusion as a covered species. Common species, or species that have very low likelihood of becoming ESA-listed, should not be covered by the HCP because every species included involves commitments of time and money by both the applicant and the Services.*

United has considered this guidance, but, given a history of third party litigation in the watershed, United has implemented a more conservative set of criteria to identify seven types of species, subspecies, or distinct population segments for coverage. Despite the differing levels of taxonomic classification, all entities considered for ITP coverage are described as "species" in this document to ease communication. Four are federally endanged (southern California steelhead, tidewater goby, least Bell's vireo, and southwestern willow flycatcher), one is federally threatened (western yellow-billed cuckoo), and two have no current federal status (Pacific lamprey and western pond turtle). It is feasible that Pacific lamprey and western pond turtle could become listed during the permit term and incidental take is reasonably certain to occur once listed given the covered activities, therefore United is seeking to conserve these species and is interested in the associated no surprises assurances through an MSHCP agreement. Three of the covered species are listed as endangered by the state of California (least Bell's vireo, southwestern willow flycatcher, and western yellow-billed cuckoo) and four are California state species of special concern (southern California steelhead, Pacific lamprey, tidewater goby, and western pond turtle).

Three of the identified species have designated critical habitat in the permit area: Southern California steelhead, southwestern willow flycatcher, and tidewater goby. A small portion of least Bell's vireo critical habitat falls in the plan area at the extreme eastern edge of the conservation focused permit area (see Chapter 4 for more detail).

2.2 PRIOR SCREENING ASSESSMENT OF COVERED ACTIVITIES AND COVERED SPECIES

The Screening Assessment of Covered Activities and Covered Species (screening assessment) developed by United in 2010 and updated in 2011, 2015, and 2016, was a tool used to inform the selection of covered activities and covered species during the planning and consultation process. The screening assessment included an overview of United's activities carried out across the service area, the potential effects of those activities, whether those activities already had incidental take coverage through Section 7, and a preliminary determination of the need for "take" coverage for those activities. Subsequently, the screening assessment included a list of covered species based on available existing information on their status, habitat, and distribution in the vicinity of all United activities. The overlap of species habitat with the disturbance area for United's activities was determined and quantified using a GIS platform. An initial assessment of effect was then made based on distribution of habitat in the analysis area. The results of the screening assessment included a preliminary list of covered activities and covered species; however, as noted in the screening assessment, the final list of covered activities and covered species, as well as additional explanation on the decision process, would be included in the MSHCP (United et al. 2015).

3 METHODS

Evaluation of species inclusion under the MSHCP initially involved database research on known species occurrences and designated critical habitat within and in the vicinity of the permit area. Following the database research, an assessment of each species was conducted in the context of the MSHCP covered activities to determine if the species is likely to occur in or near the permit area and if "take" is "reasonably certain to occur" or has the potential to occur with or without the implementation of the conservation measures. Throughout this evaluation process, on-going consultation with USFWS, NMFS, and CDFW has informed the selection process of the MSHCP covered species.

3.1 LITERATURE REVIEW AND DATABASE QUERIES

To determine the list of special-status species considered for potential inclusion in the MSHCP, United queried relevant databases of species occurrence records and designated critical habitat. For the purposes of this evaluation, United queried the following datasets as part of the review process:

- California Natural Diversity Database (CNDDB) point and polygon datasets (CDFG 2019),
- USFWS Information for Planning and Consultation (IPaC) (USFWS 2020),
- USFWS critical habitat datasets (USFWS 2019),
- United boundary dataset (United 2009a) and facilities shapefile (United 2009b), and
- Santa Clara River watershed, obtained from the Calwater v 2.2.1 dataset (Calwater 1999).

A literature review was previously completed for the prior screening assessment (United et al. 2015) and the review contained herein includes those species originally evaluated with updates to their status under the ESA and CESA, if applicable, as well as any additional species captured in the current database queries or updated observations by United staff. The spatial scale of the database queries was expanded to encompass species data available within Ventura County. However, species documented in the database queries that are within Ventura County but have no evidence of occurrence anywhere near the plan area (e.g. blunt-nosed leopard lizard) were excluded from the evaluation.

3.2 AGENCY CONSULTATION

Factors considered in evaluating whether or not a particular activity should be included in the ITP included whether the activity is ongoing, proposed, or expected to occur during the term of the permit; if the activity has a federal nexus; and the relative potential for "take" from the activity. Throughout the consultation process beginning in 2008 and continuing into 2020, United has been in regular coordination with NMFS, USFWS, and CDFW regarding the activities and species that have been considered for coverage. As the applicant, United is responsible for determining whether a particular activity or species should be included in the MSHCP; however, this close coordination has resulted in a refined list of activities and species proposed for coverage explained in more detail in Chapters 3 and 4 respectively.

3.3 CRITERIA FOR POTENTIAL TO EFFECT DETERMINATION

Assessments for the potential effects to special status species are based upon criteria including known ranges, habitat preferences for the species, habitat available within the permit area, species occurrence records from the CNDDB, species occurrence records from other sites in the vicinity of the permit area, previous reports for the permit area, and the results of surveys conducted in association with the Freeman Diversion and general United activities as well as incidental observations by United staff and contractors during United activities. The potential for effects to special status species to occur as a result of covered activities during the permit term were evaluated against the criteria above as well as the species current and projected future listing status under the ESA in support of a determination of whether to include a given species as a covered species under the MSHCP and ITP.

United assessed the likelihood of occurrence for each species based on the following criteria:

- **Not Expected.** Habitat on and adjacent to the site is clearly unsuitable for the species requirements (foraging, breeding, cover, substrate, elevation, hydrology, plant community, site history, disturbance regime), or the species would have been identified on-site if present (e.g., plant species). No known incidental observations of the species or observations following focused or protocol surveys in the permit area.
- **Low.** Few of the habitat components meeting the species requirements are present, and/or the majority of habitat on and adjacent to the site is unsuitable or of very poor quality. No known observations of the species in the permit area.
- **Moderate**. Some of the habitat components meeting the species requirements are present, and/or only some of the habitat on or adjacent to the site is unsuitable. The species has a moderate probability of being found on the site. Historic observation of the species within or in the vicinity of the permit area.
- **High.** All the habitat components meeting the species requirements are present and/or most of the habitat on or adjacent to the site is highly suitable. Recent observations of the species within or in the vicinity of the permit area.

For species with moderate to high potential to occur in the permit area, United then assessed each species behavior and natural history in the context of United's covered activities in the permit area and made a determination as to whether or not incidental take was "reasonably certain to occur" or if there was reasonable potential for take. Species were designated "covered species" under one of the following set of criteria:

1.) The species has moderate to high potential to occur, is not currently listed but could be during the permit term, and incidental take is reasonably certain to occur during covered activities.

2.) The species has moderate to high potential to occur, is listed as threatened or endangered at the state or federal level, there is a reasonable potential for take to occur during covered activities.

4 RESULTS

4.1 SPECIES CONSIDERED FOR COVERAGE UNDER THE MSHCP

Table 2 below provides an overview of the species considered for coverage under the MSHCP and inclusion in the ITP. This table has been adapted from the screening assessment (United et al. 2015) and updated to reflect the results of the current literature review, database queries, and assessment.

Table 2 Designation of Species Assessed under the MSHCP

Scientific Name/ Common Name	Status	Reasonable Potential for Take from at Least One Covered Activity	Covered Species (yes/no)	Notes
Fishes				
Catostomus santaanae (Santa Ana sucker)	ESA threatened (but not in Santa Clara River), California species of special concern; not likely to be listed during the permit term	Yes	No	Historically, the range of Santa Ana suckers was assumed to be restricted to the Los Angeles Basin and with introductions in the Santa Clara River. However, recent genetics (Richmond et al. 2016) suggests they may in fact be native to the Santa Clara River. However, the ESA listing includes only drainages in the Los Angeles Basin and USFWS has communicated that the Santa Clara River population is healthy and not likely to become listed (C. Dellith, pers. Comm.).
Eucyclogobius newberryi (tidewater goby)	ESA endangered, California species of special concern	[TBD]	[TBD]	Species occurs in the estuary and lower portions of the Santa Clara River. United's estuary effects analysis suggests proposed operations are not reasonably certain to cause take (Stillwater 2016). Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP. [REVISIT FOLLOWING MITIGATION WORKING GROUP PROCESS]
Gasterosteus aculeatus williamsoni (unarmored-threespine stickleback)	ESA endangered, California endangered and fully protected	No	No	Species occurs in the channel of the Santa Clara River and some tributaries in Los Angeles County. Further genetic studies are necessary to determine if stickleback in Piru and Santa Clara River system are the unarmored species. The species is not considered to be at risk as a result of operation and maintenance activities associated with the Freeman Diversion facility during the permit term.
Gila orcuttii (arroyo chub)	California species of special concern, USFS sensitive	Yes	No	Species occurs in the channel of the Santa Clara River and some tributaries; while native to the southern California region, arroyo chub have historically been considered introduced into the Santa Clara River watershed (CDFW 2015)." This species would be affected by flow-related activities; however, sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW during the permit term.
Entosphenus tridentatus (Pacific lamprey)	No ESA, state, or sensitive status; reasonable probability of listing during permit term	Yes	Yes	Species occurs in the channel of the Santa Clara River and some tributaries. This species would be affected by flow-related activities and presence of barriers and is an anadromous species that is vulnerable to passage barriers. Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP.
Oncorhynchus mykiss (southern California steelhead)	ESA endangered, California species of special concern	Yes	Yes	Species occurs in the channel of the Santa Clara River and some tributaries. This species would be affected by flow-related activities and presence of barriers. Sufficient information is known and adequate to define measures to support an application for a Section 10(a)(1)(B) ITP.
Amphibians				
Anaxyrus californicus (arroyo toad)	ESA endangered, California species of special concern	No	No	Species occurs in riparian areas below Castaic, Pyramid, and Bouquet Reservoirs. The species is not considered to be at risk of take as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Rana draytonii (California red-legged frog)	ESA threatened, California species of special concern	No	No	Species has not been documented in the permit area. The species is not considered to be at risk of take as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Rana boylii (foothill yellow-legged frog)	California species of special concern, USFS sensitive species; likely to be listed during the permit term	No	No	Species historically occurred in riparian areas below Pyramid Lake. The species is not considered to be at risk of take as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Spea hammondii (western spadefoot)	California species of special concern; unlikely to be listed during the permit term	No	No	Species has not been documented in the permit area. Sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Taricha torosa (coast range newt)	California species of special concern; unlikely to be listed during the permit term	No	No	Terrestrial individuals are relatively inactive in subterranean refuges most of the year. Migrations to and from breeding areas usually occur at night during, or just following, rains. Sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Birds				
Accipiter ccoperii (Cooper's hawk)	California watchlist	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Agelaius tricolor (tricolored blackbird)	California threatened	No	No	Species occurs in emergent marsh habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Aimophila ruficeps canescens (southern California rufous-crowned sparrow)	California watchlist	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Ammodramus savannarum (grasshopper sparrow)	California species of special concern	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Aquila chrysaetos (golden eagle)	California fully protected, watch list	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Athene cunicularia (burrowing owl)	California species of special concern	No	No	Species occurs in upland habitats and has been observed sheltering and foraging near the recharge basins. Nesting has not been observed in the permit area and the species is considered to be at low risk as a result of covered activities associated with the Freeman Diversion facility during the permit term.
Buteo regalis (ferruginous hawk)	California watchlist	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Charadrius alexandrinus nivosus (western snowy plover)	ESA threatened, California species of special concern	No	No	Species occurs in beach and marsh habitats, which would not be noticeably affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Complete nest avoidance measures were added to CM 2.1.7 in Chapter 5.
Coccyzus americanus occidentalis (western yellow-billed cuckoo)	ESA threatened, California endangered, USFS sensitive species	Yes	Yes	Species occurs in riparian scrub and forest habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP.
Elanus leucurus (white-tailed kite)	California fully protected	No	No	Species occurs in upland habitats, which would not be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.

Table 2 Designation of Species Assessed under the MSHCP

Scientific Name/ Common Name	Status	Reasonable Potential for Take from at Least One Covered Activity	Covered Species (yes/no)	Notes
Empidonax traillii extimus (southwestern willow flycatcher)	ESA endangered, California endangered	Yes	Yes	Species occurs in riparian scrub and forest habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP.
Eremophila alpestris actia (California horned lark)	California watchlist	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Falco mexicanus (prairie falcon)	California watchlist	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Falco peregrinus anatum (American peregrine falcon)	ESA delisted, California delisted, California fully protected	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Gymnogyps californianus (California condor)	ESA endangered, California endangered/fully protected	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Icteria virens (yellow-breasted chat)	California species of special concern	Yes	No	Species occurs in riparian scrub and forest habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Passerculus sandwichensis beldingi (Belding's savannah sparrow)	California endangered	No	No	Species occurs in saltmarsh habitats, which would not be noticeably affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Pelecanus occidentalis californicus (California brown pelican)	ESA delisted, California delisted\fully protected	No	No	Species occurs in beach and marsh habitats, which would not be noticeably affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Phalacrocorax auratus (double-crested cormorant)	California watchlist	No	No	Species occurs in beach and marsh habitats, which would not be noticeably affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Polioptila californica californica (coastal California gnatcatcher)	ESA threatened, California species of concern	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Rallus longirostris levipes (light-footed Ridgway's rail)	ESA endangered, California endangered/fully protected	No	No	Species occurs in beach and marsh habitats, which would not be noticeably affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Riparia riparia (bank swallow)	California threatened	No	No	Species occurs along rivers, which have the potential to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. However, no nesting habitat is present within the vicinity of the Freeman Diversion facility and the species is considered to be at low risk as a result of construction, operation and maintenance activities associated with the Freeman Diversion facility during the permit term.
Setophaga petechia (yellow warbler)	California species of special concern	Yes	No	Species occurs in riparian scrub and forest habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Sternula antillarum browni (California least tern)	ESA endangered, California endangered/fully protected	No	No	Species occurs in beach and marsh habitats, which would not be significantly affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. This species has been observed a few times foraging in the vicinity of the Oxnard Plain recharge facilities, but has not been observed near the Freeman Diversion or in the vicinity of the recharge basins in the last 7 years during protocol surveys and no impacts are expected as a result of proposed operation and maintenance activities associated with the Freeman Diversion facility during the permit term. Complete avoidance of nests during covered fish relocation and monitoring activities is addressed in CM 2.1.7 in Chapter 5.
Vireo bellii pusillus (least Bell's vireo)	ESA endangered, California endangered	Yes	Yes	Species occurs in riparian scrub and forest habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP.
Mammals				
Antrozous pallidus (pallid bat)	California species of special concern, USFS sensitive	No	No	The species is most common in open, dry habitats with rocky areas for roosting. Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Choeronycteris mexicana (Mexican long-tongued bat	California species of special concern	No	No	Species roosts in caves, mines and buildings. Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Corynorhinus townsendii (Townsend's big-eared bat)	California species of special concern, USFS sensitive	No	No	Species is known primarily from mesic habitats throughout California, which have the potential to be affected by United activities. Roosts in caves, mines, tunnels, buildings or other human-made structures. No roosting habitat within the area encompassing covered activities. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Euderma maculatum (spotted bat)	California species of special concern	No	No	Species occurs in some riparian habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Eumops perotis californicus (western mastiff bat)	California species of special concern	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Lepus californicus bennettii (San Diego black-tailed jackrabbit)	California species of special concern	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Microtus californicus stephensi (south coast marsh vole)	California species of special concern	No	No	Species occurs in some riparian and upland habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Neotamias speciosus callipeplus (Mount Pinos chipmunk)	USFS sensitive species	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.

Table 2 Designation of Species Assessed under the MSHCP

Scientific Name/ Common Name	Status	Reasonable Potential for Take from at Least One Covered Activity	Covered Species (yes/no)	Notes
Neotoma lepida intermedia (San Diego desert woodrat)	California species of special concern	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Onychomys torridus ramona (southern grasshopper mouse)	California species of special concern	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Perognathus alticola inexpectatus (Tehachapi pocket mouse)	California species of special concern, USFS sensitive species	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Perognathus inornatus inornatus (San Joaquin pocket mouse)	California species of special concern, USFS sensitive species	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Sorex ornatus salicornicus (southern California saltmarsh shrew)	California species of special concern	No	No	Species occurs in riparian and salt marsh habitats, which have the potential to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Taxidea taxus (American badger)	California species of special concern	No	No	Species occurs in upland habitats, which would unlikely be affected by United activities. The species also occurs in the Oxnard Plain recharge facilities and is considered to be at low risk as a result of operation and maintenance activities associated with the Freeman Diversion facility during the permit term. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Reptiles				
Actinemys marmorata (western pond turtle)	California species of special concern, USFS sensitive species; high probability of listing during permit term	Yes	Yes	Species occurs in riparian habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known, and adequate existing management prescriptions can be defined and implemented sufficiently to support an application for a Section 10(a)(1)(B) ITP.
Anniella [pulchra/ stebbinsi] (legless lizard)	California species of special concern, USFS sensitive species	No	No	Species occurs in some riparian, upland, and beach habitats, which have the potential to be affected by United activities. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Phrynosoma blainvillii (coast [San Diego] horned lizard)	California species of special concern, USFS sensitive species	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Thamnophis hammondii (two-striped garter snake)	California species of special concern, USFS sensitive species	No	No	Species has two known occurrences in the vicinity of the Freeman Diversion facility and occurs in riparian habitats, which will likely be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP. Sufficient information is known regarding the species and it is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Thamnophis sirtalis ssp. (south coast garter snake)	California species of special concern	No	No	Species occurs in riparian habitats, which have the potential to be affected by United activities. Species is not expected to be listed as endangered or threatened by the USFWS or CDFW.
Invertebrates				
Bombus crotchii (Crotch bumble bee)	California candidate endangered[1]	No	No	In California, inhabits open grassland and scrub habitats, primarily nesting underground, often in rodent burrows. These upland habitats are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Branchinecta conservatio (Conservancy fairy shrimp)	ESA endangered	No	No	Occurs in vernal pools in the Los Padres National Forest. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Branchinecta lynchi (vernal pool fairy shrimp)	ESA threatened	No	No	Occurs in vernal pools in the Santa Clara River watershed. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Streptocephalus woottoni (Riverside fairy shrimp)	ESA endangered	No	No	Occurs in vernal pools in Riverside, Orange, and San Diego Counties. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Plants				
Acanthoscyphus parishii var. *abramsii* (Abrams' oxytheca)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Allium howellii var. *clokeyi* (Mt. Pinos onion)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Arctostaphylos glandulosa ssp. *gabrielensis* (San Gabriel manzanita)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Astragalus brauntonii (Braunton's milk-vetch)	ESA endangered, CRPR 1B	No	No	Species occurs in upland habitats including coastal scrub, grassland, and chaparral. Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Astragalus didymocarpus var. milesianus (Miles' milk-vetch)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.

[1] Species designated as candidate for listing are temporarily afforded the same protections as a state-listed endangered or threatened species. Following completion of a species status report, the California Fish and Game Commission must decide whether the petitioned action is warranted. If the Commission finds that the petitioned action is not warranted, the process ends, and the species will be removed from the list of candidate species. If the Commission finds that the petitioned action is warranted, the species will be added to the list of threatened or endangered species (CDFW 2020)

Table 2 Designation of Species Assessed under the MSHCP

Scientific Name/ Common Name	Status	Reasonable Potential for Take from at Least One Covered Activity	Covered Species (yes/no)	Notes
Astragalus leucolobus (Big Bear Valley woollypod)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Astragalus pycnostachyus var. *lanosissimus* (Ventura Marsh milk-vetch)	ESA endangered, California endangered, CRPR 1B	No	No	Species occurs in beach and marsh habitats. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Astragalus traskiae (Trask's milk-vetch)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Atriplex coulteri (Coulter's saltbush)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Atriplex pacifica (south coast saltscale)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Atriplex serenana var. davidsonii (Davidson's saltscale)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Berberis nevinii (Nevin's barberry)	ESA endangered, California endangered, CRPR 1B	No	No	Species occurs in upland habitats, which would unlikely be affected by covered activities.
Calochortus clavatus var. *gracilis* (slender mariposa-lily)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Calochortus palmeri var. *palmeri* (Palmer's mariposa-lily)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Calochortus plummerae (Plummer's mariposa-lily)	Not imperiled (CRPR 4)	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Calochortus fimbriatus (late-flowered mariposa-lily)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Calystegia peirsonii (Peirson's morning-glory)	Not imperiled (CRPR 4)	No	No	Species occurs in upland habitats, which are not expected to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Castilleja gleasonii (Mt. Gleason paintbrush)	California rare, USFS sensitive	No	No	Occurs in higher elevations in the watershed, which do not have the potential to be affected by covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Chaenactis glabriuscula var. *orcuttiana* (Orcutt's pincushion)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Chloropyron maritimum ssp. *maritimum* (salt marsh bird's-beak)	ESA endangered, California endangered, CRPR 1B	No	No	Species occurs in beach and marsh habitats. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Chorizanthe parryi var. *fernandina* (San Fernando Valley spineflower)	ESA proposed threatened, California endangered, CRPR 1B, USFS sensitive	No	No	Occurs in sandy places on foothills, mixed grassland and chaparral communities. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Chorizanthe parryi var. *parryi* (Parry's spineflower)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Delphinium parryi ssp. blochmaniae (dune larkspur)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Delphinium umbraculorum (umbrella larkspur)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Dodecahema leptoceras (slender-horned spineflower)	ESA endangered, California endangered, CRPR 1B	No	No	Occurs in alluvial fans, floodplains, stream terraces, washes and associated benches. The species is not considered to be at risk as a result of covered activities associated with the Freeman Diversion facility during the permit term of the ITP.
Dudleya abramsii ssp. parva (Conejo dudleya)	ESA threatened, CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Dudleya verityi (Verity's dudleya)	ESA threatened, CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Eriogonum crocatum (Conejo buckwheat)	California rare, CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Eriogonum kennedyi var. *alpigenum* (southern alpine buckwheat)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Fritillaria ojaiensis (Ojai fritillary)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Galium grande (San Gabriel bedstraw)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.

Table 2 Designation of Species Assessed under the MSHCP

Scientific Name/ Common Name	Status	Reasonable Potential for Take from at Least One Covered Activity	Covered Species (yes/no)	Notes
Harpagonella palmeri (Palmer's grapplinghook)	Not Imperiled (CRPR 4)	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Helianthus nuttallii ssp. *parishii* (Los Angeles sunflower)	CRPR 1A	No	No	Species is presumed extirpated and has no overlap of occurrences or habitat with the area of effect for the covered activities.
Lasthenia glabrata ssp. *coulteri* (Coulter's goldfields)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Layia heterotricha (pale-yellow lavia)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Lepechinia rossii (Ross' pitcher sage)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Malacothamnus davidsonii (Davidson's bush-mallow)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Malacothrix similis (Mexican malacothrix)	CRPR 2	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Monardella hypoleuca ssp. Hypoleuca (white-veined monardella)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Monardella linoides ssp. *oblonga* (Tehachapi monardella)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Navarretia fossalis (Moran's navarretia)	ESA threatened, CRPR 1B	No	No	Occurs in vernal pools in the Santa Clara River watershed. Vernal pools located near riparian habitats have the potential to be affected by United activities.
Navarretia ojaiensis (Ojai navarretia)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Navarretia peninsularis (Baja navarretia)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Opuntia basilaris var. *brachyclada* (short-joint beavertail)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Orcuttia californica (California Orcutt grass)	ESA endangered, California endangered	No	No	Occurs in vernal pools in the Santa Clara River watershed. Vernal pools located near riparian habitats have the potential to be affected by United activities.
Orobanche valida ssp. *valida* (Rock Creek broomrape)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Senecio aphanactis (chaparral ragwort)	CRPR 2	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Sidalcea neomexicana (Salt Spring checkerbloom)	CRPR 2, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Stylocline masonii (Mason's neststraw)	CRPR 1B, USFS sensitive	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Suaeda esteroa (estuary seablite)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.
Symphyotrichum greatae (Greata's aster)	CRPR 1B	No	No	Species has no overlap of occurrences or habitat with the area of effect for the covered activities.

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4.2 COVERED SPECIES

The selection of covered species is intrinsically connected to the covered activities identified in the MSHCP due to the geographical, spatial, and temporal effects that these activities have on the species included in the evaluation as well as their current or potential future protected status. Therefore, covered species selected for inclusion under the ITP include those species currently listed as threatened or endangered under the ESA or CESA and identified as having the potential for take during the permit term due to the implementation of one or more covered activities. Additionally, the species not currently listed as threatened or endangered under the ESA or CESA that were selected as covered species include only those that have the reasonably foreseeable potential to become ESA and/ or CESA-listed during the permit term and for which take is reasonably certain to occur. As noted in Table 1 and Table 2, a total of seven species are included as covered species in the MSHCP. These species include:

- Southern California Steelhead (*Oncorhynchus mykiss*)
- Tidewater Goby (*Eucyclogobius newberryi*)
- Pacific Lamprey (*Entosphenus tridentatus*)
- Western Pond Turtle (*Actinemys marmorata*)
- Southwestern Willow Flycatcher (*Empidonax traillii extimus*)
- Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*)
- Least Bell’s Vireo (*Vireo bellii pusillus*)

Through continued consultation and coordination with the USFWS and NMFS, four species were removed from the covered species list including one federal and state listed species, California least tern (*Sternula antillarum browni*) and three California species of special concern, yellow-breasted chat (*Icteria virens*), yellow warbler (*Setophaga petechia*), and two-striped garter snake (*Thamnophis hammondii*). Although preliminarily identified as covered species, California least tern was determined to not be at risk of take as a result of covered activities following focused surveys between 2013-2019, which resulted in negative findings and addition of complete avoidance during fish relocation and monitoring activities added to CM 2.1.7 in Chapter 5. Yellow-breasted chat, yellow warbler, and two-striped garter snake, while they are known to occur within and in the vicinity of the covered activities, are not anticipated to be ESA-listed during the permit term, and therefore, did not warrant covered species status under the MSHCP. However, it should be noted that any conservation measures that conserve or restore riparian habitat will benefit these species as well. Additionally, cowbird control of any kind will benefit these birds as well as the covered birds if implemented as a covered measure. Therefore, United anticipates benefits to these species through the MSHCP even though they are not currently proposed as covered species.

Similarly, under CESA, covered species include those that are currently listed as threatened, endangered, or candidate species; however, special consideration was not given to special-status species not listed under CESA due to the lack of a “No Surprises” policy. Of the seven species included as covered species in the MSHCP requiring take coverage under the ITP, a total of three are listed under CESA, requiring coverage under a Fish & Game Code § 2080.1 Consistency Determination (CD) or 2081(b) Incidental Take Permit (ITP). These species include:

- Southwestern Willow Flycatcher
- Yellow-Billed Cuckoo
- Least Bell’s Vireo

Both listed and non-listed species that were not selected as covered species, although they may occur within the plan area, are not anticipated to be affected by the covered activities and/ or are not anticipated to become ESA-listed during the permit term. As noted above, four species were removed from coverage under the MSHCP; however, avoidance and minimization measures will be implemented as part of the construction, operations, and maintenance of the Freeman Diversion facility and will likely protect and benefit these species as well.

5 REFERENCES

California Department of Fish and Wildlife (CDFW). 2020. California Endangered Species Act Listing Process. Available on the Internet at: https://wildlife.ca.gov/Conservation/CESA/Listing

California Department of Fish and Wildlife (CDFW). 2019. California Natural Diversity Database (CNDDB). Available on the Internet at: http://www.dfg.ca.gov/biogeodata/cnddb/.

Rincon Consultants, Inc. 2016. Proposed Changes to the Screening Assessment based on 2016 CNDDB. July 2016.

Stillwater Sciences. 2016. United Water Conservation District Multiple Species Habitat Conservation Plan Study: Effects of Freeman Diversion on Habitat Conditions in the Santa Clara River Estuary. September 2016.

U.S. Fish and Wildlife Service (USFWS). 2020. Information for Planning and Conservation. Available on the Internet at: https://ecos.fws.gov/ipac/

U.S. Fish and Wildlife Service (USFWS). 2019. Critical Habitat Portal. Available on the Internet at http://crithab.fws.gov/.

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS). 2016. Habitat Conservation Planning and Incidental Take Permit Processing Handbook. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. https://www.fws.gov/midwest/endangered/permits/hcp/hcphandbook.html.

United (United Water Conservation District) and ENTRIX. 2010. Screening Assessment; Covered Activities and Covered Species, United Water Conservation District ITP. Prepared for United Water Conservation District. April 2010.

United (United Water Conservation District) and Cardno ENTRIX. 2011. Screening Assessment; Covered Activities and Covered Species, United Water Conservation District ITP. Prepared for United Water Conservation District. July 2011.

United (United Water Conservation District), Rincon Consultants, and Cardno ENTRIX. 2015. Screening Assessment; Covered Activities and Covered Species. Prepared for United Water Conservation District. Updated February 2015.

United. 2009a. United boundary shapefile.

United. 2009b. United facilities shapefiles (polyline, polygon).

FORECASTED WATER RESOURCE IMPACTS FROM CHANGES IN OPERATION OF FREEMAN DIVERSION

United Water Conservation District
Open-File Report 2016-03

PREPARED BY

GROUNDWATER RESOURCES DEPARTMENT

OCTOBER 2016

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FORECASTED WATER RESOURCE IMPACTS FROM CHANGES IN OPERATION OF FREEMAN DIVERSION

United Water Conservation District
Open-File Report 2016-03

Groundwater Resources Department
October 2016

THIS REPORT IS PRELIMINARY AND IS SUBJECT TO MODIFICATION

BASED UPON FUTURE ANALYSIS AND EVALUATION

Cover Photo: Freeman Diversion

Preferred Citation:

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FORECASTED WATER RESOURCE IMPACTS FROM CHANGES IN OPERATION OF FREEMAN DIVERSION

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EXECUTIVE SUMMARY

United Water Conservation District (United) is preparing a Multiple Species Habitat Conservation Plan (MSHCP) as part of its application packages for incidental take permits (ITP) under section 10(a)(1)(B) of the federal Endangered Species Act (FESA) and 2081(b) of the California Fish and Game Code, or a consistency determination under section 2080.1, as appropriate. United seeks ITPs for activities that may incidentally result in take of covered species. These activities are referred to in the MSHCP as "covered activities." Southern California steelhead is one of the covered species, and these fish require river flow for both upstream and downstream migration opportunities. The purpose of the underlying, covered activity of surface-water diversion at the Freeman Diversion is to sustain the reliable supply of water over the long-term based on known and foreseeable community demand for irrigation and municipal and industrial purposes. This includes maintenance of groundwater levels, prevention of groundwater quality degradation and surface deliveries in lieu of pumping in certain areas on the Oxnard coastal plain. United's Freeman Diversion and other associated facilities directly and indirectly provide irrigation supplies as well as drinking water to municipal customers, including the City of Oxnard, the Port Hueneme Water Agency, and the Naval Base Ventura County, in-lieu of coastal groundwater extractions. United's facilities are also vital to groundwater recharge, providing replenishment water to the aquifers for use during drought years, and reducing and reversing seawater intrusion in the aquifers of the Oxnard Plain.

United has developed a number of surface water diversion operational scenarios that provide various instream flows for fish migration in the Santa Clara River downstream of the Freeman Diversion. These scenarios range from use of United's full water right for diversions as licensed by the (CA) State Water Resources Control Board (which itself includes instream flow requirements), to scenarios proposed by the NMFS in a biological opinion issued to the U.S Bureau of Reclamation in 2008, to no diversion of water. This report evaluates the impacts of various diversion scenarios on conditions in aquifers underlying the Oxnard coastal plain.

Despite long-term efforts to conserve water, import more water to the District and optimize the use of local resources, water deficits exist in a number of areas throughout the District, most notably on the southern Oxnard Plain basin and in the Pleasant Valley basin. In some places, the depletion of groundwater reserves has to date simply resulted in lowered water tables. In other areas, significant water quality problems have developed in response to conditions of overdraft. The California Department of Water Resources recently revised the list of basins "subject to critical overdraft." Southern California has six basins designated as subject to critical overdraft, and the Oxnard Plain and Pleasant Valley basins have been assigned this designation. The Oxnard Plan and Pleasant Valley basins are the only two coastal basins on the list.

United staff used a surface water routing model to prescribe the distribution of available surface water under various surface-water diversion scenarios, and a groundwater flow model to forecast future aquifer conditions associated with the various scenarios. The diversion scenarios evaluated include:

- **Scenario 1 (No Diversion)** – United diverts no river flow at the Freeman Diversion other than water released from Santa Felicia Dam during the summer-fall conservation release.
- **Scenario 2 (Water Right Operations)** – United conducts operations at the Freeman Diversion in accordance with SWRCB Permit 18908.
- **Scenario 3 (Interim Bypass Operations 2010-2016)** – United conducts operations at the Freeman Diversion largely in accordance with the 2009/2010 bypass flow plans.
- **Scenario 4 (2008 Biological Opinion)** – United conducts diversion operations in accordance with reasonable and prudent alternative 2 (RPA 2(a) and 2(b)), as contained in the 2008 Biological Opinion issued by NMFS.
- **Scenario 6 (Mimic Flow Recession)** – United conducts diversion operations at the Freeman Diversion in a manner that attempts to balance mimicking the natural flow recession to benefit steelhead trout, while minimizing net yield loss compared to scenario 3.
- **Scenario 6A** – This scenario assumes the existing diversion capabilities. Diversions in this scenario are limited to suspended sediment levels in the river of 2,580 mg/l or lower, which is the current limit on diversions for sediment concentrations in the river. Potential diversions are also rejected when the groundwater mounding occurs during wet conditions.
- **Scenario 6B** – As described in scenario 2, United is currently limited in its capabilities of diverting its full water right due to high levels of sediment and infrastructure capabilities. This scenario includes major infrastructure changes to the diversion system, conveyance system, and percolation basins, in order to regain yield that would be lost by extending the duration of bypass flows. The additional yield would result from diverting water with higher turbidity levels (TSS up to 10,000 mg/l) during the peaks of the storms, and percolating additional water in new facilities (e.g. Ferro Basin) during wet years when groundwater mounding is expected to occur.
- **Scenario 7 (Increased Diversion Rate Operations)** – Under this scenario, United increases its instantaneous diversion rate to a maximum of 750 cfs and the total annual diversion limit to 188,000 AF, as a means to offset yield losses to benefit steelhead trout. Importantly, this operational scenario is not covered under United's current water right and permit. Therefore, to implement this scenario, United would need to obtain additional water rights. Additionally, the existing infrastructure of the Freeman Diversion facility and associated downstream facilities cannot accommodate operations under this scenario and would need to be modified.

The modeling results indicate significant adverse groundwater conditions in the Lower Aquifer System (LAS) and the Upper Aquifer System (UAS) in the Oxnard Plain, Forebay, Pleasant Valley, and the Mound groundwater basins under all diversion scenarios. Maintaining groundwater elevations above sea level is key to preventing further seawater intrusion and other groundwater quality problems from occurring in the aquifers underlying the Oxnard coastal plain, and for achieving sustainable management of the Oxnard Plain, Forebay, and Pleasant Valley basins, as required by the State of California under the Sustainable Groundwater Management Act. Key results of this evaluation include:

- There is a direct relationship between average annual diversions and the area where groundwater elevations are forecasted to be below sea level below the Oxnard coastal plain.

- In both the UAS and the LAS, groundwater elevations under diversion scenario 1 are forecasted to be substantially lower than under the other diversion scenarios, remaining below sea level across most of the Oxnard coastal plain throughout the simulation period. This illustrates the importance of United's artificial recharge and surface-water deliveries in lieu of pumping for preventing or mitigating undesirable results (e.g. seawater intrusion) of groundwater-level declines in the aquifers underlying the Oxnard coastal plain.
- Forecasted UAS groundwater elevations in areas of the southeastern part of the Oxnard Plain basin, southern Pleasant Valley basin, Mound basin, and northern Pleasant Valley basin remain below sea level under all diversion scenarios evaluated. The southern Oxnard Plain and Pleasant Valley basin area has historically been the site of seawater intrusion, and is of particular concern for achieving sustainable groundwater management. The area of the UAS below sea level is smallest under diversion scenarios 2 and 7, are slightly larger under scenarios 3, 6A, and 6B (1,400 to 4,900 acres greater than under scenario 2), and are substantially larger (19,000 acres, encompassing most of the remaining farmland in the eastern Oxnard coastal plain east of Oxnard and south of Camarillo) under scenario 4.
- In the LAS, groundwater elevations below most of the Oxnard coastal plain are forecasted to remain well below sea level throughout the simulation period under all diversion scenarios. Similar to the UAS, the forecasted areas below sea level for scenarios 2 and 7 are roughly equal, are somewhat larger under scenarios 3, 6A, and 6B (2,600 to 4,900 acres greater than under scenario 2), and are substantially larger (21,000 acres) under scenario 4. This will almost certainly increase the rate and areal extent of seawater intrusion into the LAS in the Oxnard Plain and Pleasant Valley basins, and could prevent the FCGMA from achieving sustainable management as required under the SGMA.

Historically, the Freeman Diversion (and United's previous diversion structures near Saticoy) have been the single most effective project providing groundwater recharge to the Oxnard Forebay and the Oxnard Plain. Any reduction in United's ability to divert water from the Santa Clara River has a direct impact on the sustainable yield of these groundwater basins and the protection and continued viability of the dependent water uses and associated economies and communities. Considering the forecasted impacts on groundwater levels described above for each diversion scenario evaluated in this analysis, Scenario 2, which reflects operations consistent with United's surface-water right, would accomplish the purposes of the Freeman Diversion better than any alternative flow operations that do not rely on additional infrastructure or new water rights. The forecasted negative impacts to groundwater levels of scenarios 1 and 4 are substantially greater than all other scenarios, increasing the potential for seawater intrusion and other undesirable results. United developed Scenario 6 to address conservation objectives for steelhead migration. However, Scenario 6A would have a larger impact to groundwater levels compared to Scenario 2. This report does not evaluate the feasibility of those actions needed to take water at higher flows.

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1 INTRODUCTION

United Water Conservation District (United) is preparing a Multiple Species Habitat Conservation Plan (MSHCP) as part of its application packages for incidental take permits (ITP) under section 10(a)(1)(B) of the federal Endangered Species Act (FESA) and 2081(b) of the California Fish and Game Code, or a consistency determination under section 2080.1, as appropriate. United owns, operates, and maintains water facilities in a number of locations in the Santa Clara River Watershed and Oxnard Plain, some of which have the potential to result in take of federally and state protected species. The federal ITPs would authorize incidental take of 11 species listed as threatened or endangered under the FESA or the California Endangered Species Act (CESA) or both, referred to in the MSHCP as "covered species." Among other issuance criteria, ITPs will be issued based on the determination by US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) that the MSHCP minimizes and mitigates the effects of incidental take of the covered species authorized by the ITPs will be minimized and mitigated consistent with the standards in FESA and CESA.

United seeks ITPs for activities that may incidentally result in take of covered species. Southern California steelhead is one of the covered species, and these fish require river flow for both upstream and downstream migration opportunities. The purpose of the underlying, "covered" activities is to sustain the reliable supply of water over the long-term based on known and foreseeable community demand for irrigation and municipal and industrial purposes. This includes maintenance of groundwater levels, prevention of groundwater quality degradation and surface deliveries in lieu of pumping in certain areas on the Oxnard coastal plain. United's Freeman Diversion and other associated facilities directly and indirectly provide irrigation supplies as well as drinking water to municipal customers, including the City of Oxnard, the Port Hueneme Water Agency, and the Naval Base Ventura County, in-lieu of coastal groundwater extractions. United's facilities are also vital to groundwater recharge, providing replenishment water to the aquifers for use during drought years, and reducing and reversing seawater intrusion in the aquifers of the Oxnard Plain.

United has developed a number of surface water diversion scenarios that provide various instream flows for fish migration in the Santa Clara River downstream of the Freeman Diversion. These scenarios range from use of United's full water right for diversions as licensed by the (CA) State Water Resources Control Board (which itself includes instream flow requirements), to scenarios proposed by the NMFS in a biological opinion issued to the U.S Bureau of Reclamation in 2008, to no diversion of water. This report evaluates the impacts of various diversion scenarios on conditions in aquifers underlying the Oxnard coastal plain.

United is proposing a conservation program, including instream flows, in the MSHCP intended to minimize and mitigate the effects of incidental take to the maximum extent practicable. For purposes of assessing impacts to groundwater-resources United has completed technical evaluations and comparisons in this report.

United staff used a surface water routing model to prescribe the distribution of available surface water under the various scenarios, and a groundwater flow model to forecast future aquifer conditions associated with the various scenarios. The modeling results indicate significant adverse groundwater conditions in the Lower Aquifer System (LAS) on the Oxnard coastal plain under all diversion scenarios, and to the Upper Aquifer System (UAS) under some diversion scenarios.

Despite existing water conservation programs and extensive investments in water resource infrastructure, the existing water deficit is significant and without improvement of this situation there would be detrimental impacts to existing users reliant on groundwater supplies. Large supplemental sources of water are not readily available, and the development of supplemental sources could have negative impacts on habitat and species at other locations. Therefore, reduced surface water diversions from the Santa Clara River are impractical as part of an effective water management strategy. United is developing an MSHCP intended to meet the issuance criteria for ITPs, including instream flows for fish migration, while also ensuring that it meets the need to benefit regional aquifers by balancing the use of surface water from the Santa Clara River and groundwater in a conjunctive manner to meet the needs of existing and foreseeable urban and agricultural water users in the community.

1.1 UNITED WATER CONSERVATION DISTRICT

United Water Conservation District (also “United” or “District”) is a public agency that encompasses nearly 213,000 acres of central and southern Ventura County. The District covers the downstream (Ventura County) portion of the valley of the Santa Clara River, as well as the Oxnard Plain. The District serves as a steward for managing the surface water and groundwater resources for all or portions of eight interconnected groundwater subbasins (Figure 1.1-1). It is governed by a seven-person board of directors elected by division, and receives revenue from property taxes, groundwater extraction (pump) charges, recreation fees, and water delivery charges. The developed areas of the District are a mix of agriculture and urban areas, with prime agricultural land supporting high-dollar crops such as avocados, berries, row crops, tomatoes, lemons, oranges, flowers, ornamental nursery stock and sod. Approximately 370,000 people live within the District boundaries, including those living in the cities of Oxnard, Port Hueneme, Santa Paula, Fillmore and eastern Ventura.

The District is authorized under its principal act (California Water Code Section 74000 et seq) to exercise multiple powers. These powers include the authority to conduct water resource investigations, acquire water rights, build facilities to store and recharge water, construct wells and pipelines for water deliveries, commence actions involving water rights and water use, prevent interference with or diminution of stream/river flows and their associated natural subterranean supply of water, and to acquire and operate recreational facilities in connection with dams, reservoirs or other District works.

1.1.1 UWCD MISSION STATEMENT AND GOALS

The District's mission statement is:

> *United Water Conservation District shall 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.*

In order to accomplish this mission, United Water Conservation District follows these guiding principles:

- Construct, operate, and maintain facilities needed now and in the future to put local and imported water resources to optimum beneficial use;
- Deliver safe and reliable drinking water that meets current and future health standards to cities and urban areas;
- Provide an adequate and economical water supply to support a viable and productive agricultural sector;
- Fight overdraft and seawater intrusion and enhance the water quality of the aquifers through the use of District programs;
- Monitor water conditions to detect and guard against problems and to report those conditions to the public;
- Seek opportunities to develop cooperative programs with other agencies in order to maximize use of District resources and promote mutually beneficial projects;
- Acquire and operate high-quality public recreational facilities that are financially self-supporting;
- Balance District operations with environmental needs to maximize use of the region's water resources; and
- Conduct District affairs in a business-like manner that promotes safe investment policy, sound financial audits and the utmost in professional and financial integrity.

The District recognizes that many of the projects and activities required to implement these guiding principles have long timelines for development and initiation, and the positive impacts of these projects and activities may be realized over many years. This is consistent with the District's mission to provide for the long-term health of the water resources within the District. To fulfill its mission, the District retains technical experts in the fields of engineering, hydrogeology, surface water hydrology, environmental science, ecology, and regulatory compliance, as well as administrative personnel with specialties in accounting and finance.

1.1.2 UWCD HISTORY

The original predecessor entity for United Water Conservation District was called the Santa Clara River Protective Association. It was formed in 1925 to protect the runoff of the Santa Clara River from being appropriated and exported outside the watershed. The Santa Clara Water Conservation District (Santa Clara District) was formed in 1927 to further the goals of the Association by protecting water rights and conserving the waters of the Santa Clara River and its tributaries. The Santa Clara District began a systematic program of groundwater recharge in 1928, primarily through constructing recharge basins along the Santa Clara River. Sand dikes were constructed on the Santa Clara River near Saticoy to divert river water into recharge basins in nearby upland areas.

The demand and need for groundwater for agricultural irrigation and municipal use exceeded natural recharge, resulting in overdraft conditions. As groundwater overdraft and seawater intrusion on the Oxnard Plain were recognized in the 1940s, it was clear that the Santa Clara District did not have the financial ability to raise money to construct the facilities necessary to combat the problem. Proposed facilities included dams on both Sespe Creek and Piru Creek. With the help of the City of Oxnard, a new district was organized in 1950 under the Water Conservation District Law of 1931. The new district was called United Water Conservation District for its unification of urban and agricultural concerns. Substantial bond measures were approved by the constituents of the District, allowing United to construct a number of water conservation projects, including:

- Santa Felicia Dam (1955) to capture and store winter runoff on Piru Creek to release in controlled amounts during the dry season. The 200-foot high dam was designed to store up to 100,000 acre-feet (AF) in Lake Piru, but sediment accumulation in the reservoir has reduced storage capacity to about 81,000 AF. The reservoir is now located downstream of a State Water Project reservoir, enabling the District to receive Northern California water via flows down middle Piru Creek without the construction of expensive delivery pipelines;
- A pipeline to new recharge basins at El Rio; and
- Municipal wells at the El Rio recharge facility to produce water for the Oxnard-Hueneme (O-H) pipeline (1954) that supplies drinking water to the City of Oxnard, the Port Hueneme Water Agency (City of Port Hueneme, Naval Base Ventura County, Channel Islands Beach Community Services District), and a number of small mutual water companies. The O-H system supplies water from the Oxnard Forebay basin (the recharge area for the Oxnard Plain basin), rather than pumping individual wells in coastal areas of the Oxnard Plain that could accelerate seawater intrusion.

Overdraft conditions and increasing intrusion of seawater generally persisted during the drought period that existed from the late 1940s through the mid-1960s, and United constructed additional facilities to increase recharge to the aquifers and to decrease groundwater pumping in areas affected by the intrusion. In 1958 a pipeline and terminal reservoir was completed to deliver diverted surface water to Pleasant Valley County Water District, which serves agricultural water to the Pleasant Valley basin. The Pleasant Valley basin, like the neighboring Oxnard Plain, had significant overdraft issues by that time.

Despite the construction of Santa Felicia Dam that allowed storage of water from the Piru Creek watershed, United recognized the need for additional water to support a growing population and industry within its district boundaries. United continued its effort to construct two reservoirs on Sespe Creek. The original bond measure funding both a dam on Sespe Creek and a dam on Piru Creek was narrowly defeated in the polls in 1952 (but a smaller bond measure of nearly $11 million passed in 1953 and funded construction of the Santa Felicia Dam on Piru Creek and the various facilities in the Oxnard Forebay described above). In 1957, United renewed its efforts to construct dams on the Sespe, but there were now claims by others to appropriate water from Sespe Creek for export to the Calleguas Creek watershed area. Lengthy legal proceedings were finally resolved in 1963. United then partnered with the U.S. Bureau of Reclamation for a feasibility study for the Sespe Creek Project, a proposal which included the Cold Spring and Topatopa dams on Sespe Creek, along with a diversion facility near Fillmore and a pipeline to distribute (high quality) Sespe water to a number of downstream cities and growers. This proposal failed at the polls in March 1966 by a very narrow margin. In the mid-1970s, United was still proposing the “Oat Mountain Diversion” near Fillmore to divert water from Sespe Creek and the “Quality Management Pipeline” to distribute diverted water, but this project was never funded or constructed.

1.1.3 POTENTIAL STATE ADJUDICATION

Above-average rainfall conditions prevailed in the later years of the 1960s, but water levels on the Oxnard Plain fell below sea level again in the early 1970s and there was a new episode of saline intrusion. In March 1979, the California State Water Resources Control Board (State Board) Division of Water Rights issued a staff report detailing groundwater conditions on the Oxnard Plain (SWRCB, 1979). The State Board threatened to initiate an adjudication of water rights on the Oxnard Plain unless local entities could demonstrate credible plans to address overdraft conditions in the aquifers of the UAS. Of particular concern was in the inland migration of saline water in the Oxnard aquifer, and the recognition that there are a number of areas where the major aquifers of the Oxnard Plain are merged (vertically), creating the potential for vertical flow between aquifers and water quality degradation in the deeper aquifers. It was envisioned by the State Board that any effective solution would include a combination of regulatory measures to reduce pumping demand and physical projects to increase recharge to the aquifers, allowing the re-establishment of seaward groundwater gradients in the Oxnard Aquifer.

Ventura County interests responded to the State Board’s demand for action, with the County of Ventura and United being the most active agencies involved with the planning and implementation of programs and projects to align groundwater demand and supply over the long term. A new agency was envisioned to regulate pumping in the coastal basins: creation of the Fox Canyon Groundwater Management Agency (FCGMA) was authorized by the California legislature in 1982, and the new agency came into existence in January 1983. The FCGMA conducted studies to determine the safe yield of the groundwater basins within its jurisdiction, and following a period to determine baseline pumping allocations, implemented a program of systematic cuts to reduce pumping by as much as 25% and attempt to bring the basins into balance.

In 1979, United already had a proposal in hand for the Freeman Diversion structure. Community support was realized, presumably in part because an adjudication likely would have had adverse consequences for existing uses. United's engineers estimated the permanent Freeman Diversion structure, including the Pumping Trough Pipeline (PTP) project, would increase the average annual yield of the existing Saticoy Diversion by some 15,500 AF, given the ability to divert water soon after large flow events when the existing earthen berms would have been washed out (and could not be repaired until flows subsided in the Santa Clara River) (United Water Conservation District, 1983). United eventually received a construction loan of $18.73M from the U.S. Bureau of Reclamation, and a loan of $5.0M from the State of California Department of Water Resources, which allowed the project to be built. Construction of the Freeman Diversion, associated canals, and the desilting basin was initiated in 1988 and completed in 1991. A major additional benefit of the Freeman Diversion was the stabilization of riverbed elevations upstream of the facility, correcting the long-term incision of the river related to decades of in-channel gravel mining in the Saticoy area.

Other physical projects to reduce overdraft on the Oxnard Plain did not take as long to design, fund and construct. United partnered with the County of Ventura to construct the PTP in 1986. This pipeline was designed to convey diverted river water to agricultural pumpers in the east-central area of the Oxnard Plain, thus reducing the amount of groundwater pumping in this critical area. The chronic pumping depression in the Oxnard aquifer in this vicinity was a major concern, and cited specifically in the State Board's call for action, as these low water levels would eventually draw saline water from the coastal areas to the center of the basin. Surface water diverted by the Freeman Diversion and delivered to the PTP is supplemented by five wells that produce from the LAS. Although pumping the deep wells would exacerbate overdraft in the Fox Canyon aquifer, the project was designed to address the more immediate concern of severe overdraft and extensive saline intrusion in the UAS. The project has been successful in eliminating the Oxnard aquifer pumping depression in the area.

1.1.4 RECENT GROUNDWATER MANAGEMENT ACTIONS AND DIRECTIVES

Following the construction of the Freeman Diversion, United constructed the Noble recharge basins (1995) to recharge additional water diverted from the river, particularly during wet periods. United then constructed the Saticoy well field in 2003 to pump down the groundwater mound that develops beneath the Saticoy recharge facility during periods of heavy recharge water deliveries. Water pumped from the Saticoy well field is distributed to agricultural users on the Pleasant Valley and Pumping Trough Pipelines, in order to reduce pumping in those areas. A grant from the California Department of Water Resources (DWR) funded about 75% of the Saticoy well field, as DWR is supportive of conjunctive use projects that maximize the use of surface water when it is available. In December 2009, United acquired the Ferro and Rose basins, former mining pits located in the Oxnard Forebay that will be used for future groundwater recharge activities. In 2015, United completed a short connection pipeline between the Noble and Rose basins, and the Rose basin can now be used for surface water recharge. Currently there is no infrastructure to convey water to the Ferro basin. The District is developing plans for the connection and associated in-basin improvements.

As mentioned in the previous section, the Fox Canyon Groundwater Management Agency has been the agency with primary groundwater use regulatory authority in the Oxnard Plain, Forebay and Pleasant Valley basins since 1983. Following the allocation base period in the late 1980s, the FCGMA required a series of 5% pumping reductions, approximately every five years, to reduce pumping demands within its area of jurisdiction. Agricultural water users had the option of demonstrating efficient irrigation practices, thereby avoiding the specified pumping reductions mandated for the municipal pumpers. The original goal of a 25% pumping reduction from baseline allocation was achieved in 2012, but this reduction was largely limited to municipal pumpers, as many agricultural pumpers were demonstrating irrigation efficiency. Despite the implementation of these various measures to reduce pumping from the coastal basins, chronic overdraft conditions persist in the aquifers of both the UAS and the LAS (FCGMA, 2015).

More recently, the FCGMA Board adopted Emergency Ordinance E in April 2014 (*www.fcgma.org*). This ordinance was crafted in response to the severely depleted groundwater conditions in the coastal basins, following the lack of substantial rainfall since spring 2011. Temporary extraction allocations were applied to wells within the FCGMA, effecting additional pumping restrictions to area wells. Additionally, in February 2015, the County of Ventura (County) passed a well ordinance prohibiting the construction of new wells in the overdrafted basins of Ventura County, including the basins within the jurisdiction of the FCGMA (*http://vcpublicworks.org/pwa/groundwater-resources*). Replacement wells can still be installed, as the ordinance was more intended to limit the expansion of groundwater use than to limit existing use. The County intends that this ordinance remain in effect until Groundwater Sustainability Agencies are formed within the various medium and high-priority basins, as per the Sustainable Groundwater Management Act (SGMA).

The SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) for all California groundwater basins. SGMA became law in January 2015 and requires that Groundwater Sustainability Plans (GSPs) be developed for all significant groundwater basins in the state. The GSPs are required to demonstrate how sustainable conditions will be achieved within the next twenty years. Basins considered to be subject to critical overdraft must recover to sustainable conditions by the year 2040. Basins designated as high and medium priority basins must be managed sustainably by 2042. The Oxnard Plain and Pleasant Valley basins are designated as subject to critical overdraft, and the other groundwater basins of the Oxnard coastal plain are either high or medium priority basins. The FCGMA is the GSA for the groundwater basins within its jurisdiction, and has retained a team of consultants to draft a GSP. A draft GSP is expected to be completed by summer 2017.

The future GSP may include some level of additional pumping restrictions, but even if so efforts to bring the Oxnard Plain to long-term groundwater sustainability will likely also require new water projects. Historically, the Freeman Diversion (and United's previous diversion structures near Saticoy) have been the single most effective project providing groundwater recharge to the Oxnard

Forebay and the Oxnard Plain. Any reduction in United's ability to divert water from the Santa Clara River has a direct impact on the sustainable yield of these groundwater basins and the protection and continued viability of the dependent water uses and associated economies and communities.

1.2 FREEMAN DIVERSION AND SATICOY RECHARGE FACILITY

The Freeman Diversion is located on the Santa Clara River about 10 miles upstream from its mouth at the Pacific Ocean. The concrete diversion structure was completed in 1991 and replaced the previous diversion method of building temporary sand and gravel diversion dikes, levees, and canals. The prior method of diverting water from the Santa Clara River near Saticoy had been in practice since the 1920s. With each high flow in the river the dikes were washed out, eliminating the ability to divert water until construction crews were able to work in the riverbed with bulldozers to restore the diversion levees. Construction of the Freeman Diversion has increased the conservation of flood flows by increasing the District's ability to more reliably divert a portion of the flood flows immediately following storm events. The current facility consists of the following structures: diversion structure, fish passage facilities, headworks, canal, flocculation building, and desilting basin.

The diversion is operated to redirect surface water from the Santa Clara River to United's Saticoy recharge facility (Saticoy, Noble, and Rose basins) and El Rio recharge facility, for the purpose of recharging the aquifers underlying the Oxnard Forebay and Oxnard Plain. The remainder of the diverted water is delivered directly to agricultural users to satisfy irrigation demands "in lieu" of the users pumping groundwater. These deliveries are designed to reduce groundwater pumping in areas where overdraft conditions and related water quality issues exist, such as where aquifers are most susceptible to saline water intrusion and the upwelling of saline waters. Water releases from Lake Piru and a portion of the natural runoff from the Santa Clara River are diverted by the Freeman Diversion.

1.2.1 EXISTING WATER RIGHTS

Diversions at the Freeman are permitted under California State Water Resources Control Board License 10173 (issued in 1972) and Permit 18908 (originally issued in 1982 and updated in 1987). The permit was issued for the anticipated increase in diversions due to the new Freeman Diversion and the PTP system. Details of these permitted activities include the following:

- License 10173
    - Maximum diversion rate = 375 cubic feet per second (cfs)
    - Annual groundwater recharge volume = 89,000 AF
    - Annual surface water recharge volume = 15,630 AF
    - No required fish bypass flows

- Permit 18908
  - Maximum diversion rate = 375 cfs to groundwater recharge and 38 cfs to surface water direct deliveries
  - Annual groundwater recharge volume = 30,000 AF
  - Annual surface water recharge volume = 10,000 AF
  - Between February 15 and May 15, 40 cfs should be bypassed through the fish ladder whenever the flow in the river subsides to 415 cfs. The total amount of water bypassed in this manner should not exceed 5,000 AF over a ten-year period.

1.2.2 PURPOSE OF FREEMAN DIVERSION AND UNITED'S ARTIFICIAL RECHARGE FACILITIES

As noted above, the Freeman Diversion diverts water from the Santa Clara River for groundwater recharge and direct delivery to support agricultural and municipal and industrial uses of water, and was intended specifically to provide yield increases over prior operations. The construction of the Freeman Diversion structure created a diversion structure highly resistant to storm damage, and stabilized the elevation from which surface water is diverted from the river. Following extensive mining of aggregate from the channel of the Santa Clara River in the Forebay area, riverbed elevations near Saticoy had dropped by about twenty feet by the late 1980s. Scour associated with large flow events in the river allowed the riverbed degradation to propagate ever farther upstream, and United was repeatedly required to move its Saticoy diversion location farther upstream. The completed structure has prevented further down-cutting of the river upstream of the facility as expected, and some recovery of channel elevations between Santa Paula Creek and the Freeman Diversion has been documented (Stillwater Sciences, 2007). Since completion in 1991, the elevation of the Freeman diversion point has been stable at 162 feet, and the facility has enabled the diversion of river flow soon after large storm events.

When the Freeman Diversion was constructed, the riverbed elevation upstream of the structure was elevated about ten feet, and materials excavated during construction were used to raise floodplain elevations in an area extending approximately 2,000 feet upstream of the facility. The dam structure extends about 40 feet into the subsurface and rests on a bench of low-permeability Pico Formation. Groundwater elevations at an upstream location near the diversion structure vary little from the crest elevation of 162 feet, as groundwater moving through shallow river alluvium stages up behind the Freeman structure. Construction of the Freeman Diversion has benefited groundwater elevations in the Santa Paula basin, as the earlier incision of the river that was lowering the discharge elevation for shallow groundwater in the basin was arrested and partially restored in the area upstream of the diversion structure (Santa Paula Basin Experts Group, 2003).

The Freeman Diversion was completed at the end of the 1990 drought and has proven itself during the 1990s and 2000s wet period. The average diversions from 1991 to 2015 are 68,100 AF per year. In 1998 the district almost reached its license and permit limit by diverting 142,300 AF for recharge and surface water delivery. Since the Freeman Diversion was built in 1991, over 1.7

million AF have been diverted at the diversion with 1.3 million AF being recharged in the Oxnard Forebay. The remainder of the 0.3 million AF went to the surface water delivery systems. Overall since 1927 diversions from this location have exceeded 3.8 million AF.

1.2.2.1 SATICOY RECHARGE FACILITY

The Saticoy Recharge Facility is located approximately 2 miles downstream of the Freeman Diversion. The facility contains several recharge basins that are interconnected with a canal system and gates. United's predecessor agency built recharge facilities in this general area in the late 1920s. They have been reconfigured several times in the past 90 years to accommodate the addition of additional basins.

1.2.2.1.1.1 SATICOY BASINS

The Saticoy basins include 12 individual sub-basins, covering a wetted area of 116 acres. This facility was built much like it is today in 1945. Percolation rates in some of these basins have been observed at over 15 feet per day due to the favorable geology and operational practices to preserve the basins. Average annual deliveries to this facility for the period 1991 to 2015 have been 21,800 AF. These basins have percolated up to 54,000 AF in one year during a very wet period. The Saticoy Basins' capability to percolate water diminishes when groundwater mounds under the facility during periods of intense recharge. Four wells known as the Saticoy well field were added to pump down the mound under these basins as part of a conjunctive use strategy to get more yield from the Oxnard Forebay.

1.2.2.1.1.2 NOBLE BASINS

The Noble basins are old gravel mining pits that have been reconfigured to into three recharge basins. The Noble basins were built in 1993 and cover an area of 120 acres. These basins are approximately 20 feet deep, much deeper than most other recharge basins operated by the District. Due to their depth, during sustained recharge activities and resulting mounded groundwater conditions, these basins become much less effective than the other basins that are above the high groundwater levels, as District staff is unable to access them with heavy equipment to perform maintenance. During wet conditions the ponds that are maintained will attain an increased percolation rate. Due to the maintenance issues of the Noble basins, they are normally the last place that the District will send water. An exception to this is when the desilting basin is not able to effectively remove all the sediment from the water it has diverted. The most turbid water goes to this facility to preserve the high performance of the other basins. From 1995 to 2015, the Noble basin system has recharged an average of 4,750 AF per year.

1.2.2.1.1.3 ROSE BASIN

The Rose basin is an adjacent gravel mine next to the Noble basins. A pipeline connecting it to the Noble basins was built in 2015. Due to the dry year in 2016, this system has not been used. The basin has the potential to provide an additional 121 acres of surface area for recharging after adding berms that will allow water to stage in the entire basin. Like the Noble basins, the Rose basin is a deep basin and the opportunity to maintain this basin is limited to years when significant groundwater mounding does not exist beneath the Saticoy Recharge Facility.

1.2.2.1.1.4 FERRO BASIN

The Ferro basin is a 183-acre reclaimed gravel mining site. This basin is an important facility as it provides an opportunity for future District operations diverting water at relatively high flows if the District can secure a permit to divert more than 375 cfs under high flow conditions in the Santa Clara River. These basins would provide a location for the water diverted at a higher diversion rate, as the large sediment load associated with these high flows cannot be managed in the other recharge basins the District operates. Extensive new canal works would need to be constructed to bring this facility online.

1.2.2.2 EL RIO FACILITY (RECHARGE BASINS AND OXNARD-HUENEME WELLFIELD)

The El Rio recharge facility is located at the terminus of the El Rio branch of the main supply line, approximately two miles southwest of the Saticoy recharge facility. Surface water diverted from the Santa Clara River is distributed to a series of basins totaling approximately 80 acres for the purpose of groundwater recharge. United built the Oxnard-Hueneme system in 1954 to move municipal groundwater extraction on the Oxnard Plain away from coastal areas subject to seawater intrusion. The well field for the O-H system surrounds the El Rio recharge basins, and water produced by the well field is a blend of recharge water that has filtered down through the aquifer, and water drawn laterally from surrounding areas. The El Rio well field includes both upper and lower aquifer wells, allowing a blending of sources for water quality purposes. In practice, the LAS wells are used less frequently, as they are primarily used as alternative wells when others have high nitrate concentrations.

When water levels in the Oxnard Forebay are low, nitrate levels tend to be high, as discussed in section 1.4.4. As a result, during dryer climatic periods, water diverted from the Freeman Diversion is preferentially sent to this facility. During wetter periods, this facility will receive as much water as the conveyance system will allow, as it is typically the least susceptible to groundwater mounding which can reduce the District's potential diversions and recharge. The conveyance pipeline to this system is limited to 120 cfs. Average deliveries for groundwater recharge to this facility from 1991 through 2015 have been 26,400 AF per year.

1.2.3 SURFACE WATER DELIVERIES

Deliveries to El Rio basins shares a portion of the same pipeline as the supplemental surface water deliveries to the Pumping Trough Pipeline System and the Pleasant Valley Delivery System for agricultural irrigation. These systems are discussed separately in the following two subsections. The surface water deliveries are considered one of the most effective ways to improving groundwater conditions in the Oxnard coastal plain. Deliveries to this system reduce the amount of pumping in this area, thereby improving groundwater conditions.

1.2.3.1 PTP DELIVERY SYSTEM

The Pumping Trough Pipeline delivery system was designed to serve surface water from the Santa Clara River to a portion of the Oxnard Plain basin where the UAS was determined to be in severe overdraft. Five LAS wells were constructed along the pipeline to balance pipeline pressures and provide additional water to the system when surface water supplies are inadequate to meet demands. The four UAS wells of the Saticoy well field, completed in 2004, can also provide groundwater to the agricultural pipelines when groundwater elevations are high near the Saticoy recharge facility. The average deliveries to the PTP system from 1991 to 2015 are about 5,800 AF of surface water per year. The demands on this system depend on the demands of the crops it delivers to. Typically, irrigation demands are down during and shortly after rain events, and the peak demand is during the establishment of the strawberries and other fall crops in October. Demands in October can exceed 1,300 AF per month. The PTP delivers water to about 4,400 acres.

1.2.3.2 PLEASANT VALLEY DELIVERY SYSTEM

Water diverted from the Santa Clara River is delivered to the Pleasant Valley County Water District (PVCWD) via the Pleasant Valley Pipeline. The pipeline terminates at United's Pleasant Valley Reservoir, located east of the Camarillo Airport near the City of Camarillo. PVCWD uses the water from the reservoir and eleven LAS wells in the western Pleasant Valley basin, to supply water to agricultural customers via a delivery system linking the wells and the reservoir. The delivery of diverted river water to PVCWD offsets pumping of irrigation wells in the area. United is obligated by contract to supply, on an annual basis, 12.22 percent of the water diverted at the Freeman Diversion to PVCWD. United has delivered an average of 9,600 AF of surface water per year to PVCWD, from 1991 to 2015. Since 2002, PVCWD has also received surface water from the Conejo Creek Diversion, operated by the Camrosa Water District. Starting in 2016, PVCWD has also received a small amount of recycled water from the City of Oxnard.

1.3 GROUNDWATER BASINS

The groundwater basins within the District vary in their water production and ability to be recharged rapidly. The groundwater basins detailed here are sub-basins of the larger basin of the Santa Clara River Valley (CA DWR, 2003). Hydraulic connection exists between all basins within the District boundaries. The Fillmore basin receives recharge as underflow from the Piru basin, and the Santa Paula basin receives significant recharge from the Fillmore basin. Often, a component of the flow between basins occurs as surface water around the basin boundaries. The Mound basin receives recharge from the Santa Paula basin as well as from the Oxnard Plain and Oxnard Forebay basins, although head differentials across the western Santa Paula basin boundary are greater than those between the other sub-basins of the Santa Clara River valley. The Oxnard Forebay basin is widely recognized as the primary recharge area for aquifers in the Oxnard coastal plain. Many of the confining clays present in the aquifer systems of the Oxnard Plain are absent or discontinuous in the Oxnard Forebay basin, creating a window for recharge to other down-gradient aquifers. High groundwater elevations in and near the Oxnard Forebay promote groundwater flow to the nearby Mound and West Las Posas basins. The Pleasant Valley basin is more distant from the Oxnard Forebay but still receives direct benefit from United's recharge operations, and pipelines have been constructed to convey irrigation water directly to water users in Pleasant Valley and on the southern Oxnard Plain.

1.3.1 OXNARD FOREBAY

Both UAS and LAS aquifers are present in the Oxnard Forebay and Oxnard Plain basins. The Oxnard Forebay maintains direct hydraulic connection with confined aquifers of the Oxnard Plain basin, which extends several miles offshore beneath the marine shelf where outer edges of the aquifer are in direct contact with seawater. In areas near Port Hueneme and Pt. Mugu where submarine canyons extend nearly to the coastline, the fresh-water aquifers may be in direct contact with seawater a short distance offshore.

The Forebay is the main source of recharge to the Oxnard Plain basin. Recharge to the Forebay benefits other coastal basins (Mound, West Las Posas, Pleasant Valley), but a majority of the water recharged to the Forebay flows down-gradient to the confined aquifers of the Oxnard Plain. The shallow sediments of the basin are dominated by coarse alluvial deposits of the ancestral Santa Clara River. The absence of low-permeability confining layers between surface recharge sources and the underlying aquifers in the Forebay allow rapid groundwater recharge in the Forebay. The recharge to the Forebay comes from percolation of Santa Clara River flows, artificial recharge from United's recharge facilities, irrigation return flows, percolation of rainfall, and likely lesser amounts of underflow from the Santa Paula basin and mountain-front recharge from South Mountain. In the area of the Oxnard Forebay between the El Rio and Saticoy recharge facilities, the LAS has been uplifted and truncated along its contact with the UAS. In this area, recharge from surface sources may enter both the UAS and the underlying LAS. The U.S. Geological Survey estimates that about 20% of the water recharged to this area reaches the LAS, with the remainder recharging the UAS. In some areas of the Forebay, significant clays are present among the deposits of the LAS.

1.3.2 OXNARD PLAIN

The Oxnard Forebay is hydraulically connected with the aquifers of the Oxnard Plain basin, which is overlain by an extensive confining clay layer. Thus, the primary recharge to the Oxnard Plain basin is from underflow from the Oxnard Forebay rather than the deep percolation of water from surface sources on the Oxnard Plain. Natural and artificial recharge to the Oxnard Forebay serves to raise groundwater elevations in this up-gradient area of the groundwater flow system for the Oxnard coastal plain. Changes in the volume of groundwater in storage in the Oxnard Forebay changes the hydrostatic pressure in the confined aquifers extending from the margins of the Forebay to the coastal and offshore portions of these continuous aquifer units. High water levels in the Oxnard Forebay are desirable, as they are required to maintain offshore pressure gradients from the Oxnard Forebay to coastal areas. While the physical movement of groundwater out of the Oxnard Forebay is fairly slow, the pressure response in the confined aquifers distant from the Oxnard Forebay responds more rapidly to significant recharge events in the Forebay. When groundwater levels are below sea level along the coastline, there can be significant groundwater recharge by seawater flowing into the aquifers.

Vertical gradients also commonly exist between aquifer units on the Oxnard Plain, resulting in some degree of water movement through low-permeability units that occur between most of the major aquifers. When LAS water levels are substantially lower than UAS water levels (creating a downward gradient), there can be substantial leakage of UAS water into the LAS through the various aquitards that generally separate the aquifer units. This movement of water can be significant in areas where the UAS is in direct contact with the LAS. Likewise, a downward pressure gradient can exist between the Semi-perched aquifer and the Oxnard aquifer when heads in the shallow confined Oxnard aquifer are lowered (either regionally by drought conditions or locally by pumping wells). The movement of poor quality water from the Semi-perched aquifer to the Oxnard aquifer has been documented in some locations, with abandoned or improperly constructed wells being a notable pathway for this downward flow (Izbicki, 1992; Stamos et al, 1992).

The highly-permeable deposits of the UAS are relatively flat, lying across approximately the upper 400 feet of the Oxnard Plain. In the northern Oxnard Plain, heads are often similar in the Oxnard and Mugu aquifers, but heads in the Mugu aquifer are considerably deeper in the greater area surrounding Mugu Lagoon. Deposits of the LAS are generally finer-grained and have been deformed by folding and faulting in many areas. An uneven distribution of pumping, along with structural and stratigraphic changes within the deposits of the LAS result in varied heads among the deep wells across the Oxnard Plain and Pleasant Valley basins. As a result of faulting and uplift of the underlying marine deposits near Mugu Lagoon, the LAS is not hydraulically connected to the Pacific Ocean in this area (Izbicki, 1996a; Hanson et al., 2003). Near Port Hueneme, both the UAS and the LAS are exposed to the ocean by the near-shore Hueneme submarine canyon.

1.3.3 PLEASANT VALLEY

The Pleasant Valley basin is bounded to the south by the Santa Monica Mountains, to the north by the Camarillo Hills, and to the west by the Oxnard Plain. The Bailey fault runs along the base of the Santa Monica Mountains, and the Camarillo fault along the Camarillo Hills to the north.

The Pleasant Valley basin is differentiated from the Oxnard Plain basin by a general lack of productive UAS aquifers (Turner, 1975). The UAS is composed of alluvial deposits about 400 feet thick. In Pleasant Valley much of the UAS is fine grained and not extensively pumped for water supply (Turner, 1975; Hanson et al, 2003). UAS deposits in the Pleasant Valley basin are comprised of sediments sourcing from the Calleguas Creek watershed, a much smaller drainage than that of the Santa Clara River which deposited the UAS deposits on the Oxnard Plain.

The LAS is composed of the Hueneme, Fox Canyon, and Grimes Canyon aquifers to a depth of about 1,400 feet. The Hueneme aquifer is composed of alternating layers of sand and finer grained deposits. The Fox Canyon and Grimes Canyon aquifers are composed of thick sequences of relatively uniform marine sand. The Fox Canyon aquifer is the major water-bearing unit in the basin.

In Pleasant Valley the LAS is surrounded and underlain by partly consolidated marine deposits and volcanic rocks. Marine deposits are present in the Camarillo Hills and in the western edge of the Santa Monica Mountains near the coast. Volcanic rocks consisting of basalts, submarine volcanic flows, and debris flows are present in the Santa Monica Mountains along the southern edge of the valley (Weber et al., 1976). The underlying marine deposits and volcanic rocks both contain high-chloride water.

High-chloride concentrations are present in water from wells throughout the Pleasant Valley basin, especially along the southern edge of the basin near the Bailey Fault. Wells yielding high-chloride water in this area may have been drilled too deep and directly penetrate deposits having high-chloride water, or brines may have invaded deep freshwater aquifers from surrounding and underlying deposits as a result of pumping. Regardless of the source, changing hydraulic pressure as water levels within the Lower Aquifer System decline as a result of pumping wells, especially during dry periods, may increase chloride concentrations in water produced from deeper wells if the proportion of high-chloride water yielded to the wells from underlying deposits increases (Izbicki et al., 2005a). Chloride concentrations in water from deep wells in the Pleasant Valley basin tend to increase during dry periods when groundwater pumping increases. Conversely, chloride concentrations generally decrease during wetter periods when alternative sources of irrigation water are available from surface supplies and groundwater pumping decreases. In addition to water from surrounding and underlying rocks, irrigation return flow also may contribute to high chloride concentrations in deep wells that are partly screened in the UAS. More recently, groundwater recharge from Arroyo Las Posas in the northern portion of the basin has been recognized as an additional source of salt in the basin.

1.3.4 WEST LAS POSAS

The West Las Posas basin lies adjacent the northeast Oxnard Plain in the area south of South Mountain and north of the Camarillo Hills. The basin generally consists of a broad alluvial plain sloping to the south, and is drained by Beardsley Wash which flows west around the Camarillo Hills. Only the western portion of the West Las Posas basin lies within United's District boundary. Tree crops are the dominant land use in this agricultural area. Much of this area is served by groundwater imports from the Oxnard Plain basin, but some agricultural pumping is reported from deep wells near Beardsley Wash and other wells along the South Mountain foothills.

Most groundwater production in the West Las Posas basin is from deposits of the San Pedro Formation. Beneath most of the Las Posas Valley, the upper San Pedro Formation consists of low permeability sediments with lenses of permeable sediments which are age-equivalent to Hueneme Aquifer on the Oxnard Plain (DWR, 1975). The permeable lenses form isolated, yet, locally important water sources. The water-bearing zones in the upper San Pedro Formation are not well connected. Some recharge to the deeper Fox Canyon aquifer may source from downward leakage from the upper San Pedro Formation. Many wells in the Las Posas Basin are perforated in the Fox Canyon aquifer, making it the principal water-bearing unit (Mukae, 1988). The Fox Canyon aquifer is exposed almost continuously along the southern flank of South Mountain. South of the outcrop, beds of the Fox Canyon aquifer dip below the valley and are folded into a series of anticlines and synclines. Groundwater in the Fox Canyon aquifer exists under confined conditions beneath the valley and unconfined conditions at the valley margins where the aquifer is folded upward and exposed at the surface. Much of the groundwater recharge to the western portion of the West Las Posas basin is believed to source from the Oxnard Plain. Minor amounts of recharge are derived likely from infiltration of precipitation and runoff in the outcrop areas.

1.3.5 MOUND BASIN

The principal fresh water-bearing strata of the Mound basin are the upper units of the San Pedro Formation and overlying Pleistocene deposits that are interpreted to be correlative with the Mugu aquifer of the Oxnard Plain basin. There is an upper confining layer of Pleistocene clay approximately 300 feet in thickness. The basin extends several miles into the offshore.

The sediments of the basin have been warped into a syncline that is oriented in an east-west direction that roughly follows Highway 126. Structural disruption along the Oak Ridge fault in the southern portion of the basin has resulted in considerable uplift and erosion of the San Pedro and younger sediments. This disruption is the cause of the topographic “mounds” near the intersection of Victoria Avenue and U.S. 101, for which the basin is named. The Montalvo anticline has traditionally been used to define the southern extent of the basin. These structural features generally offset only the deeper LAS units of the adjacent Oxnard Plain. The deposits of the UAS overlie the faults and folds along the southern margins of the basin, but the character of the deposits change as they extend to the north, becoming more finely bedded and fine-grained (UWCD, 2012).

The limited number of wells in the Mound basin, especially in the northern half of the basin, complicates efforts to ascertain the primary sources of recharge to the basin. There likely is some component of recharge from precipitation falling on aquifer units that outcrop in the hills along the northern margin of the Mound basin (Figure 1.3-1), but no wells exist to provide evidence of this occurrence. There is general agreement that the basin benefits from recharge from the Oxnard

Forebay and Oxnard Plain to the south, especially during periods of high water level on the Plain (GTC, 1972; Fugro, 1996; UWCD 2012). The hydrogeologic boundaries of the Mound basin are not coincident with the structural boundaries of the basin, so there is hydrologic connection between the Mound basin and adjoining groundwater basins (UWCD, 2012). The amount of recharge from the Santa Paula basin to the east is also unclear, but high heads in some wells in the eastern Mound basin suggests some degree of connection and recharge. Mann (1959) suggested that there is little underflow from the Santa Paula basin to the Mound basin, although more recent studies suggest it may be significant (Fugro, 1996; UWCD, 2012).

Groundwater flow in the Mound basin is generally to the west and southwest with modest to weak gradients, especially in times of drought. The poor distribution and limited number of wells with water level records complicates efforts to contour groundwater elevations in the basin. During periods of drought and increased pumping, a pumping trough forms along the southern portion of the basin that significantly modifies groundwater gradients. Groundwater elevations fall below sea level in dry periods, but saline intrusion has not been observed in the Mound basin.

1.4 CURRENT GROUNDWATER CONDITIONS

Despite long-term efforts to conserve water, import more water to the District and optimize the use of local resources, water deficits exist in a number of areas throughout the District, most notably on the southern Oxnard Plain and in the Pleasant Valley basin. In some places, the depletion of groundwater reserves has simply resulted in lowered water tables. In other areas, significant water quality problems have developed in response to conditions of overdraft. Following construction of the Freeman Diversion and the Pumping Trough Pipeline, United's increased ability to divert water from the Santa Clara River for recharge and direct delivery restored the aquifers of the UAS to healthy conditions in the late 1990s and mid-2000s. Overdraft conditions have however continued in the LAS since construction of the Freeman Diversion. In recent years, United has modified diversion operations in order to be more protective of steelhead trout, resulting in a loss of water available for in-lieu deliveries and artificial recharge.

The following sections summarize current groundwater conditions on the Oxnard coastal plan within United's district boundaries. The onset of drought conditions in 2012 exacerbated the long-term overdraft issues that exist on the Oxnard coastal plain. The California Department of Water Resources recently revised the list of basins "subject to critical overdraft." Southern California has six basins designated as subject to critical overdraft, and the Oxnard Plain and Pleasant Valley basins have been assigned this designation. The Oxnard Plan and Pleasant Valley basins are the only two coastal basins on the list.

1.4.1 UAS GROUNDWATER ELEVATIONS, SPRING AND FALL 2015

A continuous potentiometric surface extends from the (unconfined) Oxnard Forebay basin to the confined Oxnard Plain and Pleasant Valley basins. Staff from United, the County of Ventura, cities and other agencies routinely measure water levels in more than 250 wells in the greater Oxnard Plain area. United compiles available records and queries measurements for individual wells in the spring and fall of the year, then draws potentiometric-surface (groundwater-elevation) contours for the Oxnard coastal plain. Groundwater levels are severely depressed and are currently at or near record lows in both the UAS and LAS, the result of diminished rainfall and recharge and ongoing groundwater extractions since 2012.

Groundwater elevation contours for the UAS in spring 2015 are shown for the Forebay and Oxnard Plain in Figure 1.4-1. These conditions are far from typical, with heads in much of the Forebay and virtually all of the Oxnard Plain below sea level. In the northern portion of the Forebay, water levels were above sea level and gradients were steeper than usual (and groundwater flow direction is interpreted to be more southerly than usual). The -10 foot contour is drawn within about a mile of the coast across the entire Oxnard Plain coastline, indicating landward gradients at all locations. The potentiometric surface in the interior portions of the basin is nearly flat, with a few minor pumping depressions indicated. Between spring 2012 and spring 2015, the zero elevation contour moved about ten miles inland, from near Mugu lagoon to the northern portion of the Forebay. In 2015, the lowest groundwater elevations were recorded in the middle of the basin, and not at the southern margin as is typical.

By fall 2015, UAS groundwater elevations were lower than in the spring, with the -20 foot contour drawn near the coast all along the margin of the basin (Figure 1.4-2). The hydraulic gradient in the interior of the basin was still nearly flat, and the lowest Oxnard aquifer water levels were recorded in the Forebay near United's El Rio spreading grounds where the O-H well field is in operation. Steep groundwater gradients exist between this location and the northern extent of the Forebay, where heads as high as 56 feet were recorded.

In many areas of the Forebay and Oxnard Plain, groundwater elevations in the Mugu aquifer are similar to or a few feet lower than those in the Oxnard aquifer. On the southern Oxnard Plain, and most notably in the area surrounding Mugu lagoon, water levels in the Mugu aquifer may be as much as 30 feet lower than in the Oxnard aquifer. Mugu aquifer heads in some wells south of Hueneme Road are nearly as deep as LAS heads. United contours Oxnard aquifer heads (to represent the UAS) by convention, despite the lower Mugu aquifer heads at some well sites.

1.4.2 LAS GROUNDWATER ELEVATIONS, SPRING AND FALL 2015

Figure 1.4-3 displays groundwater elevations from Lower Aquifer System wells in the Oxnard Forebay, Oxnard Plain and Pleasant Valley basin from spring 2015. LAS water levels were below sea level for the entire Oxnard Plain, most of the Forebay, and much of the Pleasant Valley basin. The highest water levels were recorded in the northern Forebay and the northern Pleasant Valley basins, which are recognized areas of recharge. Although LAS water levels are lower than in preceding years, the overall pattern of the contours remains similar. A persistent broad pumping depression is centered on the Oxnard Plain/Pleasant Valley basin boundary, where several wells recorded spring 2015 water levels at least 110 feet below sea level. This pumping depression extends to the coast near the Mugu submarine canyon, where the spring 2015 water level in well CM1A-565 was measured at 58 feet below sea level.

Figure 1.4-4 displays contours of groundwater elevations recorded in LAS wells in fall 2015. Water levels in the Forebay fell about 10 feet since the spring, but the main pumping depression shifted eastward into the Pleasant Valley basin. An area of more than three square miles had groundwater elevations deeper than 150 feet below sea level, located between the Bailey fault near Round Mountain and the Pleasant Valley basin boundary to the west. The broader pumping trough with groundwater elevations deeper than 100 feet below sea level is centered beneath the Oxnard Plain/Pleasant Valley basin boundary, extending from the Camarillo Hills to near Mugu Lagoon. The water level at the coast near Mugu Lagoon was measured at 98 feet below sea level. LAS piezometers surrounding Port Hueneme recorded water levels ranging from -19 to -40 feet below sea level in fall 2015.

Figures 1.4-3 and 1.4-4 show steep groundwater gradients in the northeast Oxnard Plain near the West Las Posas basin boundary. Along the northern portion of the West Las Posas basin boundary, the production wells used for water level monitoring tend to be screened in the Hueneme aquifer. To the south in the area west of the Camarillo Hills, the Hueneme aquifer is more fine-grained and interbedded, and most wells are completed in deeper beds of the Fox Canyon aquifer where heads are lower. There are steep LAS gradients in this area as the character of the Hueneme aquifer changes, but the apparent gradient displayed in the contouring is also influenced by the shift to deeper well completions to the south. The deep LAS monitoring wells at the El Rio spreading grounds record water levels similar to the Fox Canyon wells near the Camarillo hills, so contouring water levels from the deeper LAS wells in the Forebay would extend the eastern Oxnard Plain/Pleasant Valley pumping depression into the Forebay. United's modeling of groundwater flow in the coastal basins shows the LAS aquifers of the Oxnard Plain do receive significant recharge from the Forebay, but much of the groundwater leaves the Forebay as flow in the UAS. Across the Oxnard Plain there is significant downward groundwater flow from the UAS to the LAS, especially in areas where large vertical gradients exist and aquitards between the aquifers are thin or discontinuous.

1.4.3 SALINE WATER INTRUSION

High chloride levels were first detected on the Oxnard Plain in the vicinity of the Hueneme and Mugu submarine canyons in the early 1930s (CA DWR, 1965) and became a serious concern in the 1950s. Drought conditions in the mid-1970s resulted in depleted basins conditions that resulted in another episode of saline intrusion. The State Water Resources Control Board was concerned enough to threaten adjudication of water rights on the Oxnard coastal plain, as discussed in Section 1.1.3 above. This threat spurred the construction of the Pumping Trough Pipeline and the Freeman Diversion, and the creation of the Fox Canyon Groundwater Management Agency.

Early monitoring programs used only existing production wells and abandoned wells as monitoring points; sampling of these wells indicated that there was a widespread area of elevated chloride concentrations in the Hueneme to Mugu areas. In 1989, the U.S. Geological Survey initiated their Regional Aquifer-System Analysis (RASA) study and other cooperative studies with local water agencies. United, Calleguas Municipal Water District and the FCGMA provided significant funding for various USGS studies within the greater Santa Clara-Calleguas groundwater basin. As part of these studies, a series of 14 nested well sites, with three or more wells installed at each site, were drilled and completed at specific depths in the Oxnard Plain basin (Densmore, 1996). Water quality samples from this new network of coastal monitoring wells provided significant new insight into the both the extent of saline intrusion in coastal areas and the various processes by which saline intrusion occurs (United, 2016a).

The installation of a dedicated monitoring network and detailed chemical analysis of water samples from the new wells and other wells yielded new interpretations on the extent of seawater intrusion on the Oxnard Plain. It is now known that some areas of the Oxnard Plain are not intruded by seawater, and instead may be subsurface brine intruding into adjacent fresh water supply aquifers from surrounding and underlying formations (Izbicki, 1992; Stamos and others, 1992; Izbicki and others, 1995; U.S. Geological Survey, 1996). Historic assessments of saline intrusion focused largely on chloride and total dissolved solids (TDS) or electrical conductivity (EC) as indicators of water quality degradation. The evaluation of major and minor-ion chemistry, trace element analysis and specific isotope chemistry from samples collected during and since the USGS RASA study has led to the conclusion that chloride degradation in the Oxnard Plain and Pleasant Valley basins is related to four sources and processes (Izbicki, 1991, Izbicki et al, 2005a). Lateral intrusion of seawater is most common near the Hueneme and Mugu submarine canyons where seawater enters confined production aquifers in response to landward hydraulic gradients. Near-shore submarine canyons can shorten the flow path of seawater into onshore coastal aquifers, enhancing the potential for seawater intrusion (Hanson et al., 2009).

Another source of saline intrusion is subsurface brine intruding into adjacent fresh water aquifers from surrounding and underlying formations. Clay beds are common both between and within the aquifers of the Oxnard Plain, and saline connate waters may be expelled from these clays as they compact in response to prolonged periods of low pressure within the surrounding aquifer units. Saline water (also referred to here as brine) can also originate from older geologic formations, which may be displaced by faulting to a position adjacent fresh water aquifers, or may move upwards from greater depths, along fault traces in response to low pressures in production aquifers (Izbicki et al, 2005a).

Cross contamination through corroded or improperly constructed wells also may be a source of saline water detected in aquifers underlying the Oxnard coastal plain. Heads are commonly higher in the Semi-perched aquifer than in deeper confined aquifers. Saline or brackish groundwater has been documented in the Semi-perched aquifer, and may result from a combination of 1) seawater that recharged the aquifer through offshore outcrops or infiltrated into the aquifer through coastal wetlands or during coastal flooding, 2) elevated concentrations of dissolved minerals resulting from the evaporative discharge of groundwater at land surface, or 3) the infiltration of irrigation return flows (Izbicki, 1996c). Large differences in head can also exist between production aquifers at a single location. When long-screen production wells are screened across several aquifers with differential heads, passive flow within these wells can be significant (Alvarado et al, 2009), allowing poor-quality groundwater from one aquifer to migrate to other (underlying or overlying) aquifers.

In summary, detailed chemical analysis of samples from the coastal monitoring wells has revealed that the source of the elevated chloride levels varies among wells on the Oxnard Plain (Izbicki, 1991, 1992). Four major processes of chloride degradation have been documented in this area:

- **Lateral Seawater Intrusion -** the inland movement of seawater (under the influence of a landward hydraulic gradient) from areas where aquifers crop out in the Hueneme and Mugu submarine canyons.
- **Cross Contamination** - the introduction of poor quality water into fresh water aquifer zones via existing wellbores that were improperly constructed, improperly destroyed, or have been corroded by poor quality water in the Semi-perched zone.
- **Compaction of Salt-Laden Marine Clays** - the dewatering of marine clays, interbedded within the sand and gravel rich aquifers, yields high concentrations of chloride enriched water. This dewatering is the result of decreased pressure in the aquifers, caused by regional pumping stresses.
- **Lateral Movement of Brines from Tertiary formations** - the lateral movement of saline water from older geologic formations that have been uplifted by faulting to positions adjacent to younger freshwater-bearing formations. The lateral movement occurs across a buried fault face near Pt. Mugu where Tertiary rocks are in contact with the younger aquifers.

Chloride degradation from each of the processes listed above is directly related to water levels in the basin. The water balance of the Oxnard Plain and the offshore component of the aquifer units is a dynamic relationship between groundwater recharge, groundwater extraction and change in aquifer storage. The primary source of groundwater recharge for the Oxnard Plain groundwater basin is the Oxnard Forebay, where United's recharge basins are located. High water levels in the Forebay exert a positive pressure on the confined aquifers of the Oxnard Plain, and water flows from the recharge areas toward the coast. The pressure (piezometric) surface of the confined aquifer is diminished by the extraction of water from the system. If pressure heads at the coast fall below sea level, the lateral intrusion of seawater will occur, resulting in aquifers being recharged with seawater due to landward pressure gradients. The dewatering of marine clays will occur if heads in the surrounding sediments remain below their historic levels for prolonged periods, allowing formerly immobile salts to be expelled into surrounding aquifer material. Brine migration into fresh aquifers also results from low pressure in the aquifers compared to historic conditions. United's recharge activities and delivery of surface water to the southern regions of the Oxnard coastal plain serves to diminish pumping stress on the aquifers and mitigate all forms of saline intrusion.

In addition to drilling coastal monitoring wells, in 1990 the USGS conducted a time domain electromagnetic (TDEM) geophysical survey to determine the general extent of the high-saline areas (Stamos and others, 1992; Zohdy and others, 1993). This work indicated that the high-saline areas consisted of two distinct lobes (near Port Hueneme and Mugu Lagoon), with relatively fresh water separating the lobes (U.S. Geological Survey, 1996). The survey also revealed that areas of aquifer degradation by saline water varies with depth. The greater Mugu area was again surveyed with TDEM geophysics in 2010 (UWCD, 2010). Wire line conductivity surveys were conducted by the USGS in a number of the well bores for the coastal monitoring wells, and these surveys were also later repeated by United. Results from the wire line surveys indicate that the edges of the observed saline lobes are relatively distinct, with the first saline intrusion occurring in thin individual beds of permeable sand and gravel. As intrusion continues, more individual beds are impacted, resulting in increasing chloride levels.

Figures 1.4-5 through 1.4-10 plot recent chloride concentrations from the coastal monitoring wells sampled by United, and use results from United's 2010 geophysical survey as a base image. The density and distribution of available monitoring wells is fairly poor for the large area of the southern Oxnard Plain, but the TDEM findings of high salinity are substantiated in a number of wells. In other areas there is poor agreement between sampled chloride concentrations and areas of impact modeled by the TDEM geophysical methods. Without additional monitoring well installations it is difficult to ascertain whether high salinity exists in beds not screened by the short screened intervals of the monitoring wells, or if the geophysical survey results are inaccurate. The maps include an interpreted line suggesting the current inland extent of saline intrusion based on measured concentrations from monitoring wells, United's 2010 geophysical survey, and other prior studies detailing the extent of the intrusion front. Saline impacts associated with the compaction of sediments or brine migration have a more random distribution, however, and are not necessarily represented by a frontal boundary.

An additional source of saline water, the upwelling brines from deeper formations, has been documented in a number of production wells in the Pleasant Valley basin. Advancements in the tools used in sampling pumping production wells has allowed for the documentation of flow and water quality profiles in long-screen production wells (Izbicki et al, 2005a, 2005b). Data from some area wells indicate that poor water quality at the wellhead results from saline water entering the well from specific aquifer zones rather than thick portions of the aquifer. High chloride concentrations most commonly observed in the deepest portion of a well may be indicative of brines migrating from deeper zones towards a water level depression (low pressure area) created by long-term conditions where demand and pumping exceed recharge. This upwelling of brines is another form of saline intrusion, and like the compaction of marine clays, where occurrence is not limited to coastal areas (Izbicki, 1992). An increase in the number of LAS wells recording increases in chloride concentrations suggest areas impacted by brine intrusion are increasing, most notably in the Pleasant Valley basin.

The shallow groundwater of the Semi-perched aquifer is rarely used for supply purposes, and relatively little water quality data exists for this zone. Water quality of the Semi-perched zone can vary dramatically with time and location, ranging from fresh to saline. United's fall 2015 sampling event documented chloride concentrations in Semi-perched wells ranging from 77 milligrams per liter (mg/l) to 13,000 mg/l (Figure 1.4-5). Near Port Hueneme, groundwater of this unit is consistently saline, with chloride concentration recorded at 13,000 mg/l in well A2-70. Chloride concentrations are much lower east of Port Hueneme, with well SW recording 398 mg/l chloride, and fresh water observed in the SWIFT well (77 mg/l chloride). Farther inland between Port Hueneme and Point Mugu, chloride concentrations are variable in the SCE well, with higher chloride concentrations observed during dry periods (Figure 1.4-5). Elevated chloride of 1,950 mg/l was recorded in well SCE-38 in fall 2015. The leakage of poor-quality water from the Semi-perched aquifer can degrade water quality in the deeper confined aquifers. Corroded and improperly constructed wells can provide a pathway for this downward leakage.

The Oxnard aquifer is the shallowest confined aquifer of the UAS. There are two distinct areas of known saline intrusion in the Oxnard aquifer, generally occurring near and southeast of Port Hueneme, and in the area surrounding Mugu Lagoon (Figure 1.4-6). Near Port Hueneme, chloride concentrations have been increasing since 2013 in the area west of the harbor, with 1,080 mg/l recorded in well A2-170 in fall 2015. This is new saline intrusion associated with the current drought conditions. Concentrations in well A1-195 located to the east of the harbor have remained stable, and were measured at 159 mg/l in 2015. Southeast of Port Hueneme, an area of elevated chloride is observed and includes the locations of coastal wells CM4 and CM7, and the more inland wells SW and SWIFT. The highest fall 2015 chloride concentrations are found near the coast, with 5,520 mg/l recorded in well CM4-275 and 1,890 mg/l in well CM7-190. Well CM7-110 has had nearly a ten-fold increase in chloride, rising from 2,470 mg/l in 2013 to a peak of 22,500 mg/l in March 2015. It is interesting to note that nearby coastal well clusters CM4 and CM7 both have two wells screened in the Oxnard aquifer. Each of these four wells have significantly different chloride concentrations in 2015, and the lesser chloride is recorded in the shallower well at CM4 and the deeper well at CM7. To the southeast of well CM7, the coastal well CM5 records relatively low and fairly stable chloride. The more inland wells SW and SWIFT recorded 2015 chloride concentrations of 462 and 1,100 mg/l, respectively.

Located on the coast south of Mugu Lagoon and near the Mugu submarine canyon, Oxnard aquifer well CM1A-220 has historically had chloride levels approaching that of seawater, recorded at 16,700 mg/l in fall 2015 (Figure 1.4-6). Northwest of that location, water quality in well CM6-200 remains moderately degraded, measuring 2,060 mg/l chloride in 2015. At the DP and Q2 well sites, Oxnard aquifer chloride was measured at 374 and 402 mg/l, respectively, in fall 2015.

The Mugu aquifer is the deeper aquifer of the UAS. Chloride impacts are less widespread in the Mugu aquifer than in the Oxnard aquifer. Well CM2-280, located west of Port Hueneme and on the coast near the Hueneme submarine canyon, recorded a slight increase in chloride in recent years, measuring 117 mg/l in 2015 (Figure 1.4-7). Wells A1-320 and A2-320, also located near Port Hueneme, record chloride concentrations common to unimpaired areas of the Mugu aquifer. The Mugu aquifer wells located north and northwest of Mugu Lagoon record high chloride values that have increased fairly consistently since the wells were installed. Fall 2015 chloride concentrations in wells CM6-300, Q2-285 and Q2-370 ranged from 2,590 to 2,900 mg/l (Figure 1.4-7). These elevated chloride concentrations are believed to be associated with brines and not direct lateral seawater intrusion. The remaining piezometers completed in the Mugu aquifer and located in both the coastal and more inland areas between Port Hueneme and Point Mugu consistently have low chloride concentrations ranging from about 30 to 40 mg/l.

The Lower Aquifer System is comprised of the Hueneme, Fox Canyon and Grimes Canyon aquifers. Relatively few coastal monitoring wells are completed in the Hueneme aquifer, and all of those are located in the area surrounding Port Hueneme. Wells A1-680 and CM4-760, located east of the port, do not indicate any recent or historic chloride impacts (Figure 1.4-8). Three of the four Hueneme aquifer wells located west of Port Hueneme, however, have recorded elevated chloride concentrations. The highest chloride concentrations are recorded in well CM2-760, and have generally measured greater than 10,000 mg/l since fall 2003. An increase in chloride has also been observed since 2014 in well CM2-520, recently reaching 365 mg/l. Chloride concentrations in this well reached 2,800 mg/l in 1993, but this peak concentration was followed by a long period of decreasing chloride lasting until 2014. The A2 well cluster is located north of the CM2 site, and chloride impacts have not been observed in well A2-560. Chloride concentrations have however increased in well A2-740 since 2004, reaching a high of 208 mg/l in fall 2015. No Hueneme aquifer monitoring wells exist in the area surrounding Mugu Lagoon, as the sediments that make up the Hueneme aquifer are interpreted to have been uplifted and eroded in this vicinity.

Evidence of saline water intrusion has not detected by the sampling of existing monitoring wells screened in the Fox Canyon aquifer near Port Hueneme and nearby coastal areas to the east. The Fox Canyon aquifer wells surrounding Mugu Lagoon, however, document significant water quality degradation (Figure 1.4-9). Well Q2-640 is located north of Mugu Lagoon, and samples show steady degradation since the well was constructed. In fall 2015 sampling of this well recorded 5,140 mg/l chloride. Northwest of Mugu Lagoon, chloride concentrations in well CM6-400 have had an increasing trend since 1999, measuring 1,430 mg/l in a recent sampling event. Well CM6-550 has shown a decreasing trend in chloride concentrations since a significant peak in 2004, most recently measuring 205 mg/l chloride. The Fox Canyon aquifer wells of the DP cluster, located north of CM6 well cluster, have differing trends. Well DP-580 has recorded an increasing chloride trend, rising from 460 to 1,790 mg/l throughout the period of record, while well DP-450 has had a more stable chloride trend (average concentration of approximately 1,000 mg/L) since 2007. Further inland and north of Mugu Lagoon a slightly elevated chloride concentration of 99 mg/l was recorded in fall 2015, which is consistent with the ten-year record for well GP1-740. Fox Canyon aquifer well GP1-460 does not show chloride impacts, nor does well SCE-414 located farther to the north.

There are no Grimes Canyon aquifer monitoring wells at Port Hueneme, and wells CM4-1395 and CM5-1200, located near the coast to the southeast of the port do not show evidence of saline intrusion (Figure 1.4-10). Grimes Canyon wells surrounding Mugu Lagoon do show significant chloride impacts. At the coast near the Mugu submarine canyon, well CM1A-565 has become steadily more saline since its installation in 1989, with 5,820 mg/l chloride recorded in fall 2015. North and northwest of Mugu Lagoon, deterioration of water quality is documented at the Q2 and DP well locations. Chloride concentrations of 14,300 and 4,050 mg/l were recently observed in wells Q2-840 and Q2-970, respectively. Northwest of that location, chloride was measured at 6,060 mg/l in well DP-720 in fall 2015. The rising chloride concentrations in these deep wells in the Mugu Lagoon area is thought to be associated with brines and not the directed lateral intrusion of seawater.

1.4.4 NITRATE IN THE OXNARD FOREBAY

The Oxnard Forebay is vulnerable to nitrate contamination for some of the same reasons the basin is valued for water resource projects. The coarse alluvial sediments common to the area allow the rapid vertical transport of water from the near-surface to the water table. During wet periods, the regional water table is often only tens of feet below the land surface in the Forebay. Nitrate is highly soluble and very mobile, making it susceptible to leaching from soils and transport to groundwater. United monitors water quality in 43 monitoring wells in the Oxnard Forebay, in its public supply wells, and in 11 privately-owned production wells. Nitrate concentrations tend to be low in wells near the Santa Clara River and near the Saticoy Recharge Facility, as Santa Clara River water consistently has low nitrate concentrations (UWCD, 2008). Wells completed in the LAS also tend to have low nitrate concentrations. Measured nitrate concentrations are more variable in the down-gradient portions of the basin. Figure 1.4-11 shows the maximum-recorded nitrate concentrations for Forebay wells in calendar year 2015.

United's El Rio facility was developed in the early 1954 as part of a groundwater management strategy to move groundwater pumping associated with growing coastal populations away from the coastal areas that were increasingly impacted by saline intrusion. The El Rio Recharge Facility and well field are located in the down-gradient portion of the Oxnard Forebay, and the Oxnard-Hueneme (O-H) Pipeline was constructed to convey potable groundwater from the Forebay to the City of Oxnard and the Port Hueneme Water Agency (City of Port Hueneme, Naval Base Ventura County, Channel Islands Beach Community Services District), and several small mutual water districts. This strategy remain)s effective in mitigating pumping impacts in coastal areas subject to saline intrusion. Nitrate concentrations are however quite variable in United's El Rio wells, and at times United has to monitor production wells frequently and blend water from various wells to maintain nitrate concentrations below regulatory standards. A primary health standard exists for nitrate, and the maximum contamination level (MCL) for nitrate of 45 mg/l nitrate (or 10 mg/l for nitrate as N). Adherence to this standard is enforced by the California State Water Resources Control Board's Division of Drinking Water (DDW), as high nitrate concentrations can result in methemoglobinemia (or "blue baby syndrome"), a condition where ingested nitrogen interferes with the blood's ability to carry oxygen.

Water produced by United's El Rio wells is a mixture of groundwater that enters the well at various depths along the screened interval of the well. Santa Clara River water that is spread in the El Rio recharge basins located adjacent the wells migrates downward fairly rapidly, and this high-quality water often makes up a large percentage of the water produced by the UAS wells during periods of active recharge operations. When recharge at the El Rio facility ceases or is significantly reduced, groundwater flow paths from up-gradient areas become the dominant source of water produced by the wells. Groundwater travel times are difficult to determine, but nitrate can remain in the groundwater of the basin for years or decades before arriving at well screens, even in relatively shallow wells (Boyle et al, 2012).

Nitrate levels in the El Rio area have fluctuated widely through time, with highest nitrate levels commonly observed during and following drought periods, and relatively low nitrate levels are often recorded during wet periods (UWCD, 1998, UWCD, 2008). Nitrate levels tend to stay relatively low during wet periods when low-nitrate Santa Clara River water is spread by United in the El Rio recharge basins and natural recharge to the basin is abundant. However, when there is not sufficient river water to spread at El Rio, nitrate levels in the O-H wells sometimes rise, particularly in the northeastern (up-gradient) portion of the recharge facility.

Monthly recharge totals and recorded nitrate concentrations from the El Rio UAS wells, from 2011 to present, are shown in Figure 1.4-12. The figure shows a clear inverse relationship between recharge volumes and nitrate concentrations in many of the wells. Nitrate concentrations were consistently low from January 2011 through May 2012, when surface water was available for recharge at El Rio. Nitrate concentrations increased in some wells in summer 2012, but recharge in fall 2012 and in early 2013 reduced nitrate concentrations to below the MCL in all but one well. Nitrate concentrations in all the wells increased in the summer and fall when there was no recharge activity. Since that time, nitrate concentrations more than twice the MCL have become common in some of the wells, and the wells with the lowest nitrate concentrations commonly range from about 20 to 40 mg/l.

Beginning in spring 2013, United began operating its deeper El Rio (LAS) wells in the Forebay as a source of blending water to mitigate high nitrate concentrations in the UAS wells. While low in nitrate, the LAS wells have iron and manganese concentrations that pose water quality treatment challenges for some of the O-H customers. It is a particular problem for the Port Hueneme Water Agency, as the iron and manganese interferes with the reverse osmosis system it operates. Because of this, United and its O-H customers are contemplating construction of an iron and manganese treatment system at El Rio. Construction of the facility would cost approximately $4.5 million, and cost about $200 per acre-foot to treat water produced by the LAS wells.

2 ANALYSIS

To inform the MSHCP, United has developed a set of instream flow/diversion operational scenarios. They included proposed facilities modifications. Below is a description of the operational scenarios:

Scenario 1 (No Diversion) – United diverts no river flow at the Freeman Diversion other than water released from Santa Felicia Dam during the summer-fall conservation release.[1]

Scenario 2 (Water Right Operations) – United conducts operations at the Freeman Diversion in accordance with SWRCB Permit 18908. Under this scenario, United diverts up to 375 cfs on a daily basis for distribution to groundwater recharge percolation basins and an additional 38 cfs for consumptive use within its service area. The maximum annual diversion volume on a calendar year basis is 144,630 AF. During the period February 15 to May 15, each time the Santa Clara River flows recede to 415 cfs, United must provide a minimum bypass flow of 40 cfs for 48 hours. Due to various limitations such as excessively high total suspended solid (TSS) levels (TSS greater than 2,580 mg/l) and limited recharge facilities during high groundwater conditions, United cannot always divert what is allowed under the water right. The calculated diversions included from the Hydrologic Operations Simulation System (HOSS) model (discussed in the section below) incorporated the existing facilities' limitations in the model to estimate the diversions and bypass flows under this water right at the facilities' current capabilities.

Scenario 3 (Interim Bypass Operations 2010-2016) – Between 2010 and 2016, United conducted operations at Freeman Diversion largely in accordance with the 2009/2010 bypass flow plan. This scenario includes a 160 cfs bypass target within an 18-day ramp-down schedule for migration of steelhead adults between January 1 and May 31st. Additional restrictions on diversions depend upon turn-in procedures. Smolt bypass flows are implemented from March 15th to May 31st. The District reserves the right to divert the first 40 cfs of the river after the upstream migration releases have ceased and the smolt flows are being released. The target flow at the critical riffle during this period is 120 cfs. The critical riffle is the point in the river downstream of the diversion that is the most difficult riffle for an upstream migrant. This point can move within the river although has always been located in the Forebay. The critical riffle is the compliance point for many of the bypass flows downstream of the diversion. Bypass flows are to remain at 120 cfs until all the water in the river less the critical diversions is unable to maintain the targeted flow. The critical diversions are the flows that are needed to maintain the surface water deliveries to the PTP and PVCWD. Bypass flows will then continue until all the

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[1]United releases water at the Santa Felicia Dam from Lake Piru during the fall months to recharge the Piru, Fillmore and Santa Paula groundwater basins and divert remaining flows at the Freeman Diversion.

water in the river less the critical divisions is unable to maintain 80 cfs at the critical riffle. At this time a 3-day ramp down may commence to divert the remaining river.

Scenario 4 (2008 Biological Opinion) – United conducts diversion operations in accordance with reasonable and prudent alternative 2 (RPA 2(a) and 2(b)), as contained in the 2008 Biological Opinion issued by NMFS. Under this scenario, United must bypass a flow magnitude that maintains a minimum 160 cfs over the critical riffle. After 160 cfs is maintained at the critical riffle, the remaining provisions apply. When United initiates the turn-in procedure, and when total river flows are higher than 750 cfs, United may divert up to 100 percent of the remaining flows (total flow minus minimum bypass flow) up to its full diversion limit of 375 cfs. At total river flows from 635 to 750 cfs United may divert up to 30 percent of the remaining flow up to its full diversion limit, and at total river flows less than 635 cfs United may divert up to 20 percent of the remaining flow up to its full diversion limit. Bypass flows are to be implemented until flows at the critical riffle go below 160 cfs with all the water in the river and none being diverted. From March 1 through May 31, when total river discharge immediately upstream of the Freeman Diversion is sufficient to maintain connectivity with the Santa Clara River estuary during the emigration season for juvenile steelhead, United extends the 18-day bypass flows to ensure volitional emigration of juvenile steelhead to the estuary. When total river discharge immediately upstream of the Freeman Diversion recedes to a magnitude no longer capable of maintaining connectivity with the Santa Clara River estuary (80 cfs), even with all water in the river passing downstream and none being diverted, United ceases bypass flows. The 2008 Biological Opinion was based on United's existing facilities, therefore the limitations to diversions in this scenario were based on the existing facilities' capabilities, as were scenarios 2 and 3.

Scenario 5 (Yield Neutral – Mimic Flow Recession) – This scenario is not included in the analysis.

Scenario 6 (Mimic Flow Recession) – United conducts diversion operations at the Freeman Diversion in a manner that attempts to balance mimicking the natural flow recession while minimizing net yield loss compared to scenario 3. This scenario guarantees, at a minimum, all the bypass flows in scenario 3 as well as additional flows to mimic the receding limb of the hydrograph and extend the operations of the fish passage facility from 18 to 30 days. The mimicking of the receding limb will bypass, if possible, 650, 450, 350, 280, 235, 205, 185, and 170 cfs for each consecutive day after the peak of the storm. If there is insufficient flow in the river to maintain the targeted bypass, then United returns to operations described in scenario 3. Bypass flows continue at a minimum of 160 cfs at the critical riffle for 30 days after the peak of a migration storm, available flows permitting. United implements scenario 3 flows if there is not sufficient water in the river to meet the targeted additional flows that mimic the receding limb of the hydrograph.

- **Scenario 6A** - This scenario assumes the existing diversion capabilities. Diversions in this scenario are limited to suspended sediment levels in the river of 2,580 mg/l or lower, which is the current limit on diversions for sediment concentrations in the river. Potential diversions are also rejected when the groundwater mounding occurs during wet conditions. If this scenario becomes the accepted alternative, then it will most likely be closest to actual operations until improvement have been made to reflect scenario 6B.

- **Scenario 6B** - As described in scenario 2, United is currently limited in its capabilities of diverting its full water right due to high levels of sediment and infrastructure capabilities. This scenario includes major infrastructure changes to the diversion system, conveyance system, and percolation basins, in order to regain yield that would be lost by extending the duration of bypass flows. The additional yield would result from diverting water with higher turbidity levels (TSS up to 10,000 mg/l) during the peaks of the storms, and percolating additional water in new facilities (e.g. Ferro Basin) during wet years when groundwater mounding is expected to occur.

Scenario 7 (Increased Diversion Rate Operations) – Under this scenario, United increases its instantaneous diversion rate to a maximum of 750 cfs and the total annual diversion limit to 188,000 AF. Under this scenario, United diverts water with TSS levels as high as 10,000 mg/l (current maximum levels are around 2,580 mg/l). United also implements all bypass flows as described in scenario 6. When suspended sediment and the bed load sediments reach levels that would overwhelm the system, United turns out and stops diverting water. Diversions resume when the TSS levels in the river fall below 10,000 mg/l. United diverts up to 750 cfs if the bypass flows detailed in scenario 6 are met. Upon turning-in, diversions are limited by the ramping rate schedules as detailed in Appendix A of the MSHCP (United, 2016b). Importantly, this operational scenario is not covered under United's current water right and permit. Therefore, to implement this scenario, United would need to obtain additional water rights. Additionally, the existing infrastructure of the Freeman Diversion facility and associated downstream facilities cannot accommodate operations under this scenario and would need to be modified. In many normal and wet years, storm water runoff in the Santa Clara River often is over 1,000 cfs for several days. New infrastructure at the Freeman Diversion headwork's would allow for diversions of 750 cfs during these higher flow events while providing sufficient bypass flows for the migration of steelhead and lamprey. Most of the additional yield would be accrued when there is enough water in the river to maintain both bypass flows and diversions, helping to make up for the water dedicated to bypass flows for fish migration.

The following subsections describe the models used to develop and evaluate forecasted effects of each simulated diversion scenario on groundwater conditions.

2.1.1 HYDROLOGICAL OPERATIONS SIMULATION SYSTEM (HOSS)

The HOSS is a hydrology-based operations model that simulates flow magnitudes in the Santa Clara River downstream of the Freeman Diversion. The HOSS is based upon the earlier hydrology-based Freeman Operations Model (FOM), developed by United to simulate the Freeman Diversion operations' effects upon Santa Clara River flows downstream of the Diversion, and based upon several decades of historical flow gage data, groundwater conditions in the aquifer, and diversion flow rates. The HOSS is a more user-friendly operations model with a graphical user interface

(GUI), but still incorporates United's original hydrology-based model (FOM) (R2 2016). The HOSS calculates the magnitude of flow at five locations using operational rules defined in the various scenarios. The main outputs from the model are the magnitude of diversion flows, and the magnitude of flows within the "critical reach." The critical reach is the section of the Santa Clara River extending from approximately the Highway 118 bridge downstream to the Highway 101 bridge, and includes transects to measure flow characteristics at a series of critical riffles. Since the 1990s, the HOSS has been expanded to include additional operational rule sets and refined to better represent surface and ground water interactions within the critical reach. In general, the HOSS processes total river flow entering the Freeman Diversion facility and the operational rules determine the amount of water that is diverted, the amount of water that continues to flow downstream of the facility, and the amount of water that is lost or gained to/from groundwater in the critical reach.

2.1.2 OXNARD PLAIN SURFACE WATER DISTRIBUTION MODEL

The Oxnard Plain Surface Water Distribution model is essentially a water routing model that simulates amounts of groundwater recharge in United's recharge basins and supply to surface water delivery systems, based on a series of adjustable hydrologic inputs (e.g. total river flow, diversions) and operational assumptions. All model calculations are performed in daily time steps in Excel software, using hydrologic inputs from the period of record between January 3, 1944 and December 31, 2015. The surface water distribution model was used in the current report to calculate recharge and surface water deliveries for seven operational scenarios, which are required as inputs for the groundwater model described in Section 2.1.3. In order to match the groundwater model stress periods, Oxnard Plain Surface Water Distribution model outputs were converted to monthly totals for the period between January 1, 1985 and December 31, 2015. The water distribution model was also used to calculate pumping demands for the groundwater modeling period, based on the difference between surface water deliveries and total agricultural demands within United's service area.

Water resource inputs to the model include diversion amounts, pumping from Saticoy wells and Conejo Creek diversions. Operational assumptions determine how the distribution of water resources is prioritized among recharge basins and surface water deliveries, and change based on seasons and hydrologic conditions (dry or wet years). For operational scenarios 2 to 7 (with diversions), it is assumed that diverted water can supply all recharge basins and surface water delivery systems, while supplies from the Saticoy wells are restricted to surface water delivery pipelines, and supplies from Conejo Creek diversions are restricted to the Pleasant Valley (PV) surface water delivery pipeline. For scenario 1 (no diversions), only conservations releases are diverted, and delivered to the El Rio recharge basin. Infrastructure limitations restrict maximum daily recharge in each basin and surface water deliveries, and additionally infiltration rates in the Saticoy and El Rio basins are gradually decreased, based on cumulative recharge volumes. Infiltration rates in the latter basins become limiting only when basins are filled to capacity.

2.1.2.1 INPUTS AND ASSUMPTIONS

Water resource inputs include:

- Diversions at Freeman Diversion: Daily average diversions (cfs) for all operational scenarios. Diversions were calculated in the HOSS (described in Section 2.1.2), but reduced by 10% for days when bypass flows were provided to account for inefficiencies in diversion operations due to flushing, maintenance and other reasons. For scenario 1, 100% efficiency was assumed.
- Saticoy Well Field: Daily average supply from Saticoy well field (cfs). The Saticoy well field is used to pump down the groundwater mound that develops beneath the Saticoy recharge basins, with the capacity of the Saticoy well field dependent upon groundwater elevation. The well field does not supply water during periods of heavy spreading in the recharge basins. Water pumped from the Saticoy well field is distributed to the PTP and PV pipelines. Supply input was calculated as potential supply (i.e. without considering demand) based on a correlation between the actual water levels near the pumps to the observed production rate. The Saticoy well field will only be utilized for scenarios 2 to 7, when the demands for surface water deliveries exceed the potential supply of the surface water. The Saticoy well field is not operational under scenario 1.
- Conejo Creek Diversions: Daily average diversions from Conejo Creek by Camrosa Water District and delivered to Pleasant Valley County Water District. These diversions exclusively supply the PV surface water delivery system. Diversions were assumed constant at 6.1 cfs, based on data from 2012.

Water routing prioritization indicates the order in which recharge basins and surface water delivery systems receive available water. Facilities assigned a priority of 3 or higher often receive no water, as all water has been used by higher priority facilities. Prioritization rules for water routing are summarized in Table 2.1-1, and depend on the following factors:

- Water year hydrology is defined as low, moderate or high, based on stream flow magnitude (R2 Resource Consultants, 2016).
- Season: summer is defined as July 1st to first significant storm event of the winter (equal to first turn-out of season); winter is the remaining period. During summer dry and normal conditions, the highest priorities for surface water routing are El Rio, PTP and PV (percentages to each facility are detailed in Table 2.1-1). During winter season and wet summers, the highest priority is surface water deliveries (equally divided between PTP and PV), followed by El Rio and then other recharge basins.
- Forebay available storage (AF) is the volume of groundwater that is able to be stored in the Forebay and is calculated based on water elevation in 2 key wells. Conditions with available storage > 70,000 AF indicate dry conditions with a high priority for recharge in El Rio.
- Suspended sediment concentrations. When sediment levels in the river exceed 3,000 NTUs, diversions are routed to Noble Basin first, to avoid clogging of the surface layer in the Saticoy basins due to accumulation of sediment. Sediment levels in the river were estimated based on correlation between average daily streamflow and sediment concentration.

Table 2.1-1. Prioritization order for water resources supply to United's facilities.

Facility	Scenarios 2 to 7				Scenario 1
	Summer (low – moderate)	Summer (high), winter	Forebay storage > 70,000 AF	NTU > 3,000	
El Rio basin	1 (50%)	2	1	5	1
PTP system	1 (25%)	1 (50%)	2 (50%)	6 (50%)	n/a
PV system	1 (25%)	1 (50%)	2 (50%)	6 (50%)	n/a
Saticoy basin	2	3	3	4	n/a
Noble basin	3	4	4	1	n/a
Rose basin	4	5	5	2	n/a
Ferro basin	5	6	6	3	n/a

Notes: "1" is the highest priority; when facilities are assigned identical priorities, the percentages of supply received for each facility are included in parentheses.

Instantaneous conveyance capacity limits for the facilities were the following: 225 cfs for Saticoy, 80 cfs for Noble, 30 cfs for Rose, 100 cfs for Ferro (increased to 375 cfs for scenario 7), 120 cfs for El Rio (increased to 405 cfs for scenario 1), 65 cfs for PTP and PV systems individually, and 75 cfs for PTP and PV systems combined. In addition, cumulative restrictions on supply to the Saticoy and El Rio basins were applied for scenarios 2 to 7 to reflect reduced infiltration rates during period of high recharge (Table 2.1-2). These rates only applied when the storage capacities for Saticoy (576 AF) or El Rio (700 AF) were exceeded. Note that the model applied no additional restrictions on supplies to Ferro basin under scenarios 2 to 6A, while in reality Ferro basin is not in use for these scenarios and any supplies should be applied to the nearby Noble basin. However, modeled supplies to Ferro basin are low for scenarios 2 to 6A, and implications for groundwater elevations in the Forebay are negligible.

Table 2.1-2. Maximum infiltration rates for scenarios 2 to 7 for Saticoy and El Rio basins.

Cumulative diversions to basin (AF)	Saticoy (cfs)	El Rio (cfs)
< 35,000	375	100
35,000 – 45,000	320	90
45,000 – 50,000	300/280*	80
50,000 – 55,000	275/240*	70
> 55,000	240	60

* Rates marked with asterisk apply when available storage in the Forebay remained below 20,000 AF during the 100 days prior. The correlation was developed by observed percolation rates in both facilities.

Pumping demands for the PTP and PV service areas were calculated as the difference between total irrigation demands and surface water deliveries within each service area. Total demands were set at the 2013 level, but adjusted monthly throughout the modeling period, based on growing season and rainfall. Total demands for periods 1 (January - June) and 2 (July – August) were 5,597 and 6,112 AF for the PTP System, and 13,947 and 16,411 AF, for the PV System, respectively. An example of monthly adjustments in demand for the PV system for 1985 is shown in Figure 2.1-1. For scenarios 2 to 7, pumping in the PTP service area was distributed between the PTP LAS and UAS wells based on historic ratios of pumping between the systems. For scenario 1, the ratios of pumping for the year 2014 (with minimal surface water deliveries) were used for this purpose.

2.1.2.2 VALIDATION

Comparison of modeled (for scenario 3) and actual (measured) monthly supplies to recharge basins and the PTP and PV systems for the period 1998-2001 indicated good accuracy of the model (Figure 2.1-2). The validation serves as a rough check of the model, because important differences exist between actual operations at the time and model inputs and assumptions: actual diversions did not fully match scenario 3 diversions, water routing to recharge basins was somewhat different than assumed in the model, and Rose and Ferro basins were not yet in service.

2.1.3 GROUNDWATER MODEL

United has developed a numerical groundwater flow model (the United model) for the aquifers underlying the Oxnard coastal plain, adapted from a USGS model for the region (Hanson and others, 2003). The United model was originally planned as an update of the USGS model, but evolved into a distinct, new model, with revised grid, layering system, and boundary conditions. The United model is still being tested and updated as new data become available; however, based on calibration results to date and initial review by an expert panel, it is a significant improvement over past groundwater models of the region, and is a suitable tool for evaluating changes to groundwater conditions under the Oxnard coastal plain resulting from potential changes in operation of the Freeman Diversion.

2.1.3.1 DEVELOPMENT

Development of the United model began with considerable effort to review and update the hydrostratigraphic conceptual model for the Oxnard Plain, Oxnard Forebay, Pleasant Valley, and Mound groundwater basins, with the goal of explicitly representing each aquifer and aquitard present in the study area. The hydrostratigraphic conceptual model for the basins was updated based on review of geophysical and lithologic logs from hundreds of gas, petroleum, and water wells in the study area, resulting in significant adjustment to aquifer top and bottom elevations in key areas compared to the USGS model, which contained only two model layers representing the UAS and the LAS. In addition, the geometry of some faults and folds was adjusted in the conceptual model during construction of multiple new cross sections developed for the model area.

Following completion of the hydrostratigraphic conceptual model, a numerical model grid was developed using MODFLOW-NWT (USGS, 2011), with 2,000-foot uniform grid spacing and 13 layers representing the seven recognized aquifers and six aquitards present in the model area. The current active domain of the UWCD model includes the Oxnard Forebay, Mound, Oxnard Plain, Pleasant Valley, and West Las Posas basins, part of the Santa Paula basin, and the submarine (offshore) outcrop areas of the principal aquifers that underlie these basins. The active model domain spans approximately 282 square miles, of which 60% (169 square miles) is onshore and 40% (113 square miles) is offshore.

Boundary conditions vary around the active model domain, as follows:

- The eastern edge of the active model domain in the West Las Posas basin adopts a no-flow boundary coincident with the East Las Posas basin boundary and the Central Las Posas Fault.
- The eastern edge of the active model domain in the Pleasant Valley basin adopts a no-flow boundary assuming negligible groundwater flux from the Santa Rosa basin.
- The northeastern boundary of the active model domain currently terminates just inside Santa Paula basin. This boundary is simulated as a general-head boundary.
- The northern edge of the active model domain coincides with the contact of Pleistocene and Holocene alluvial deposits with the San Pedro Formation near the northern edge of the Mound basin. Recharge into the San Pedro Formation (Hueneme and Fox Canyon aquifers) is simulated from the San Pedro outcrop north of the model boundary.
- The southeastern edge of the active model domain is a no-flow boundary coincident with the contact between Holocene alluvial fill deposits and bedrock of the Conejo Volcanics along the foothills of the Santa Monica Mountains. Mountain-front recharge to the semi-perched aquifer is implemented in the model adjacent to this boundary.
- The southwestern edge of the active model domain extends offshore to the submarine outcrop areas of the aquifers of the Oxnard Plain basin. This boundary is implemented as a general-head boundary to simulate the interaction of seawater with freshwater in aquifers that outcrop under the sea floor and submarine canyons.

The simulation period of the UWCD model for calibration was January 1985 through December 2012, with 336 monthly stress periods with variable recharge and pumping rates. The simulation period was selected based on the following considerations:

- The timeframe for model historical calibration was selected to span several cycles of dry and wet years so that the model can be demonstrated to simulate a wide range of climatic conditions. This calibration period included several dry periods, including the severe drought that culminated in 1990, and record-low rainfall in 2007.
- The model calibration period also was a time of major changes in groundwater management in Ventura County, including the establishment of Fox Canyon Groundwater Management Agency and construction of a pipeline to deliver water to farmers to limit groundwater pumping from UAS wells in 1986.
- Reporting of various data, including groundwater level measurements and pumping records, became more detailed and extensive starting in the early- to mid-1980s.

- At the time the current modeling effort commenced (2013), groundwater-level, pumping, and other hydrogeologic data through 2012 were reported and available in databases. Therefore, December 2012 was selected as the end-point of the model's historical calibration period. The simulation period was subsequently extended through December 2015.

A number of aquifer tests and slug tests have been performed in aquifers underlying the Oxnard coastal plain by United and the USGS. Review of the aquifer test results indicate that the hydraulic conductivities for the aquifers of the UAS typically range from 100 to 300 feet per day. The hydraulic conductivity of the aquifers in the LAS generally range from 10 to 50 feet per day. The inferred hydraulic conductivity values from the aquifer tests, together with other available information regarding hydraulic parameters for aquifers in the region, were used to set the range of initial aquifer parameters in the model. The aquifer parameters were adjusted during calibration, as described below.

2.1.3.2 CALIBRATION

The groundwater flow model was calibrated by adjusting input parameters, including:

- hydraulic conductivity
- specific yield
- storage coefficient
- stream-channel conductance
- general head boundary head and conductance
- horizontal flow barrier conductance
- recharge rates
- multi-node well conductance.

By comparing simulated groundwater levels with measured groundwater levels, and adjusting model input parameters to minimize differences between the two, a set of calibrated model parameters was determined to yield an optimal fit based on manual and automated calibration simulations. The most sensitive parameter influencing calibration of simulated to measured heads was hydraulic conductivity; this parameter is typically also subject to the greatest variability and uncertainty. Therefore, hydraulic conductivity commonly receives the greatest degree of adjustment during model calibration. The vertical to horizontal anisotropy ratio is generally set to 0.1 through most of the United model. However, the vertical anisotropy ratio in the layers representing the aquifers of the UAS in the Oxnard Forebay basin is 0.5, to represent improved hydraulic communication between layers in this area.

Results of calibration indicate that the model is well calibrated throughout most of the Oxnard Forebay, Oxnard Plain, and Pleasant Valley basins. The model is not as well calibrated yet in the Mound basin and the northeast margin of the Pleasant Valley basin; however, these areas are of minor relevance for modeling the effects of potential changes to Freeman Diversion operations on groundwater levels across most of the Oxnard Coastal Plain. Figures 2.1-3 and 2.1-4 show model calibration hydrographs, comparing measured to simulated groundwater elevations, for several UAS and LAS wells in the Oxnard Plain, Oxnard Forebay, and Pleasant Valley basins. These are just a few examples from the hundreds of calibration hydrographs used to calibrate the model, and are provided in this report simply to illustrate the degree to which the modeled groundwater elevations agree with measured groundwater elevations.

2.1.3.3 REVIEW

Following initial calibration, the model was peer-reviewed by an expert panel, including:

- Dr. Sorab Panday, of GSI Environmental, Inc., co-author of the two most recent versions of MODFLOW: MODFLOW-NWT and MODFLOW-USG;
- Jim Rumbaugh, of Environmental Simulations Inc., creator of GW Vistas, a widely used MODFLOW pre- and post-processor; and,
- John Porcello, of GSI Water, Inc., a consultant with extensive experience in groundwater modeling in general, and specific experience with hydrogeologic conditions in Ventura County.

The expert panel provided "the following key observations regarding the model's significant and most substantive simulation capabilities" in a preliminary review memorandum (Porcello and others, 2016):

- "The model's layering and choice of boundary conditions is appropriate for simulation of the very complex geologic and hydrostratigraphic conditions that exist in the Oxnard and Pleasant Valley groundwater basins – specifically the discrete multiple layered aquifers and aquitards; the moderate to strong compartmentalization of certain aquifers by faults; the significant well-to-well variability in the depths and aquifers which are furnishing groundwater to production wells in each groundwater basin; the strong influence of UWCD's managed aquifer recharge programs (recharge basins) on groundwater elevations and flow directions; and the complex three-dimensional nature of the ocean interface and its interaction with each shallow and deep aquifer zone along the coast and offshore.
- The model provides an accounting of groundwater budgets and flow conditions for current land use and water use conditions. This includes the conditions that have been observed during the current drought, which began during the end of the calibration period and has continued through the period being used for model verification (2013 through 2015).
- The model is well-calibrated to changes in groundwater levels over time, including through multiple series of drought years (1985 through 1991; 1999 through 2003; 2012 to present) and above-normal rainfall years (1992-1993, 1997-1998, 2004-2005) which together comprise a hydrologic cycle composed of highly variable rainfall and streamflow conditions. Additionally, the calibration time period accounts for the gradual historical increase in dry-weather baseflows that occurred in Arroyo Las Posas from the late 1980s through the 1990s, which has substantially increased the annual volume of groundwater recharge to the Pleasant Valley basin.
- UWCD has invested considerable time and resources in updating and refining the hydrostratigraphic model, creating a new model with discrete representation of each aquifer and aquitard, and estimating the detailed recharge processes of a nearly 3-decade time period. This effort has had a direct beneficial effect on the ability of the model to simulate

> the historical fluctuations in groundwater levels that have occurred in the past. Model-simulated hydrographs of water level changes and scatter plots of the water-level-change residuals (the differences between modeled and measured changes) indicate that the model is simulating the month-by-month and year-by-year aquifer system responses to fluctuating natural hydrologic conditions (rainfall and streamflows), groundwater pumping, and managed aquifer recharge quite well, though in a few areas it was noted that water level recovery during high-rainfall years is under-predicted."

Several modifications were made to the model following the review, and model documentation is currently in preparation, in response to recommendations provided by the expert panel. United is planning to complete the model documentation by January 2017, and can share the documentation with interested parties at that time.

2.1.3.4 APPLICATION

The overall approach for applying the United model to evaluate potential effects of various operations of the Freeman Diversion was to simulate a 31-year future period with alternating cycles of above- and below-average natural and artificial recharge to the groundwater system, similar to the large fluctuations in hydrologic conditions observed during the past 31 years (January 1985 through December 2015). This was a period of greater climatic variability than has generally been observed in the historical record and is likely to be representative of the range of future climatic conditions, even if the average precipitation during the forecasting period increases or decreases to some degree as a result of long-term regional climate cycles (e.g. the Pacific Decadal Oscillation) or global climate change. The groundwater model was then used to forecast the magnitude and extent of groundwater elevation changes resulting from the different Freeman Diversion operational scenarios described in at the beginning of this Section 2. Results from simulation of each diversion scenario were evaluated by comparing the extent of the areas where groundwater elevations are forecasted to be below sea level during a representative future water year. The differences between simulation results of each diversion scenario are key to this evaluation, as the magnitude of groundwater elevations forecasted by any one scenario are partly dependent on climate and other factors that are subject to substantial uncertainty. Therefore, the analysis of groundwater modeling results (in Section 3.2) focuses on comparison of the modeled effects of the diversion scenarios (e.g. "Groundwater elevations under scenario 2 are forecasted to be higher than those under scenario 4") instead of the specific forecasts of each scenario (e.g. "groundwater elevations under scenario 3 are forecasted to be 6 feet above mean sea level at well X").

For each diversion scenario simulated, it was assumed that extractions for municipal and agricultural use from the coastal groundwater basins will continue at current rates, with some variation from year to year in response to changes in precipitation rates. It is understood that under the SGMA, a Groundwater Sustainability Plan (GSP) must be developed for most groundwater basins in the state. Because the "Oxnard basin" (defined by the DWR as consisting of both the Oxnard Plain and Forebay basins as described previously in this report) and Pleasant Valley basin are considered to be in critical overdraft, they must be managed under a GSP by January 31, 2020; the FCGMA has taken the lead role for developing GSPs for these basins. This evaluation does not incorporate assumptions regarding future water-supply changes that may be implemented as a result of GSPs for the Oxnard Plain and Pleasant Valley basins. It is recognized that the GSPs being developed by the FCGMA for the Oxnard Plain and Pleasant Valley basins could propose reductions in pumping from the UAS and/or LAS in the near future in order to avoid multiple "undesirable results" related to declining groundwater levels.

2.1.3.5 ASSUMPTIONS AND LIMITATIONS

Each of the Freeman Diversion operational scenarios described in this section was simulated assuming:

- a repeat of 1985 through 2015 climatic and boundary conditions (hydrologic-cycle inputs),
- artificial recharge rates at the Saticoy and El Rio spreading grounds and surface water deliveries to the PTP, Pleasant Valley, and Oxnard-Hueneme pipelines consistent with each diversion scenario,
- corresponding changes in pumping rates at wells that provide groundwater to agricultural lands that historically received a portion of their water supply from the Freeman Diversion via the PTP, Pleasant Valley, and Oxnard-Hueneme pipelines (e.g. more pumping from wells when a diversion scenario results in reduced surface water delivered from the Freeman Diversion),
- municipal and industrial pumping rates proportional to 1985 to 2015 rates from each well (municipal and industrial pumping in the area have remained relatively stable over time), and
- agricultural irrigation proportional to 2015 rates, adjusted upwards or downwards depending on rainfall and surface-water delivery rates.

A limitation of this approach is that it assumes a repeat pattern of climatic conditions in the study area during the period from 1985 through 2015, which included two severe droughts only 25 years apart, separated by several of the wettest years on record in the region during the 1990s. However, the extreme climatic conditions occurring during this period are potentially representative of the range of future climatic conditions when considering global climate change, which is anticipated to cause an increase in variability of precipitation amounts in southern California. Another limitation is that this approach assumes no significant land use changes during the forecasting period. Forecasting of future long-term average rainfall amounts and land-use changes in the study area were beyond the scope of this effort, but are not expected to have a large impact on the *relative* effects of each diversion scenario on future groundwater conditions (comparing one forecast to another).

3 RESULTS

This section summarizes results of the surface-water and groundwater modeling conducted to evaluate water-resource impacts forecasted to result from each diversion scenario described in Section 2.

3.1 SURFACE WATER DISTRIBUTION ON OXNARD PLAIN

Annual average Freeman diversions for the model forecasting period are presented in Figure 3.1-1. Scenario 6A presents a significant loss of yield over scenario 2 (over 8,000 AF per year). However, the infrastructure improvement projects proposed under scenarios 6B and 7 would make up for most or all of the yield loss. Scenario 4 includes by far the lowest amount of average annual diversions among scenarios with diversions (excluding scenario 1), approximately 20,000 AF less than scenario 1, which represents operations without any conservation measures for steelhead between the restrictions in the state water rights. Diversions under scenario 1 are limited to the conservation releases, and are approximately 38,000 AF less than scenario 4. Note that the climate conditions under the 31-year model forecasting period were relatively wet, and average annual diversions are between 4,500 and 8,500 AF higher compared to those using climate conditions for the 72-year period of record (1944-2015). However, relative differences between scenarios are mostly similar for the two periods.

A comparison of modeled surface water distribution to recharge basins and surface water delivery systems for scenarios 4, 6B, and 7 is provided for 2010 (a representative year with close to average rainfall) on Figure 3.1-2(a-c). During 2010, priorities for surface water distribution for normal years were in effect, specifically, the highest priorities were surface water deliveries and El Rio recharge, except during high turbidity events (see Table 2.1-1). Surface water deliveries were roughly equal for all scenarios, but under scenario 4, recharge to El Rio was significantly reduced during the January to September period due to limited diversions. Improvements in yield under scenario 7 compared to scenario 6B include more recharge to Noble, Rose and Ferro basins when higher flows can be diverted. Surface water distribution in the fall was associated with United's conservation releases from Santa Felicia Dam, and amounts were equal between scenarios.

Results modeled for 2010 agree well with those for the entire model forecasting period. Average annual recharge to El Rio and Saticoy basins was significantly lower under scenario 4 compared to all other scenarios with diversions (Figure 3.1-3, Table 3.1-1). Surface water deliveries to the PTP and PV systems were roughly equal among scenarios 2 through 7, except for a small decrease under scenario 4. Under scenario 7, significantly higher amounts of water were directed towards the Noble, Rose and Ferro basins, compared to the other scenarios. Under scenario 1, all diversions were directed toward the El Rio basins.

Table 3.1-1. Distribution of surface water on Oxnard Plain for scenarios 2 to 7.

Facility	Scenarios						
	2	3	4	5	6A	6B	7
El Rio	30,012	28,406	22,775	28,374	28,021	27,928	27,475
Saticoy	20,324	16,754	12,632	16,563	15,688	16,505	16,267
Noble	4,419	3,324	2,016	3,241	2,989	4,872	6,171
Rose	443	355	258	356	344	1,144	1,721
Ferro	380*	322*	196*	320*	317*	1,841	6,140
PTP	5,369	5,342	4,684	5,330	5,329	5,339	5,340
PV	8,848	8,749	7,437	8,735	8,722	8,735	8,738
Total	**69,795**	**63,252**	**49,998**	**62,919**	**61,410**	**66,364**	**71,852**

Notes:

Values indicated are average annual rates, in AF per year.

Deliveries to the PTP and PV systems only include surface water diverted at the Freeman Diversion.

* Under diversion scenarios 2, 3, 4, 5, and 6A, the surface-water distribution model transferred small quantities of surface water from Noble basin to Ferro basin. Such transfers are not realistic given the assumptions for each scenario; however, the transferred quantities are negligible and do not significantly affect the results of the water-resources evaluation presented herein.

A more detailed comparison of recharge to El Rio and surface water deliveries for scenarios 7 and 4 indicate that for many years, total annual recharge to El Rio is between approximately 3,500 and 13,000 AF less for scenario 4, because of reduced recharge during the winter season (Figure 3.1-4a and 3.1-4b). During most dry years, when total diversions are low, recharge is similar between the two scenarios. Surface water deliveries are between 500 and 2,200 AF higher for scenario 7 during half of the forecasting period. For the other years, the difference is less than 500 AF. Scenarios 6A and 6B compare similarly to scenario 4 with respect to recharge to El Rio and surface water deliveries.

3.2 GROUNDWATER MODEL

The United groundwater model was used to forecast groundwater elevations in each of the aquifers underlying the Oxnard coastal plain in response to changes in pumping and recharge assumed during the next 30 years under each diversion scenario described in Section 2. For each diversion scenario, time-series hydrographs were prepared for representative wells to illustrate forecasted changes in groundwater elevation over time. In addition, the forecasted 0 ft msl (sea level) groundwater contour was mapped in the Oxnard aquifer (representing the UAS) and Fox Canyon (main) aquifer (representing the LAS) during a model stress period considered representative of groundwater conditions in the region during a typical year, when groundwater elevations are not forecasted to be anomalously high or low as a result of extended wet periods or droughts. The “typical” year selected for contouring of groundwater levels was year 17 of the simulation. Forecasted groundwater elevations in the Mugu (UAS) and Hueneme (LAS) aquifers were also inspected by United, and were very similar to those in the Oxnard and Fox Canyon aquifers, respectively. Therefore, forecasted results are only shown in this report for the Oxnard and Fox Canyon (main) aquifers. Review of the time-series hydrographs shown on Figures 3.2-1 and 3.2-2 indicates that forecasted groundwater elevations during year 17 of the simulation approximately represent typical long-term conditions during average to wet years, rather than the two severe droughts culminating in years 7 and 31 of the simulation period. For this evaluation, groundwater elevations during average- to wet-year hydrologic conditions are considered most relevant; both measured and simulated groundwater elevations during severe droughts decline significantly and rapidly, but are not as representative of long-term average conditions.

Figures 3.2-1 and 3.2-2 show groundwater elevations forecasted to occur under each diversion scenario, at representative UAS and LAS wells (01N21W17D02S and 01N21W07J02S, respectively, with locations shown on Figures 3.2-3 and 3.2-4) in the eastern Oxnard Plain basin near the boundary with the Pleasant Valley basin. The percentage of time during the 31-year simulation period that groundwater elevations at the representative UAS well is forecasted to be below sea level under each diversions scenario is summarized below each hydrograph on Figure 3.2-1. Groundwater elevations are consistently below sea level at the representative LAS well; therefore, the percentage of time that groundwater levels are below sea level under each scenario is not shown on Figure 3.2-2.

Figure 3.2-1 indicates that under most diversion scenarios, groundwater elevations in the UAS at well 01N21W17D02S are forecasted to typically fluctuate between -10 to +10 ft msl, except during severe droughts near the beginning and end of the simulation. Maintaining groundwater elevations above sea level in the Oxnard Plain and Pleasant Valley basins will likely be key to preventing further seawater intrusion and other groundwater quality problems from occurring in the aquifers underlying the Oxnard coastal plain. Groundwater elevations are forecasted to be below sea level slightly more than 50 percent of the simulation period under diversion scenarios 2 and 7, and 59 to 76 percent under scenarios 3, 6A, and 6B. It is notable that under diversion scenarios 1 and 4, groundwater elevations at this well are forecasted to remain below sea level throughout the duration of the simulation, indicating a strong potential for increased seawater intrusion into the UAS in the central Oxnard Plain.

Figure 3.2-2 indicates that forecasted groundwater elevations in the LAS at well 01N21W07J02S typically fluctuate from -40 to -100 ft msl, and deeper during the simulated severe droughts. If groundwater elevations were to actually remain at these depths below sea level for a decade or longer, seawater intrusion would likely advance at a rapid pace, potentially causing some water-supply wells to be shut down due to poor water quality. The model simulations assume that all existing wells will continue pumping throughout the simulation period; however, continued pumping from parts of the LAS may not actually be feasible if water quality declines further due to seawater intrusion.

In both the UAS and the LAS, groundwater elevations under diversion scenario 1 are forecasted to be substantially lower compared to the other diversion scenarios, indicating the importance of surface-water diversions (which are the primary source of artificial recharge and deliveries of surface water in lieu of pumping) in preventing or mitigating undesirable results of groundwater-level declines in the aquifers underlying the Oxnard coastal plain.

Scenario 1 was modeled for the sole purpose of illustrating the importance of surface-water diversions from the Santa Clara River on groundwater conditions in the region. Therefore, subsequent discussion of forecasted effects of the various diversion scenarios generally does not include scenario 1—if included, scenario 1 would always result in the greatest declines in groundwater levels and resultant negative effects on groundwater quality (e.g. seawater intrusion). The large differences in the forecasted groundwater impacts resulting from scenario 1 versus all of the other diversion scenarios illustrates how successful the operation of the Freeman Diversion is at sustaining UAS groundwater elevations across the Oxnard coastal plain. Forecasted UAS groundwater elevations in a typical year under scenario 1 are similar to the current basin conditions following five years of sustained drought. Water levels are currently at or near record lows for many wells in both the UAS and LAS as a result of drought conditions since 2012, which have greatly reduced United's artificial recharge operations.

Across the Oxnard coastal plain, forecasted groundwater elevations are typically highest in both the UAS and LAS under diversion scenarios 2 and 7, with somewhat lower groundwater elevations under diversion scenarios 3, 6A, and 6B. Forecasted groundwater elevations under diversion scenario 4 are significantly lower than groundwater elevations under all other scenarios (except scenario 1), typically 5 feet deeper in the UAS and 10 feet deeper in the LAS compared to scenarios 2, 3, 6A, 6B, and 7.

The purpose of including the hydrographs shown on Figures 3.2-1 and 3.2-2 is to illustrate the general temporal trends in forecasted groundwater elevations under each diversion scenario. Although the timing of the upward and downward trends in groundwater elevation shown on these figures would be consistent throughout the Oxnard Plain and Pleasant Valley basins, the specific groundwater elevation for a given time would depend on location. Forecasted groundwater elevations at locations near the coast and in areas with a relatively high density of pumping wells are typically lower than groundwater elevations at the inland margins of the basins, particularly in areas with few pumping wells.

Figures 3.2-3 and 3.2-4 show the areas where groundwater elevations in the Oxnard aquifer (selected to represent the UAS) and the Fox Canyon aquifer (selected to represent the LAS) are forecasted to be below sea level under each diversion scenario during a typical water year (year 17 of the simulation period). Areas where groundwater levels remain below sea level during average to wet years would be most prone to lateral seawater intrusion and other related groundwater quality problems, with the potential for chloride concentrations to increase to levels that could make the aquifer unusable for years to decades. Detailed modeling of seawater intrusion rates and extents was beyond the scope of this evaluation; however, seawater intrusion in the region has historically been directly correlated with groundwater-level decline below sea level in the aquifers of the Oxnard Plain and Pleasant Valley basins. Under diversion scenarios 1 and 4, the areas where groundwater elevations are forecasted to be below sea level extend offshore under the Pacific Ocean seafloor near Hueneme Submarine Canyon (scenario 1) and Mugu Submarine Canyon (scenarios 1 and 4). Such an occurrence would likely exacerbate seawater intrusion in the region, as these submarine canyons are considered to be the primary locations for seawater to enter the aquifers underlying the Oxnard coastal plain.

Inspection of Figures 3.2-3 and 3.2-4 indicates the following:

- All of the modeled diversion scenarios are forecasted to have negative impacts on groundwater elevations in the UAS and LAS in the Oxnard Plain, Forebay, Pleasant Valley, and the Mound basins.
- Diversion scenarios 2 and 7 result in the smallest areas where groundwater elevations in the UAS and LAS are forecasted to be below sea level. In the UAS, groundwater elevations are forecasted to be below sea level in a circular area that includes the southeastern Oxnard Plain basin and in the southern Pleasant Valley basin, and in smaller areas in the southwestern Mound and northern Pleasant Valley basins. In the LAS, groundwater elevations are forecasted to be below sea level across nearly the entire extent of the coastal plain. The forecasted occurrence of groundwater elevations below sea level across large areas during average to wet years would be expected to result in further seawater intrusion relative to the current extent, shown with black dotted lines on Figures 3.2-3 and 3.2-4.
- The areas where groundwater elevations in the UAS and the LAS are forecasted to be below sea level under diversion scenarios 3, 6A, and 6B are somewhat larger than under diversion scenarios 2 and 7.
- The areas where groundwater elevations in the UAS and LAS are forecasted to be below sea level under diversion scenario 4 are substantially larger than all other diversion scenarios (except scenario 1). In particular, the area where forecasted groundwater elevations are below sea level in the UAS includes most of the remaining farmland (and associated water-supply wells) in the eastern portion of the Oxnard coastal plain, south of Camarillo and east of Oxnard.

The areas of forecasted UAS and LAS groundwater elevations below sea level under each diversion scenario (during a typical year) are summarized on Figures 3.2-5 and 3.2-6. These graphs indicate areas of the UAS and the LAS forecasted to be below sea level under diversion scenarios 3, 4, 6A, 6B, and 7 relative to scenario 2, quantifying the differences in impact that are qualitatively apparent on Figures 3.2-3 and 3.2-4. Figures 3.2-5 and 3.2-6 indicate that:

- There is a direct relationship between average annual diversions and the area where groundwater elevations are below sea level below the Oxnard coastal plain.
- The forecasted areas of the UAS and LAS below sea level under scenario 7 are approximately equal to those under scenario 2.
- The forecasted areas below sea level under scenarios 3, 6A, and 6B range from approximately 1,400 to 4,900 acres (2.2 to 7.7 square miles) greater than under scenario 2 in the UAS, and from 2,600 to 7,900 acres (4.1 to 12.4 square miles) greater than under scenario 2 in the LAS.

- The forecasted area below sea level under scenario 4 is approximately 19,000 acres (30 square miles) greater than under scenario 2 in the UAS, and 21,000 acres (33 square miles) greater in the LAS.

Table 3.2-1 compares modeled surface water diversion scenarios based on the annual average volume of surface water available for diversion. The table also contains notes with additional information and other considerations.

Table 3.2-1. Comparison of diversion scenarios.

Scenario	Average Annual Estimated Surface Water Diversions (AF per year)[1]	Total Area Where Groundwater Elevations Are Forecasted to be Below Sea Level During a Typical Year (acres)[1]	Comments
1 – No Diversion	0	UAS: 104,300 LAS: 124,800	Modeled solely to illustrate the importance of surface-water diversions from the Santa Clara River on groundwater conditions in the region and generally is not compared to the other scenarios. Scenario 1 always results in the greatest declines in groundwater levels and likely negative effects on groundwater quality (e.g. seawater intrusion).
2 – Water Rights Operation	69,800	UAS: 12,000 LAS: 85,300	Represents operation allowed under current surface-water rights and without any infrastructure modification. Similar in effects on groundwater resources to scenario 7.
3 – Interim Bypass Operations 2010-2016	63,200	UAS: 15,400 LAS: 91,300	Would not require additional water rights or substantial infrastructure modification; however, forecasted impacts to groundwater resources are significantly greater than scenarios 2, 6B, or 7.
4 – 2008 Biological Opinion	49,900	UAS: 31,500 LAS: 106,200	Much greater impacts to groundwater resources than all other scenarios (except scenario 1).
6a – Mimic Flow Recession	61,400	UAS: 16,900 LAS: 93,200	This scenario assumes the existing diversion capabilities. It does not require a modification of the District's existing water right. However, forecasted impacts to groundwater resources are significantly greater than scenarios 2, 3, 6B, or 7.

Table 3.2-1. Comparison of diversion scenarios.

Scenario	Average Annual Estimated Surface Water Diversions (AF per year)[1]	Total Area Where Groundwater Elevations Are Forecasted to be Below Sea Level During a Typical Year (acres)[1]	Comments
6b – Mimic Flow Recession	66,300	UAS: 13,400 LAS: 87,900	This scenario involves infrastructure modifications required to capture storm flows with higher turbidity, but does not include an expansion of the District's surface-water right from the State Water Resources Control Board. Although final infrastructure design parameters are not yet available, it is estimated that construction costs for these infrastructure changes will be in the range of $5-10 million[2] and the maintenance of that infrastructure will have significant, but as yet unquantified, operational costs.
7 – Increased Diversion Rate Operations	71,800	UAS: 11,200 LAS: 84,500	Requires extensive infrastructure modifications and also a new water right from State Water Resources Control Board to allow higher instantaneous surface water diversion rates and higher annual diversion quantities (feasibility not addressed in this report). Although final infrastructure design parameters are not yet available, it is estimated that construction costs for these infrastructure changes will be in the range of $25-30 million[2] and the infrastructure will have significant, but as yet unquantified, operational costs.

[1] Rounded to the nearest 100 acre-feet.

[2] These costs are in addition to funds that may be required for construction of a new fish passage structure and associated infrastructure.

The modeling results also provide an indication of the relative benefit of delivering surface water in lieu of pumping groundwater from the UAS and/or LAS in the Oxnard Plain and Pleasant Valley basins. The major differences in groundwater elevation between the UAS (most commonly above sea level) and the LAS (most commonly below sea level) under each diversion scenario are largely a result of the rate of groundwater extraction from the LAS, and how readily natural and artificial recharge (which occur primarily in the UAS in the Forebay) reaches those areas of pumping. Natural and artificial recharge entering the UAS in the Forebay basin has a substantial and immediate effect on groundwater levels in adjacent areas of the Oxnard Plain, particularly in the UAS. Recharge entering the UAS in the Forebay basin also migrates radially outward and downward to more distal locations, and thus has a substantial influence on groundwater levels in the LAS in the eastern Oxnard Plain and Pleasant Valley basins. However, delivering surface water to these areas and reducing pumping from the LAS by a corresponding amount is a more direct, expedient, and effective approach to limiting groundwater elevation decline in the LAS in much of the Oxnard Plain and Pleasant Valley basins.

As noted previously in this section, GSPs being developed by the FCGMA may include pumping reductions in portions of the UAS and/or LAS most susceptible to seawater intrusion, which would maintain groundwater elevations above sea level as a potential approach to achieve sustainable yield in the Oxnard Plain and Pleasant Valley basins. It is currently unknown specifically how such pumping reductions would be achieved, but likely options include: increased surface water imports to replace groundwater withdrawals, new sources of locally derived water, more pumping from the UAS, reduction in irrigated farmland, or increased conservation in cities. Regardless of how such pumping reductions would be achieved, the differences in forecasted effects of each diversion scenario would tend to be accentuated by the resultant higher average groundwater elevations. For example, Figure 3.2-4 indicates that without pumping reductions, all of the simulated diversion scenarios result in groundwater elevations in the LAS that are below sea level across most of the Oxnard coastal plain, even during average to wet years. If pumping reductions were implemented that raised groundwater elevations across most of the LAS to near-sea-level, then the differences in artificial recharge and surface-water deliveries (in-lieu of pumping) that are inherent in each diversion scenario would result in greater differentiation between scenarios in measurable objectives such as area and duration of groundwater elevations above sea level, and frequency of seaward versus landward hydraulic gradients. United will consider updating this analysis when sufficient information is released by FCGMA during its groundwater sustainability planning efforts to simulate the likely locations and magnitudes of LAS (or UAS) pumping reductions if included in the GSPs.

Also, it is beyond the scope of this analysis to evaluate economic or other impacts to water users and the region of curtailments of groundwater pumping or surface water delivery.

4 CONCLUSIONS

Despite long-term efforts to conserve water, import more water to the District and optimize the use of local resources, water deficits exist in a number of areas throughout the District, most notably on the southern Oxnard Plain and in the Pleasant Valley basin. In some places, the depletion of groundwater reserves has to date simply resulted in lowered water tables. In other areas, significant water quality problems have developed in response to conditions of overdraft. The California Department of Water Resources recently revised the list of basins “subject to critical overdraft.” Southern California has six basins designated as subject to critical overdraft, and the Oxnard Plain and Pleasant Valley basins have been assigned this designation. The Oxnard Plan and Pleasant Valley basins are the only two coastal basins on the list.

Using a combination of surface water and groundwater models, United compared diversion amounts at the Freeman Diversion, amounts of groundwater recharge and surface water deliveries at United’s facilities, and resultant forecasted groundwater elevations in the Oxnard Plain and Pleasant Valley basins, for pertinent diversion scenarios. All diversion scenarios except scenario 7 provided lower diversion amounts for recharge and surface-water deliveries in lieu of pumping, compared to scenario 2 (Water Rights Operations). Scenario 4 provides by far the lowest amount of average annual diversions (excluding scenario 1), approximately 20,000 AF per year less than scenario 2 and 22,000 AF per year less than scenario 7. Under the current assumptions, the differences in diversions between scenarios were predominantly reflected in differences in groundwater recharge to United’s various recharge basins. Average annual recharge to El Rio and Saticoy basins was significantly lower under scenario 4 compared to all other scenarios (between approximately 8,000 and 15,000 AF per year). In turn, significantly higher amounts of water were directed towards the Noble, Rose and Ferro basins under scenario 7 compared to the other scenarios (between approximately 7,000 and 12,000 AF per year). Surface water deliveries and groundwater pumping are less sensitive to changes in diversions, except for lower surface water deliveries and corresponding groundwater pumping increases in the PTP and PV service areas under scenario 4 (approximately 2,000 AF per year). However, differences in surface water deliveries and groundwater pumping can be much greater during individual years.

Key conclusions of the evaluation of forecasted impacts to groundwater include:

- All of the modeled diversion scenarios are forecasted to have negative impacts on groundwater elevations in the UAS and LAS in the Oxnard Plain, Forebay, Pleasant Valley, and the Mound basins.
- Under each diversion scenario, groundwater elevations in the Oxnard Plain and Pleasant Valley basins are forecasted to rise and decline over time primarily in response to modeled groundwater recharge (largely from surface water obtained from the Freeman Diversion) and withdrawal (pumping) rates. Maintaining groundwater elevations above sea level is key to preventing further seawater intrusion and other groundwater quality problems from

occurring in the aquifers underlying the Oxnard coastal plain, and for achieving sustainable management of the Oxnard Plain, Forebay, and Pleasant Valley basins, as required by the State under the SGMA.

- There is a direct relationship between average annual diversions and the area where groundwater elevations are below sea level below the Oxnard coastal plain.
- In both the UAS and the LAS, groundwater elevations under diversion scenario 1 (surface-water diversions limited to those associated with releases from Santa Felicia Dam) are forecasted to be substantially lower than under the other diversion scenarios, remaining below sea level across most of the Oxnard coastal plain throughout the simulation period. This illustrates the importance of United's artificial recharge and surface-water deliveries in lieu of pumping for preventing or mitigating undesirable results (e.g. seawater intrusion) of groundwater-level declines in the aquifers underlying the Oxnard coastal plain.
- Under the assumptions applied to the groundwater model for this evaluation, forecasted groundwater elevations in the UAS remain above sea level across much of the Oxnard coastal plain during most average to wet years. However, forecasted groundwater elevations in areas of the southeastern part of the Oxnard Plain basin, southern Pleasant Valley basin, Mound basin, and northern Pleasant Valley basin remain below sea level under all scenarios (Figure 3.2-3). The southern Oxnard Plain and Pleasant Valley basin area has historically been the site of seawater intrusion, and is of particular concern for achieving sustainable groundwater management. The area of the UAS below sea level is smallest under diversion scenarios 2 and 7, are larger under scenarios 3, 6A, and 6B (1,400 to 4,900 acres greater than under scenario 2), and are substantially larger (19,000 acres, encompassing most of the remaining farmland in the eastern Oxnard coastal plain east of Oxnard and south of Camarillo) under scenario 4. Because of the long distance between the southeastern Oxnard Plain and the artificial-recharge basins of the Forebay basin, continuing direct delivery of surface water to farms in lieu of groundwater pumping would likely to be the most effective way to raise groundwater elevations and mitigate seawater intrusion in this area.
- In the LAS, groundwater elevations below most of the Oxnard coastal plain are forecasted to remain well below sea level throughout the simulation period under all diversion scenarios. Similar to the UAS, the forecasted areas below sea level for scenarios 2 and 7 are roughly equal, are somewhat larger under scenarios 3, 6A, and 6B (2,600 to 4,900 acres greater than under scenario 2), and are substantially larger (21,000 acres) under scenario 4. This will almost certainly increase the rate and areal extent of seawater intrusion into the LAS in the Oxnard Plain and Pleasant Valley basins, and could prevent the FCGMA from achieving sustainable management as required under the SGMA. However, GSPs being developed by the FCGMA may include pumping reductions in portions of the LAS most susceptible to seawater intrusion, as a potential approach to assist in achieving achieve sustainable yield. United will consider updating this analysis when sufficient information is released by FCGMA during its groundwater sustainability planning efforts to simulate locations and magnitudes of potential LAS (or UAS) pumping reductions.

Historically, the Freeman Diversion (and United's previous diversion structures near Saticoy) have been the single most effective project providing groundwater recharge to the Oxnard Forebay and the Oxnard Plain. Any reduction in United's ability to divert water from the Santa Clara River has a direct impact on the sustainable yield of these groundwater basins and the protection and continued viability of the dependent water uses and associated economies and communities. Considering the forecasted impacts on groundwater levels described above for each diversion scenario evaluated in this analysis, Scenario 2, which reflects operations consistent with United's surface-water right, would accomplish the purposes of the Freeman Diversion better than any alternative flow operations that do not rely on additional infrastructure or new water rights. The forecasted negative impacts to groundwater levels of scenarios 1 and 4 are substantially greater than all other scenarios, increasing the potential for seawater intrusion and other undesirable results. United developed Scenario 6 to address conservation objectives for steelhead migration. However, Scenario 6A would have a larger impact to groundwater levels compared to Scenario 2. This report does not evaluate the feasibility of those actions needed to take water at higher flows.

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5 REFERENCES

Alvarado, J.A. Corcho, Barbecot, F., Purtschert, R., 2009, Ambient vertical flow in long screen wells: a case study in the Fontainebleau Sands Aquifer (France), Hydrogeology Journal (2009) 17: 425-431p.

Boyle, D., King, A., Kourakos, G., Lockhard, K., Mayzelle, M., Fogg, G.E. & Harter, T., 2012, Groundwater nitrate occurrence. Technical Report 4 in: *Addressing nitrate in California's drinking water with a focus on Tulare Lake basin and Salinas Valley groundwater. Report for the State Water Resources Control Board, Report to the Legislature.* Center for Watershed Sciences, University of California, Davis.

California Department of Water Resources, 1965, Seawater intrusion: Oxnard Plain of Ventura County: Bulletin No. 63-1, 59 p.

California Department of Water Resources, 1975, Compilation of technical information records for the Ventura County cooperative investigation: California Department of Water Resources, volume 1.

California Department of Water Resources, 2003, California's groundwater, Bulletin 118 update 2003, dated October 2003, 222p.

Densmore, J.N., 1996, Lithologic and ground-water data for monitoring wells in the Santa Clara-Calleguas ground-water basin, Ventura County, California, 1989-95: U.S. Geological Survey Open-File Report 96-120, 179p.

Fox Canyon Groundwater Management Agency, 2015, Calendar year 2014 annual report, 65 p.

Fugro West, Inc., 1996, Calendar Year 1995 Annual report, Mound ground water basin, Ventura County, California. A summary of hydrologic conditions, prepared for the City of Ventura, 21p.

Geotechnical Consultants, Inc., 1972, Hydrogeologic investigation of the Mound ground water basin for the City of San Buenaventura, California. Draft hydrogeologic investigation.

Hanson, R.T., Martin, P. and Koczot, K.M., 2003, Simulation of groundwater-water/surface-water flow in the Santa Clara-Calleguas ground-water basin, Ventura Country, California, U.S. Geological Survey, Water-Resources Investigation Report 02-4136, 157p.

Hanson, R.T., Izbicki, J.A., Reichard, E.G., Edwards, B.D., Land, M., Marin, P., 2009, Comparison of groundwater flow in Southern California coastal aquifers. Earth science in the urban ocean: the southern California continental borderland: Geological Society of America Special Paper 454, 29p.

Izbicki, J.A., 1991, Chloride sources in a California coastal aquifer. American Society of Civil Engineers symposium on ground water in the Pacific Rim. Honolulu, Hawaii, July 22-26. 71-77p.

Izbicki, J.A., 1992, Sources of chloride in ground water of the Oxnard Plain, California, in Prince K.R. and Johnson, A.I., eds., Regional aquifer systems of the United States—Aquifers of the far west: American Water Resources Association Monograph Series, no.16, 5-14p.

Izbicki, J.A., Martin, P., Densmore, J.N. and Clark, D.A., 1995, Water-quality data for the Santa Clara-Calleguas hydrologic unit, Ventura County, California, October 1989 through December 1993: U.S. Geological Survey Open-File Report 95-315, 124p.

Izbicki, J.A., 1996a, Source movement and age of groundwater in a coastal California aquifer, U.S. Geological Survey, Fact Sheet 126-96, 4p.

Izbicki, J.A., 1996b, Use of O18 and H2 to define sweater intrusion. North American Water Congress, Anaheim, California. June 23-28.

Izbicki, J.A., 1996c, Seawater intrusion in a coastal California aquifer. U.S. Geological Survey Fact Sheet 125-96. 4p.

Izbicki, J.A., Christensen, Allen H., Newhouse, Mark W., Smith, and Aiken, George R., 2005a, Inorganic, isotopic, and organic composition of high-chloride water from wells in a coastal southern California, Applied Geochemistry, V. 20, no. 8, 1496-1517p.

Izbicki, J.A., Christensen, Allen H., Newhouse, Mark W., Smith, Gregory A., and Hanson, Randall T., 2005b, Temporal changes in the vertical distribution of flow and chloride in deep wells, Ground Water: Journal of the Scientists and Engineers Division of National Ground Water Association, V. 43, no. 4, 531-544p.

Mann, J.F., Jr., 1959, A plan for ground water management, United Water Conservation District: Report to United Water Conservation District, 120p.

Mukae, Mike, 1988, General geology and groundwater occurrence within Calleguas Municipal Water District service area. Progress report no. 9. Prepared for Metropolitan Water District of Southern California.

National Marine Fisheries Service, Southwest Region, 2008, Final biological opinion for the Bureau of Reclamation's approval of United Water Conservation District's proposal to operate the Vern Freeman Diversion and fish-passage facility.

Porcello, J., Panday, S. and Rumbaugh, J., 2016, Peer review team evaluation of UWCD groundwater flow model for the Oxnard Plain, Oxnard Forebay, and Pleasant Valley basins (Ventura County, California) [Draft Interim Memorandum], dated June 30, 2016.

R2 Resource Consultants, 2016, Riverine effects analysis of Freeman Diversion flow releases on steelhead and Pacific lamprey; Attachment A, model documentation report. Prepared for United Water Conservation District. September 2016.

Santa Paula Basin Experts Group, 2003, Investigation of Santa Paula basin yield *prepared for* Santa Paula Basin Technical Advisory Committee dated July 2003.

Stamos, C.L., Predmore, S.K., and Zohdy, A.A.R., 1992, Use of D-C resistivity to map saline ground water: American Society of Civil Engineers National Conference, Water Forum 1992, Baltimore, Maryland, August 2-6, 1992, Proceedings, 80-85p.

State Water Resources Control Board, Division of Water Rights, 1979, Oxnard Plain groundwater study – Water Code Section 2100, 68p.

Stillwater Sciences, 2007, Santa Clara River parkway floodplain restoration feasibility study: assessment of geomorphic processes for the Santa Clara River watershed, Ventura and Los Angeles Counties, California. Prepared by Stillwater Sciences for the California Coastal Conservancy.

Turner, J.M., 1975, Aquifer delineation in the Oxnard-Calleguas area, Ventura County, in Compilation of technical information records for the Ventura County cooperative investigation: California Department of Water Resources, 45 p.

United Water Conservation District, 1983, Environmental assessment report on Freeman Diversion improvement project, Public Law 84-984, October 1983.

United Water Conservation District, 2007, Modifying agricultural practices, nutrients and pesticides, Calleguas Creek and Santa Clara River, August 31, 2007, 104p.

United Water Conservation District, 2008, Nitrate observations in the Oxnard Forebay and vicinity, 1995-2006.

United Water Conservation District, 2010, Oxnard Plain time domain electromagnetic study for saline intrusion, Open-File Report 2010-003, October.

United Water Conservation District, 2012, Hydrogeologic assessment of the Mound basin, United Water Conservation District Open-File Report 2012-001.

United Water Conservation District, 2016a, Saline intrusion update, Oxnard Plain and Pleasant Valley basins, United Water Conservation District Open-File Report 2016-04.

United Water Conservation District, 2016b, Administrative draft United Water Conservation District multiple species habitat conservation plan, October 11, 2016.

United States Geological Survey, 1996, Seawater intrusion in a coastal California aquifer, Fact Sheet 125-96, 4p.

United States Geological Survey, 2011, http://water.usgs.gov/ogw/modflow-nwt/.

USFWS and NMFS (United States Fish and Wildlife Service and National Marine Fisheries Service). 2016. Draft habitat conservation planning handbook. United States Department of the Interior, Fish and Wildlife Service and United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Washington, DC.

Weber, F.H., Kiessling, E.W., Sprotte, E.C., Johnson, J.A., Sherburne, R.W., and Cleveland, G.B., 1976, Seismic hazards study of Ventura County, California: California Department of Conservation, California Division of Mines and Geology Open-File Report 76-5, 396 p., pls. 3A and 3B.

Zohdy, A.A.R., Martin, Peter, and Bisdorf, R.J., 1993, A study of seawater intrusion using direct-current soundings in the southeastern part of the Oxnard Plain, California, USGS Open-File Report 93-524, 139p.

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FIGURES

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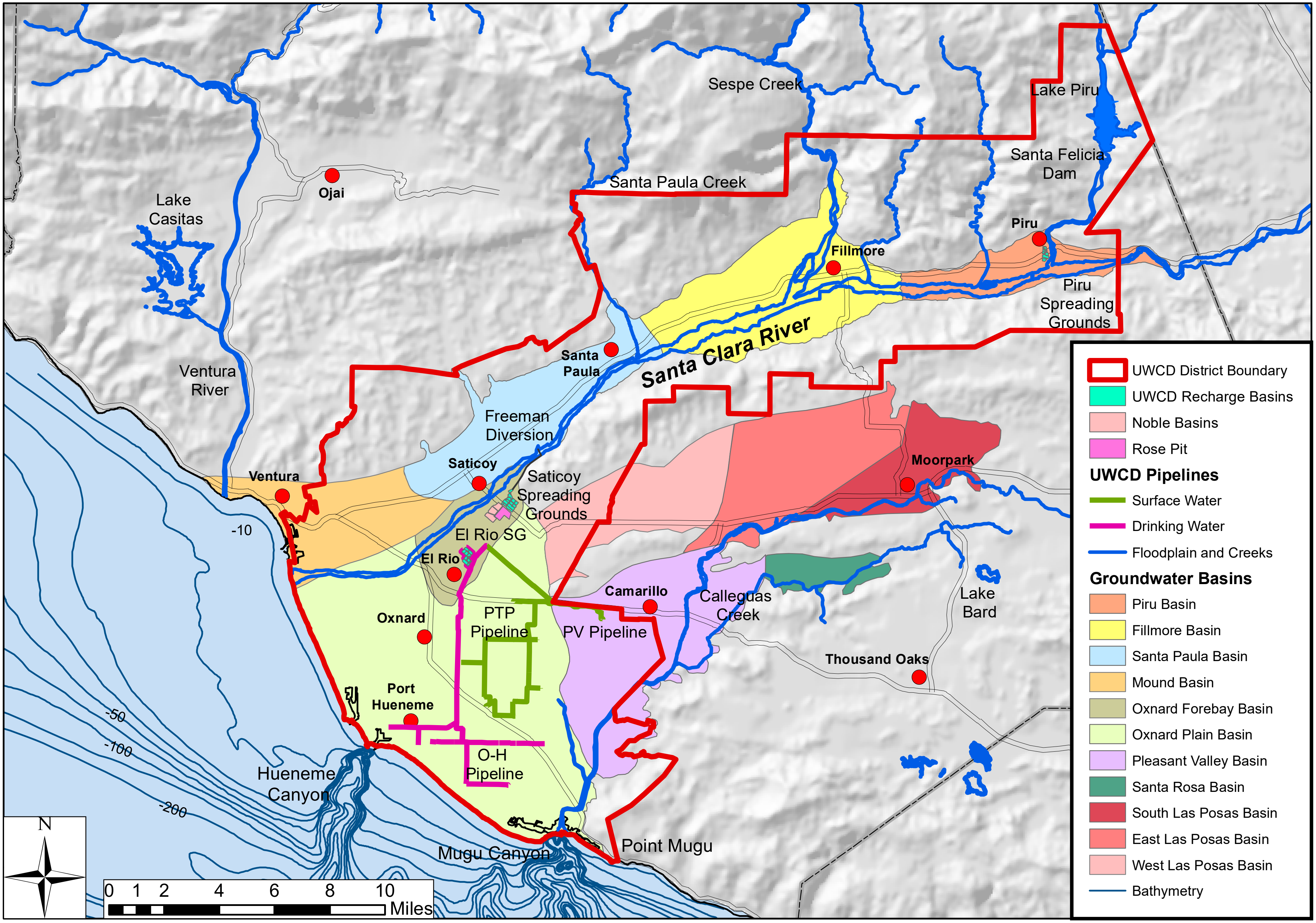


Figure 1.1-1. Groundwater basins, District boundary, and major recharge and conveyance facilities.

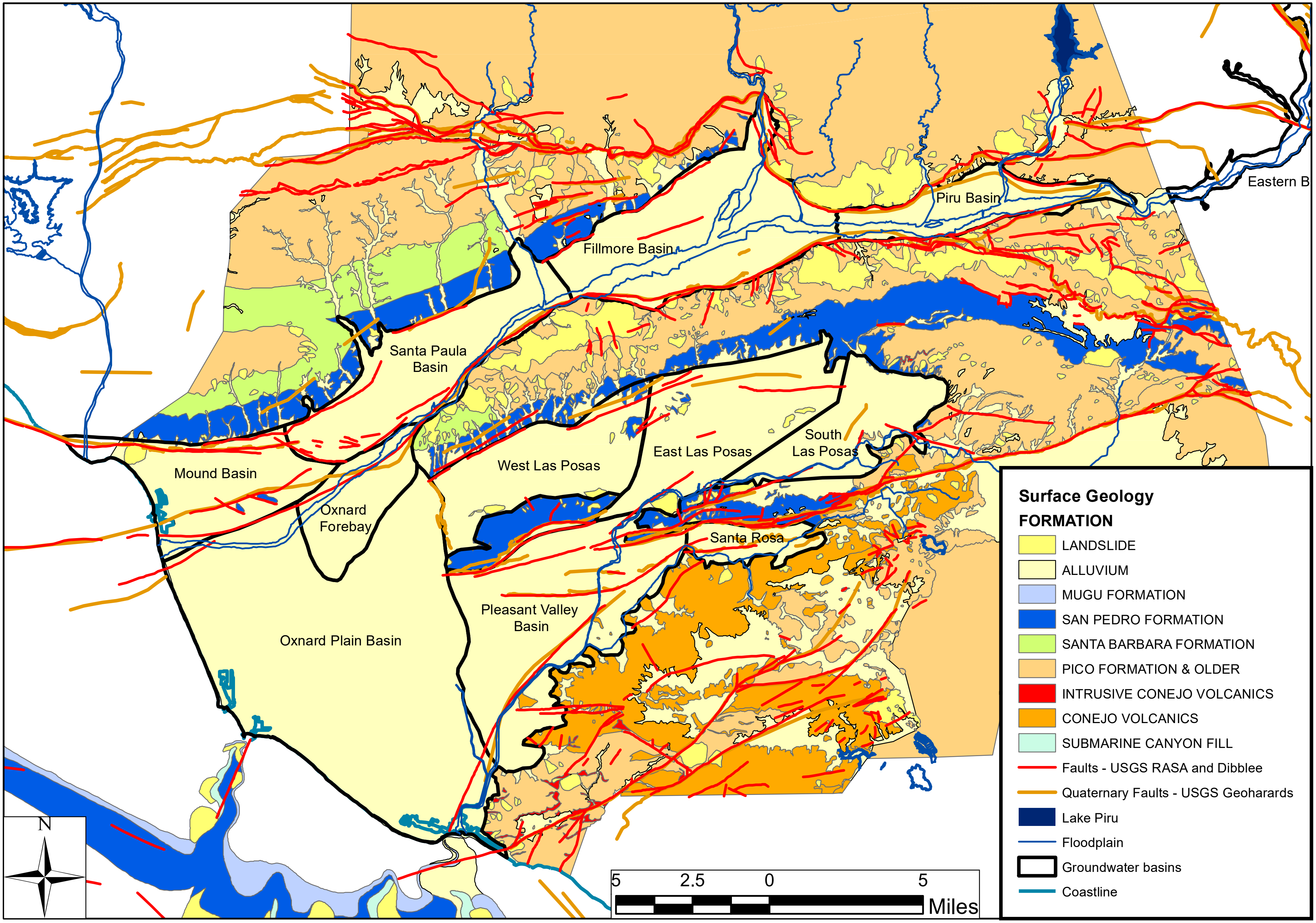


Figure 1.3-1. Surface geology and faults.

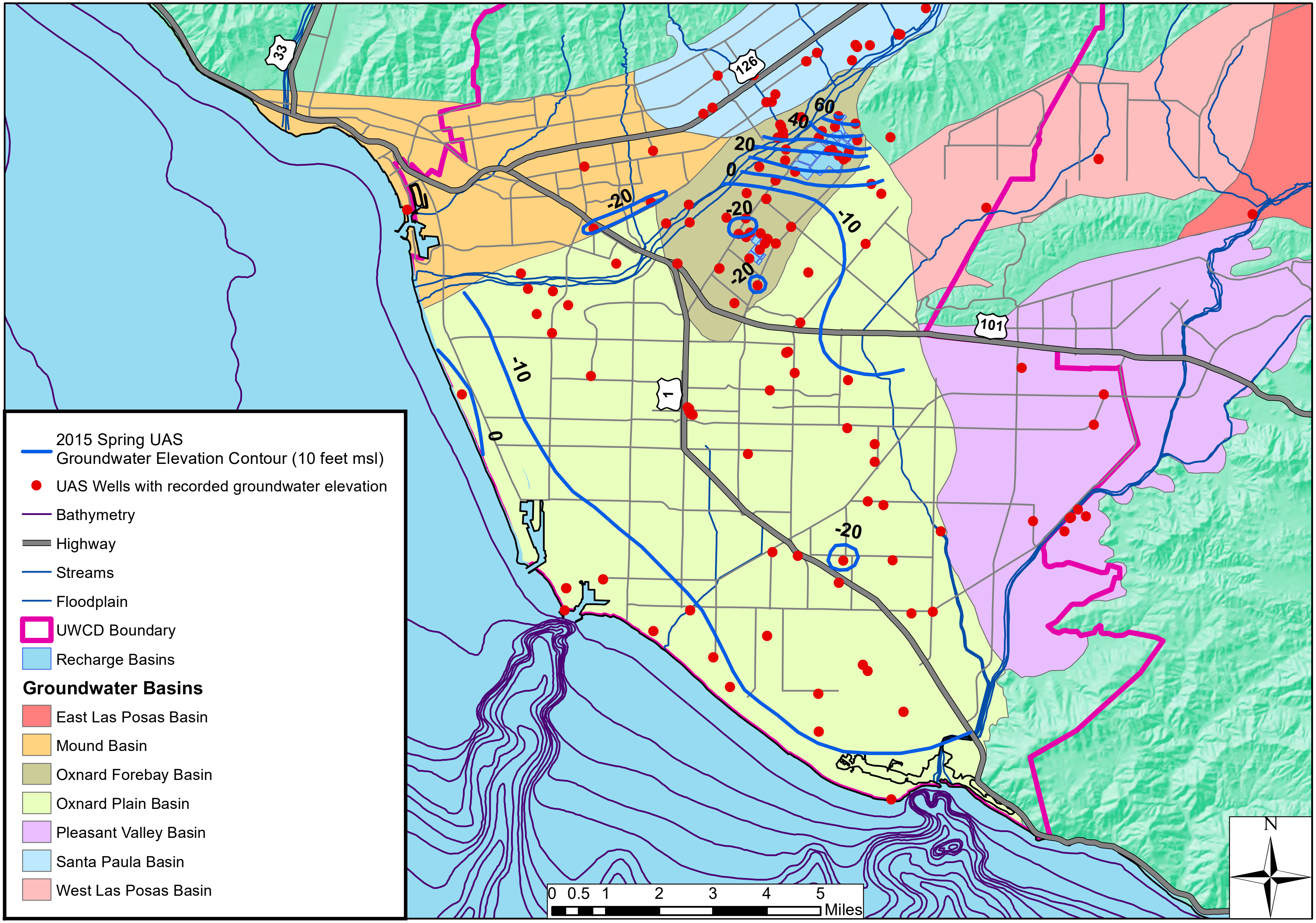


Figure 1.4-1. Spring 2015 groundwater elevations, Upper Aquifer System wells.

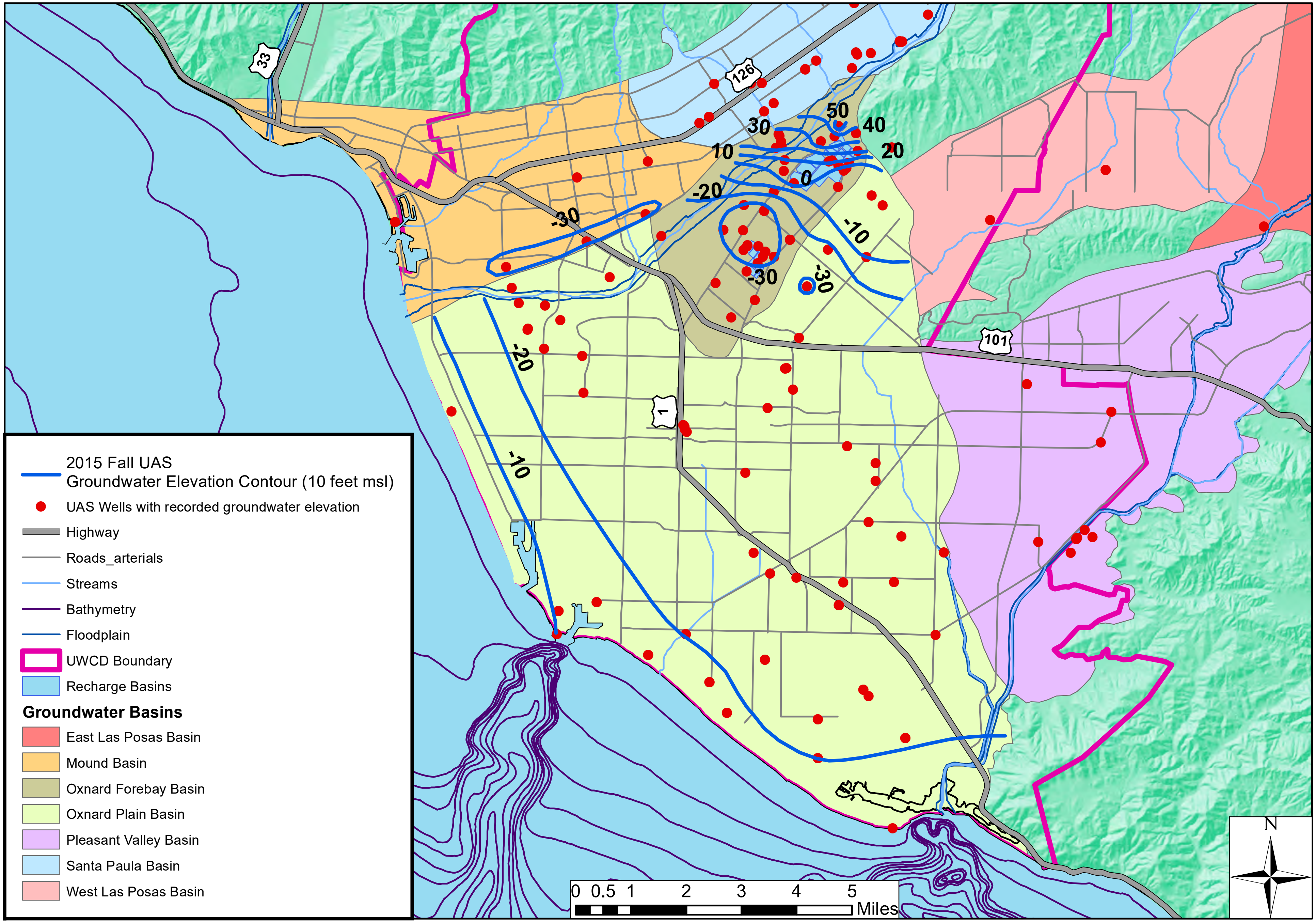


Figure 1.4-2. Fall 2015 groundwater elevations, Upper Aquifer System wells.

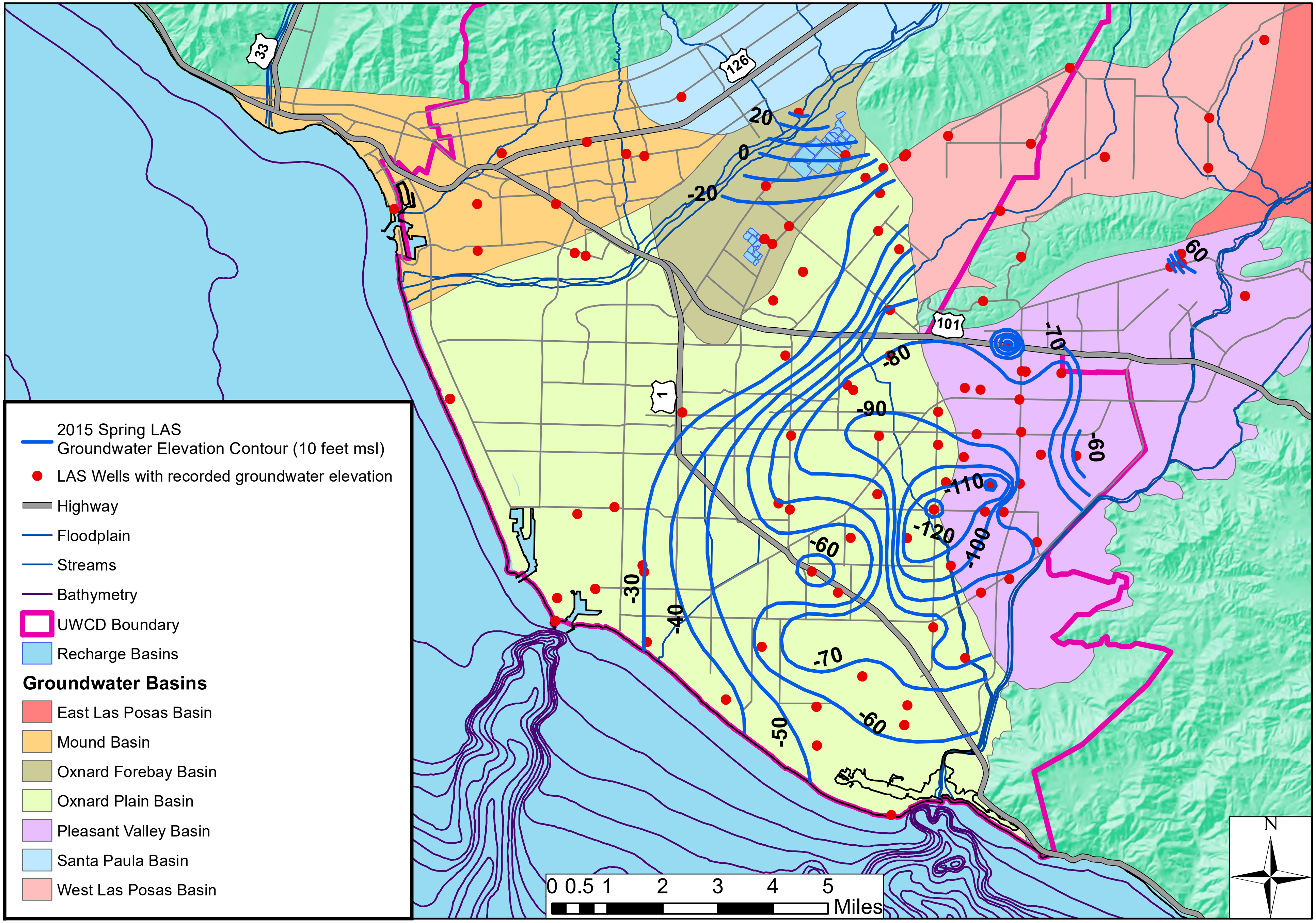


Figure 1.4-3. Spring 2015 groundwater elevations, Lower Aquifer System wells.

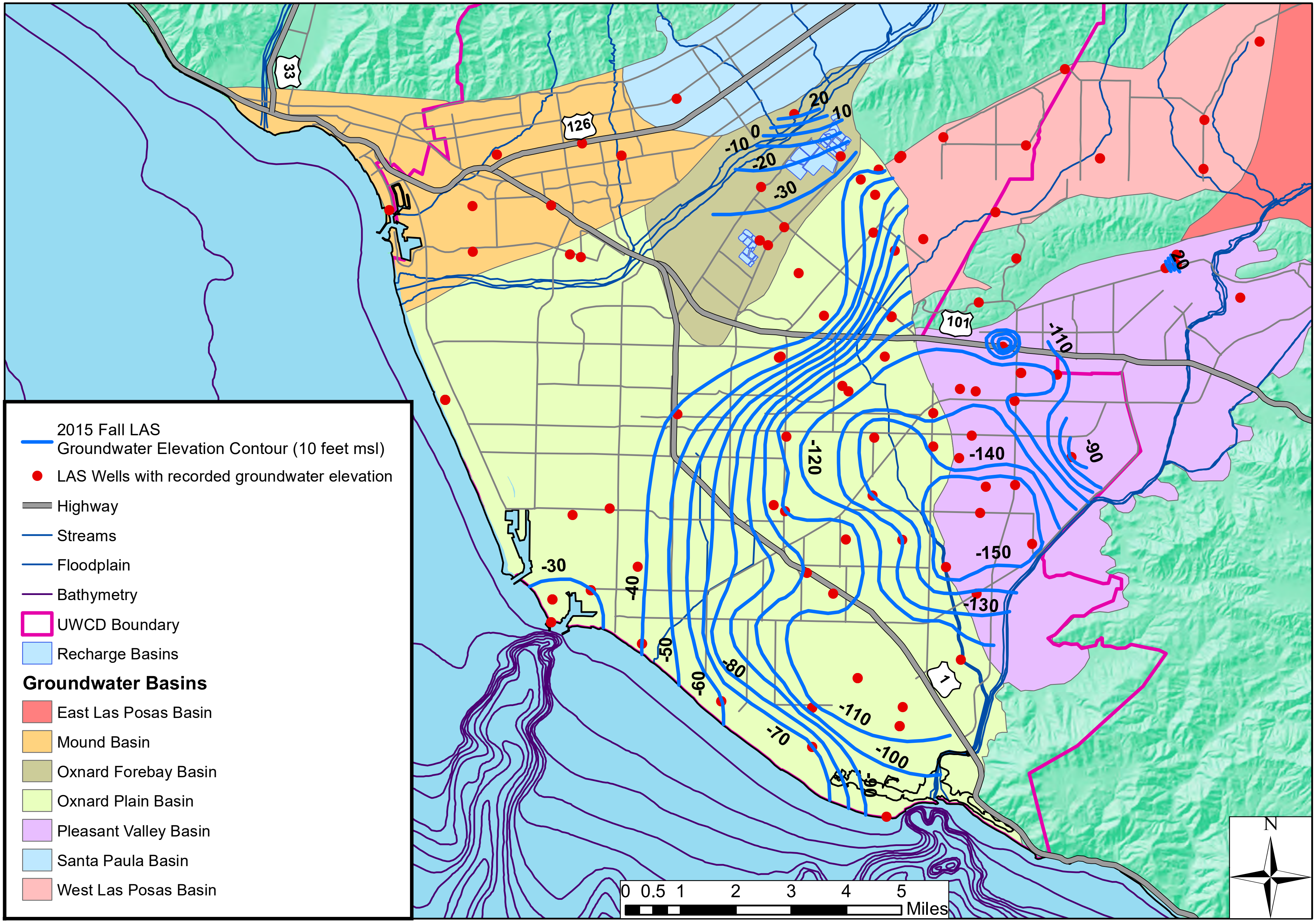


Figure 1.4-4. Fall 2015 groundwater elevations, Lower Aquifer System wells.

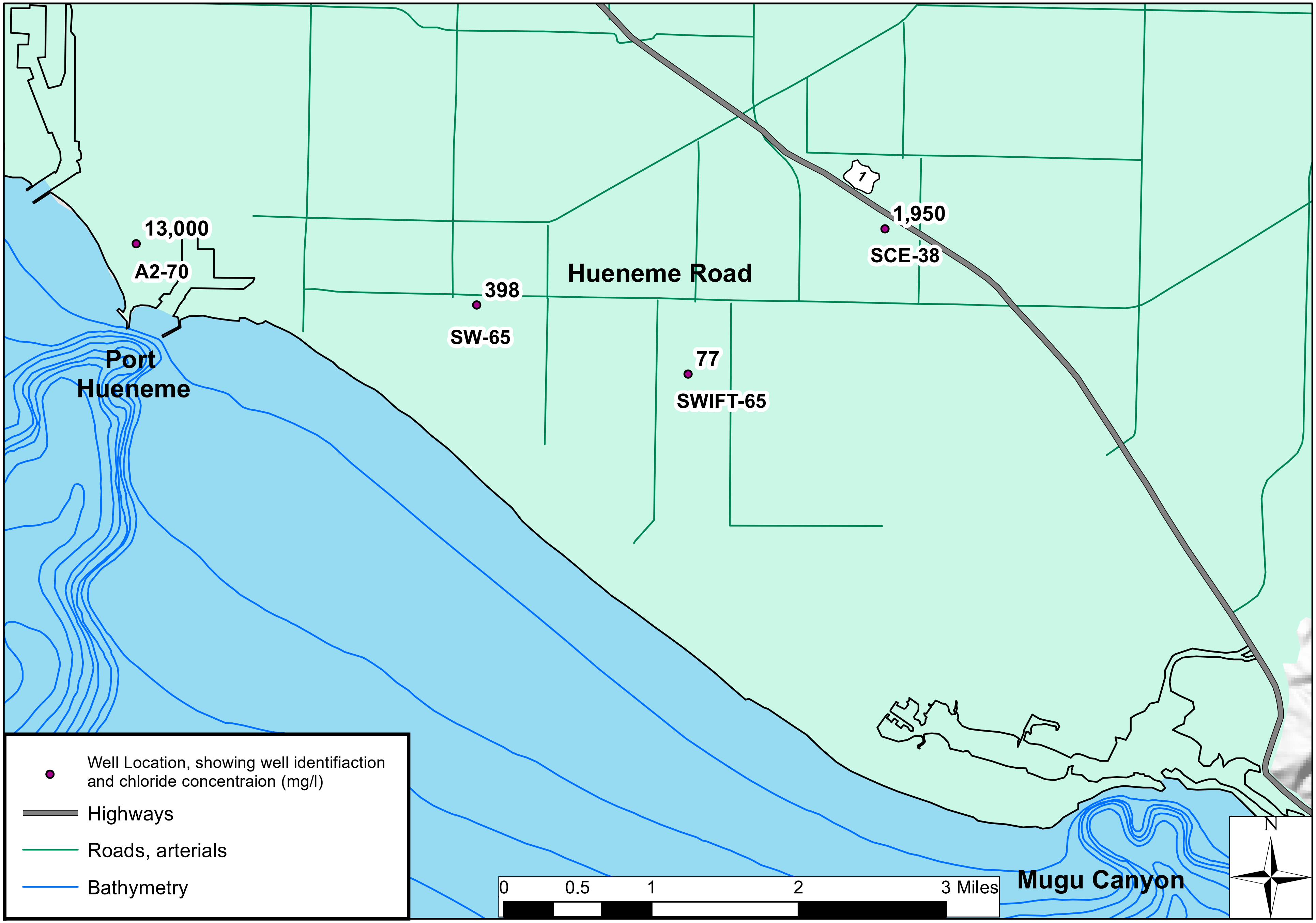


Figure 1.4-5. Semi-perched aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Black label = Background level.

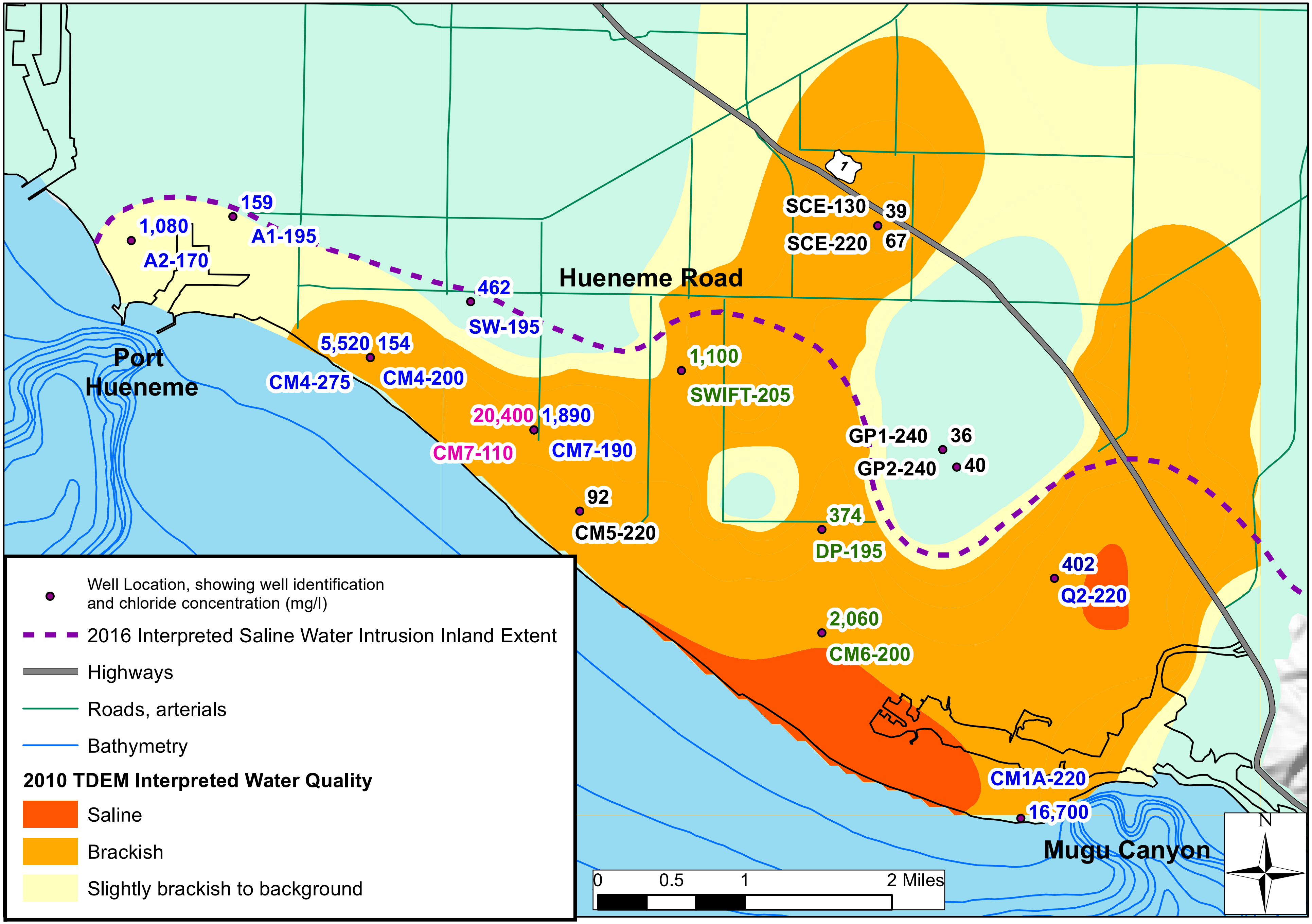


Figure 1.4-6. Oxnard aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Green label = Sediments; Blue label = Seawater; Pink label = Semi-perched water; Black label = Background level.

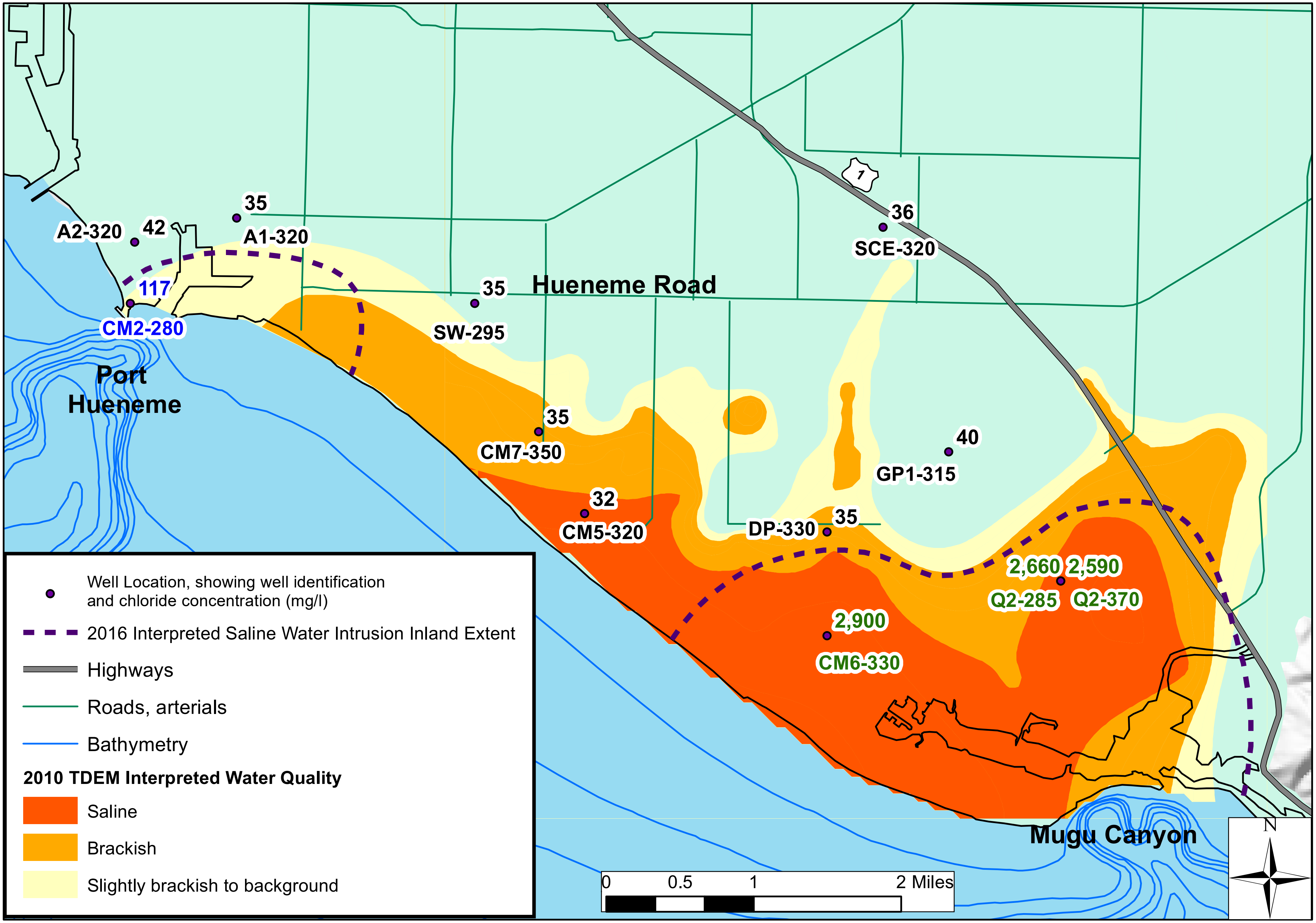


Figure 1.4-7. Mugu aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Green label = Sediments; Blue label = Seawater; Black label = Background level.

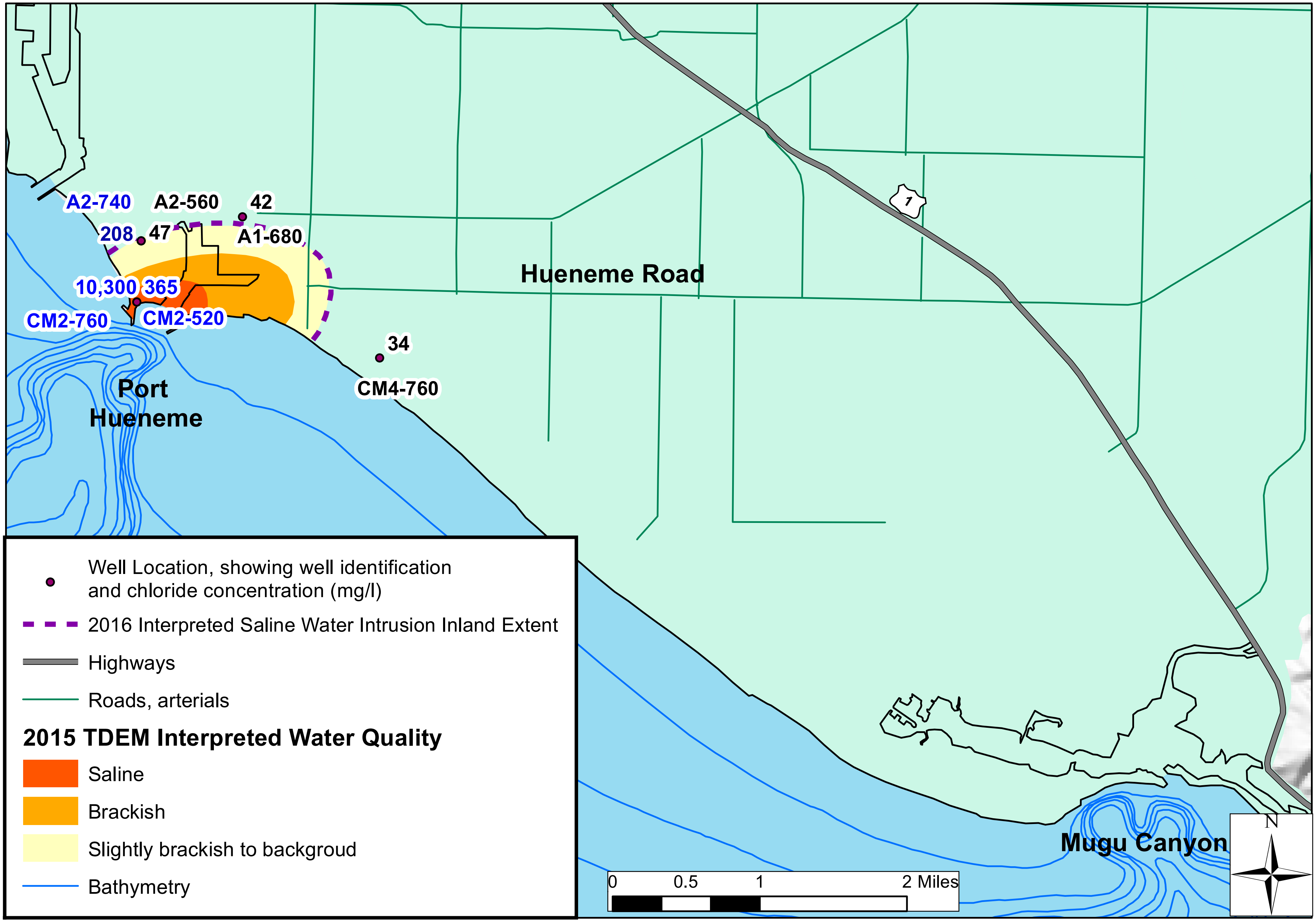


Figure 1.4-8. Hueneme aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Blue label = Seawater; Black label = Background level.

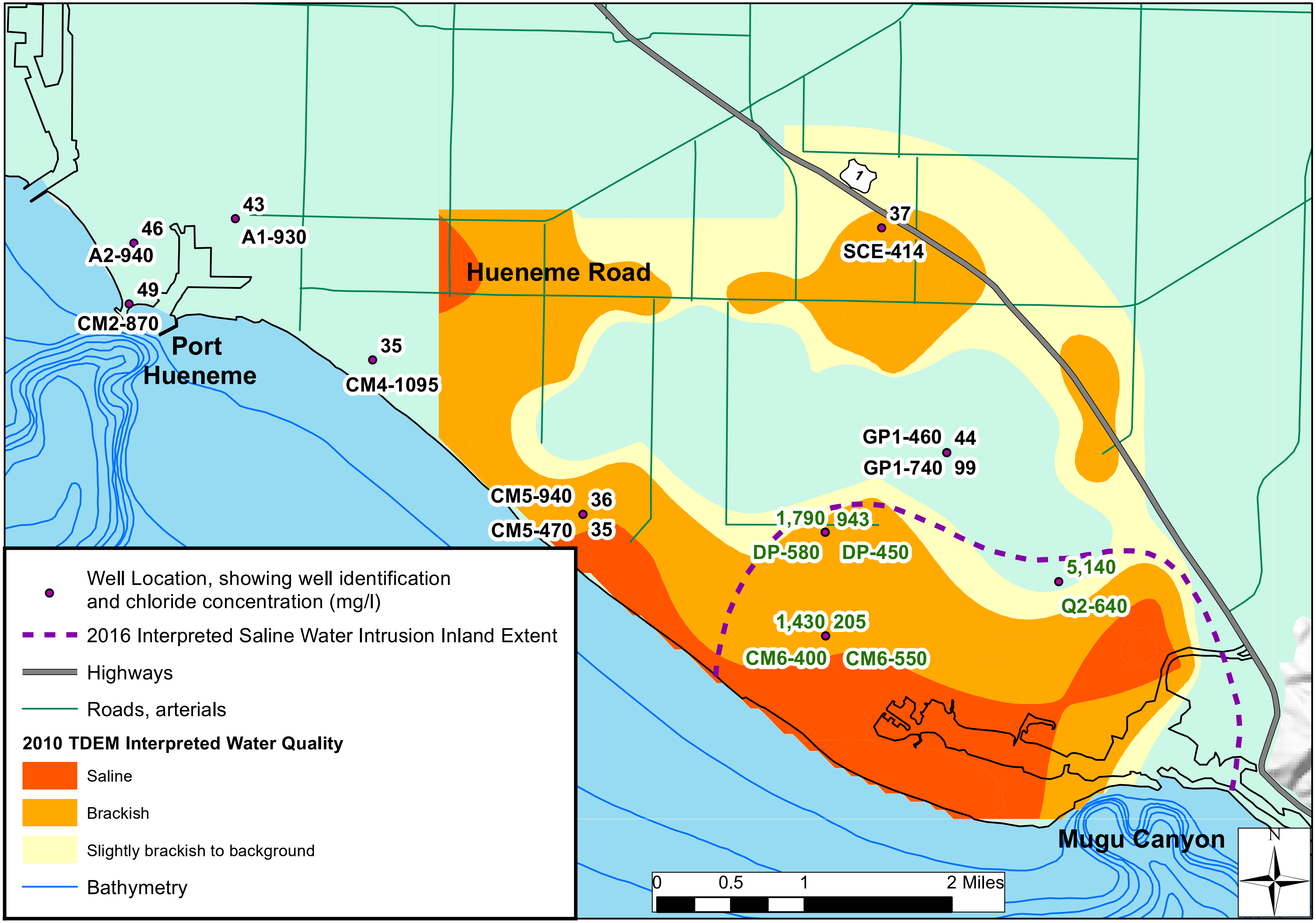


Figure 1.4-9. Fox Canyon aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Green label = Sediments; Black label = Background level.

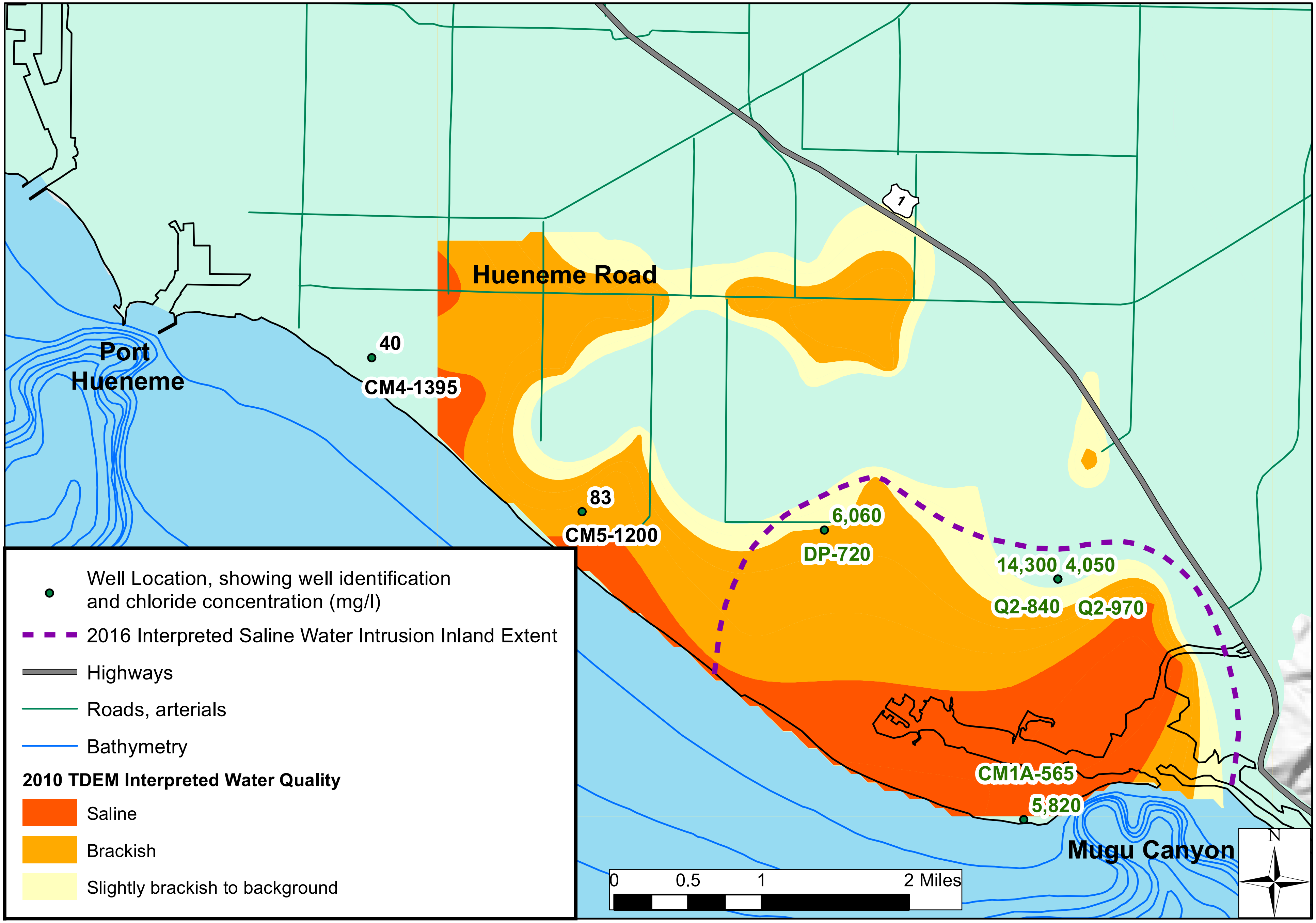


Figure 1.4-10. Grimes Canyon aquifer chloride concentrations, coastal monitoring wells, fall 2015.
Interpreted source of elevated chloride levels key: Green label = Sediments; Black label = Background level.

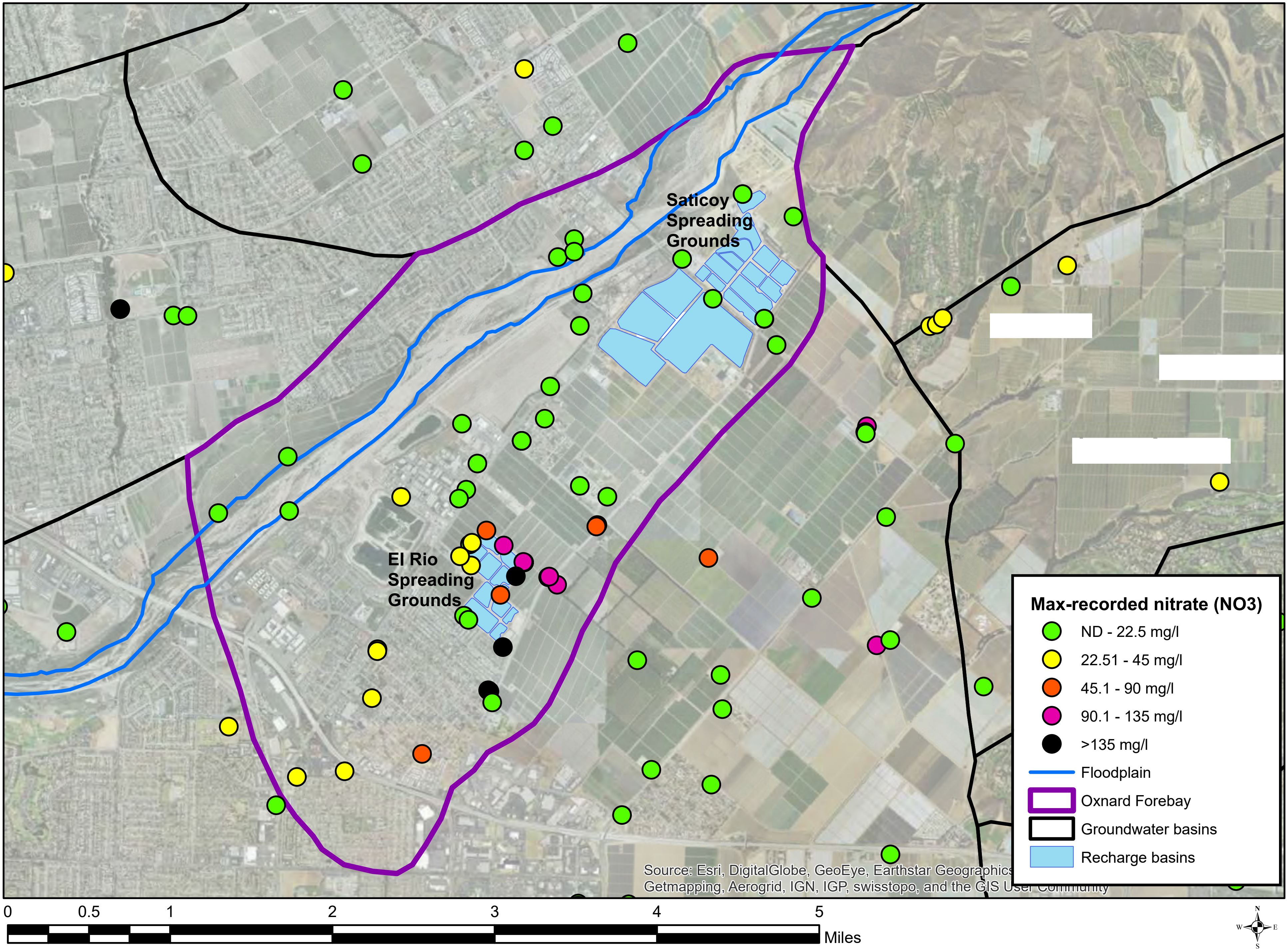


Figure 1.4-11. Maximum recorded nitrate in wells, 2015 calendar year.

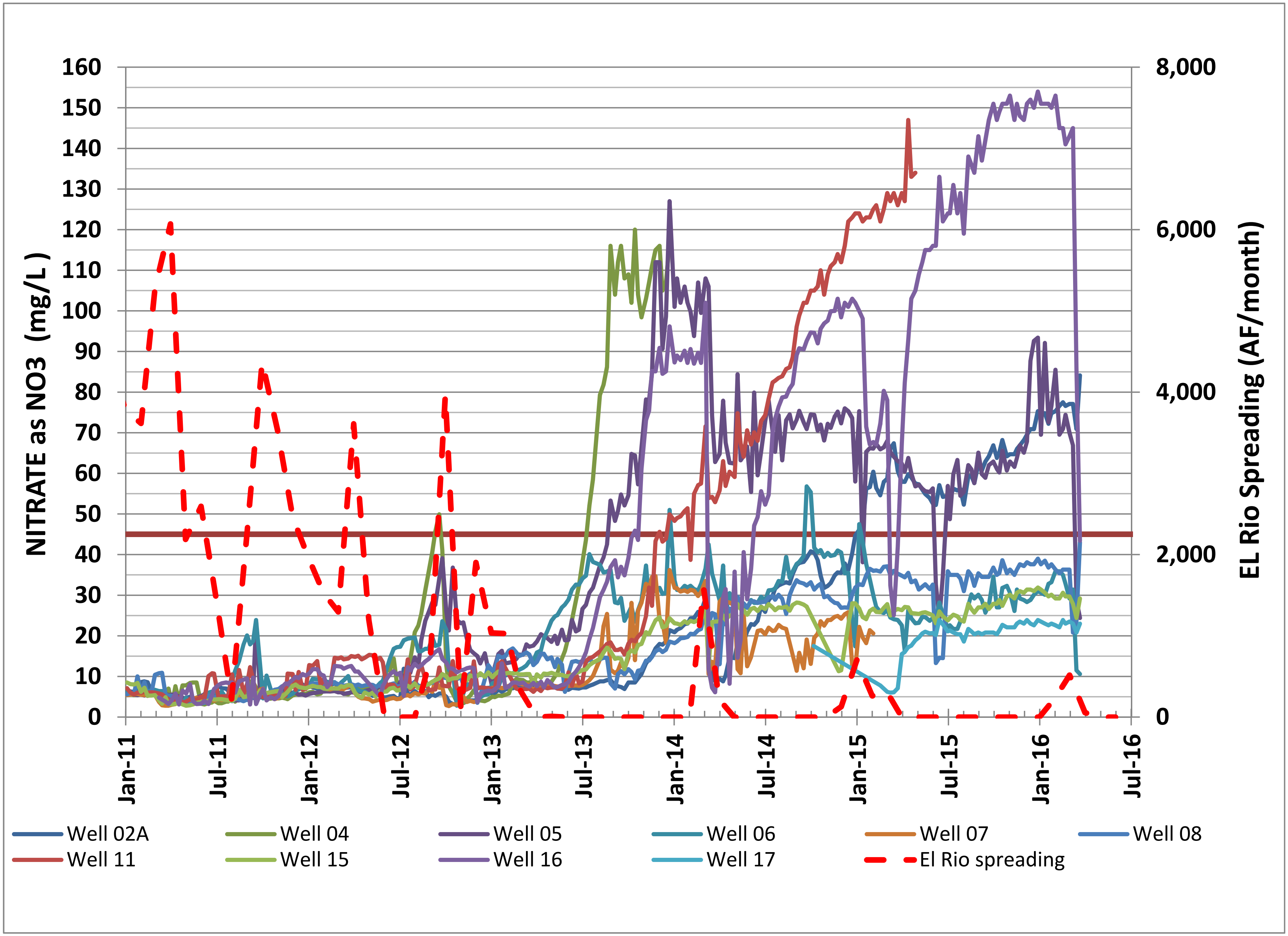


Figure 1.4-12. Recorded nitrate concentrations in El Rio UAS wells, with monthly recharge volumes.

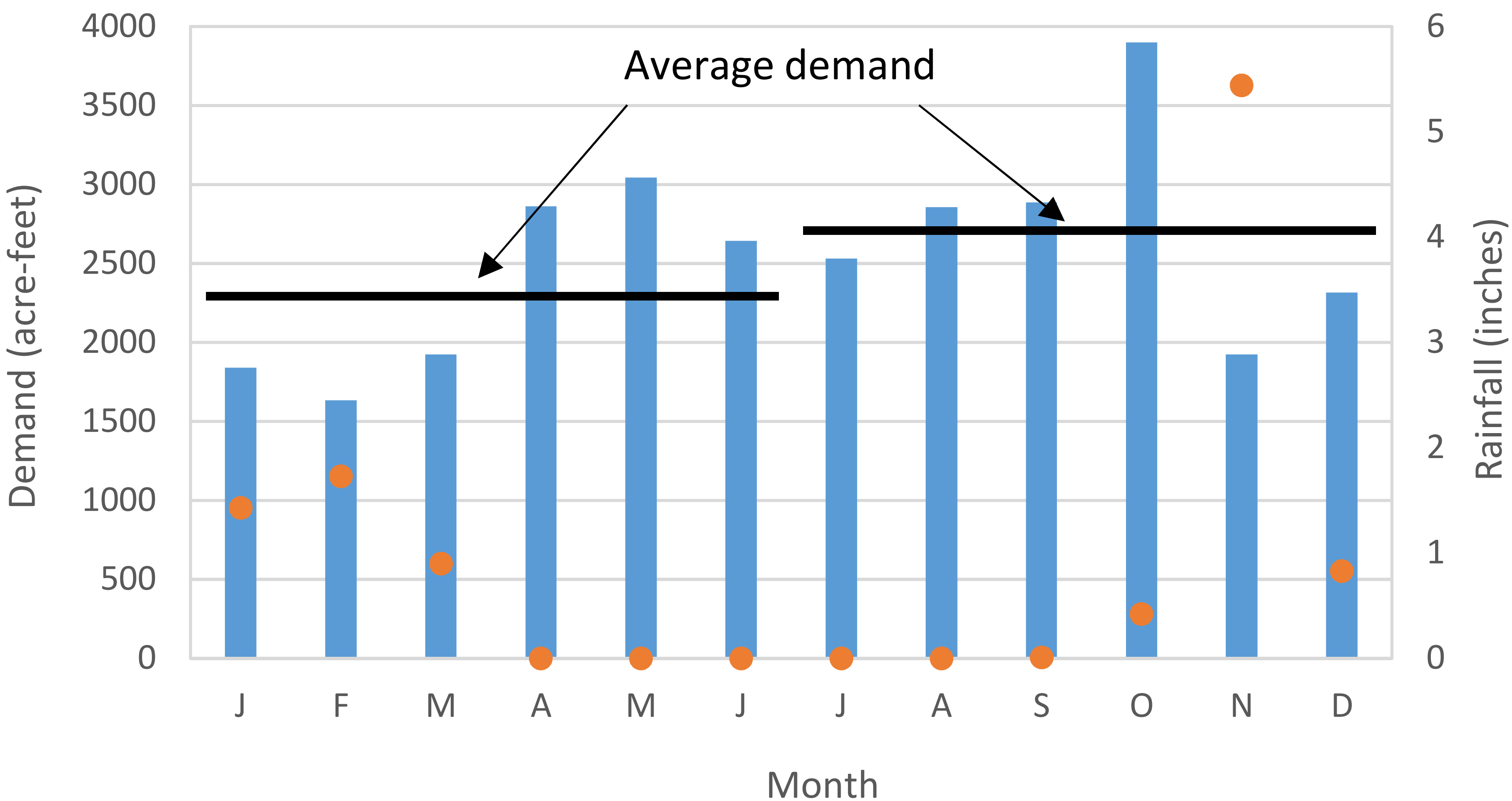
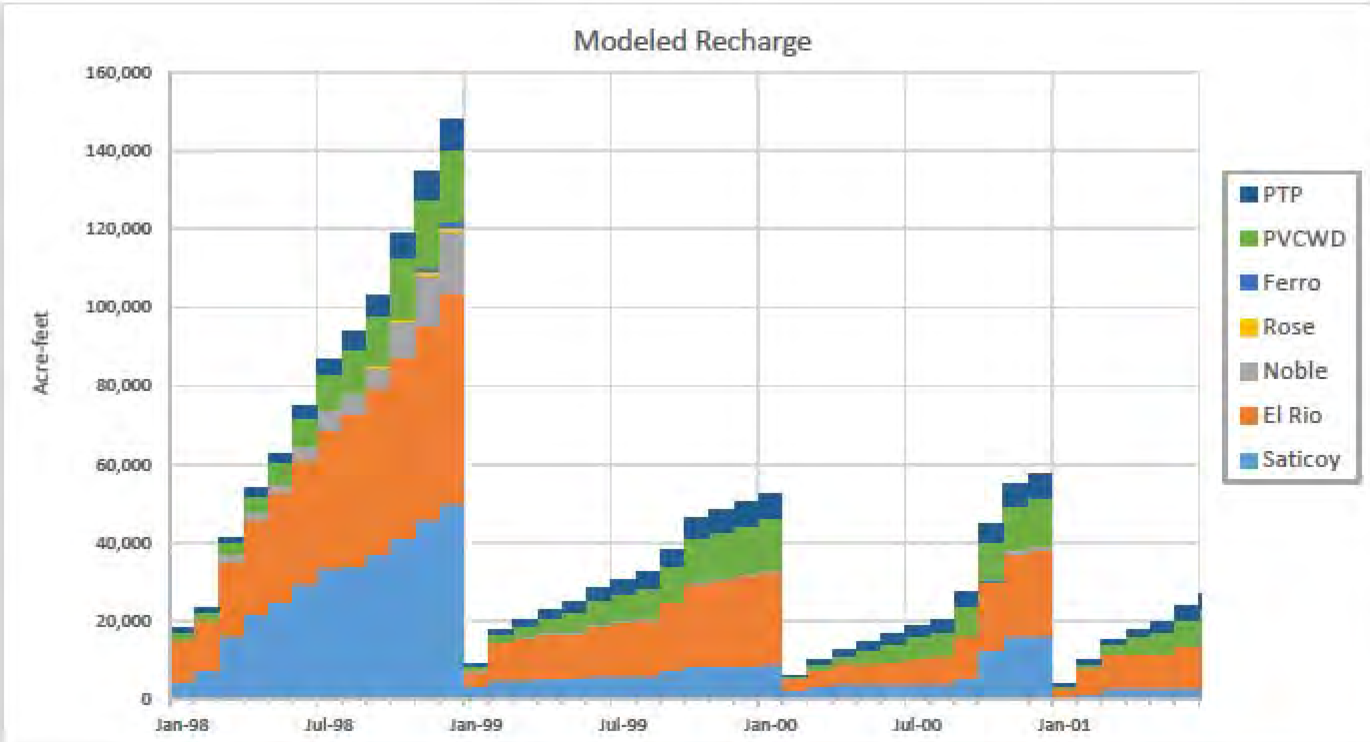


Figure 2.1-1. Irrigation demands for Pleasant Valley County Water District service area (1985). Black lines indicate average demands for each 6-month period, bars indicate adjusted monthly demands, and circles indicate monthly rainfall.



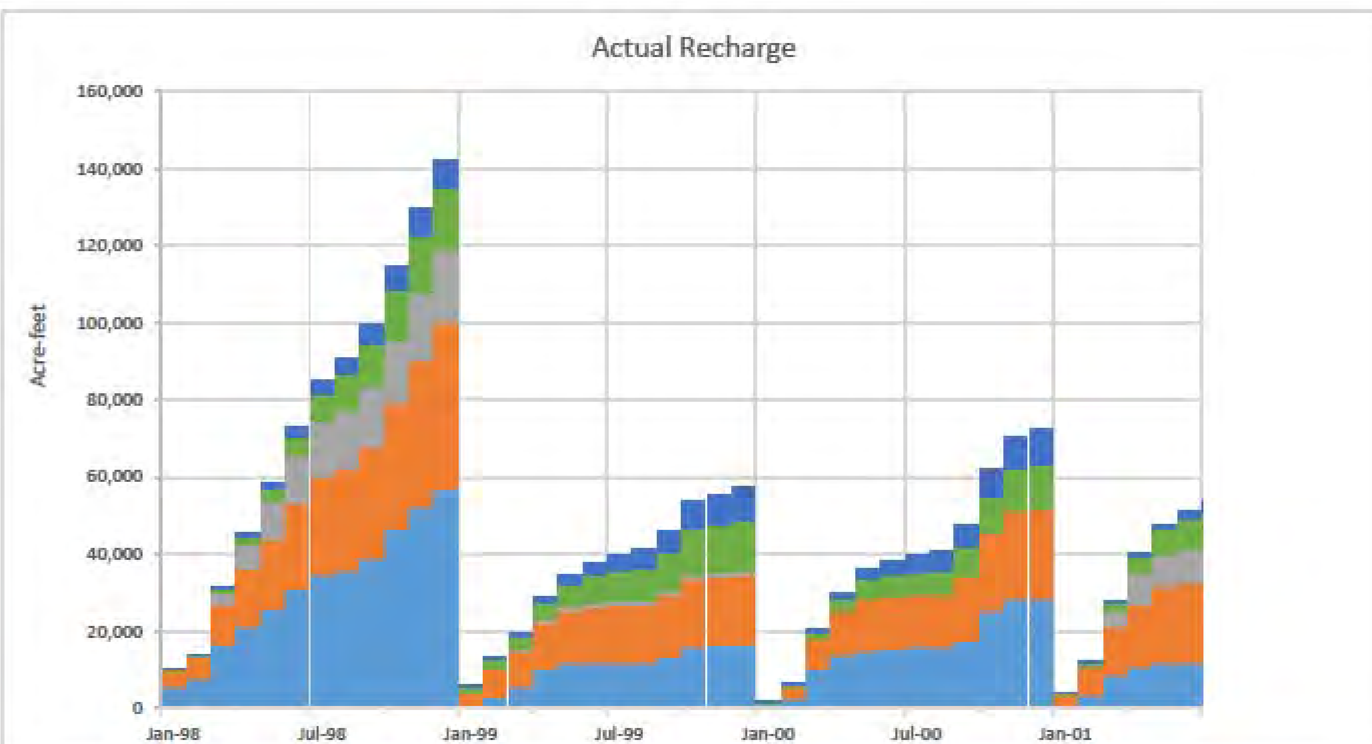


Figure 2.1-2. Cumulative volumes (annual) of modeled and actual recharge and surface water deliveries for 1998 to 2001.

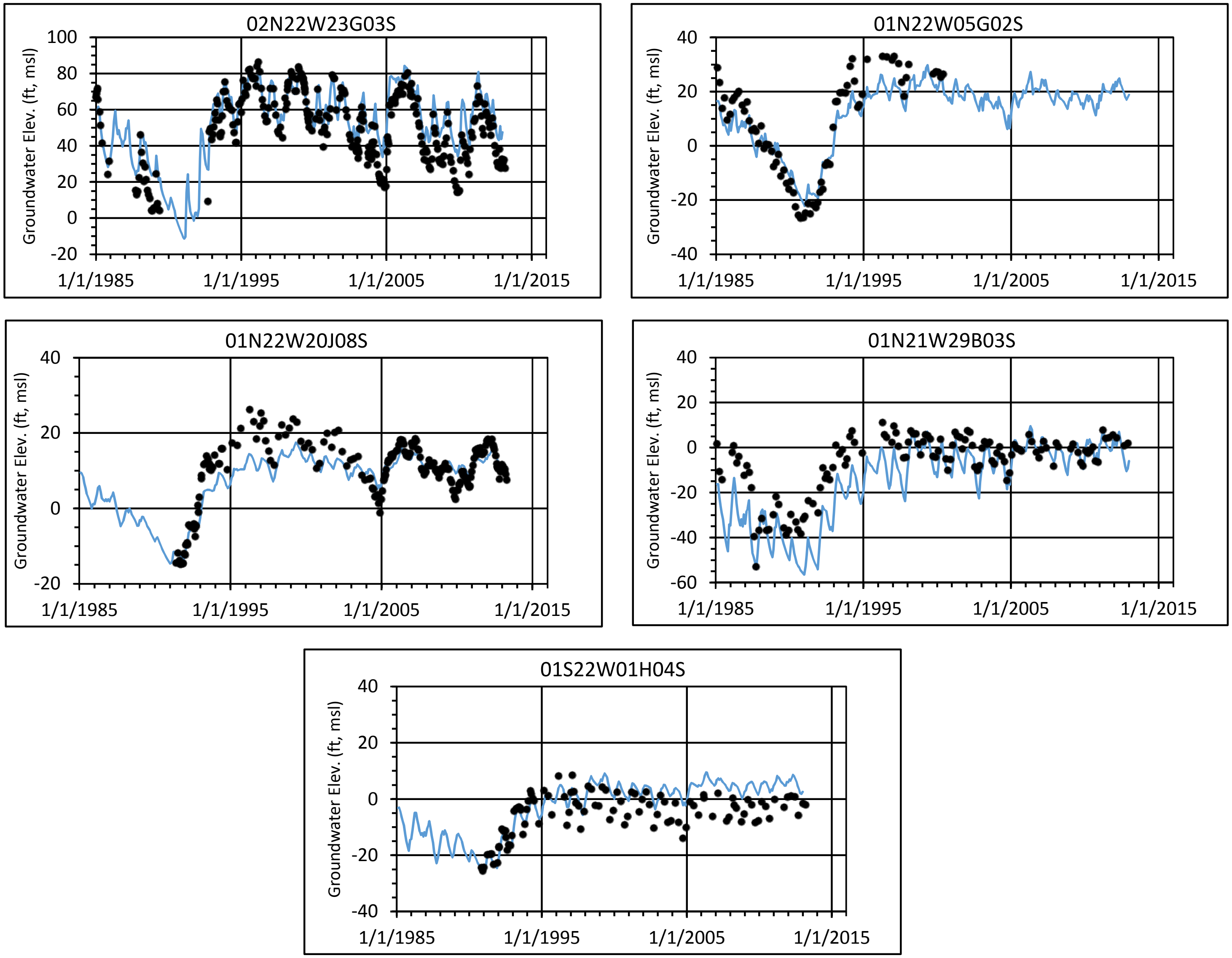


Figure 2.1-3. Model calibration hydrographs for selected UAS wells in Oxnard Plain, Oxnard Forebay, and Pleasant Valley basins.

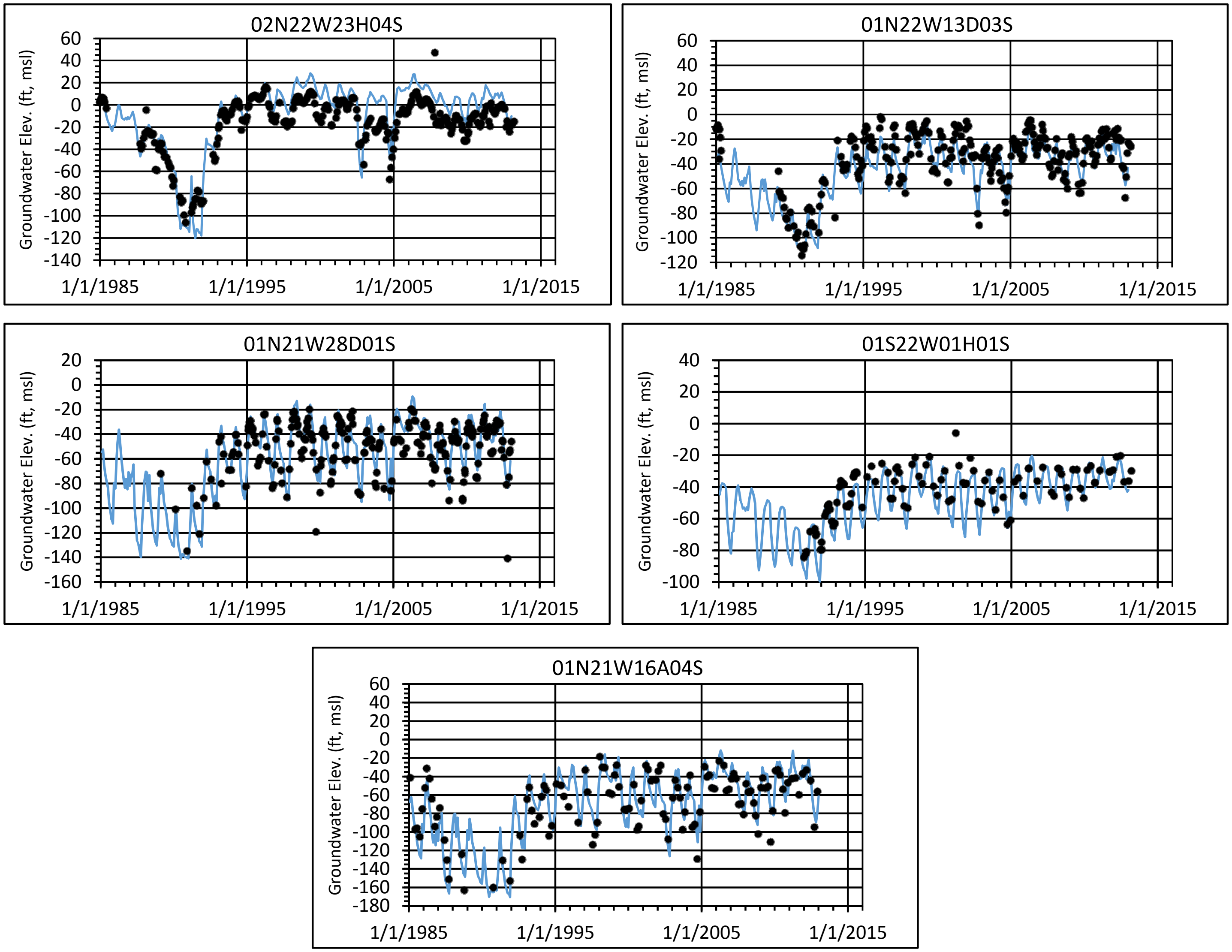


Figure 2.1-4. Model calibration hydrographs for selected LAS wells in Oxnard Plain, Oxnard Forebay, and Pleasant Valley basins.

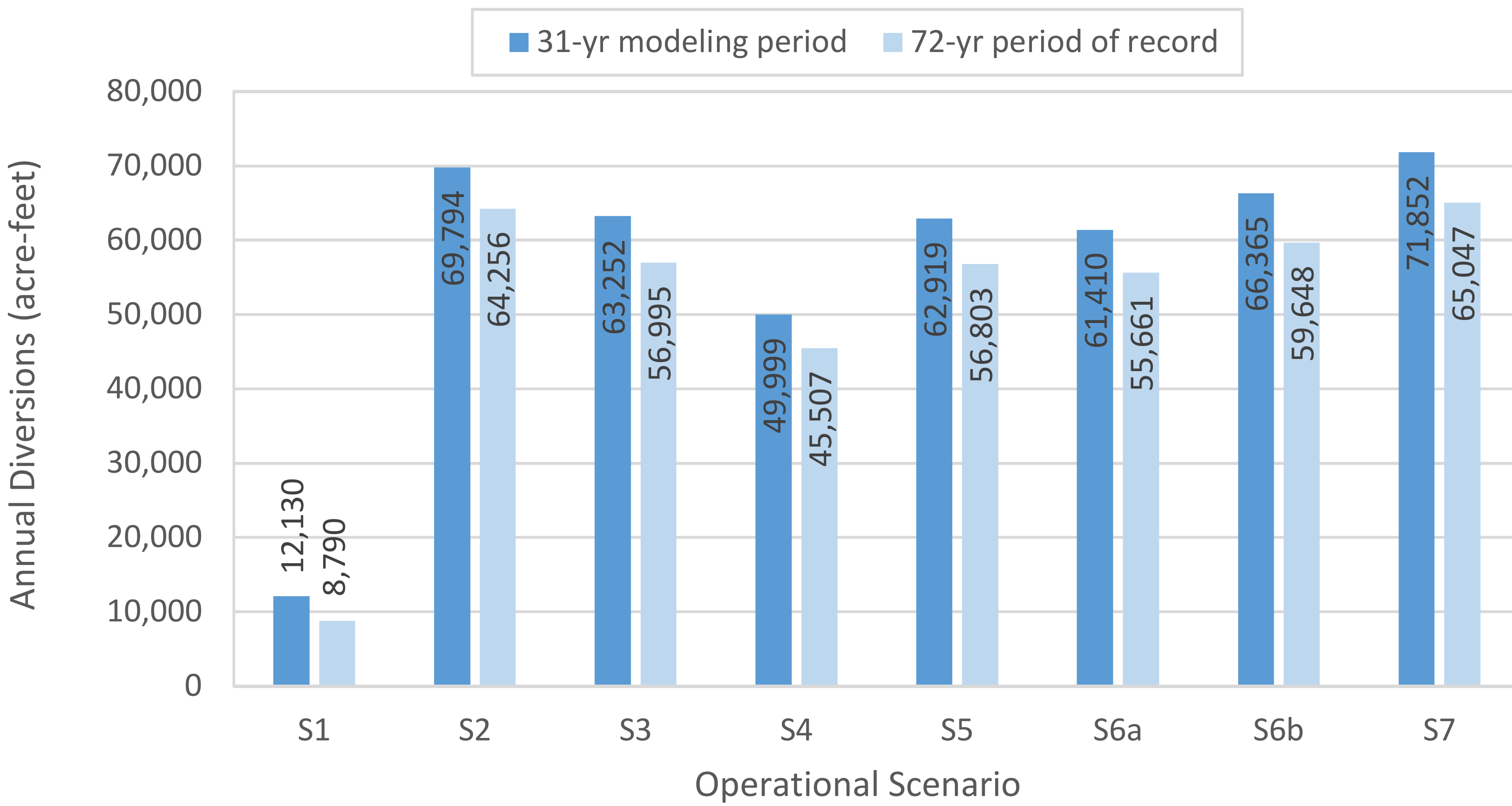


Figure 3.1-1. Average annual diversions for each operational scenario (1985-2015 and 1944-2015).

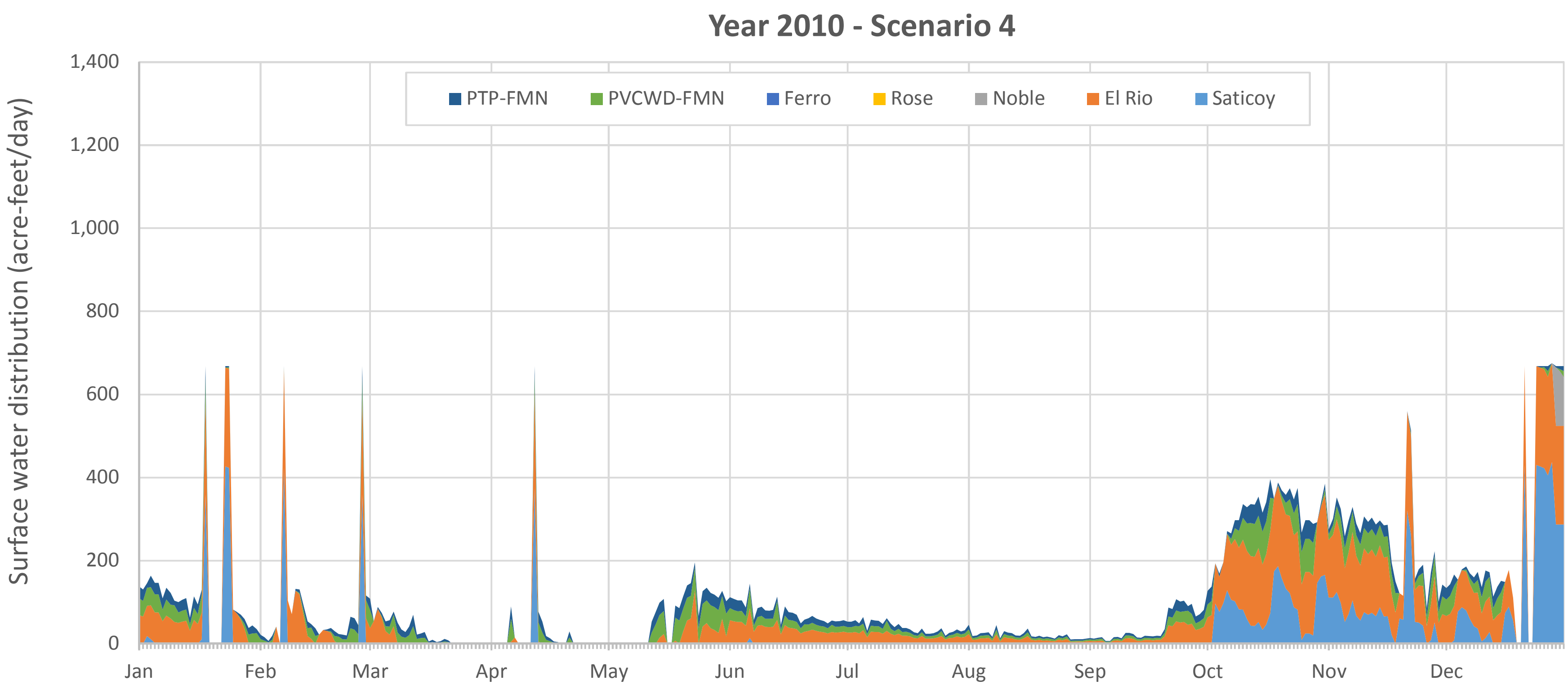


Figure 3.1-2a. Surface water distribution to recharge basins and surface water deliveries for scenario 4 (model year 2010).

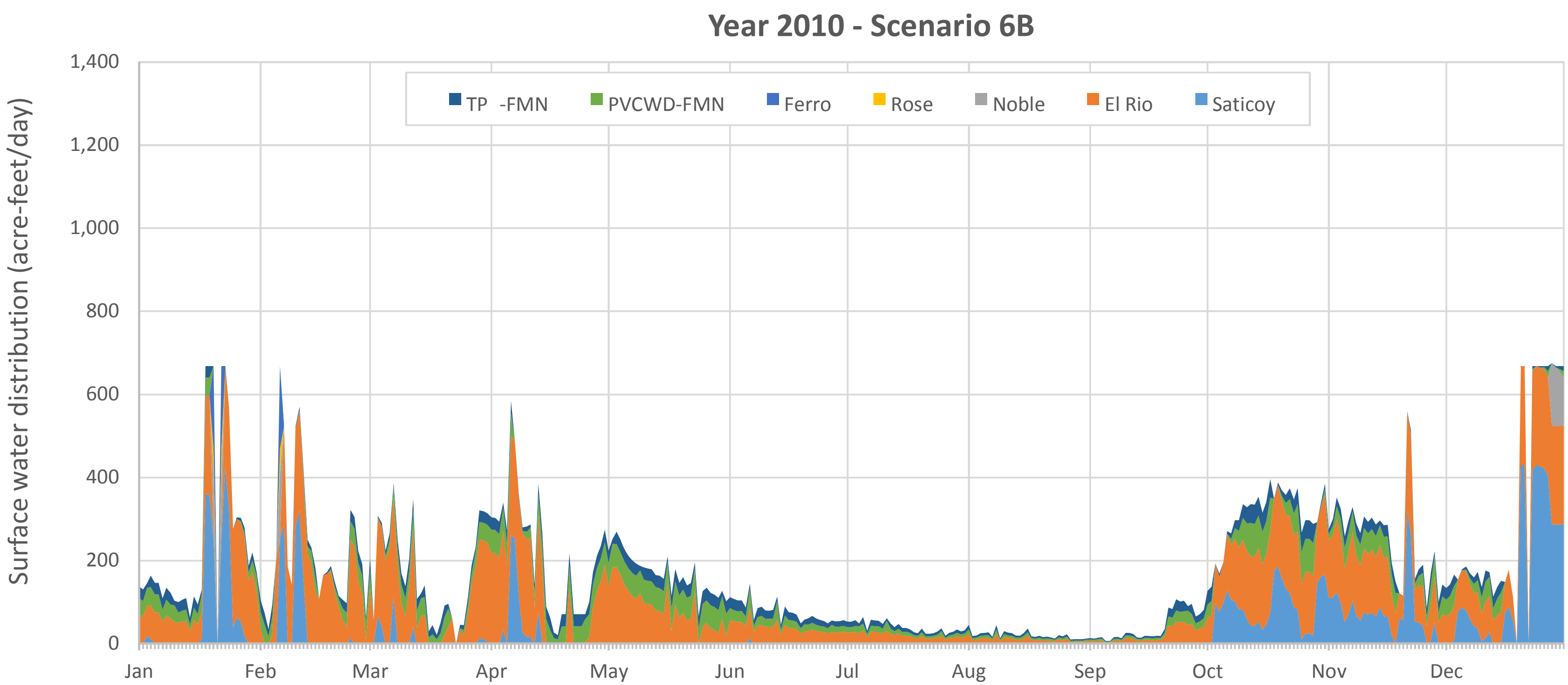


Figure 3.1-2b. Surface water distribution to recharge basins and surface water deliveries for scenario 6B (model year 2010).

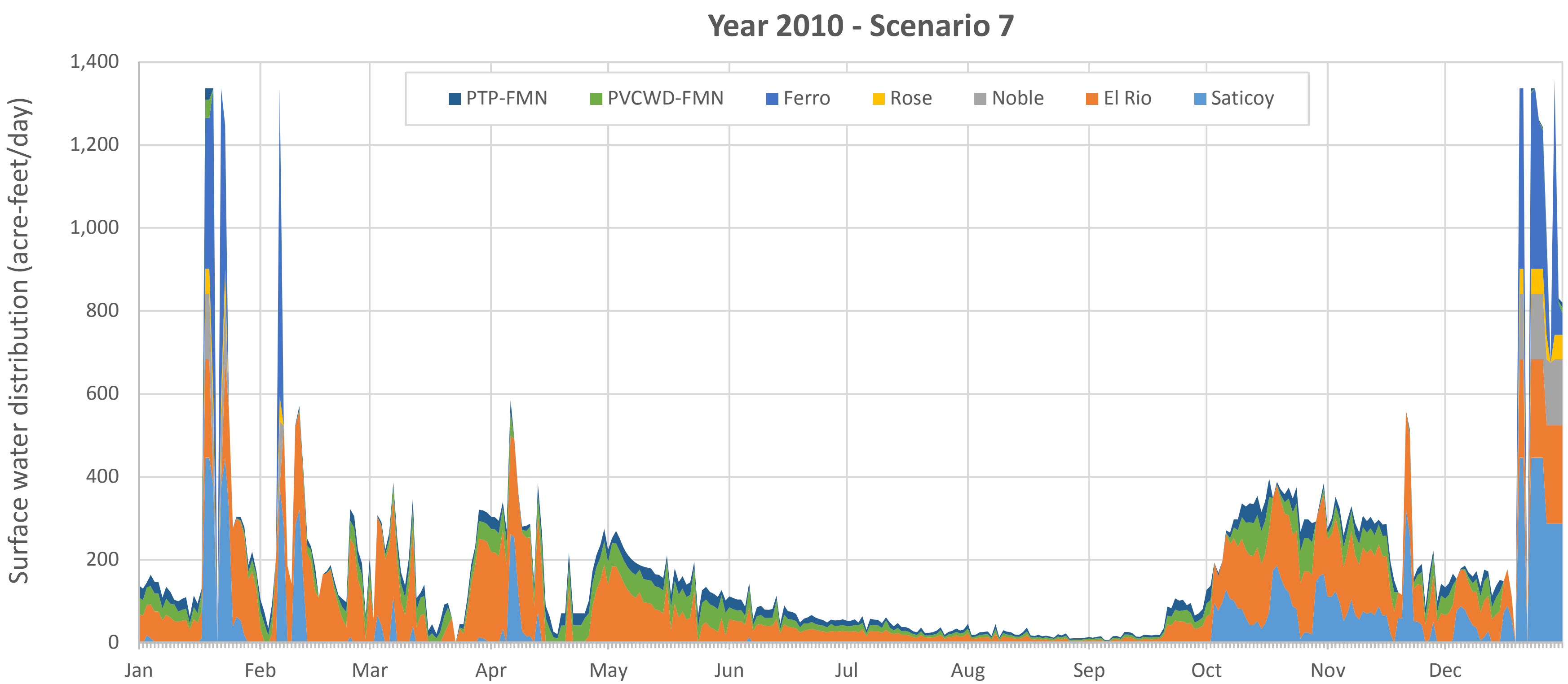


Figure 3.1-2c. Surface water distribution to recharge basins and surface water deliveries for scenario 7 (model year 2010).

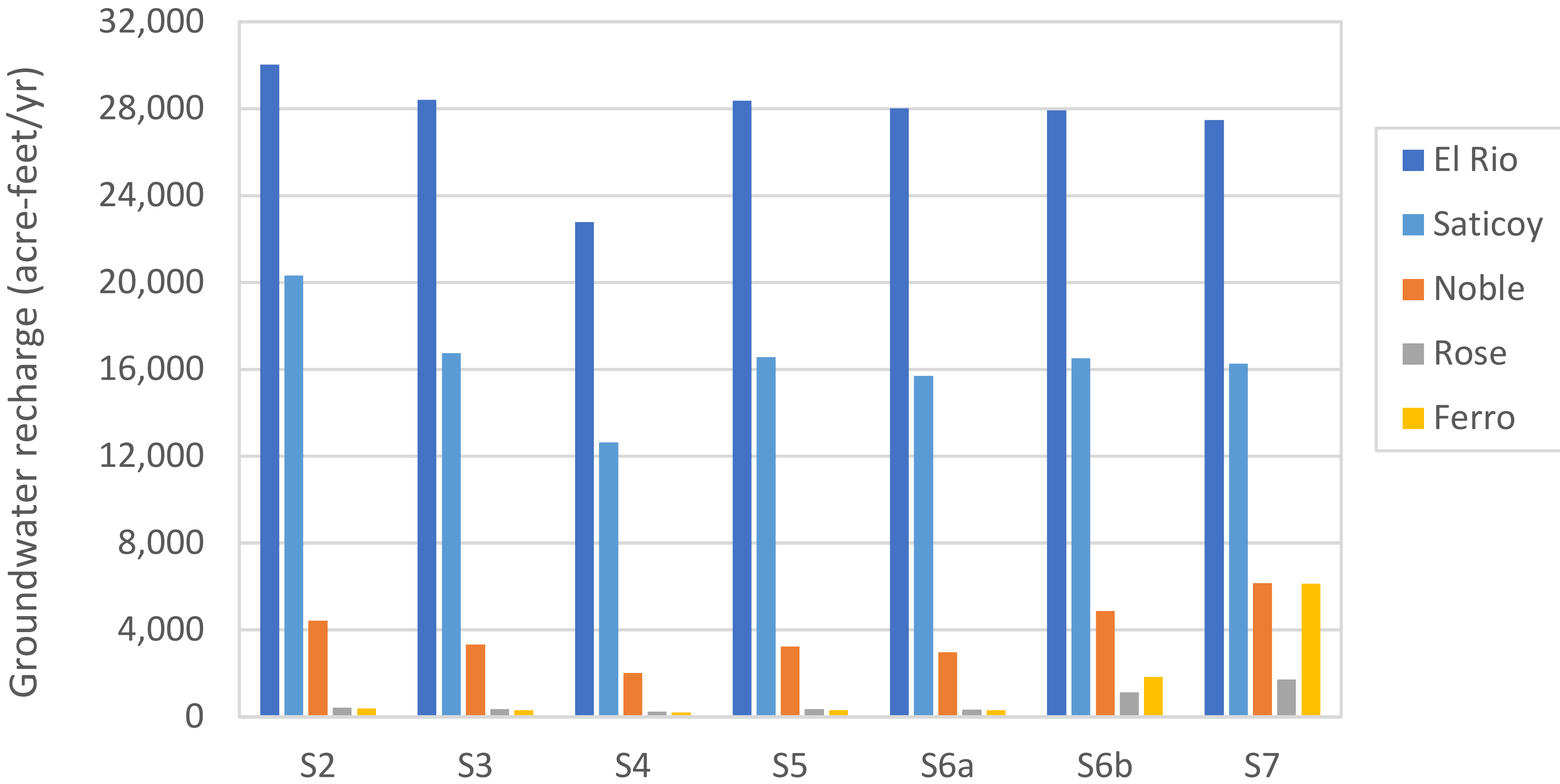


Figure 3.1-3. Comparison of average annual groundwater recharge between scenarios for the 1985-2015 modeling period.

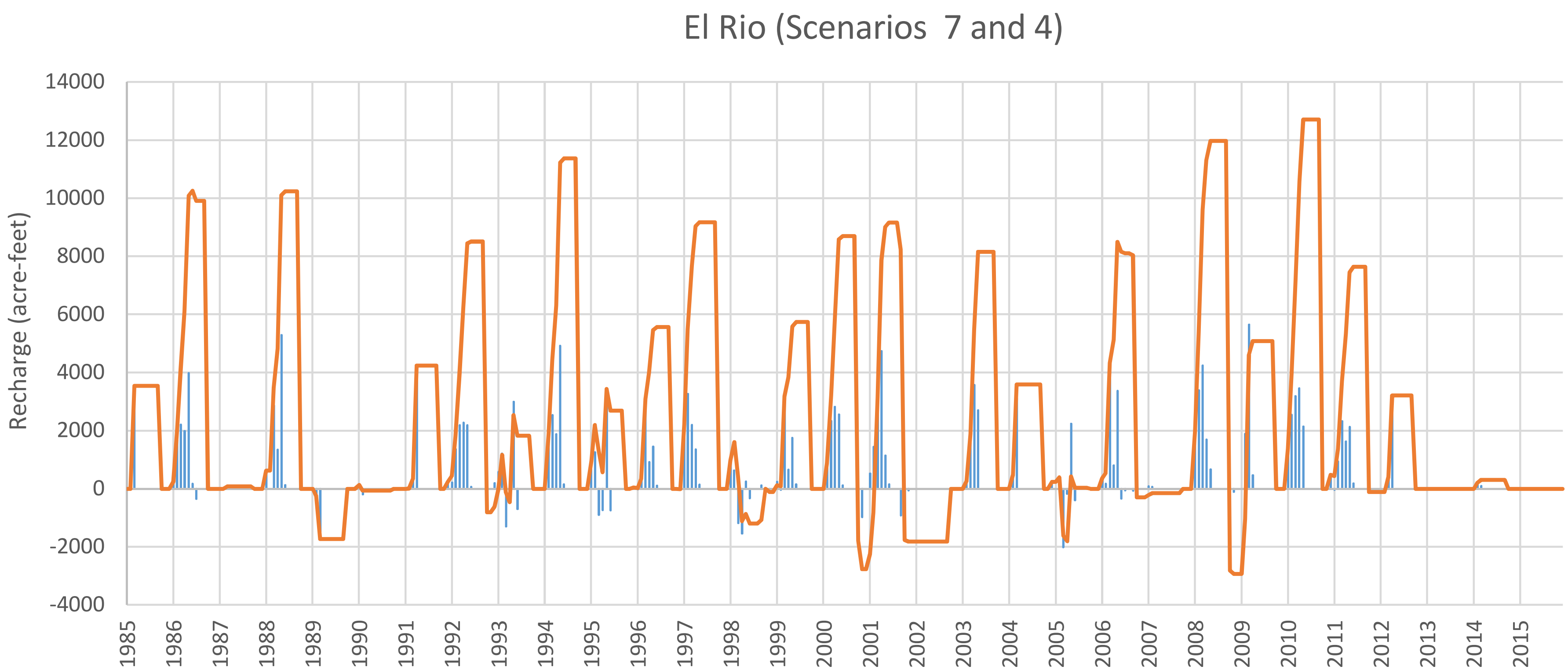


Figure 3.1-4a. Difference in recharge at El Rio between scenarios 7 and 4. A positive difference indicates higher deliveries under scenario 7. Bars indicate monthly amounts, line indicates cumulative amounts per water year.

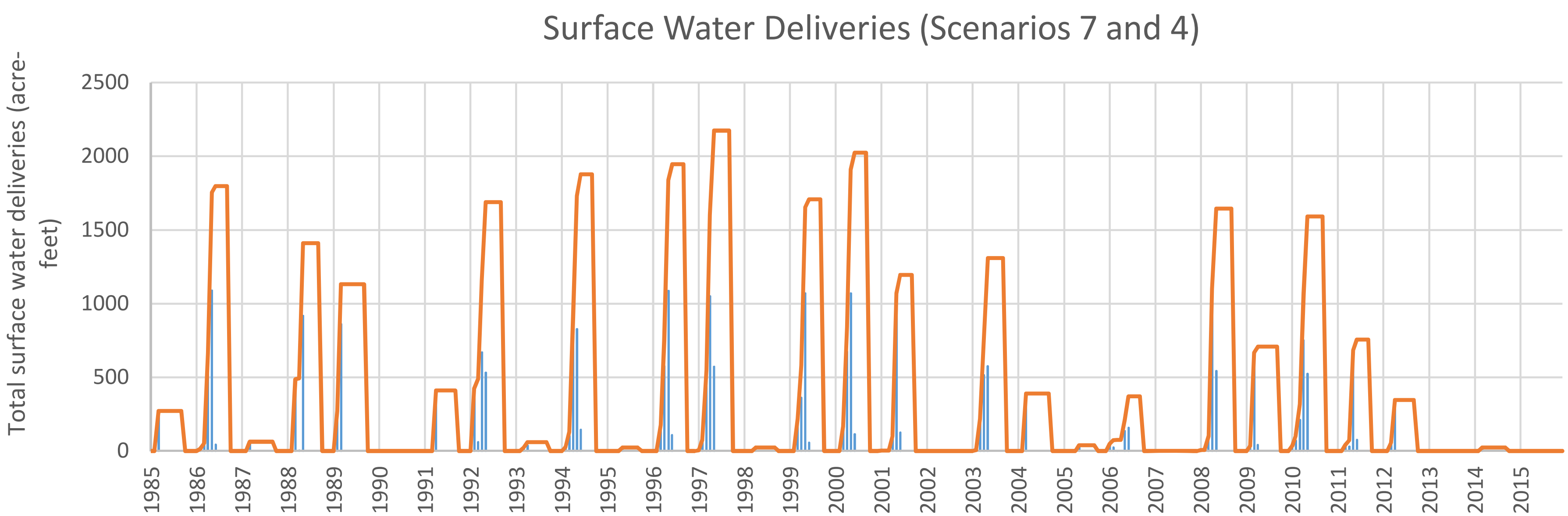


Figure 3.1-4b. Difference in deliveries to surface water delivery system between scenarios 7 and 4. A positive difference indicates higher deliveries under scenario 7. Bars indicate monthly amounts, line indicates cumulative amounts per water year.

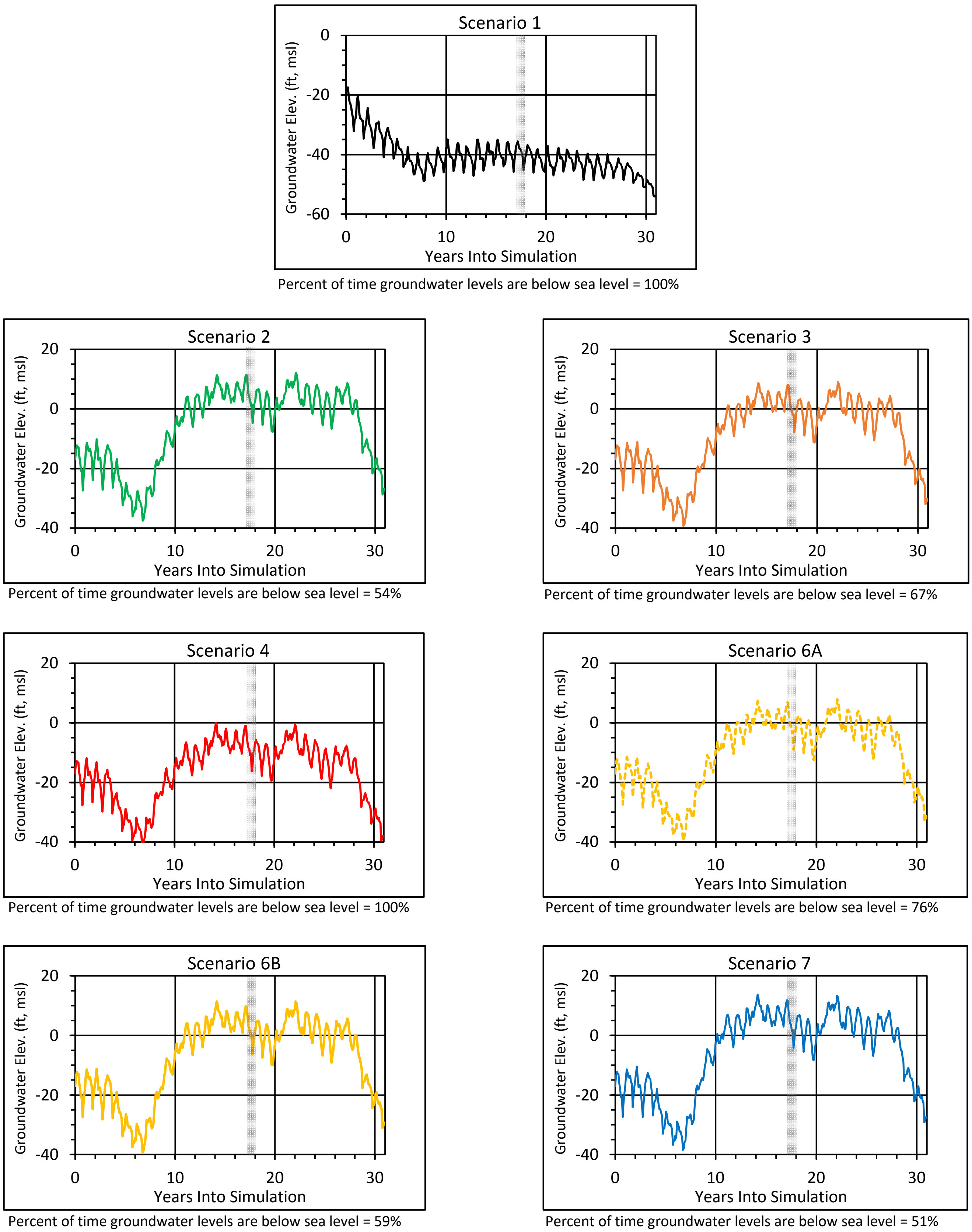


Figure 3.2-1. Forecasted hydrographs for UAS well 01N21W17D02S (in eastern part of Oxnard Plain basin; gray bar on graphs highlights year 17 of the simulation).

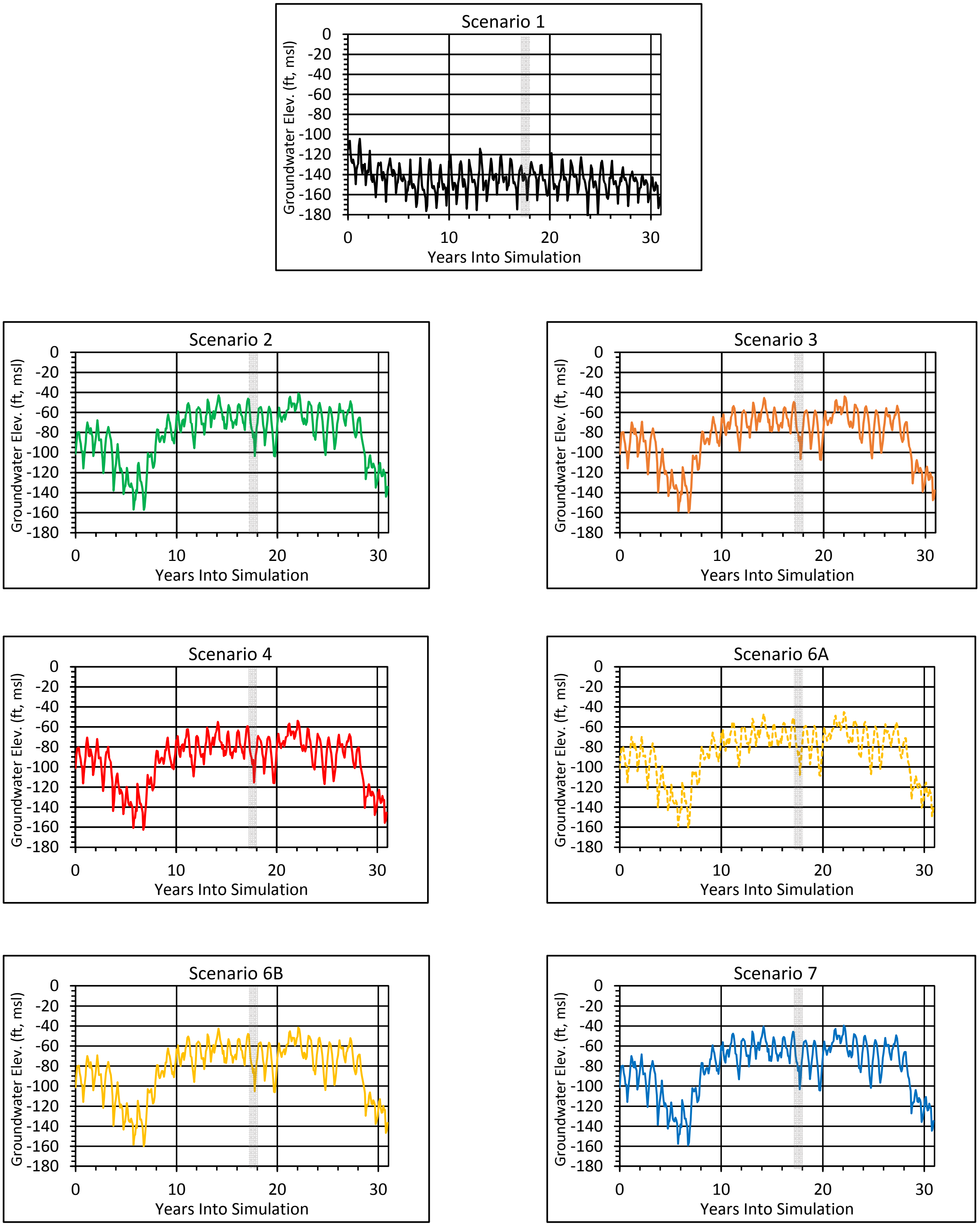


Figure 3.2-2. Forecasted hydrographs for LAS well 01N21W07J02S (in eastern part of Oxnard Plain basin; gray bar on graphs highlights year 17 of the simulation).

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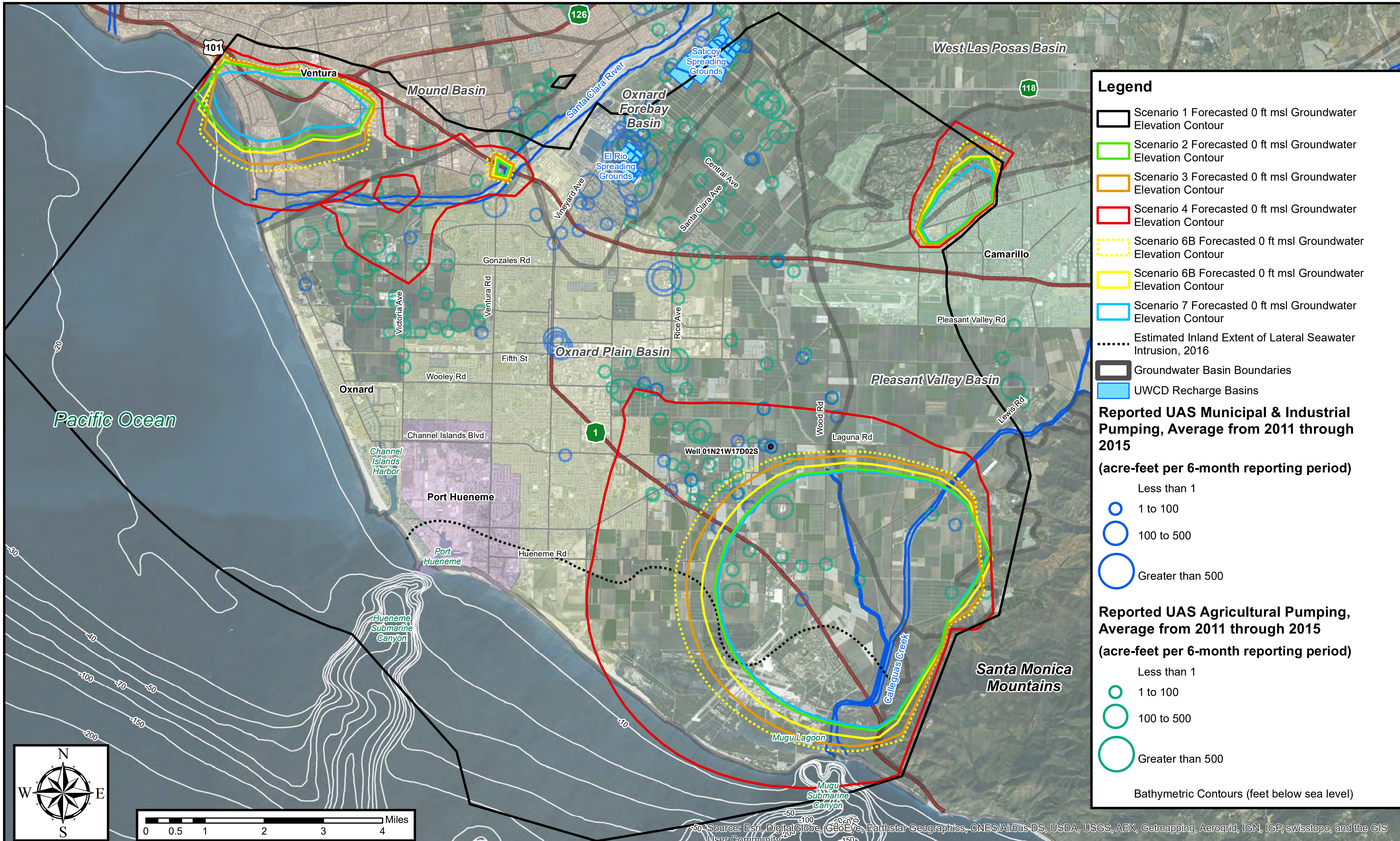


Figure 3.2-3. Areas where groundwater elevations in the UAS (Oxnard Aquifer) are forecasted to be below sea level during a typical water year.

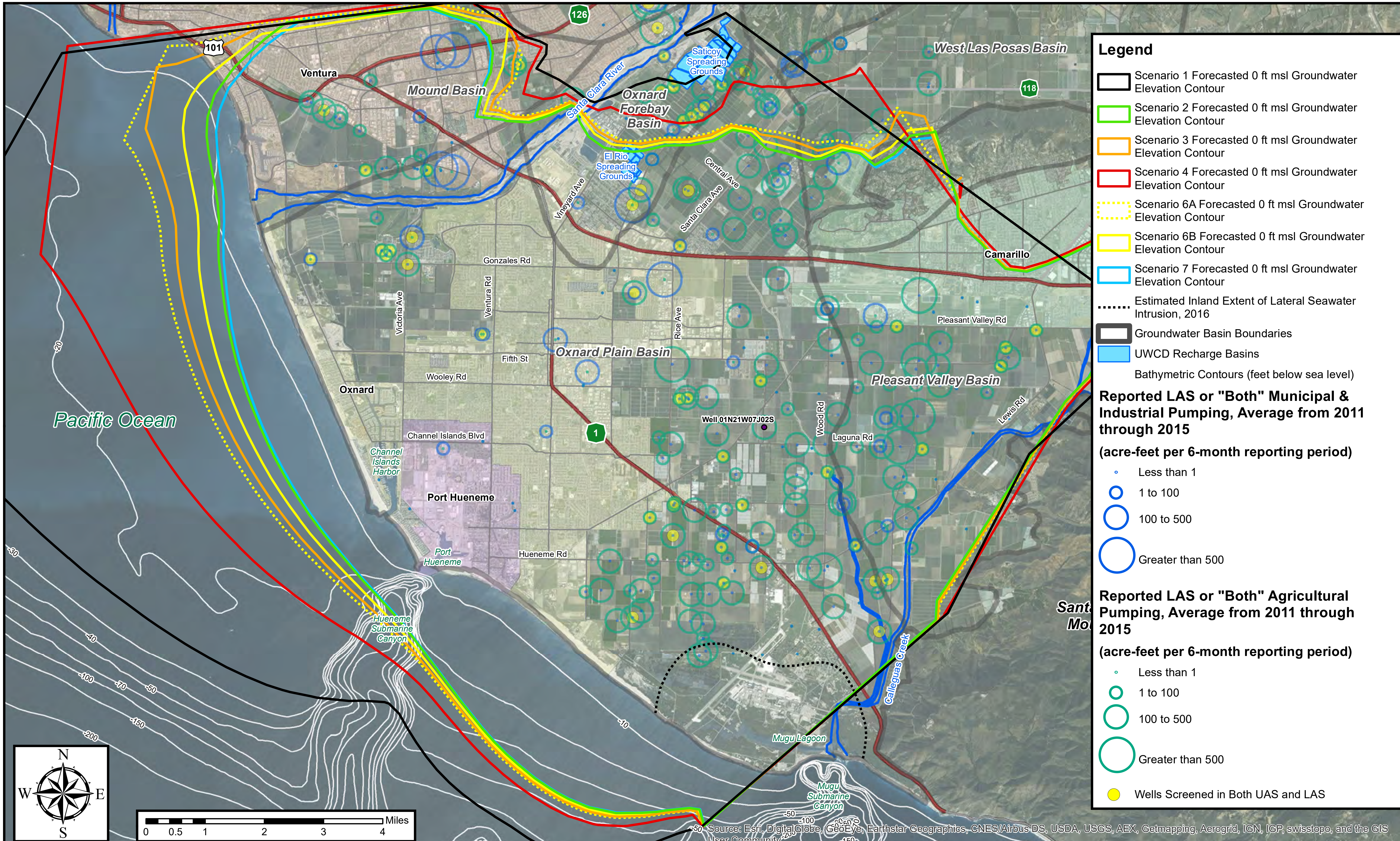
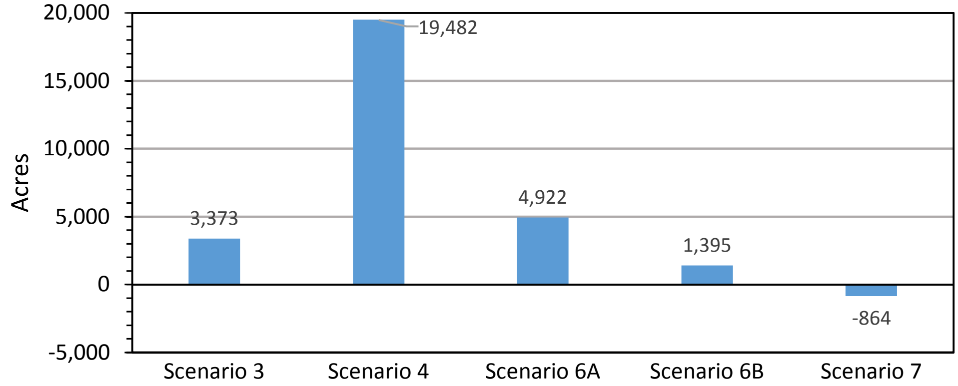
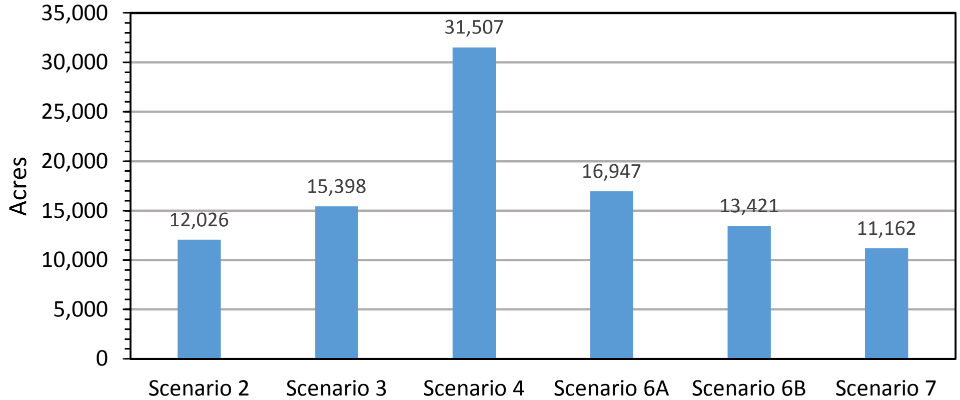


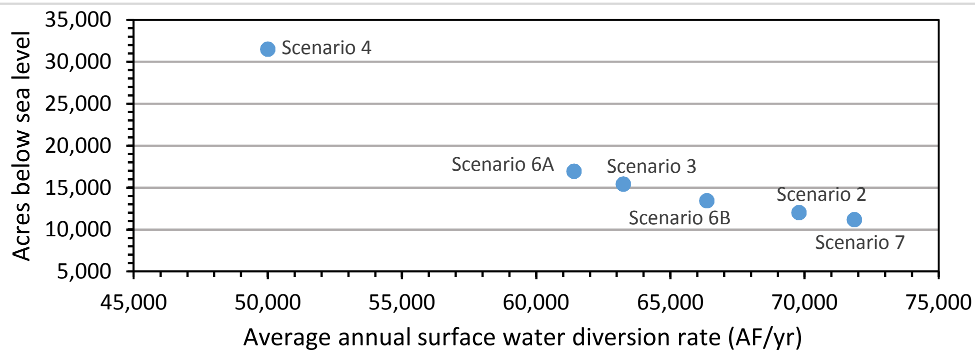
Figure 3.2-4. Areas where groundwater elevations in the LAS (Fox Canyon Main Aquifer) are forecasted to be below sea level during a typical water year.



a) Additional area (compared to Scenario 2) in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Oxnard aquifer are forecasted to be below mean sea level during a typical (non-drought) water year

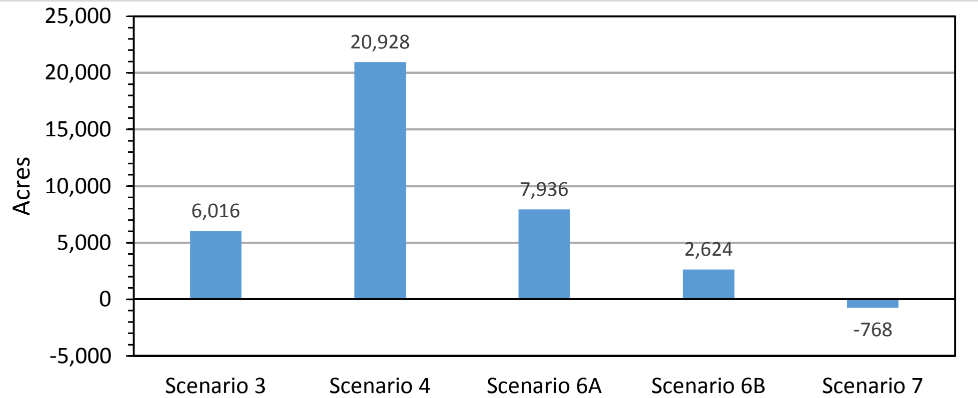


b) Total area in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Oxnard aquifer are forecasted to be below mean sea level during a typical (non-drought) water year

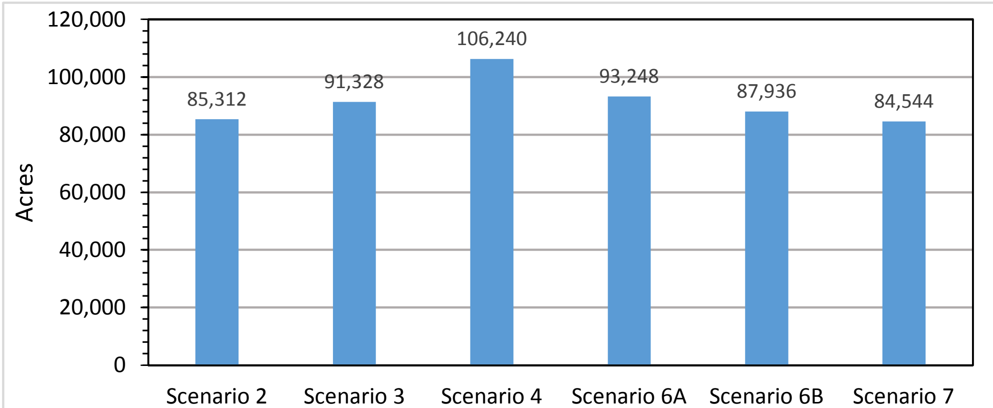


c) Average annual Freeman Diversion rate versus total area in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Fox Cyn. aquifer are forecasted to be below mean sea level during a typical (non-drought) water year

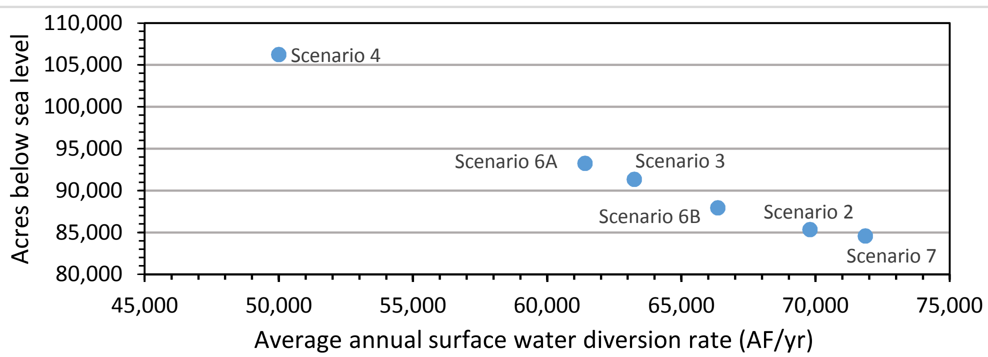
Figure 3.2-5. Graphical comparison of effects of diversion scenarios on groundwater elevations in the UAS.



a) Additional area (compared to Scenario 2) in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Fox Cyn. aquifer are forecasted to be below mean sea level during a typical (non-drought) water year



b) Total area in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Fox Cyn. aquifer are forecasted to be below mean sea level during a typical (non-drought) water year



c) Average annual Freeman Diversion rate versus total area in Mound, Forebay, Oxnard Plain, and Pleasant Valley basins where groundwater levels in the Fox Cyn. aquifer are forecasted to be below mean sea level during a typical (non-drought) water year

Figure 3.2-6. Graphical comparison of effects of diversion scenarios on groundwater elevations in the LAS.

Appendix C.

Vern Freeman Dam Vertical Slot Fish Ladder Hydraulic Basis of Design Report

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

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Vern Freeman Dam
Vertical Slot Fish Ladder

Hydraulic Basis of Design Report

December 6, 2019

Prepared for:

United Water Conservation District

Prepared by:

Stantec Consulting Services Inc.

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Abbreviations

AWS	Auxiliary Water System
BiOp	Biological Opinion
CDFW	California Department of Fish and Wildlife
cfs	Cubic feet per second
fps	Feet per second
NMFS	National Marine Fisheries Service, NOAA Fisheries
NTU	Nephelometric Turbidity Unit
PLC	Programmable Logic Controller
RCC	Roller Compacted Concrete
sf	Square feet
UWCD	United Water Conservation District
VFDD	Vern Freeman Diversion Dam

1.0 INTRODUCTION

1.1 BACKGROUND

In 2008, the National Marine Fisheries Service (NMFS), Southwest Region issued a final Biological Opinion (BiOp) (Administrative Record File #151422SWR01PR6149) to the United Water Conservation District (UWCD) which concluded that the operations of Vern Freeman Diversion Dam (VFDD) were likely to jeopardize the continued existence of the steelhead trout in the Santa Clara River. The first element of the Reasonable and Prudent Alternative of the BiOp was to convene "a panel of qualified fish passage engineers, hydrologists, and fish biologists, and serve as facilitator of this panel." The Panel's charge was to make recommendations for modifying or replacing the exiting fish passage facilities. The Panel conducted a formal alternative study to identify both interim and long term physical and operations modifications to pass steelhead above the dam.

The Panel completed their task with a Conceptual Design Report in September 2010. The report evaluated possible long-term modifications by narrowing down a list of alternatives to five: a vertical slot ladder, a nature-like fishway, a rock ramp, a hardened ramp, and dam removal. Dam removal was judged to be beyond the purview and expertise of the Panel and was removed from further analysis. Using a Pugh score matrix, the characteristics among the four alternatives were evaluated and estimates of probable costs were made. The results of the evaluation were that the scores of the remaining four were very close. In the conclusions of their report, "...the Panel recommends that additional work be focused on the development of the Vertical Slot ladder and the Hardened Ramp alternatives." Further in their conclusions, the Panel states, "In addition to the upstream passage issues, the Panel concludes that the existing screen structure is deficient and should be upgraded. If updates are desired, the project would benefit from a coordinated planning and design effort for the upstream and downstream passage features." To identify which of the alternatives was most appropriate, the Panel recommended further study such as additional engineering analysis, drawings, and operational studies.

The National Marine Fisheries Service recommended that UWCD proceed with design of a hardened ramp passage alternative, which was the expert panel's other highest-rated alternative. Development was initiated on the hardened ramp but after considerable work on that alternative, and with a (resultant) better understanding of its challenges and limitations, UWCD concluded that it was necessary to investigate the vertical slot ladder. UWCD then proceeded with a design study of the vertical slot fish ladder along with fish screen improvements as recommended by the expert panel. The Vertical Slot Fish Ladder Project Feasibility Report (2018 Feasibility Report) was completed by Stantec in 2018.

The 2018 Feasibility Report describes the vertical slot fish ladder components and their operation. It also describes the alternatives for these components and the reasons for selecting or not selecting them for inclusion in the passage project. The design also incorporates up-to-date fish screens for both auxiliary water system (AWS) and water delivery diversions.

The fish screen for canal flows was sized for 750 cfs in the 2018 Feasibility Report. It may not be practical for UWCD to obtain water rights and implement the expansion of the fish screen facility within the timeframe desired for the fish ladder construction, so a technical memorandum was created to evaluate alternative configurations for the AWS and canal diversion screens for consideration by UWCD.

The 2019 Configuration Assessment was proposed in order to develop functional layouts for four alternate flow combinations. The Configuration Assessment presented evaluation of the concepts, described their hydraulic and physical details and compared the merits and constraints of each configuration. The scope of this fish ladder project consisted of the following components: a crest gate on the dam at the south abutment, a vertical slot fish ladder, an AWS, and canal fish screening facilities.

This report further develops the vertical slot ladder concept by increasing the fish ladder entrance flows from 300 to 600 cfs and increasing the size and capacity of the crest gate. This concentrates all the 6,000 cfs maximum design flow through the entrances and over the crest gate at the south abutment to the dam.

1.2 OBJECTIVE

The objective of this work is to evaluate and document the hydraulic and physical design of the vertical slot ladder alternative. This report describes the replacement fish ladder and fish screen components and their operation. It also describes other alternative elements and the reasons for selecting or not selecting them for inclusion in the passage project.

2.0 EXISTING SITE, CRITERIA, AND CONSTRAINTS

2.1 EXISTING FACILITIES AND THEIR OPERATION

VFDD, constructed in 1991, is used to divert water from the Santa Clara River for irrigation and recharging local groundwater supplies. The diverted water is conveyed to a series of infiltration facilities located downstream of the dam or delivered directly to users. VFDD consists of a 28-foot-tall roller compacted concrete (RCC) gravity dam, sediment flushing gate and sluice, canal gates, Denil fish ladder, fish screen and fish bypass, and head gates. Drawing G-2 in Appendix B shows the existing dam, fish ladder and diversion facilities.

VFDD is located approximately 10.5 river miles from the Santa Clara River's outflow into the Pacific Ocean, near Ventura, California. The Santa Clara River has a high sediment load and is very turbid during high flows. The turn out and turn in of flows to the canal are based on measurements of river sediment load and not river flow. Suspended sediment load during high flows renders the water undesirable for infiltration. Therefore, when the turbidity levels are high, the canal gates are closed, and diversion ceases. This action is called "turning out". When the turbidity levels drop sufficiently, usually on the receding limb of the hydrograph, the water is "turned in" to the canal.

UWCD is currently allowed to divert up to 375 cfs at the VFDD, which is then conveyed through the canal for deliveries to the infiltration basins and customers. To maintain the purpose of the Freeman Diversion under modified diversion criteria that include, at important times, lesser rates of diversion than allowed under its water rights, UWCD intends to file for a water right to divert an additional 375 cfs of diverted Santa Clara River water, making its total allowed instantaneous diversion right 750 cfs. Flow in the canal is controlled by the head gates located immediately downstream of the fish screens. Currently, UWCD operates the existing Denil fish ladder January through May when water is available in the river.

Figure 2-1 Vern Freeman Dam, April 2019

2.2 PROJECT CRITERIA AND CONSTRAINTS

2.2.1 Fish Species

The southern California steelhead population is listed as an endangered distinct population segment. The objective of this project is to pass steelhead but passage for Pacific Lamprey is also expected to be a requirement. The adults return from January 1 through May 31. Smolts generally migrate downstream during high flows from January to March, although observed migration has occurred as late as June on the nearby Ventura River.

2.2.2 Design Flows

2.2.2.1 Canal Flows

UWCD plans to file a water right for an additional 375 cfs of diverted Santa Clara River water, making its total allowed instantaneous diversion right 750 cfs. The fish screen for canal flows will be sized for 750 cfs in this design. A fish bypass flow will be required in addition to the 750 cfs to carry fish back to the river.

2.2.2.2 Upstream Passage Flows

The river flow, at which passage will be required, depends on several requirements such as criteria guidance from the NMFS and the suspended sediment load in the water. A flow of 6,000 cfs was set as the criteria for maximum flow that the fish facility would be operated to meet NMFS standards under (NMFS 2011). The fish passage facilities can operate above this flow, but passage criteria might not be met.

The fish ladder will be designed to pass 34 cfs at the design upstream water level of 161.5. The forebay water surface will be controlled to an elevation of 161.5. The ladder flow ranges between 34 cfs and 37 cfs over the design river flow range. The auxiliary water flow will be a maximum of 570 cfs. The 570 cfs auxiliary water flow in addition to the ladder flow provides at least 600 cfs of attraction out of the entrance gates, nominally 10 percent of the design river flow of 6,000 cfs.

2.2.3 Design Criteria and Parameters

The new fish facilities are designed to the criteria and guidance stated by the NMFS in the northwest (NMFS Northwest Region, July 2011) and southwest (NMFS Southwest Region, January 1997) and to California Department of Fish and Wildlife (CDFW) Statewide Fish Screening Policy and applicable sections of the *California Salmonid Stream Habitat Restoration Manual (Part XII, 2009)*. Due to the flashy nature of the hydrographs in the Santa Clara River and the migration windows for the steelhead, it is desirable to pass migrants with little or no delay.

For this report, it was decided to use the vertical datum of NGVD 1929 because as-built drawings of the original dam and fish facilities were on that datum as was the canal capacity analysis (Northwest Hydraulic Consultants, January 7, 2015). Further it was assumed that in order for the proposed canal facilities to properly operate, the canal piped section located between the end of the open channel section of the canal and the sedimentation basins would be replaced so that they cause no additional backwater within the canal under a 750 cfs flow. The design criteria and design parameters used in developing the fish facilities are given in Table 2.1 on the following page.

Table 2.1 Outline of Specific Design Criteria and Parameters

Number	Item	Criteria	Units	Comments
1	Type of fish	Southern California Steelhead DPS	-	-
2	Anticipated Upstream operational period	January 1 through May 31	-	As provided in prior (2008) biological opinion and prior drafts of UWCD's Multi-Species Habitat Conservation Plan (MSHCP).
3	Anticipated Downstream Operational period	January through March	-	-
4	Minimum Operating Tail Water Level	138.5	ft	NGVD 29 datum
5	Maximum Operating Tail Water Level	144.0	ft	NGVD 29 datum, Facilities can operate above 144.0 ft but may be out of criteria. Above this level the fish transport tunnel goes full.
6	Minimum Operating River Flow (U/S of dam)	0-45	cfs	-
7*	Maximum Operating River Flow (U/S of dam)	6,000	cfs	Facilities can operate above 6,000 cfs but may be out of criteria.
8	Minimum Operating Water Level Upstream	161.5	ft	Controlled by the Crest Gate through the operating range of the crest gate.
9*	Maximum Operating Water Level Upstream (6,000 cfs)	162.0	ft	-
10	Maximum Operating Water Level in Canal (D/S of Head Gates)	158.0	ft	NGVD 29 datum
Ladder Entrance				
11*	Attraction Flow Type	Entrance Flow	cfs	-
12*	Attraction Flow (AWS plus Ladder flow)	570 AWS 30+ Ladder	cfs	600 cfs total flow out entrance gates.
13	Hydraulic Drop, entrance	1-1.5 (Operating) 0.5-2 (Design)	ft	NMFS 2011
14	Wall Diffuser Velocity	1.0	fps	NMFS 2011
15	Wall Diffuser Head Loss	1.0	ft	Discretionary value, 6% Open area porosity plate to evenly spread flow across diffuser.
16	AWS energy dissipation rate	16	$\frac{ft-lbf/s}{ft^3}$	NMFS 2011
17	Entrance Gate Type	Slide gate	-	All gates will be slide gates that open from the bottom up.
Ladder				
18	Ladder Type	Vertical Slot	-	This is a standard type of ladder with a long history of successful operation in passing steelhead and salmon.

Number	Item	Criteria	Units	Comments
19	Ladder Pools	8' wide x 10' long	ft	US Army Corps of Engineers Fisheries Handbook
20	Hydraulic Drop Max.	≤ 1	ft	Average, the upper two pools act to regulate the rest of the pools and may have drops of 0.6-0.8 ft.
21	Fish Counter	False Weir	-	Due to turbid water must force fish above water to identify.
22	Transport Channel Velocity	1.5 to 4.0	fps	NMFS 2011
23	Transport channel width x depth, min	4' x 5'	ft	NMFS 2011 (note: proposed transport channel width is 3' wide due to velocity requirements for sediment movement.)
Ladder Exit				
24	Exit Opening Dimensions	5' wide by 6' tall	ft	To the Approach Channel
25	Exit Gate Type	Slide gate	-	Slide gate bottom up opening.
26	Exit Channel Expansion Width	3' – 5'	ft	Expands from exit gate to trash rack.
27	Trashrack bar spacing	10 - 12	in	-
28	Approach velocity to trashrack	1.2	fps	Project set for cleaning (NMFS 2011 criteria ≤ 1.5 fps)
AWS and Canal Screens				
29	Max Slot Opening	1.75	mm	NMFS 2011 criteria for salmonid fry.
30	Min Open area	27	%	NMFS 2011
31*	Max Avg Approach Velocity	0.40	fps	CDFW
32*	Fish Exposure Time to Screens	1	minute	At design maximum flow, length of screen divided by transport velocity
33*	Screen Cleaning Method	Automated Brush or Vertical Traveling	-	Screen cleaning required for fish protection and operational reliability.
Fish Return				
34	Fish Bypass Flow	24	cfs	Geometry dependent
35	Bypass Width	18	in	NMFS 2011
36	Depth at Bypass Entrance	12	in	NMFS 2011
37	Bypass Flow Velocity	6 - 12	fps	NMFS 2011
38	Flow Depth	Free surface of flow >40% Dia.	ft	NMFS 2011
	** indicates revision to the value used in the 2018 Feasibility Report*			

2.2.3.1 Hydraulic Design Data

The rating curves above and below the dam, Figures 2-2 and 2-3 respectively, were taken from the Vern Freeman Dam Fish Passage Conceptual Design Report (September 2010). Flood flows were also taken from this reference, and flood elevations upstream and downstream of the dam were obtained from the Flood Insurance Rate maps issued for Ventura County (FEMA 2018). UWCD's recorded tailwater elevation records show a wide variation due to changes in channel morphology and debris deposition downstream of the dam.

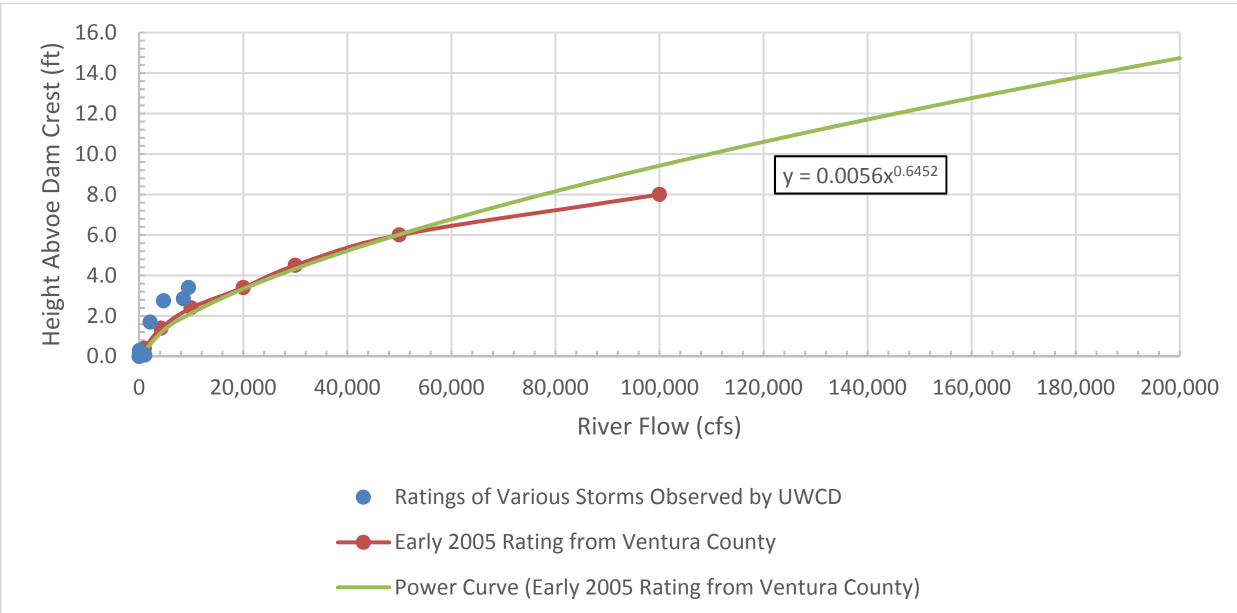

Figure 2-2 Upstream Rating Curve at Vern Freeman Dam

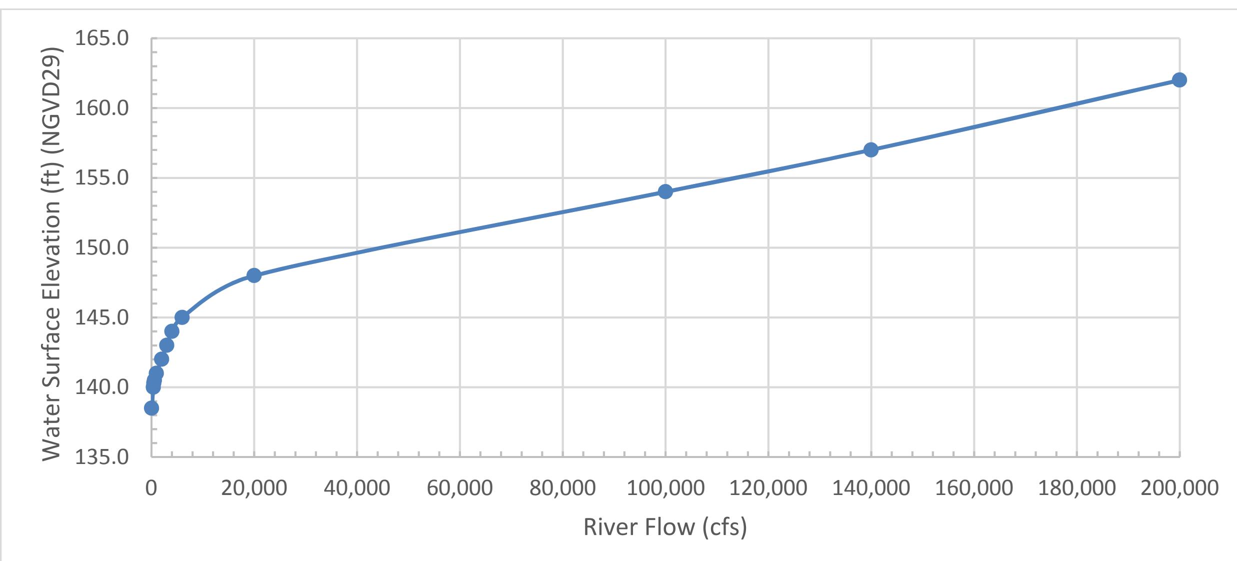

Figure 2-3 Downstream Rating Curve at Vern Freeman Dam

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3.0 PROJECT DESCRIPTION

The project consists of the following components: a crest gate, a vertical slot fish ladder, a north ladder entrance, a south ladder entrance, an auxiliary water system (AWS), a fish evaluation station, fish screens and canal facilities. See Drawing C-1 in Appendix B for a plan view of the proposed facilities described below.

3.1 CREST GATES

Operating the fish ladder and the fish screens for the canal and AWS system is facilitated by maintaining a constant forebay water level at elevation 161.5. This provides 0.5 feet of operating freeboard before spill occurs over the fixed crest of the dam. To better and more immediately control the forebay and to concentrate initial spill over the diversion crest to improve attraction to the ladder, a new crest gate will be installed in the dam adjacent to the flushing channel. The RCC dam will be notched about 10 feet deep and about 73 feet long adjacent to the flushing channel. A reinforced concrete foundation and sidewalls will be placed in the cut to seal the exposed RCC and provide a foundation for the crest gates. Plates embedded in the concrete side walls will provide a smooth surface for the sides of the crest gates to seal against. The new reinforced concrete floor provides a mounting surface for an Obermeyer gate 8 feet high and 70 feet long as shown on Drawings C-1 and 1S-1. The width of the gate can be divided into sections and operated separately. This will allow for deeper flows over the gate at lower crest gate flows. On the north side of the crest gates the sidewall will be carried down the face of the dam to create a training wall to isolate the spill from the crest gates from the north fish entrance for flows up to the 100-year flow. The downstream face of the dam below the crest gates will be filled to accommodate the fish transport tunnel. The fill will have a downstream face shaped to provide a smooth surface for downstream passage of juvenile steelhead. Spill nappe over the crest will fall and contact the smooth spillway face at a small angle, which will minimize potential juvenile fish injury and disorientation. This will provide a much safer path for downstream migrating fish passing the diversion. A spillway of this type was used as a downstream passage improvement at Landsburg Dam on the Cedar River in Washington with good results.

Downstream of the crest gate the stilling basin has been extended downstream. The floor of the extended stilling basin is at elevation 138.0. This is to provide a velocity barrier to upstream migrants. See Drawing C-1 for the extents of the new apron.

The crest gate is proposed to be an Obermeyer System that consists of a rubber bladder, which can be inflated to raise shaped steel plates to form the dam. In the fully raised position the crest will be at elevation 162.0 feet matching the existing dam crest. In the fully lowered position, the gate crest will be elevation 154.0 feet. Crest position is controlled by inflating or deflating the rubber bladder. The compressor and other equipment for the Obermeyer dam will be located on a new platform over the flushing channel. Actuation of the crest gate will be controlled by the Programmable Logic Controller (PLC) with input from an upstream water level sensor. The target upstream water level will be 161.5, which provides a 0.5-foot freeboard before water spills over the fixed dam crest. The gate will control the water surface at 161.5 over a gate discharge range from approximately 0 to 4,400 cfs. Once fully lowered the crest gate discharge increases to approximately 4,900 cfs as the river flow increases to elevation 162.0 when water will start to spill over the fixed crest of the dam. At the passage design point of 6,000 cfs, the discharge through the crest gate area increases to about 4880 cfs. Combined with the ladder flow, this constitutes about 81 percent of the design flow attracting fish to the ladder entrances.

Under normal operation, the crest gate would remain in the full down position during high flows or floods providing additional flood conveyance. Figure 3-1 presents an estimated operating curve of the crest gate.

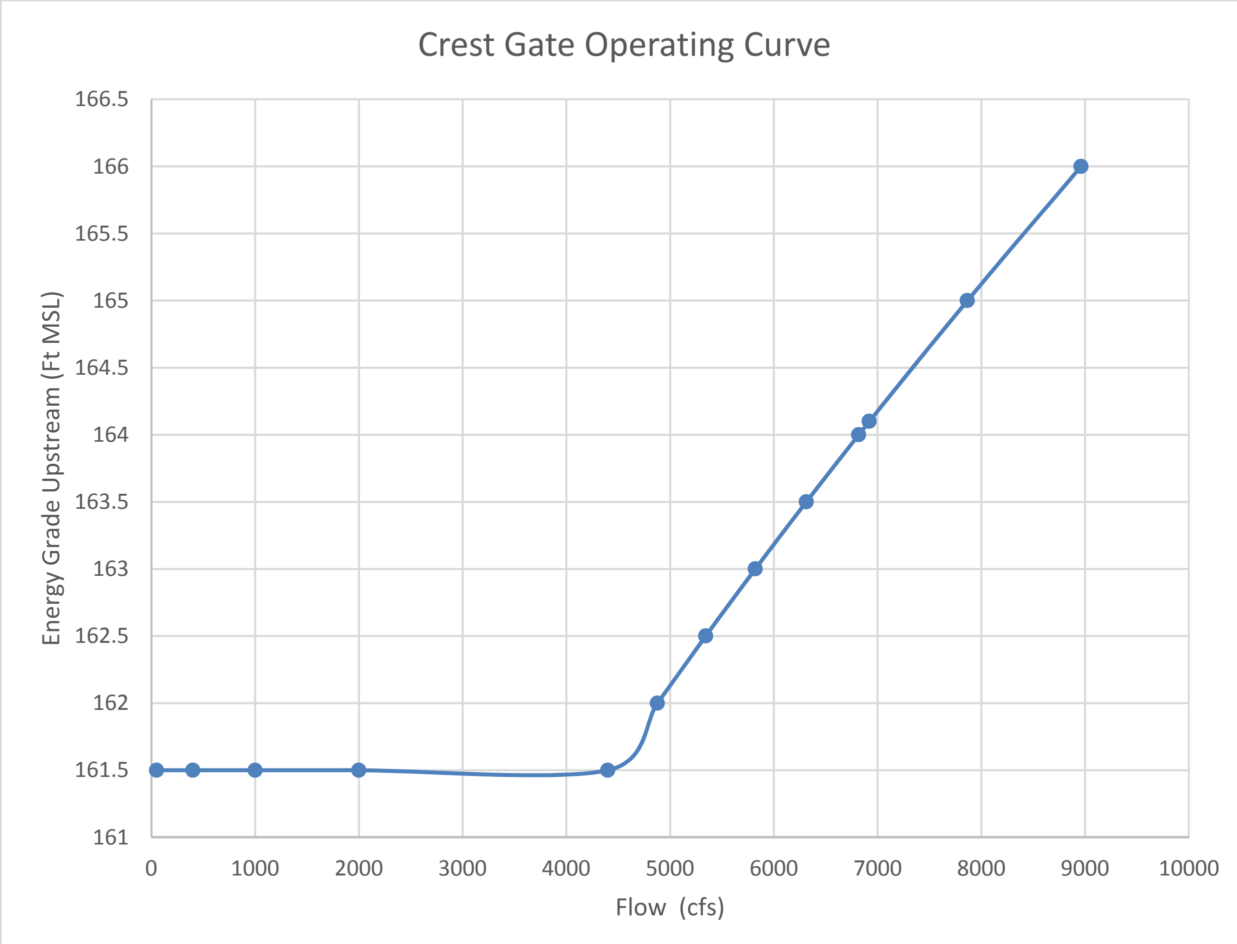

Figure 3-1 Crest Gate Operating Rating Curve

3.2 FLUSHING CHANNEL

The existing flushing channel is located between the dam crest to the north and the intake and fish ladder to the south (see Drawings C-1 and 5S-1). From upstream to downstream, the flushing channel consists of an approach channel, a roller gate, and a chute section. The approach channel and roller gate will not be changed as part of the fish ladder project. However, the chute slab from the roller gate downstream to the end of the present chute will be raised to accommodate the new transport tunnel. Due to the location of the proposed ladder exit, the operation of the roller gate in the flushing channel will require operational changes that are integrated with the fish ladder operation.

3.2.1 Approach Channel

The upstream end of the approach channel is 61 feet wide with an upstream invert elevation of 155.5. The channel narrows to 15 feet wide 40 feet upstream of the roller gates. The approach channel slab slopes downstream at a slope of 3.155 percent. This geometry has been shown to effectively remove deposited sediments and debris from in front of the trash rack and proposed fish ladder exit. Water levels and flow velocities in the approach channel are controlled by the roller gate during flushing operations.

3.2.2 Roller Gate

Flushing channel flow is controlled by a single 15-foot-wide by 10-foot-high roller gate located at the downstream end of the flushing channel. The roller gate opens vertically against a headwall and is controlled with an electric multi-turn actuator above the gate, on a platform at elevation 177.0. The invert of the gate is at elevation 149.0, about 13 feet below the top of dam. The roller gate will be used for maintenance only to maintain the approach channel and fish ladder exit free of debris and sediment deposition. Its operation will depend on sediment deposition rates and fish passage requirements. See drawing 5S-1.

3.2.3 Chute

The flushing channel chute downstream of the roller gate is approximately 83 feet long. Due to scour and wear from sediment, the concrete slab was replaced about 12 years ago. It is due for another replacement now. For this project, the chute slab will be removed and replaced slightly higher with a vertical curve to accommodate the new transport tunnel. The full slab will be replaced from the roller gate to the existing horizontal apron at elevation 134.0. No structural changes are proposed to the chute walls. The existing slope of the approach channel (3.2%) will be extended to be over the transport tunnel where the slope will steepen to approximately 34% slope until it reaches elevation 134.0.

3.3 VERTICAL SLOT FISH LADDER

The vertical slot fish ladder facility consists of two entrance pools with a transport tunnel between them, vertical slot style ladder, a fish counting station, a transport channel, and an exit. This section describes the fish ladder components that can be seen on Drawings C-1 and 2S-1 through 2S-5.

3.3.1 Entrance Pools

The purpose of the entrance pools are to attract fish from the tailwater pool into the ladder and then to guide fish to the ladder once inside the entrance pool. Attraction flow discharging from the entrance pool is a combination of fish ladder flow and Auxiliary Water System (AWS) flow. The AWS is described in Section 3.4. See Drawing C-1 for a drawing of the two entrance pools and the transport tunnel connecting them.

To maximize the ability of upstream migrants to find and enter the fish ladder without delay, the design consists of two entrances, one on the north side of the crest gate and one to the south near the flushing channel. The two entrances are connected by a transport tunnel under the crest gate spillway and the flushing channel. The AWS flow enters the south entrance pool where it is combined with the flow in the ladder. The flow then discharges through one, two, three or four ladder entrance gates in the south entrance depending on operational preferences. The remainder of the flow travels through the transport channel to the north entrance pool, where it can be discharged through one or two entrance gates depending on operating preferences. The maximum entrance flow of about 600 cfs would discharge through a combination of four entrance gates located in the north and south entrance pools.

The fish ladder enters at the southwest corner of the south entrance pool, where it is supplemented by AWS water that enters the pool through a diffuser rack on the east side of the entrance pool. Screened AWS water comes through the energy dissipation chamber located below grade on the east side of the entrance pool. AWS water is distributed to the diffuser rack through a baffle wall consisting of perforated plates with holes about 2 inches in diameter and a porosity of about 6 percent. The baffle wall hydraulic drop (differential) would be about 1 foot. This system spreads the flow uniformly through the diffuser panel consistent with NMFS guidelines. Diffuser panels are oriented to help guide the fish to the first pool in the fish ladder at the southwest corner of the south entrance pool.

3.3.1.1 North Entrance Pool

The north entrance pool is 20 feet wide (north to south) and 20 feet wide at its invert (west to east). It is formed by vertical reinforced concrete walls on the north and south sides. The north wall contains one 6-foot-wide by 5-foot-high entrance gate. The wall on the west side is also reinforced concrete and contains two 6-foot-wide by 5-foot-high entrance gates. The east side of the entrance pool is comprised of the existing dam spillway. The transport tunnel enters the north entrance pool on its south side.

Personnel access is provided to the north entrance over the flushing channel and crest gate via a 6-foot-wide truss bridge. Personnel can observe the operation of the gates and conditions in the pool from the bridge. Maintenance platforms will be provided for servicing the gate actuators. However, removal of the actuators or larger gate parts would require special planed access by cranes from the channel below the dam or across the dam crest.

The purpose of the north entrance is to reduce any potential delay to fish that might approach the dam from the right (north) side of the channel. Flow through the north entrance is controlled by the entrance gates in both the north and south entrance pools. Each fully open entrance gate can discharge about 150 cfs with one foot of head across it. The maximum design discharge from the north entrance is about 300 cfs, which is half of the total discharge from the ladder entrances. One entrance gate is located on the north side of the pool to attract fish from the stilling basin of the dam. Fish might be holding in the stilling basin after high flows over the fixed dam crest.

3.3.1.2 Transport Tunnel

The transport tunnel will be 13 feet wide and 11 feet high and connects the north entrance pool to a transport channel south of the flushing channel. The height is set to maintain a free surface at estimated tailwater elevations up to the 6,000 cfs design flow plus 1 foot of head across entrance gates. This provides free surface flow over the design flow range for fish passage. The tunnel is 88 feet long. Ambient light can enter the tunnel from both its north and south ends. Additional lighting or the provision for future lighting would be installed in the tunnel.

Dewatering the tunnel can be accomplished by shutting off the ladder and AWS and closing the entrance gates in the north and south entrance pools. Then water would be pumped out of the entrance pools. Access to this area for personnel or mechanical equipment would be possible from the river bed to the west.

The tunnel can carry variable flows up to a maximum flow of 300 cfs without exceeding the NMFS velocity guidelines. To get the full effect of the entrance gates, it is recommended to operate at or near the capacity of each gate, which is 150 cfs. The transport velocity would be 4.2 fps at minimum tailwater and 2.1 fps at maximum tailwater. Velocities for different conditions within the 6,000 cfs design flow are presented on Table 3.1. The tunnel will continue to operate and pass fish at river flows above 6,000, cfs, but the tunnel would be flowing full.

Table 3.1 Transport Tunnel Hydraulic Operation

Two-Gate Operation	Minimum Tailwater (Low Flow)	Maximum Tailwater (High Design Flow, 6,000 cfs)
Velocity (fps)	4.2	2.1
Depth (ft)	5.5	11.0
One Gate Operation	**At Min. TW**	**At Max. TW**
Velocity (fps)	2.1	0.6
Depth (ft)	5.5	11.0

3.3.1.3 South Entrance Pool

The south entrance pool runs about 120 feet long and is shaped to guide fish. The channel width varies from 8 feet at the ladder entrance to 30 feet at its widest point. The southeast wall includes a 120-foot-long diffuser rack that is sized for an approach velocity of 1.0 fps. See Section 3.4 for additional description of the AWS system. The entire pool floor is at elevation 134.0. There are two fish entrances on the north wall and two on the west wall directed downstream. Entrance openings are 5 feet wide and 6 feet high with the bottom of the openings at the floor level. Flush bottom sluice gates are mounted on the inside of the openings. The fish transport tunnel starts at the east end of the south entrance pool.

The south entrance pool would be dewatered by shutting off flow to the fish ladder and AWS and closing the gates in the north and south entrance pools. Water remaining in the pool would be pumped out. Access to the south entrance pool for inspection and gate maintenance would be by ladder from above.

The water level in the south entrance pool would be from 0.0 to 0.4 feet above the north entrance pool. This head difference is required to convey flow to the north entrance pool. At the minimum design flow only one entrance gate would be open. When the full AWS and ladder flows are available, two, three or four south entrance gates could be open.

3.3.2 Vertical Slot Ladder


Typ. Vertical Slot Ladder Pool

As fish travel through the entrance pool, they are guided to the fish ladder along the diffuser rack. The ladder consists of 23 steps. See Drawing C-1 and 2S-4. There is an overall drop of 23.0 feet across the entire ladder under normal low flow conditions. This is from the low tailwater level of 138.5 to the controlled water level upstream of 161.5. Ladder steps will have a 1-foot drop except the upper two pools. Each pool has inside dimensions of 8 feet wide and 10 feet long. As seen in the adjacent photo of a vertical slot ladder, the pools are designed to discharge through a slot into the corner of the next pool downstream. This dissipates the flow energy in each pool and provides resting areas. This is a traditional style of fish ladder with a long history of successful operation in passing steelhead and salmon. It was developed by the International Pacific Salmon Fisheries Commission to provide fish passage through a large land slide area at Hell's Gate on the Frasier River in British Columbia. Due to the slide there was a large sediment debris load, and the vertical slot ladder was designed and is proven to pass both sediment and debris load.

3.3.3 Fish Counting Station

It is assumed that fish passing the ladder must be enumerated to monitor the recovery of endangered steelhead. Due to the high turbidity in the Santa Clara River, normal counting equipment cannot provide reliable and accurate data, because they rely on seeing the fish through the water. Forcing the fish to the surface and partially above it, exposes them to an above-water camera. Such a system has been developed and is currently in use at the VFDD.

It is proposed to duplicate the current counting system for the new ladder in the upper pools. The system utilizes a standard false weir to attract fish to the surface. When a fish jumps over the false weir it triggers a video camera to record the fish. See Drawing 2S-4. About 6 cfs is drawn from the pool upstream of the counting station and is delivered to the false weir by a 15-inch diameter pipe. A valve in the pipe controls the false weir flow. About 1 foot of head drop across the upstream baffle is used to deliver the flow to the false weir. The rest of flow in the ladder, about 30 cfs, passes through a baffled wall to uniformly distribute the flow through a picket lead fence, which guides the fish to the false weir. A single 4-foot by 5-foot gate is installed to block flow from passing the wall at the counting station. This gate is closed to prevent water from flowing out of the transport channel during a ladder shutdown. When this gate and the exit gate are closed, water is retained in the transport channel to preserve fish in the channel.

3.3.4 Transport Channel

After traversing 23 ladder steps the fish enters a transport channel. The transport channel is 3 feet wide and has an invert elevation of 155.5. The velocity in the channel would be about 2 fps to facilitate fish movement through the channel toward the fish ladder exit.

The 2.0 fps velocity should move sediment in the size range of medium sand and smaller. Larger sediment sizes may accumulate within the transport channel. To clean the channel, sediment deposits can be flushed by closing the gate at the fish counting baffle, opening the fish exit gate and opening the sediment discharge gate located just upstream of the fish counting baffle. This will increase velocities and help move the sediment in the transport channel through a pipe into the flushing channel. See drawing C-2.

3.3.5 Fish Exit

As fish exit the transport channel, they pass through the fish ladder exit gate, which is a flush bottom 3-foot-wide by 6-foot-tall sluice gate. This gate and the head wall above it will be strong enough to resist the head created by the 100-year flood elevation upstream. The exit channel expands to a 5-foot-wide channel as it nears the exit trash rack. Trash rack bar spacing would be 10 to 12 inches. The approach velocity to the rack is about 1.2 fps. The exit gate will be closed during flushing operations. Access will be provided to the transport and exit channel to clean the channel.

3.4 AUXILIARY WATER SYSTEM

AWS flow, along with the canal flow, enters through the main canal trash rack. The opening for the trashrack and the trashrack will be new. This provides better hydraulics approaching the canal gates and fish screens. See Drawing C-1. This flow then is separated at the canal gates. Two gates serve the AWS and the other three gates pass the canal flow. The descriptions in this section follow the flow of the auxiliary water from the forebay to the entrance pool. See Drawings C-1 and 3M-1.

3.4.1 Inlet

The entrance to the canal is protected by an existing trash rack, which has been modified with windows to pass fish upstream. The existing Denil ladder exit is routed into the upper canal on the canal side of the trash rack. The bar spacing in the trashrack was increased (by removing bars) near the bottom of the rack to allow passage of steelhead. In the proposed fish ladder layout, the new ladder connects directly into the flushing channel immediately downstream of the canal inlet trash rack. The inlet to the canal and AWS screens have been widened and a new trashrack will be installed. The new trashrack will provide uniform and narrower bar spacing to reduce debris entering the screens and canal. The new trashrack will be cleaned with the Duperon trash rake system and the controls for the rake will be unchanged, as is provided now. The gross approach flow to the trash rack will be at about 2.7 fps at maximum flow (1,368 cfs max). The existing fish ladder exit gate will be removed and the opening filled with concrete.

3.4.2 Canal Gate

There are two existing canal gates, 9 feet wide and 8 feet high. New gates and new side walls will be located to provide good approach hydraulic conditions for the AWS ladder. The three additional gates would be used to divert water into the canal fish screens. See Drawing 3S-1.

3.4.3 Approach Channel

Downstream of the canal gates the south wall of the AWS fish screens extends above the water surface. This allows the AWS water system to operate independently of the canal water supply. The approach channel to the AWS screen is 27 feet wide, and the invert is at elevation 152.7 at the entrance to the screens. This matches the existing canal invert. Fixed porosity baffles will be used to remove any flow imbalance in front of the screens. A large amount of head (energy) must be dissipated in the AWS flow before it enters the ladder entrance pool so the added head loss from the fixed baffling will not restrict operation. The total flow entering the screen facility is 594 cfs, 24 cfs for fish bypass and 570 cfs for AWS water to the entrance pool.

3.4.4 Primary AWS Fish Screen

The fish screen structure has been laid out to provide 3.0 fps transport velocity in front of the screens. The surface of the water entering the screen structure will be at elevation of 159.9 providing a depth of about 7.4 feet. Vertical flat panel fish screens will be mounted on a sill providing a wetted height on the screens of about 6.5 feet. Screen panels will be stainless steel frames and profile wire screen material having 1.75-mm slots to meet juvenile fry screening requirements. The screens will be in the shape of a “V” with flow passing through screens on the sides of the Vee. The screens will be 112 feet long (56 feet on each side) including support piers. The maximum approach velocity to the screens will be less than the required 0.40 fps. Total flow through the primary AWS screens would be 526 cfs with another 68 cfs passing the primary screens into the secondary screens. See Drawing 3M-1 for details.

The AWS screen would have a brush screen cleaner with one or more brush head assemblies. Brush assemblies will be hung from a trolley, which is suspended from a rail. The brush trolley will be pulled by a wire rope wound around a drum powered by an electric motor. The motor will drive the brush the length of the screens, and its speed of travel can be adjusted. This type of a brush system has been used successfully on many similar installations. The back eddy formed by the brush lifts debris off the screens into the sweeping flow to be carried down to the bypass. Severe debris loading from moss and other debris occur annually at the existing screens and will need to be addressed by the design of a new brush system. Concepts for mechanical systems may provide brushing in the downstream direction only or a rotating brush that would disrupt the matts of debris would need to be developed in subsequent design development. High-pressure backwash systems would also be evaluated as possible alternate to a down and back brush system. Another option for cleaning is continuously operating vertical traveling screens. This type of screen is self-cleaning but would likely be aided with a backwash cleaner to ensure proper operation.

Aquatic Vegetation Accumulation on the screens (June 2019)

Sediment deposition in the screen area is a known problem due to the high suspended sediment load in the Santa Clara River. High-pressure (60-100 psi) pumps would be located behind the fish screens. They would deliver water to a rectangular tube steel located under the fish screens along the floor. Water jet orifices, one-quarter or three-eighths inch diameter, would direct high-velocity jets along the floor. These jets would suspend sediment deposited on both sides of the screens. Once resuspended, the sediment would then be carried downstream in the AWS. These systems have been used at several other screen installations to re-suspend sediment and are shown to be effective as far as 30 feet from the screen.

Alternate screen types, like vertical belt screens, that would replace the screen panels and cleaning systems described above could be adapted to this layout.

3.4.5 Secondary AWS Fish Screen

At the entrance to the secondary screens the channel is 3 feet wide and the invert is at approximately elevation 152.5. This floor elevation maintains the same invert profile as in the existing canal up to the secondary screens. Starting at the upstream end of the secondary screen, the floor is sloped upward at a grade of 1V to 6.6H. To maintain or accelerate the free stream velocity in the channel as required by NMFS guidelines, the channel narrows from 3 feet wide to 1.5 feet wide at the downstream end. Screens with about 110 total square feet of wetted area would be installed to pass 44 cfs to the energy dissipation chamber (55 sf on each side of the Vee). Screen panels would be cleaned by a smaller brush or a back-spray system, same as the primary screens. The final mechanical system would be selected after further evaluation. If the back-spray system is chosen, it could utilize the sediment suspension high-pressure pumps described below.

The flow passing the secondary screen, 24 cfs, would reach critical depth and 8 fps (trapping velocity) at the end of the secondary screens. A tilting flume at the end of the secondary screens would maintain a constant elevation below the upstream water surface to pass the desired 24 cfs under small variations in river level.

Sediment control features in the AWS channel will include floor jets a flushing gate and a floor drain. High-pressure floor jets will be used for periodic resuspension of material while in operation. Jets are located under the screen panels and strategically in areas such as the toe of the ramp where normal operating accumulations are anticipated. A 4-foot square flushing gate installed in the wall between the canal screen and AWS screen for maintenance use to move material down to the canal and sedimentation ponds. A grated floor drain has been included also to allow drainage water and to help in recovery after severe accumulation events in the facility.

3.4.6 Fish Return and Finishing Screen

To accommodate a fish trapping and evaluation station used to monitor and evaluate the fish runs, finishing screens would be provided to reduce the flow to a manageable amount for holding tanks. The trapping velocity created at the downstream end of the secondary fish screens traps fish to go to the evaluation station or to the river. To reduce the velocity through the finishing screens, the channel would be expanded to 3 feet wide and 3 feet in depth. See Drawings C-1 and 2S-2. A total gross screen area of 55 sf is provided. If the flow velocity through the structure is maintained (NMFS Guideline) then 19.6 cfs will be screened and removed leaving 4.4 cfs to return fish to the river or evaluation station. An additional 2 cfs can be removed without violating the 0.40 fps screen approach velocity if a reduced flow into the evaluation station is desired. Screened flow is controlled by a gate on the structure outlet. The channel at the downstream end of the finishing screens is reduced to 12 inches wide. The flume is rotated out of the structure toward the river through a 5-foot radius sweep. The channel then transitions to a 24-inch diameter fish return pipe that returns fish to the river near the fish ladder entrance pool. This is the normal operating configuration when not sampling. To sample fish, the channel must be reconfigured by replacing a short section of channel. A short shutdown of water to the finishing screens will be required. The channel design will accommodate gasketed guides for rapid removal and replacement of the channel sections and lifting assistance would be provided. Once the channel is installed the full 2.0 - 4.4 cfs bypass flow (with fish and any debris) is passed into the evaluation station.

In the normal configuration the fish return flow will be routed to the river in a 24-inch diameter fish return pipe. The pipeline will include 10-foot radius sweeps in accordance with NMFS guidelines. The alignment is shown on Drawings C-1 and 3S-2. The pipe profile will be controlled to limit velocities in the pipe and at the discharge contact with the tailwater. The pipeline will be secured to the concrete wall and hardened to protect it from debris during floods.

Screened water from the finishing screens is regulated by a side gate at the pipe inlet. The screened flow from the finishing screens is combined with the finishing screen flow from the canal screens and water from the evaluation building and is all fish free. Flow can be routed either to the canal downstream of the head gates or to the river at the flushing channel to supplement the AWS flow in the ladder. The pipe size from the finishing screen will be 24-inch diameter to the common 30-inch diameter pipe that can convey water to either the canal or to the flushing channel.

3.4.7 Evaluation Station

Bypass flow would enter the evaluation station in an open channel into a holding pool. Drawing 3S-2 shows a concept layout for the evaluation station that could be used for monitoring and evaluation of the steelhead runs or for short term trap and transport operations should they be needed due to downstream river conditions. Details of the station and equipment would be revised once the full scope of the sampling requirements is defined. The holding pool is 30 inches wide, 10 feet in length and designed for a nominal operating depth of 3 feet. The nominal volume of the pool is 105 cf. The holding pool would include a screen at the downstream end with a weir to maintain pool level. A 1-foot deep recess in the floor upstream of the belt screen would serve to store a brail tray to remove fish for sampling. An electric hoist would be installed to lift the brail tray. Holding pond crowding screens and picket panels for predator separation would be provided. To process fish the crowding panel would be moved to the edge of the brail and fixed in position while the brail is raised. The brail can be raised to the top of the wall for inspection or above the wall to transfer fish to separate holding tanks for evaluation. Fish would be returned to the screened water trench in the floor to be returned to the river. The evaluation station would contain a non-potable water sink, work bench, service water supply, and tagging equipment. This station would contain an identical set up for the bypass from the AWS screening facility.

3.4.8 Bypass Outlet

The bypass flows and fish from the evaluation station would be diverted to a 24-inch pipe to carry the fish back to the river. The flow in the fish return pipe would be about 4 - 8 cfs from both screening facilities. The fish return pipe is smooth interior and would require a minimum 10-foot radius sweeps at the elbows. The fish return also collects flow from the evaluation facility so fish can be released once the sampling is completed. The required pipe slope and the 24-inch pipe (per the NMFS guideline) would result in flow depths that would be 3 inches to 4 inches which would not meet the NMFS guideline for depth to diameter ratio. Pipeline velocities are within the NMFS guidelines. Further development of the design could include consideration of changing the pipe size to a 16-inch pipe to balance guideline for flow depth versus the physical pipe diameter. The bypass flow and fish would drop into the pool to the west of the ladder entrance. The discharge end of the pipe would be at about elevation 146.0 and will not become submerged within the design flow range. The maximum fall of the bypass flow would be about 8 feet at minimum tailwater. The pipe discharge receiving pool will be deep to prevent the fish return flow from plunging to the bottom of the channel. Flows from the fish entrance of 8 fps would maintain a pool that the fish would drop into. See Drawing C-1.

3.4.9 AWS Stilling Basin and Diffusion System

The screened AWS flow of about 570 cfs will pass into a 9-foot diameter pipe. The pipe is laid on a descending curve bending from the fish screen structure to the stilling channel. A 9-foot gate attached to a headwall is installed over the pipe outlet. The bottom of the gate and stilling basin channel is at elevation 134.0. The channel is 12 feet wide and is about 180 feet long. A 3 foot 4-inch-high weir across the channel is located 50 feet downstream of the gate. The weir serves to control the location of the hydraulic jump between the weir and the AWS gate. The channel widens into the AWS pool downstream of the weir. Water then flows through a baffle wall consisting of perforated plates with about a 6 percent open area consisting of 2-inch diameter holes. This will cause about a 1-foot drop across the wall providing an even flow distribution. The flow then passes through a six-foot high by 120-foot long of vertical diffusion grating into the south entrance pool. The baffle wall and diffusion grating are parallel and oriented to lead fish to the ladder at the southwest end of the entrance pool.

3.5 CANAL FACILITIES

This section follows the water from the forebay to the head gates and canal downstream. It describes the proposed facilities in this flow path. The existing head gates and canal downstream would not change. See Drawings C-1 and 3M-1.

3.5.1 Inlet

The canal inlet is the existing canal inlet modified as described in Section 3.4.1.

3.5.2 Canal Gates

Three new 9-foot-wide by 8-foot-high sluice gates, identical to the existing canal gates, will be installed south of the AWS canal gates and in line with them. The gates will be flush bottom with their inverts at elevation 152.7, the same elevation as the existing gates. The new gates will have electric motor actuators. The location of the canal gates will provide even flows approaching the canal screens.

3.5.3 Approach Channel

The channel between the canal gates and the entrance to the canal fish screens is rectangular in section and is 35 feet wide at the entrance to the screens. The invert of the channel slopes at 0.08 percent. The elevation at the gates is 152.7, and the elevation at the entrance to the fish screens is 152.5. This is the same profile as the existing channel. The center line of the channel is a straight line from the center of the center canal gate to the center of the pier between the two head gates. Therefore, the flow approaching the fish screens will be parallel to the center of the Vee screen, resulting in balanced flow approaching the screens. The total flow entering the screen facility is 774 cfs, 24 cfs for fish bypass and 750 cfs for delivery to the canal downstream.

3.5.4 Primary Fish Screen

The fish screen structure has been laid out to provide a flow by the screens of 3.0 fps. The surface of the water entering the screen structure will be at elevation of 160.0 providing a depth of about 7.5 feet. The screens will be mounted on a sill providing a wetted height on the screens of about 6.5 feet. The 1-foot-high sill allows for sediment accumulation before interfering with the screens and the brush cleaners. The screens will be in the shape of a “V” with flow passing through screens on the sides of the Vee. The primary screens will be 150 feet long including support piers (75 feet on each side). Each screen panel will be 10 feet long and 6.5 feet high. Screen panels will be stainless steel frames and profile wire screen material having 1.75-mm slots to meet juvenile fry screening requirements. There will be a blank panel on top of the screen up to elevation 162. The approach velocity to the screens will be 0.4 fps. The flow through the primary screens would be 706 cfs with 68 cfs passing into the secondary screen reach.

Each side of the Vee will have an independent brush screen cleaner with one or more brush head assemblies. Brush assemblies will be hung from a trolley, which is suspended from a rail. The brush trolley will be pulled by a wire rope wound around a drum powered by an electric motor. The motor will drive the brush the length of the screens, and its speed of travel can be adjusted. This type of a brush system has been used successfully on many similar installations. The back eddy formed by the brush lifts debris off the screens into the sweeping flow to be carried down to the bypass.

Severe debris loading from moss and other debris occur annually at the existing screens and will need to be addressed by the design of a new brush system. Concepts for mechanical systems may provide brushing in the downstream direction only or a rotating brush that would disrupt the matts of debris would need to be developed in subsequent design development. High-pressure backwash systems would also be evaluated as possible alternate to a down and back brush system. Another option for cleaning is continuously operating vertical traveling screens. This type of screen is self-cleaning but would likely be aided with a backwash cleaner to ensure proper operation.

Sediment deposition in the screen area is a known problem due to the high suspended sediment load in the Santa Clara River. Sediment control measures available in the main screen channel will include a system of floor jets and a floor drain at the end of the primary screens and removable screen panels. High-pressure floor jets will be used for periodic resuspension of material while in operation. High-pressure pumps (60-100 psi) would be installed behind the fish screens. They would deliver water to a rectangular tube steel located under the fish screens along the floor. One quarter or three eighth-inch holes in both sides of the tube steel would spray high velocity jets of water along the floor. These jets would suspend sediment deposited on both sides of the screens. Once resuspended, the sediment would then be carried downstream in the canal by the transport flow. These systems have been used at several other screen installations to re-suspend sediment and are shown to be effective as far as 30 feet from the screens.

A floor drainpipe would provide the ability to drain water and possibly sediment under limited conditions back to the river. Drawing C-2 shows the proposed routing of the pipe. The drain would be normally closed at a buried plug valve to prevent fish entrainment. Screen and baffle assemblies would be designed to be removable with lifting equipment to allow flushing of sediment into the canal if needed to restore operation. Raising screens in combination with the head gates and possibly the sediment jets would provide a rapid method to restore proper operating conditions at the fish screens.

Alternate screen types, like vertical belt screens, that would replace the screen panels and cleaning systems described above could be adapted to this layout.

3.5.5 Secondary Fish Screen

The secondary canal fish screens are similar to those for the AWS, described in Section 3.4.5. At the entrance to the secondary screens the channel is 3 feet wide and the invert is at elevation 152.5. At the entrance the floor starts to slope upward at a grade of 1V:6.6H. See Drawing 3M-1. The channel would decrease in width from 3 feet at the entrance to 1.5 feet wide at the bypass gate. About 110 square feet of wetted screen area would be provided to pass 44 cfs. There would be 55 square feet of screens on each side of the channel. The three screen panels on each side would be 2.33 feet high and 8 feet long. The screens would be cleaned by a set of smaller brushes or a back-spray system. The type would be decided after further evaluation. If the back-spray system is chosen, it could utilize the sediment suspension high-pressure pumps described below.

The flow passing the secondary screen, 24 cfs, would reach critical depth (trapping velocity of 8 fps) at the end of the secondary screens. A weir gate at the end of the secondary screens would maintain a constant elevation below the upstream water surface to pass the desired 24 cfs under small variations in river level.

Sediment control measures provided in the screen channel will include a system of floor jets and the floor drain at the end of the primary screens. High-pressure floor jets will be used for periodic resuspension of material while in operation. Jets are located under the screen panels and strategically in areas such as the toe of the ramp where normal operating accumulations are anticipated.

3.5.6 Fish Return and Finishing Screen

The fish bypass would be the same as in the AWS screen facility. An 18-inch-wide bypass weir would pass flow 2 feet deep into a flume attached to the top of the weir. The 24-cfs bypass would flow down the flume and into a transition channel to a 36-inch diameter pipe. The pipe would flow about half full at 6.7 fps. The pipe would bend in a long radius sweep to the evaluation station. Once outside of the channel the pipe would transition into the finishing screen. The finishing screen and conveyance are the same as described in Section 3.4.6.

In the normal configuration the fish return flow will be routed to the river in a 24-inch diameter fish return pipe. The pipeline will include 10-foot radius sweeps in accordance with NMFS guidelines. The alignment is shown on Drawing C-1. The pipe profile will be controlled to limit velocities in the pipe and at the discharge contact with the tailwater. The pipeline will be secured to the concrete wall and hardened to protect it from debris during floods.

Screened water from the finishing screens is regulated by a side gate at the pipe inlet. The screened flow from the finishing screens is combined with the finishing screen flow from the canal screens and water from the evaluation building and is all fish free. Flow can be routed through valve settings either to the canal below the head gates or to the river at the flushing channel to supplement the AWS flow in the ladder.

3.5.7 Evaluation Station

Fish return flow would be routed to the evaluation station through the same process as described for the AWS screen. The evaluation station accommodates flow from both screens and is described in Section 3.4.7.

3.5.8 Bypass Outlet

The bypass flows and fish from the evaluation station would be diverted to a 24-inch diameter pipe to carry the fish back to the river. The flow from the main canal screens is combined with the AWS fish return, which is described in Section 3.4.8.

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4.0 PROJECT OPERATIONS

4.1 CANAL FLOW OPERATIONS

During operations at the VFDD, turning water into the canal depends on the suspended sediment load in the river flow. The turbidity of the water is analyzed, and, if the turbidity is acceptable, the flow is turned into the canal. In general, the sediment load approaching the dam is higher when:

- The river flow is high,
- The flow is on the rising limb of the hydrograph, and
- The event is at the beginning of the high-flow season.

The procedure for turning water into or out of the canal would be accomplished as described below.

4.1.1 Turn In

Once the decision is made to turn water into the canal, the following steps would be performed.

1. Flush sediment from in front of the intake, if required, to reduce the sediment load into the canal. See Section 4.2 below.
2. Set up the evaluation station to admit the screen bypass flow to capture fish or pass them through to the river, as desired.
3. Open the three canal gates fully to admit water into the canal fish screen area.
4. When the water is at the proper level in the fish screen facility, start the screen cleaners and activate the automatic adjustable flume bypass gate to send bypass flows to the evaluation station.
5. Open the two head gates downstream of the fish screen and adjust the gates to achieve the proper flow into the canal and the proper water level in the fish screen structure.
6. Start the auxiliary water system by opening the AWS shutoff gate; after the AWS pipe has filled open the adjustable flume bypass gate and open the AWS control gate.
7. During operation, the crest gate, the head gates, and the auxiliary water control gate would work together to maintain the water level in the forebay at elevation 161.5. This would be monitored and controlled by the PLC located in the control building based on information from water level sensors.

4.1.2 Turn Out

When the river turbidity and sediment concentration in the river increases to the point that the flow into the canal must be stopped, the following procedure would be used.

1. Start closing the canal gates for the canal flow.
2. Close the head gates to maintain an operating water level in the screening facility.
3. Activate the service water pump to provide water to the evaluation station holding tanks, if fish are to be maintained in the evaluation station.
4. Open the head gates slightly to drain the fish screen area. Personnel would be standing by to salvage fish in front of the screen and area up to the canal gates.
5. After the fish screen area has been drained, close the head gates.

4.2 CREST GATE

The crest gate is operated automatically with the head gates and AWS control gate to maintain an upstream water surface elevation of 161.5. It is simpler and more reliable to control the water level with a bottom hinged weir than with the roller gate in the flushing channel. The crest gate will have to work in sequence with the two canal head gates and the AWS control gate to effectively provide the required flows downstream and to maintain a constant upstream water level.

The positioning of the crest gate is controlled by the compressor, which maintains the inflation of the bladders and height of the steel gate panels. The compressor and control valves to the bladder are actuated by the PLC, which accepts input from pressure sensors and water level sensors located in the forebay.

4.3 FISH LADDER

4.3.1 Entrance and Auxiliary Water

There are seven entrances to the fish ladder. In the south entrance pool two entrances are located to attract fish from the pool over the flushing channel apron. These gates will provide a flow to attract fish from the pool area which might extend to the north in the area just downstream of the crest gate. The two other gates in the south entrance pool are located on the west side of the south entrance pool. These would attract fish moving along the south shoreline. Three additional gates are located in the north entrance pool. Two gates would discharge to the west and attract fish moving up the north shore of the river. The third gate is located on the north side of the north entrance pool. It would direct flow into the pool in the stilling basin along the dam to the north. During events higher than 6,000 cfs, fish could be attracted to the dam and remain in the stilling basin pool. After the flow receded, the northward facing gate could be opened to attract fish from this area. Initial operation plan for the gates to best attract fish to the ladder would be first predicted in a CFD model to assess the velocity and vector directions under different spill and flow conditions.

Minimum flow requires delivering 45 cfs downstream. This would be regulated through the fish ladder, about 34 cfs, and fish bypass flow from the AWS screens or from the canal screens, about 11 cfs, while maintaining the forebay water surface elevation at 161.5. In this case one entrance gate would be opened. Any of the seven gates could be operated to provide the best fish attraction based on river conditions.

When the AWS system is operating with the full 570-cfs flow, the ladder would provide an additional 34 to 37 cfs. These combined flows will be discharged through four or more entrance gates in the north and south entrance pools. Zero, one, or two entrance gates would be operated in the north entrance pool. Two, three or four entrances would be open in the south basin. See the Table 4.1 below for possible operating scenarios, when the full AWS water is available. In the table it is assumed that 600 cfs is available at the entrance pools.

Table 4.1 Entrance Gate Operations at Full AWS and Ladder Flows of 600 cfs

Flow out of South Entrance	Number of South Entrance Gates	Flow to North Entrance	Number of North Entrance Gates	Scenario
300	2	300	2	Equal flows to attract from north and south of the crest gate
450	3	150	1	Can be used on receding limb of hydrograph to attract fish from the stilling basin to the north
600	4	0	0	If it is found that fish move only on the south bank and fish can be attracted through notches in the training walls

Under maximum operating flow conditions of about 6,000 cfs in the river upstream of the dam, the forebay water level would be below elevation 162.0, the flow in the ladder would be about 37 cfs and the auxiliary water flow would be 570 cfs (nominally 600 combined). Under these conditions it is anticipated that two gates would be in operation in each entrance pool with the gates fully open with 1-foot of head differential across the gates in the north entrance pool and about 1.1 feet . The maximum head across the south entrance pool entrances would be 1.4 feet under the conditions of a full 600 cfs entrance flow and a minimum tailwater.

4.3.2 Fish Counting

The turbidity in the river greatly limits the ability to see through the water. Therefore, under these conditions the video and VAKI Riverwatcher counting systems will not accurately count fish. A false weir system will be used to bring fish to or above the water surface to expose the fish for counting. Fish going over the false weir will be sensed by a light system. When a fish is detected over the weir, a camera will be activated to take a video of the fish. This system is used presently and has been found to be effective.

The false weir and fish counter would be placed in the ladder west of the exit. It would be easily accessed from the ground outside the ladder. About 6 cfs would be brought through a pipe from the upstream ladder pool to operate the false weir. The remaining flow in the ladder would be channeled beside the false weir and brought back into the ladder channel through a picket lead, which would also guide adult fish to the false weir. Flow velocities through the picket lead would be 1.0 to 1.5 fps.

4.3.3 Fish Ladder Exit

The last ladder pool is upstream of the fish counter. Above this is the transport channel, which leads to the fish ladder exit. When nearing the exit, the fish will encounter the exit gate, then the trash rack before entering the flushing channel just west of the main trash rack. The exit channel invert is about 5 feet above the flushing channel to exclude bed load sediment from entering the fish transport channel and ladder. The exit gate will remain open during ladder operation. The trash rack at the ladder exit will be cleaned by an automated mechanical trash rake activated manually or by a timer.

4.3.4 Maintenance

The ladder and trashrack should be inspected once per year between June and December when Steelhead are not migrating. This requires dewatering the fish ladder by a procedure described below. The existing Duperon trash rake and gates would be maintained according to the manufacturer's requirements.

4.3.4.1 Ladder Dewatering

Maintenance of the fish ladder is required once per year and would take place when adult steelhead are not anticipated to be present in the river. At times during the high flow season sediment can accumulate in front of the fish ladder exit and canal intake trash rack. During these times and during annual maintenance the ladder must be dewatered. The procedure for dewatering the ladder is as follows:

1. Close the auxiliary water gate.
2. Close the fish ladder exit gate slowly. As flow decreases in the ladder, personnel would monitor the fish ladder to make sure that fish are not stranded and adjust the closure to allow fish to travel downstream.
3. As the exit gate is being closed, close the transport channel gate located at the fish counting station at the same time. The goal is to have a fully watered transport channel after both gates are closed. Any fish in the transport channel would have sufficient water to hold in. The fish ladder would be monitored as it is slowly being dewatered.
4. After all fish in the ladder have moved to the south entrance pool, close the entrance gates in both entrance pools. At this point the only part of the ladder that is dewatered is the sloping vertical slot ladder section, and fish can hold in the entrance pools and the transport channel. If they are present, fish could be salvaged from these areas.
5. The entrance pools could be dewatered using a portable pump.

4.3.4.2 Sediment Removal

Removing sediment from in front of the fish ladder exit and canal intake requires opening the roller gate and accelerating the flow down the flushing channel. During this time the water level at the fish ladder exit will be lowered and operating the ladder to meet criteria requirements is not possible. The flushing operation takes about 2 hours. Shutting down the ladder would be done prior to opening the roller gate for flushing operations. The procedure is described in Section 4.3.4.1.

During operations the flow in the transport channel will be about 2 fps, which is sufficient to move medium sized sand and small sediment. Sediment of any size will move down the ladder. The transport channel can be flushed by opening the fish exit gate and sediment valve in the pool upstream of the false weir. This would allow a flow of about 40 cfs, which would be sufficient to flush the transport channel while maintaining a lower depth of flow. Access to the ladder, south entrance pool, and transport channel is sufficient to allow for mechanical cleaning. The north entrance pool will have to be cleaned by hand or by equipment accessing the pool from the top of the dam or from downstream.

4.3.4.3 Ladder Startup

After the ladder has been dewatered the following procedure would be used to put it back into operation:

1. Open the entrance gates as required to accommodate the desired flow.
2. Open the exit gate slowly.
3. At the same time open the transport channel gate to resume flow in the fish ladder.
4. Open the AWS control gate to the desired setting.

4.4 AUXILIARY WATER SYSTEM

The operation and maintenance requirements are described from upstream to downstream.

4.4.1 Trash Rack

The new trashrack will not have to pass upstream migrating fish. Therefore, it will have uniform bar spacing. This spacing would be expected to be similar to the factory spacing of the existing trashrack. It will be cleaned with a Duperon trash rake similar to the existing rake. The trash rake will be operated by manual push button, on a timer, or from the PLC triggered by a high head differential across the trash rack. At maximum diversion of auxiliary water and canal flow, the velocity of approach to the trash rack would be about 2.7 fps.

4.4.2 Canal Gate

The AWS canal gates provide flow to the auxiliary water screening facility. This flow consists of 24-cfs fish bypass flow and from 0 to 570-cfs AWS flow. These gates are meant to shut off the AWS screening facility and auxiliary water system. The flow in the AWS is controlled by the AWS control gate located at the end of the AWS pipe between the upper and lower portions of ladder.

4.4.3 Fish Screen

4.4.3.1 Fish Screen Cleaning

The AWS water is screened by two screens. Of the 570 cfs auxiliary water, 526 cfs passes through the primary screens and 44 cfs passes through the secondary screens. An additional 24 cfs passes by all the screens and carries the fish to the bypass.

The AWS water flows evenly through the fish screens. The baffles behind both the primary and secondary fish screens consist of perforated plates with a fixed open area of about 6 percent of the total screen area. This provides an even drop across the baffles of about 1 foot. The high head drop evenly distributes the flow through the screens. The AWS water then travels through the AWS pipe to the AWS control gate near the entrance pool. The gate is automatically adjusted to maintain a set AWS flow into the entrance pool.

The primary fish screen is cleaned with a brush cleaner that is attached to a trolley that moves the length of the screen to sweep the debris to the entrance of the secondary screen section. The main mechanism for cleaning the screens is by the back eddy behind the brush, which lifts debris off the screens and into the transport flow to be carried downstream. The brush cleaner is activated by manual push button, a timer, or by the water level differential across the fish screens. High head differential indicates a clogged condition on the screens.

The secondary fish screens and finishing screens are cleaned by a water backwash system. A pump behind the screens pumps water at about 80 psi and delivers the high-pressure water to nozzles located behind the screens. The back spray lifts the debris off the screens and into the flow passing by the screens and to the bypass. The transport velocity of flow by the screens of 3 fps carries the debris to the bypass.

4.4.3.2 Sediment Cleaning System

The pumps located behind the fish screens used to clean the secondary screens would also have the capacity to supply high-pressure water (100 psig) to nozzles located at the base of the fish screens. The nozzles would discharge high-velocity jets over the floor of the areas in front of and behind the fish screens. These jets would lift up sediment settled on the floor into the water column. The sediment would be carried away into the screened AWS water. The water jets would be directed in front of and behind the screens. This system has been used in fish screening systems located in other high sediment rivers.

4.4.4 Fish Return

At the end of the secondary screen is a weir gate with a flume attached. The weir would be automatically raised and lowered in response to varying water levels to maintain the 24-cfs bypass flow over a range of water levels in the screen area. The flow is further reduced to 4.4 cfs by finishing screens. Downstream of the secondary screen bypass a 36-inch diameter pipe would carry the juvenile fish from the secondary screens to the finishing screen area located near the evaluation station. Algae or debris carried passed the secondary screens would be cleaned from the finishing screens with vertically traveling screen with a spray bar. From the finishing screen the primary channel will transition to a fish return pipe routed back to the river. Any algae or debris that bypass the finishing screens would be routed back to the river as well. If sampling is required, the flowline channel can be changed to route flow to the evaluation station. The fish return pipe would be about half full to allow floating debris to pass more easily, and the water would be traveling at about 10-12 fps.

4.4.5 Evaluation Station

An evaluation station would serve both the AWS screens and the canal screens. Flow from each screen enters into separate holding ponds that contain screens to retain fish. Continuous belt screening will allow for the debris to be removed from the water. The screened water would be returned to the fish return pipe. When it is desired to mark fish, the operators would crowd the fish to the end of the tank and manually remove them. The fish would then be moved to a holding tank and a free-standing recovery tank after handling. After recovery, they would be released into the bypass flow.

4.4.6 Bypass Outlet

The bypass pipe from the evaluation station would return the fish to the pool located immediately west of the south entrance pool. The bypass pipe would flow partially full, and the water would be traveling at about 10-12 fps. The fish would fall a maximum of about 8 feet and would enter the pool about 8 feet from the ladder entrances.

4.5 CANAL FACILITIES OPERATION

4.5.1 Trash Rack and Trash Rake

About 1368 cfs would pass through the trash rack and to the canal. This flow consists of 750 cfs for the canal, 570 cfs for the ladder AWS flow and 24 cfs for each of the two screen fish bypasses. The approach velocity to the trash rack would be about 2.7 fps including AWS flow. The trash rack openings would be modified to be more efficient at collecting debris, since adult fish do not have to pass through the trash rack.

4.5.2 Canal Gates

Three identical new canal gates would be automatically controlled from the project PLC. These would normally be fully opened to accept the flow from the river. To improve the hydraulic conditions in the screen area and to maximize wetted area on the fish screens the primary regulation point will be moved to the canal head gates. This is a change to the current flow control, which is provided now by the Canal Gates.

The canal gates are centered on the fish screen to deliver flow parallel to the fish screen axis. This provides the necessary approach hydraulics for evenly distributing the flow through the screens. To minimize turbulence at the screens the canal gates will be maintained in the full open position when the facility is in operation, and they are not intended to be used to throttle flow.

4.5.3 Fish Screen

Like the AWS fish screens, the canal screens contain primary and secondary screens. The primary fish screen is shaped in a Vee configuration, with screens located on both sides of the Vee. About 706 cfs pass through the primary screens with an approach velocity of 0.40 fps. Approximately 68 cfs passes the primary screen into the secondary screens where 44 cfs is screened. The remaining 24 cfs enters the bypass. The fish screen panels are passive with no moving parts. Baffles downstream of the screen panels are adjustable but normally they are adjusted during project commissioning and fixed in place.

See Section 4.4.3.1 for screen cleaning options.

Sediment in front of and behind the screens would be lifted into suspension by water jets and carried downstream in the canal. This is the same system employed in the AWS screen facility. See Section 4.4.3.2 for a description of the sediment suspension system.

4.5.4 Fish Return

The bypass for the canal screen facilities is the same as that described above for the AWS screen system. See Section 4.4.4.

4.5.5 Evaluation Station

See Section 4.4.5 for information on the evaluation station.

4.5.6 Bypass Outlet

This is the same pipe containing the AWS bypass flow. See section 4.4.6 above.

4.6 FLOW ALLOCATION

The flow in the Santa Clara River approaching the VFDD either passes the dam or is diverted and sent down the canal to the settling basins. Drawings G-3 and G-4 show the different routes that water can take through the VFDD facilities. All flow routes direct the water to the left bank for all flows below the 6,000 cfs design flow, except for the water that passes over the spillway and water diverted down the canal. Uncontrolled spill occurs when all other flow paths are at the design capacity above 6,000 cfs.

The flow paths through the dam and intake facilities can be opened to pass or divert water as desired. Two tables have been developed showing possible operation and allocations depending on whether the Canal (Table 4.2) or AWS (Table 4.3) diversions are prioritized first. These two tables represent the ends of the operation spectrum. Additional operation configurations are available between them, but not outside these options. The tables also show the percent of the time that each flow regime would be in operation during the presence of upstream migrants.

Table 4.2 Canal Flow First

River Flow Range Upstream	Flow Duration	Percent of Time During Fish Passage	Approximate Ladder	Canal	Canal Fish Bypass	Auxiliary Water	Auxiliary Water Fish Bypass	Crest Gate	River Flow Downstream	Remarks
45	77%	23%	34		11				45	First 45 cfs goes to ladder
45-58	74%	3%	34		24				58	Next 24 cfs goes to canal screen fish bypass
58-808	15%	59%	34	750	24				58	Next 750 cfs goes to canal
808-832	14%	1%	34	750	24		24		82	Next 24 cfs goes to aux water fish bypass
832-1402	8%	6%	34	750	24	570	24		652	Off the Flow Duration Curve
1402-2686	5%	3%	34	750	24	570	24	1284	1936	Off the Flow Duration Curve
2686-6000	2%	3%	34	750	24	570	24	4598	5250	Off the Flow Duration Curve

Table 4.3 Auxiliary Water Flow First

River Flow Range Upstream	Flow Duration	Percent of Time During Fish Passage	Approximate Ladder	Canal	Canal Fish Bypass	Auxiliary Water	Auxiliary Water Fish Bypass	Crest Gate	River Flow Downstream	Remarks
45	77%	23%	34				11		45	First 45 cfs goes to ladder
45-58	74%	3%	34				24		58	Next 24 cfs goes to aux water screen fish bypass
58-628	18%	56%	34			570	24		628	Next 570 cfs goes to auxiliary water
628-652	17%	1%	34		24	570	24		652	Next 24 cfs goes to canal fish bypass
652-1402	8%	9%	34	750	24	570	24		652	Off the Flow Duration Curve
1402-2686	5%	3%	34	750	24	570	24	1284	1936	Off the Flow Duration Curve
2686-6000	2%	3%	34	750	24	570	24	4598	5250	Off the Flow Duration Curve

4.7 CARE OF DEBRIS

4.7.1 Floating Debris

Large floating debris are currently managed within the canal and AWS screening areas by the Duperon traskrack and rake.

Much of the floating debris is expected to be excluded by the trashrack. At the fish ladder exit with a bar spacing of 10 - 12 inches, large debris is removed automatically, operated by a PLC. Debris would be removed similar to the present raking system on the canal trashrake. The smaller debris that passes through the ladder trashrack should pass through the vertical slots in the ladder, but periodic inspection and cleaning would be performed.

The canal trashracks have a smaller opening that will be maintained to protect the fish screens, cleaners, and bypass systems. The current type of automated rake system will be maintained. Because the canal gates will be normally fully open and the water surface on the upstream end of the gates would submerge the opening, the canal gates may catch much of the floating debris that passes the rack. The existing platform would be used to reach and remove floating debris at this location using mobile equipment. Small floating debris could pass this location and would be caught by the fish screens or pass downstream into the fish bypass. If the screen is cleaned by brush it is likely that the debris will be cleaned off and sent towards the fish bypass. alternative fish screen is a vertical traveling screen, which would pass the debris downstream of the screens.

4.7.2 Algae/Weeds

At times algae has been a problem at the existing fish screens. The present reciprocating multi-brush system tends to move the material back and forth across the screen. More effective technologies have been used successfully using a single brush that travels the length of the screen and back again. This type of screen cleaner has an eddy behind the brush as it moves. This eddy forms a flow back through the screens, which tends to lift debris out into the sweeping flow. The debris then moves with the flow to the bypass. The debris is then moved back to the river in the bypass pipe. If capturing fish is desired, the debris must be removed in the evaluation station. The rotating drum or traveling screens in the evaluation station will remove the debris from the water. The water level difference across fish screens will be measured. If the difference is larger than a value set into the PLC, the screen cleaner will be activated. If the difference reaches a higher set point an alarm will be sent to maintenance personnel. If the difference reaches a critical set point, the canal gates will be shut to prevent damage to the screens. This logic will be operated by the PLC.

Another possible solution to this problem is to use vertical belt screens in the primary and secondary screen area of both screening facilities. Algae pinned to the screens will travel up and over the screens and into the screened water flow. The algae will then be carried downstream in the canal or AWS. It’s possible that the flow through the back side of the screen is not sufficient to clean them properly. If this is found to be true, an additional back wash system could also be provided which could backwash algae and similar plants back into the screening area and it would travel down the bypass.

4.7.3 Sediment

Sediment has been a major issue encountered in operating the VFDD diversion. The suspended sediment load has caused problems counting fish due to turbidity and depositing sediment in the intake channel. A fish counter has been proposed to induce fish out of the water to identify it by video. Later review of the video by personnel will provide a good count of steelhead and other species. A sediment re-suspension system has been incorporated in the fish screening structures to re-suspend sediment in the water column, where it will move downstream with the flow. In the AWS the sediment would be carried downstream through the entrance pool and back to the river. In the canal screening facility, the re-suspended sediment would travel downstream in the canal.

4.7.3.1 Suspended

The focus of the hydraulic design is to shape the structures to keep water and fish moving efficiently through the facility guiding them to the bypass at the downstream end where they can be routed back to the river. To manage deposition within the structures, two systems will be employed. The first is a sparger system that consists of a series of nozzles at or near floor level that will impact the accumulated sediment but also create secondary currents that will help resuspend the material allowing the current to move the sediment through the system either to the canal or to the bypass. The second system that would be used is an educator manifold. These would be installed in the screens and transport channel and would flush deposited sediment to the flushing channel. See Drawing C-2.

The sparger system could also be used upstream of the canal gates and in front of the trashrack to resuspend the larger material deposited there. This could reduce sediment deposition in the area in front of the intake and reduce the need to open the flushing gate.

4.7.3.2 Bed Load

It is anticipated that the inclusion of the crest gates will create a concentrated path for larger bed load material to be attracted to and over the crest gate, which is eight feet lower than the dam crest. This could reduce the bed load that would enter the approach channel. The bed load that does reach the Inlet of the diversion would be deposited below the sill under the trashrack. This sill will remain as part of the proposed layout. Buildup of bedload at the canal entrance is currently managed by the flushing channel.

4.7.3.3 Flushing Operation

The roller gate and flushing channel would be used for keeping the area in front of the trash rack and fish ladder exit free of sediment. The water level control upstream of the dam would not be controlled by the roller gate in the flushing channel. When sediment needs to be removed upstream of the trash rack and fish ladder exit, the following procedure would be used to remove the sediment.

1. Close ladder as described in Section 4.3.4.1.
2. Open the roller gate. Depending on the flow in the river, the water surface in the flushing channel could fall below the sill of the trash rack and fish ladder exit. For upstream water levels below the dam crest, the flow under the roller gate will become free surface during the flushing operation. This is due to the slope of the flushing channel. The maximum flow while maintaining an upstream water surface elevation of 162.0 would be about 1,900 cfs.
3. After flushing is complete, close the roller gate.
4. Place the ladder back into operation. See Section 4.3.4.3.

Sediment is also deposited downstream from the trash rack through the fish screen structures. Removing sediment in this area would be by sparger system to resuspend sediment to be carried downstream in the current through the fish screen structures as described in 4.4.3.2.

5.0 COST OPINION

An Opinion of Probable Construction Cost (OPCC) was prepared for the work to implement the new facilities described herein. The Total Estimated Cost is $57M including the new ladder, crest gate and new canal and AWS screens. A summary of cost per major feature is given in Table 5.1.

Table 5.1 OPCC Summary for New Fish Ladder and Canal Facilities

Item	Description	Value
1	General Items/Temporary Works	$2,661,000
2	Access Road and Sitework	$611,000
3	Care of Water	$2,409,000
4	Crest Gate and Dam Modifications	$1,639,000
5	Fish Ladder Structure	$18,101,000
6	Canal and AWS Screens & Channel	$25,502,000
7	Electrical and Instrumentation	$6,022,000
	Total Estimated Point Value	**$56,946,000**
	Estimated Market Range	**$43M - $71M**
	Mid-Point Market Range	**$57M**
	Suggested Project Budget	**$57M**

Additional OPCC details and assumptions can be found in Appendix A. Please note the following limitations and basis notes:

- Costs are presented in 2019 dollars.
- The current 12-month price index is 156.4 as published in the California Department of Transportation, Price Index for Selected Highway Construction Items, First Quarter ending March 31, 2019.
- No out-year price escalation has been included.
- No indirect costs for administration, engineering, environmental or geotechnical studies are included.

Estimates are based on the information presented consistent with an AACE International Class 4 Cost Estimate. Class 4 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is 10%- 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from –15% to –30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

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6.0 CONCLUSIONS

6.1 ATTRIBUTES

6.1.1 Meets Fishery Agency Criteria

The proposed fish ladder and fish screens meet NMFS and CDFW criteria for these types of facilities. The proposed facilities have been built and operated successfully for salmonids in other locations in the western United States and Canada. Using proven technology provides the best chance of successful passage of VFDD.

6.1.2 Operations and Maintenance

The primary passage facilities are located on the left bank of the Santa Clara River at the existing diversion structure. This area has excellent access. This means that operational problems can be repaired quickly without having to wait for flows in the river to subside for access from the river channel. This is a benefit to the fish resource, since it means that facility problems affecting the fish can be repaired sooner. The only features that cannot be accessed during high flows is the Obermeyer inflatable bladder and the steel gate plates that it supports, as well as the north fish entrance gates. These would need to be accessed from downstream during low flows for major repair or replacement. Access to both these areas are available for personnel access via the pre-fabricated truss walkway, but heavy maintenance of these gates would likely have to occur during the non-fishing season with a crane.

6.1.3 Allows for Fish Capture and Evaluation

Fish biologists have many questions about endangered fish, while trying to recover their populations. The proposed facilities allows them to have access to the fish. Both upstream and downstream migrants can be captured and evaluated in the proposed facilities. This allows tagging of fish for population and migration studies. For example, one of the questions is: What is the population of rainbow trout that out-migrates and become steelhead? Capturing downstream migrants allows inspection to see whether they are smolting for migration to saltwater or they are resident rainbow trout. Downstream migrants can be captured, and PIT tags inserted. A PIT tag reader can be installed in the transport channel for detection and enumeration of these fish when they return.

6.1.4 Addressing Passage Challenges

Table 6.1 on the following page summarizes passage challenges encountered at Vern Freeman Dam and the solutions used to overcome these challenges.

Table 6.1 Addressing Passage Challenges

Passage Challenge	Solution
1. Attraction to the Ladder Entrances	
a. Concentrate Flows Up to 6,000 cfs as Much as Possible	The combination of the fish passage facilities (ladder and screens) and the crest gate will concentrate all (100%) of the 6,000 cfs river flow. This will provide a significant attraction to the left side of the channel where the fish ladder entrances are located.
b. Left Bank Approach	Fish approaching from the main thread of the river or those using the structure along the left bank during higher flows will end up at the dam in a deep sheltered pool created by the ladder entrance and flushing channel training wall. This area is typically shaded and would be a natural resting area for migrating fish. From here the fish can move directly into the south ladder entrance attracted by the 300 to 600 cfs attraction flow.
c. Right Bank Approach	Fish approaching the dam in the main channel that move north of the attraction from the crest gate will be directed by currents into calmer waters to the north fish ladder entrance. Fish in the channel can move directly into the entrance gate and then transit to the ladder.
d. Channels in the Right Bank	In flows above 6,000 cfs fish that approach through braided channels further to the north would eventually reach the stilling basin. After flows recede below 6,000 cfs the fish are stranded in the pool formed in the stilling basin of the dam. The north facing entrance can be activated to attract fish from this pool south toward and into the north ladder entrance.
2. Sedimentation	
a. At the Fishway Entrances	South Entrances - Sediment deposition has historically been managed by operation of the flushing channel. The north facing gates can be maintained by continued strategic use of the roller gate. The entrance gates are susceptible to deposition and debris in flood conditions based on current operational history due to the backwater. The flow out of the entrance gates will scour a pool outside the entrance gates. Further hydraulic analysis of this area is warranted as design progresses to ensure proper operation or other mitigation measures could be incorporated such as booms, jets or deflectors.
	North Entrances - The height of the north entrance walls was set to prevent overtopping during flood events. Deflection of flow around the structure may still result in deposition of material around the entrance, but this can be managed through arrangement of the training walls and dam sill design.
b. At the Fishway Exit	Sediment and debris accumulations at the ladder exit should be managed through use of a sparger system to suspend sediment and move it into and through the intake. Strategic use of the flushing gate can flush the heavier material downstream. The crest gate which is set eight feet below the dam crest will serve to move bed load over it during higher flows. Preventing larger gravel and cobbles from entering the ladder is necessary to ensure the ladder operates as intended and passes fish without delay. The exit contains a bottom sill above the flushing channel floor to help reduce entrainment of rolling bedload material. Maintaining the approach channel free of accumulated sediment is important to facility operation.
c. Within the Fishway	One of the benefits of the vertical slot ladder design is its ability to pass debris and sediment. The full depth slot (no bottom sills) provides a large through passage window even if partially obstructed by a stick. Ladder operation is easy to visually inspect and debris, if observed, can normally be removed from the walkway. The vertical slot ladder is protected from high flood flows due to its location on the left bank making the main structure less susceptible to direct impact by the large debris that moves in the river.
3. Startup and Shutdown within the Passage Season	
a. Startup	From a short or long duration outage the ladder can be watered up and put in full operation within minutes. Typical procedures are described in Section 4.3 of this Report.
b. Shutdown	Ladder shutdown is described in Section 4.3 of this Report. Depending on the purpose and expected duration of the outage, the ladder can be either closed and dewatered or closed with a small amount of water supplier for life support for any stranded fish.

7.0 REFERENCES

FEMA, *Flood Insurance Study Ventura County, California and Incorporated Areas*, April 2018

Milo Bell, *US Army Corps of Engineers Fisheries Handbook*, 1991

NMFS Northwest Region, *Anadromous Salmonid Passage Facility Design*, July 2011

NMFS Southwest Region, *Fish Screening Criteria for Anadromous Salmonids*, January 1997

Northwest Hydraulic Consultants, *Sediment Transport and Deposition Assessment of the Freeman Diversion Conveyance System*, January 7, 2015

Stantec, *Vern Freeman Dam Vertical Slot Fish Ladder Project Feasibility Report*, July 20, 2018

Stantec, *Vern Freeman Diversion, Intake and Fish Screen Configuration Assessment*, May 24, 2019

Vern Freeman Dam Fish Passage Panel, *Vern Freeman Dam Fish Passage Conceptual Design Report*, Final, September 15, 2010

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Appendix A OPINION OF CONSTRUCTION COST (OPCC)

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United Water Conservation District (UWCD)
Vern Freeman Diversion Dam, Vertical Slot Fish Ladder Study
Left Bank Fish Ladder and Expanded Juvenile Screens
(<20% Predesign, HBOD Report 12/6/19)

Opinion of Probable Construction Costs (OPCC)

Currency: USD-United States-2019 Dollar

Estimated Point Value:	$57,000,000	
Estimated Market Range:	$43M-$71M	
Mid Point Market Range:	$57M	
Suggested Project Budget:	$57M	*Pending inclusion of excluded items*

Proj #	GC	Description	Quantity	UOM	Unit Cost	Total Cost	Comments	Final Item Total
		LEFT BANK FISH LADDER AND EXPANDED JUVENILE SCREENS	1	LS	$32,181,692	$32,181,692		*$56,945,000*
1.00		GENERAL ITEMS/TEMPORARY WORKS	1	ls	$1,504,000	$1,504,000		$2,661,000
1.01	P	Mobilization and Demobilization	1	ls	$1,200,000	$1,200,000	gen allowance 4% on dir cost (ref SCI at CGDF)	
1.02	P	Environmental Protection and Erosion Control	1	ls	$100,000	$100,000		
1.03	P	Temporary Facilities & Field Oversight Staffing	1	ls	$0	see below		
1.04	P	Temporary Utilities	1	ls	$0	see below		
1.05	P	Owner's Field Office	18	mos	$3,000	$54,000	18 months	
1.06	P	Temporary Works	1	ls	$150,000	$150,000		
2.00		ACCESS ROAD AND SITEWORK	1	ls	$345,522	$345,522		$611,000
2.01	P	Grade Access Road and Parking	112,000	sf	$2	$239,956	yard to site 8000 ft x 14ft	
2.02	P	Temporary Crossing Protection	4	ea	$10,712	$42,849	Allowance for placement of fill for canal crossings	
2.03	P	Develop Construction Access to River US/DS Of Div	1	ls	$26,781	$26,781	Allowance	
2.04	P	Site Fence	800	lf	$25	$19,867	Replace south fence assumption	
2.05	P	Base Rock and Gravel Access Road at Completion	1,000	cys	$16	$16,068	gravel, spread, grade and roll top course	
3.00		CARE OF WATER	1	ls	$1,361,269	$1,361,269		$2,409,000
3.01	P	Upstream Diversion (Supersack)	140	cys	$295	$41,242	supersack, approach ch, 3-60cf bags 60'w x ~9.3'h (el 164), low flow only	
3.02	P	Dam Mod Diversion (Sheet Pile R&R)	7,030	sf	$80	$564,808	sheet pile, 190 ft 165' to el 130' ~siltstone	
3.03	P	Downstream Isolation (Supersack)	800	sf	$295	$235,671	60cf supersack, 340 ft long 3-bag section avg	
3.04	P	Diversion of River Around Work	1	ls	$53,562	$53,562		
3.05	P	Groundwater Pumping	12	mo	$32,137	$385,644	$1k/dy incl tender, moderate inflow	
3.06	P	Water Quality/Sediment Removal for Dewatering	1	ls	$80,342	$80,342	scaled 150% for larger work area	
4.00		CREST GATE	1	ls	$926,022	$926,022		$1,639,000
4.01	S	Demolition RCC and Reinforced Concrete	336	cys	$321	$107,980	ysp	
4.02	S	Excavation (Common)	500	cys	$21	$10,712	ysp	
4.03	S	Concrete (CIP, Notch, and Dam Cap)	94	cys	$1,821	$171,188	ysp	
4.04	S	Compressor Building & Supports above Flushing Channel	1	ls	$8,570	$8,570		
4.05	S	Crest Gate (35 ft, 1 system)	560	sf	$750	$419,923	ysp	
4.06	S	Compressor Building Structural/Mech above Flushing Channel	284	sf	$279	$79,100	ysp	
4.07	S	Air Pipe SST	500	lf	$171	$85,699	3ea*120ft @ ysp u/p	
4.08	S	Mechanical Installation	1	ls	$42,849	$42,849		
5.00		FISH LADDER STRUCTURE	1	ls	$10,229,595	$10,229,595		$18,101,000
5.01		Demolition	1	ls	$180,288	$180,288		$319,000
5.01.01		Structure Demolition	841	cys	$161			
.01.01.01	P	*CIP Concrete*	*652*	*cys*	*$161*	*$104,767*		
.01.01.02	P	*RCC*	*189*	*cys*	*$161*	*$30,369*		
5.01.02		Demolition-Mech	1	ls	$5,000		allowance	
.01.02.01	P	*Remove 30-inch HDPE Pipe*	*200*	*lf*	*$161*	*$32,137*		
.01.02.02	P	*Remove 54-inch concrete pipe*	*45*	*lf*	*$289*	*$13,015*		
5.02		Excavation & Backfill	1	ls	$622,047	$622,047		$1,101,000
5.02.01	P	Rip Rap Removal	1,112	cys	$27	$29,780	Remove existing rip rap, store it to be placed back	
5.02.02	P	Common Excavation	14,311	cys	$16	$229,956		
5.02.03	P	River Sediment Removal	2,658	cys	$27	$71,183		
5.02.04	P	Backfill Structural	2,862	tns	$43	$122,643		
5.02.05	P	Backfill - Rip Rap	2,224	tns	$37	$83,385	Place reused rip rap; same quantity as removed	
5.02.06	P	Slab-On-Grade Foundation Prep (No Rock)	512	sy	$21	$10,969		
5.02.07	P	Aggregate Base Foundation	256	cys	$80	$20,568	Crushed rock under slab	
5.02.08	P	Slab Anchors Allowance	1	ls	$53,562	$53,562	allowance	
5.03		CIP Concrete	1	ls	$6,075,041	$6,075,041		$10,750,000
5.03.01		Slab-On-Grade	705	cys	$510			
.03.01.01	P	*Pools 1-22*	*121*	*cys*	*$779*	*$94,233*	Reinforced concrete slab on grade; 8 ft wide	
.03.01.02	P	*Transport Channel (Pool 23)*	*44*	*cys*	*$779*	*$34,267*	Reinforced concrete slab on grade; 3 ft wide + transition	
.03.01.03	P	*Entrance Pool & Flushing Ch Slab*	*263*	*cys*	*$779*	*$204,821*	Reinforced concrete slab on grade; 40 ft N-S	
.03.01.04	P	*Crest Gate Apron*	*243*	*cys*	*$779*			
.03.01.05	P	*Energy Dissipation Pool*	*34*	*cys*	*$779*	*$26,479*	Reinforced concrete slab on grade; 8 ft E-W	
5.03.02		Walls	3,806	cys	$1,285			
.03.02.01	P	*Ladder*	*870*	*cys*	*$1,285*	*$1,118,367*		
.03.02.02	P	*Entrance Pool*	*1,424*	*cys*	*$1,285*	*$1,830,523*		
.03.02.03	P	*Ladder Baffles*	*53*	*cys*	*$1,285*	*$68,130*	Reinforced Concrete walls; intricate forming	
.03.02.04	P	*Transport Channel*	*219*	*cys*	*$1,285*	*$281,520*	Reinforced Concrete walls; includes transition and exit walls	
.03.02.05	P	*Crest Gate Spillway (Curved)*	*1,240*	*cys*	*$1,285*	*$1,593,995*		
5.03.03		Walls	512	cys	$1,607			
.03.03.01	P	*Energy Dissipation Pool*	*512*	*cys*	*$1,607*	*$822,707*	Slab under ladder & over entrance pool and dissipation pool	
5.04		Structural Metals	1	ls	$1,310,685	$1,310,685		$2,319,000
5.04.01	P	Grating	8,800	sf	$99	$867,270		
5.04.02	P	Handrail/Guardrail	1,100	lf	$139	$153,186		
5.04.03	P	Miscellaneous Metals Guides/Embeds	1	ls	$53,562	$53,562		
5.04.04	P	Prefab Gangway (71' ft)	1	ls	$236,667	$236,667	ref Leaburg 2003 OPCC esc at 3%/yr scaled to length	
5.05		Miscellaneous	1	ls	$2,041,534	$2,041,534		$3,612,000
5.05.01	S	False Weir & Counting Equipment	1	ls	$21,425	$21,425		
5.05.02	S	AWS Diffuser Panel	720	sf	$107	$77,129		
5.05.03	S	AWS Diffuser Baffles	720	sf	$107	$77,129		
5.05.04	S	AWS Gate & Energy Diss Gate	162	sf	$4,017	$650,774		
5.05.05	S	Fish Entrance Gates (4ea-5'x5')(3@6x5')	190	sf	$4,017	$763,253	3 ft by 6 ft sluice gates; 35 foot head sluice gates	
5.05.06	S	False Weir, Camera System, & Shade Roof	1	ls	$37,493	$37,493	15 inch pipe, 15 inch valve, false weir, picket lead	
5.05.07	S	Fish Exit Cut Into Existing Wall	150	sf	$54	$8,034		
5.05.08	S	Exit Gate	24	sf	$4,017	$96,411	3 ft by 8 ft high 30 foot sluice gate	
5.05.09	S	60" Valve	-	ea	$32,137	$0	60" knife gate valve with 30' ext. & electric multiturn actuator and controls	
5.05.10	S	Trashracks at U/S End of Fish Ladder	144	sf	$664	$95,640		
5.05.11	S	Installation Crew	50	days	$4,285	$214,247		
6.00		CANAL & AWS SCREENS & CHANNELS	1	ls	$14,411,886	$14,411,886		$25,502,000
6.01		Demolition	1	ls	$52,490	$52,490		$93,000
6.01.01	P	Demolition - Structural	260	cys	$161	$41,778	Both sides of existing canal including fish screens	
6.01.02	P	Demolition - Mechanical	1	ls	$10,712	$10,712		
6.02		Excavation & Backfill	1	ls	$433,099	$433,099		$766,000
6.02.01	P	Slope Excavation & Cut (Common, Access Ramp)	4,800	cys	$16	$77,129	Remove from south of existing canal gates and store	
6.02.02	P	Slope Excavation & Access Fill	4,800	cys	$16	$77,129	Bring back fill and compact against new wall & re-shape access road	
6.02.03	P	Excavation (Common, North of Screens)	2,380	cys	$16	$38,243	Dirt and previous backfill	
6.02.04	P	Excavation (Common, South of Screens)	6,630	cys	$16	$106,534		
6.02.05	P	Excavation (Rock)	-	cys	$27	$0		
6.02.06	P	Backfill Structural	2,503	cys	$54	$134,065		
6.03		CIP Concrete	1	ls	$2,784,221	$2,784,221		$4,927,000
6.03.01		Canal Screens	1	ls	$1,675,308			
.03.01.01	P	*Canal Gate Headwall*	*120*	*cys*	*$1,071*	*$128,548*		
.03.01.02	P	*Canal Gate Slab*	*617*	*cys*	*$779*	*$480,511*		
.03.01.03	P	*Slab-On-Grade*	*361*	*cys*	*$779*	*$281,142*	Additional slab added to existing slab, includes Fin Screen	
.03.01.04	P	*Walls*	*86*	*cys*	*$1,285*	*$110,551*	from canal gates to head gates both sides, includes Fin Screen	
.03.01.05	P	*Canal Sill*	*19*	*cys*	*$1,607*	*$30,530*		
.03.01.06	P	*Pillars*	*11*	*cys*	*$1,285*	*$14,140*		
.03.01.07	P	*Canal Gate Walls*	*490*	*cys*	*$1,285*	*$629,885*		
6.03.02		AWS Screens	1	ls	$489,998			
.03.02.01	P	*Slab-On-Grade*	*245*	*cys*	*$779*	*$190,803*	, includes Fin Screen	
.03.02.02	P	*Walls*	*194*	*cys*	*$1,285*	*$249,383*	, includes Fin Screen	
.03.02.03	P	*AWS Sill*	*22*	*cys*	*$1,607*	*$35,351*		
.03.02.04	P	*Pillars*	*9*	*cys*	*$1,607*	*$14,462*		
6.03.03		Trap Building	1	ls	$385,644			
.03.03.01	P	*Slab-On-Grade*	*600*	*cys*	*$643*	*$385,644*		
6.03.04		Headgates and Canal	1	ls	$233,272			
.03.04.01	P	*Walls*	*118*	*cys*	*$779*	*$91,922*		
.03.04.02	P	*Slab-On-Grade*	*110*	*cys*	*$1,285*	*$141,350*		

United Water Conservation District (UWCD)
Vern Freeman Diversion Dam, Vertical Slot Fish Ladder Study
Left Bank Fish Ladder and Expanded Juvenile Screens
(<20% Predesign, HBOD Report 12/6/19)

Opinion of Probable Construction Costs (OPCC)

Currency: USD-United States-2019 Dollar

					Estimated Point Value:	**$57,000,000**		
					Estimated Market Range:	**$43M-$71M**		
					Mid Point Market Range:	**$57M**		
6.04		**Structural Metals**	**1**	**ls**	**$1,475,270**	**$1,475,270**		$2,610,000
6.04.01		**Canal Screens**	**1**	**ls**	**$867,002**	**$867,002**		
.04.01.01	*P*	*Grating & Supports*	*6,300*	*sf*	*$99*	*$620,887*	Grating deck including supports between piers on the fish screen	
.04.01.02	*P*	*Handrail/Guardrail*	*1,575*	*lf*	*$139*	*$219,335*		
.04.01.03	*P*	*Miscellaneous Metals Guides/Embeds*	*1*	*ls*	*$26,781*	*$26,781*		
6.04.02		**AWS Screens**	**1**	**ls**	**$608,267**	**$608,267**		
.04.02.01	*P*	*Grating & Supports*	*4,360*	*sf*	*$99*	*$429,693*		
.04.02.02	*P*	*Handrail/Guardrail*	*1,090*	*lf*	*$139*	*$151,794*		
.04.02.03	*P*	*Miscellaneous Metals Guides/Embeds*	*1*	*ls*	*$26,781*	*$26,781*		
6.05		**Mechanical**	**1**	**ls**	**$9,145,544**	**$9,145,544**		$16,183,000
6.05.01		**Canal Screens**	**1**	**ls**	**$3,746,155**			
.05.01.01	*P*	*Primary Canal Fish Screen Material and Headwalls*	*2,250*	*sf*	*$375*	*$843,596*		
.05.01.02	*P*	*Secondary Canal Fish Screen Material and Headwalls*	*110*	*sf*	*$375*	*$41,242*		
.05.01.03	*P*	*Finishing Screen Material and Headwall Framing*	*55*	*sf*	*$375*	*$20,621*		
.05.01.04	*P*	*Canal Primary Screen Brush Cleaning System*	*2*	*ea*	*$267,808*	*$535,616*		
.05.01.05	*P*	*Canal Secondary Screen Brush Cleaning System*	*1*	*ea*	*$160,685*	*$160,685*		
.05.01.06	*P*	*Canal Weir Gate & Ramp*	*1*	*ea*	*$48,205*	*$48,205*		
.05.01.07	*P*	*Canal Screen Bypass 36" Reducer Pipe Transition*	*1*	*ea*	*$5,356*	*$5,356*		
.05.01.08	*P*	*Fish Bypass Pipe (24" HDPE or WSP)*	*200*	*lf*	*$214*	*$42,849*	Includes 90° sweeping bend & 70° sweeping bend	
.05.01.09	*P*	*90" Spiral weld Steel AWS Pipe*	*160*	*lf*	*$771*	*$123,406*		
.05.01.10	*P*	*Sediment Drain and Fin Screen Drain (24" WSP)*	*144*	*lf*	*$214*	*$30,852*		
.05.01.11	*P*	*Screened Water Return, Common Pipe(30" WSP)*	*240*	*lf*	*$236*	*$56,561*		
.05.01.12	*P*	*Screened Water Return, Valves(24",30",Tideflex-30")*	*3*	*ea*	*$26,781*	*$80,342*	buried worm gear actuator	
.05.01.13	*P*	*Canal Sediment Re-Suspension & Secondary Piping*	*1*	*ls*	*$64,274*	*$64,274*	1000lf 4" emb. pipe, 90° elbow, 200ea nozzles, 6ea 4" act. butterfly valves	
.05.01.14	*P*	*Canal Sediment Re-Suspension & Secondary Pumps*	*1*	*ls*	*$160,685*	*$160,685*	2 vertical 75hp turbine pumps	
.05.01.15	*P*	*Canal Gates (3-new 9x8)*	*216*	*v*	*$4,017*	*$867,699*	Additional Canal gates	
.05.01.16	*P*	*Headgates (2-new 9*8)*	*144*	*v*	*$4,017*	*$578,466*	New headgates	
.05.01.17	*P*	*Installation Crew*	*20*	*days*	*$4,285*	*$85,699*		
6.05.02		**AWS Screens**	**1**	**ls**	**$2,571,334**			
.05.02.01	*P*	*Primary AWS Fish Screen Material and Headwalls*	*1,680*	*sf*	*$375*	*$629,885*		
.05.02.02	*P*	*Secondary AWS Fish Screen Material and Headwalls*	*110*	*sf*	*$375*	*$41,242*		
.05.02.03	*P*	*Finishing Screen Material and Headwall Framing*	*55*	*sf*	*$375*	*$20,621*		
.05.02.04	*P*	*Brush Cleaning System Primary Screens*	*2*	*ea*	*$267,808*	*$535,616*		
.05.02.05	*P*	*Back Spray Cleaning System Secondary Screens*	*2*	*ea*	*$160,685*	*$321,370*		
.05.02.06	*P*	*AWS Weir Gate & Ramp*	*1*	*ea*	*$48,205*	*$48,205*		
.05.02.07	*P*	*AWS Screen Bypass 36" Reducer Pipe Transition*	*1*	*ea*	*$5,356*	*$5,356*		
.05.02.08	*P*	*Fish Bypass Pipe (24" HDPE or WSP)*	*98*	*lf*	*$214*	*$20,996*	Finish Screen plus Eval Building outlet	
.05.02.09	*P*	*Sediment Drain and Fin Screen Drain (24" WSP)*	*150*	*lf*	*$214*	*$32,137*		
.05.02.10	*P*	*Screened Water Return, Valves(24" ecc plug)*	*1*	*ea*	*$26,781*	*$26,781*	buried worm gear actuator	
.05.02.11	*P*	*AWS Sediment Resuspension System Piping*	*1*	*ls*	*$64,274*	*$64,274*	1000lf 4" emb. pipe, 90° elbow, 200ea nozzles, 6ea 4" act. butterfly valves	
.05.02.12	*P*	*AWS Sediment Resuspension System Pumps*	*1*	*ls*	*$160,685*	*$160,685*	2 vertical 75hp turbine pumps	
.05.02.13	*P*	*AWS Gates (2-new 9x8)*	*144*	*v*	*$4,017*	*$578,466*	Additional AWS gates	
.05.02.14	*P*	*Installation Crew*	*20*	*days*	*$4,285*	*$85,699*		
6.05.03	**P**	**Trash Rack Replacement**	**12**	**ea**	**$160,685**	**$1,928,219**		
6.05.04		**Trap Holding Pond**	**1**	**ls**	**$899,836**			
.05.04.01	*P*	*Trap Holding Pond Swing Gates*	-	*ea*	*$82,780*	*$0*	Removed from Eval Building, now in Finish Scrn	
.05.04.02	*P*	*Trap Holding Pond Belt Screens*	*2*	*ea*	*$80,342*	*$160,685*		
.05.04.03	*P*	*Trap Holding Pond Crowder (hand)*	*2*	*ea*	*$10,712*	*$21,425*		
.05.04.04	*P*	*Trap Holding Pond Size Sorting Panels*	*2*	*ls*	*$10,712*	*$21,425*		
.05.04.05	*P*	*Trap Hoppers/Brail*	*2*	*ea*	*$42,849*	*$85,699*		
.05.04.06	*P*	*Trap Building Hoist System (davit, elec)*	*2*	*ls*	*$26,781*	*$53,562*		
.05.04.07	*P*	*Loose Tanks, anesthetic, Tables*	*1*	*ls*	*$42,849*	*$42,849*		
.05.04.08	*P*	*Sed System-Pumps*	*2*	*ea*	*$80,342*	*$160,685*		
.05.04.09	*P*	*Sed System-Pipe, Valves, Nozzles, System*	*1*	*ls*	*$267,808*	*$267,808*		
.05.04.10	*P*	*Installation Crew*	*20*	*days*	*$4,285*	*$85,699*		
6.06		**Miscellaneous**	**1**	**ls**	**$521,262**	**$521,262**		$922,000
6.06.01	**S**	**Evaluation Station**	**600**	**sf**	**$268**	**$160,685**	20'x30'	
6.06.02	**S**	**Remove Control Building**	**1**	**ea**	**$12,855**	**$12,855**	existing 20'x30'	
6.06.03	**S**	**Build New Control Building**	**600**	**sf**	**$348**	**$208,890**	20'x30', cmu wall w/ wall and roof insulation	
6.06.04	**S**	**Remove Storage Building**	**1**	**ea**	**$10,284**	**$10,284**	20x24=480 sf (exist ~300sf), no domestic water/sewer	
6.06.05	**S**	**Build New Storage Building**	**480**	**sf**	**$268**	**$128,548**	20x24=480 sf (exist ~300sf), no domestic water/sewer	
7.00		**ELECTRICAL & I&C**	**1**	**ls**	**$3,403,398**	**$3,403,398**		**$6,022,000**
7.01	**S**	**Temporary Power and Control Relocate**	**1**	**ls**	**$53,562**	**$53,562**		
7.02	**S**	**500kW Genset**	**1**	**ea**	**$214,247**	**$214,247**		
7.03	**S**	**Electrical/Instrumentation Installation**	**1**	**ls**	**$3,135,590**	**$3,135,590**	25% Mechanical Items	
8.00		**ANCILLARY SUPPORT FACILITIES**	**1**	**ls**	**$0**	**$0**		**$0**
8.01	**S**	**TBD**	**1**	**ls**	**$0**	**$0**	allowance	$0
					Running Subtotal:	**$32,181,692**		

tec Consulting
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12/6/2019

United Water Conservation District (UWCD)
Vern Freeman Diversion Dam, Vertical Slot Fish Ladder Study
Left Bank Fish Ladder and Expanded Juvenile Screens
(<20% Predesign, HBOD Report 12/6/19)

Opinion of Probable Construction Costs (OPCC)

Currency: USD-United States-2019 Dollar

					Estimated Point Value:	**$57,000,000**		
					Estimated Market Range:	**$43M-$71M**		
					Mid Point Market Range:	**$57M**		
A		**Startup/Commission/Owner Training**	1	ls		**$160,908**		
1	P	Pre-Commissioning	1,073	hrs	$150	**$160,908**		
2	S	Vendor Support	-	ls	$0	**$0**	Covered above	
3	P	Final Commissioning	-	hrs	$150	**$0**	Covered above	
4	P	Owner Training	-	hrs	$100	**$0**	Covered above	
5	P	Startup Expendables	-	ls	$0	**$0**	Covered above	
6		Spare Parts	-	ls	$0	**$0**	Covered above	
					Running Subtotal:	**$32,342,600**		
B		**Construction Allowances**	1	ls		**$241,363**		
1	P	Submittals/Procurement/POs/Resource Coordination	1	ls	$0	**$0**	Covered below	
2	S	Establish Survey Controls	1	ls	$0	**$0**	Covered below	
3	S	Alignment Layout Survey/Final As-Builts	-	hr	$325	**$0**	Covered below	
4	P	Initial Equipment Mobilization	1	lds	$0	**$0**	Covered above	
5	P	Initial Labor Mobilization	1	ls	$0	**$0**	Covered above	
1	P	Contractor Quality Control	1	ls	$241,363	**$241,363**	at 0.75%	
5	P	Crew / Mgt Perdiems	1	ls	$0	**$0**	Excluded	
					Running Subtotal:	**$32,583,963**		
			Markup Factor	1.0125				
6	P	**Estimating Accuracy, Unlisted Items Allowance**	1	ls	5.0%	**$1,629,198**	to offset estimating methodology on provided scope	
7	P	**Allowance for Scope Growth**	1	ls	5.0%	**$1,629,198**	to offset new undefined new scope	
8	P	**Allowance for Constructability**	1	ls	1.0%	**$325,840**	to offset undefined constructability issues	
					Running Subtotal:	**$36,168,199**	Direct Construction Costs (DCC)	
			Markup Factor	1.1239				
C		**Contractor Markups/Indirect Costs**	1	ls		**$13,349,631**		
1		Prime Contractor General Conditions	1	ls	10.0%	**$2,927,598**		
2		Subcontractor General Conditions	1	ls	10.0%	**$689,300**		
3		Market Factor (current market conditions are considered competitive)	1	ls	5.0%	**$1,989,255**	Premium for uncompetitive conditions, complexity, etc.	
4		Escalation	1	ls	0.0%	**$0**	excluded	
5		Construction Phasing Factor (sgl mob, uninterrupted execution)	1	ls	0.0%	**$0**	Premium for stages, interface constraints, etc.	
6		Subcontractor Overheads & Markups	1	ls	15%	**$1,033,832**	H/O Overheads, Job Fee & Risk	
7		Prime Contractor OH&P on Subs	1	ls	6.5%	**$447,994**	Oversight + Risk on Subs	
8		Prime Contractor OH&P on Self-Perform	1	ls	10.0%	**$4,325,618**	Job Fee + Risk	
9		Contractor Insurance Program	1	ls	2.5%	**$731,900**	Performance/Payments Bonds, Genl Liability	
10		Subcontractor Bonding	1	ls	1.5%	**$103,383**	Reference Activity Summary for subtotal	
11		State Sales Taxes (CA)	1	ls	8.50%	**$1,076,004**		
12		Contractor Furnished Permits	1	ls	0.25%	**$24,747**	covered above	
					Running Subtotal:	**$49,517,830**	Base Construction Cost (BCC)	
13		Design Scope Market Contingency	1	ls	15.00%	**$7,427,674**	on running subtotal, unknowns	
					Running Subtotal:	**$56,945,504**	Total Field Cost	***$56,945,000***
				Cost Range:	**$43,000,000**	**$71,000,000**		
			Markup Factor	1.7695				
D		**Owner Project Allowances**				**$0**		***$0***
1		Sunk Costs - All	1	ls		**$0**	Excluded	
2		Construction Change Contingency	1	ls	0.0%	**$0**	Excluded	
3		Contractor Provide Resident Engineer's Field Office	-	mos	$3,500	**$0**	Excluded	
4		Land Purchase - Property Value	-	ac	$0	**$0**	Excluded	
5		Land Purchase - Condemnation Process	1	ls	$0	**$0**	Excluded	
6		Management Reserve	1	ls	0.0%	**$0**	Excluded	
			Markup Factor	1.7695				TPC
						$56,946,000	Total Project Costs (TPC)	***$56,945,000***
				Cost Range:	**$43,000,000**	**$71,000,000**	AACE Criteria	

Assumes the scope is not changed, significant risk events do not occur and project control is excellent.

Notes/Exclusions:

1) Cost estimating team has visited the project site.
2) Any addendum issued to contractors were not available at time of this cost estimate's development.
3) Cost estimate is based on quoted costs for some equipment.
4) Preliminary construction field schedule under development
5) Market Assumption: Desirable local project that should generate contractor interest. (Expecting at least five responsible bidders).
6) Clients are urged to budget towards the high range value pending the final design cost estimate. Suggested construction budget provided above.
7) This OPPC is not intended to be a predictor of lowest bid. Rather the intent is to represent fair market value assuming competitive conditions.
8) Wage decision = CA Prevailing
9) Undefined environmental mitigations/landscaping and slope stability items are excluded.
10) Work areas assumed to be available from 6am to 6pm M-F without constraint to the contractor.
11) P=Prime, S=Subcontractor
12) Unknown outside third party special inspections not included.
13) No escalation included.
14) Pricing assumes competitive market conditions at time of tender (+4 bidders/trade).
15) Assumed contracting strategy: design-bid-build
16) This OPPC is classified as a Class 4 cost estimate per AACE guidelines. Stated accuracy range = -25% to + 25%
17) Pricing level is Q2 2019

C Disclaimer

ec has no control over the costs of labor, materials, competitive bidding environments, unidentified field conditions, financial and/or commodity market conditions, or any other factors likely to affect the OPPC of this project, all of which are and will unavoidably remain in a state of change, especially in light of high market volatility attributable to Acts of God other market forces or events beyond the control of the parties. As such, Client recognizes that this OPPC deliverable is based on normal market conditions, defined by stable resource supply/demand relationships, and does not account for extreme inflationary or deflationary market cycles. Client further acknowledges that this OPPC is a "snapshot in time" hat the reliability of this OPPC will degrade over time. Client agrees that Stantec cannot and does not make any warranty, promise, guarantee or representation, either express or implied that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from Stantec's good faith **CLASS 4 OPPC**

E International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all s 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an opriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

Appendix B DRAWINGS

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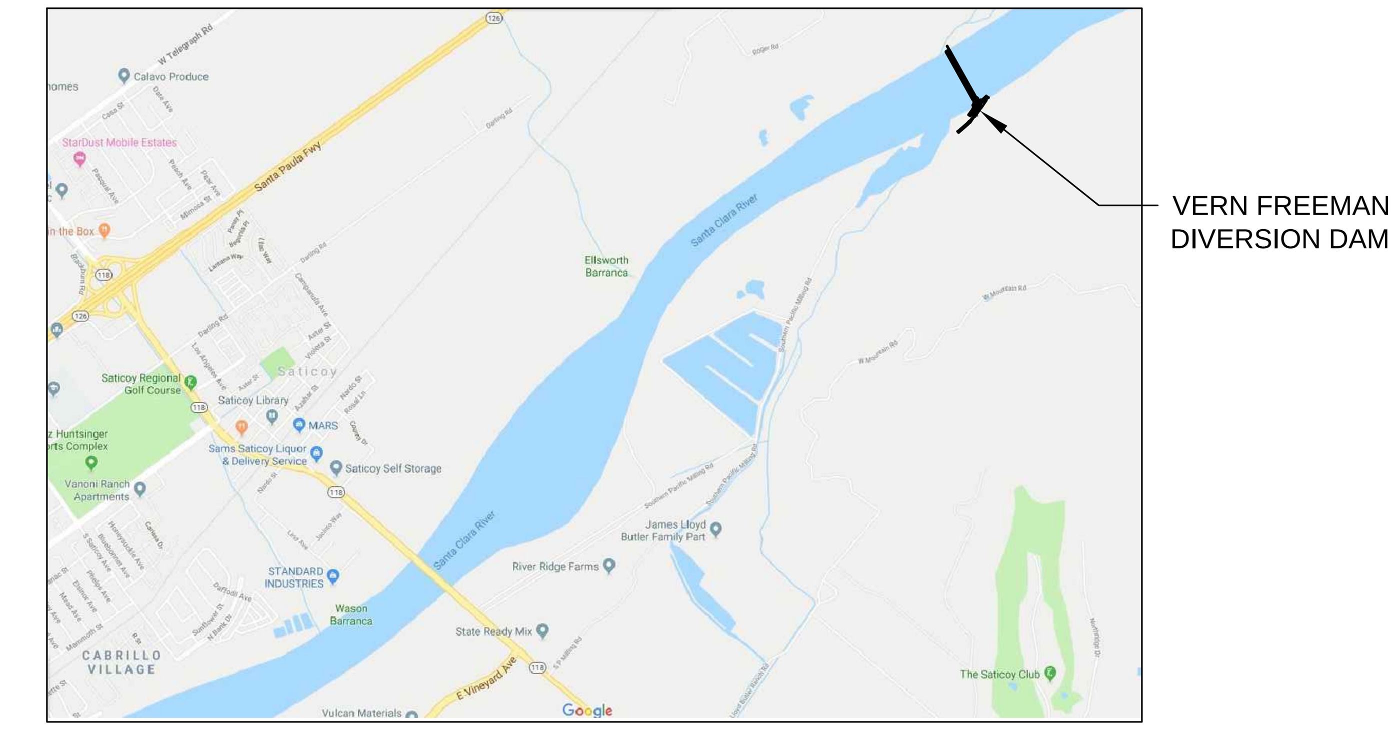
LOCATION MAP



VICINITY MAP

VERN FREEMAN DAM VERTICAL SLOT FISH LADDER

SHEET	DRAWING NO.	TITLE
1	G-1	COVER SHEET
2	G-2	EXISTING SITE PLAN
3	G-3	HYDRAULIC PLAN, PROFILE AND DESIGN CRITERIA - FISH LADDER
4	G-4	HYDRAULIC PLAN, PROFILE AND DESIGN CRITERIA - SCREEN AND BYPASS
5	C-1	SITE PLAN
6	C-2	YARD PIPING PLAN
7	C-3	CIVIL SECTION
8	1S-1	CREST GATE AND STILLING BASIN PLAN
9	1S-2	CREST GATE AND STILLING BASIN SECTION
10	2S-1	NORTH FISH LADDER ENTRANCE TOP PLAN AND SECTION
11	2S-2	FISH LADDER TRANSPORT TUNNEL TOP PLAN AND SECTION
12	2S-3	SOUTH FISH LADDER ENTRANCE TOP PLAN AND SECTION
13	2S-4	FISH LADDER MIDDLE TOP PLAN AND SECTION
14	2S-5	FISH LADDER EXIT TOP PLAN AND SECTION
15	3S-1	FISH SCREEN KEY PLAN AND CONTROL
16	3S-2	EVALUATION STATION PLAN
17	4S-1	CONTROL BUILDING FLOOR AND FOUNDATION PLANS
18	4S-2	STORAGE BUILDING FLOOR AND FOUNDATION PLANS
19	5S-1	FLUSHING CHANNEL PLAN AND SECTION
20	1M-1	CREST GATE MECHANICAL PLAN
21	2M-1	SOUTH FISH LADDER ENTRANCE MECHANICAL PLAN
22	3M-1	FISH SCREEN MECHANICAL PLAN
23	GE-1	POWER ONE-LINE DIAGRAM
24	GI-1	NETWORK BLOCK DIAGRAM

2019.12.06

PROJECT NUMBER: 224202210

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ORIGINAL SHEET - ANSI D

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-G-2	GJH	GJH	CWS	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
EXISTING SITE PLAN

Project No. 224202210
Scale 1"=20'

Revision
Sheet 2 of 24
Drawing No. G-2

ORIGINAL SHEET - ANSI D

GENERAL SHEET NOTES

1. WSEL'S SHOWN ARE THOSE AT MINIMUM DESIGN RIVER FLOW. WSEL'S IN (...) ARE THOSE AT MAXIMUM DESIGN FLOWS [6,000 CFS] AND A FOREBAY WSEL OF 161.5.

ABBREVIATIONS

INV - INVERT
TW - TOP OF WALL
WSEL - WATER SURFACE ELEVATION

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-G-3 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
HYDRAULIC PLAN, PROFILE AND DESIGN CRITERIA - FISH LADDER

Project No. 224202210
Scale NONE

Revision
Sheet 3 of 24

Drawing No. **G-3**

ORIGINAL SHEET - ANSI D

GENERAL SHEET NOTES

1. WSEL'S SHOWN ARE THOSE AT MINIMUM DESIGN RIVER FLOW. WSEL'S IN (...) ARE THOSE AT MAXIMUM DESIGN FLOWS [6,000 CFS] AND A FOREBAY WSEL OF 161.5.

ABBREVIATIONS

INV	-	INVERT
TW	-	TOP OF WALL
WSEL	-	WATER SURFACE ELEVATION

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-G-4 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
HYDRAULIC PLAN, PROFILE AND DESIGN CRITERIA - SCREEN AND BYPASS

Project No. 224202210
Scale NONE
Revision
Sheet 4 of 24
Drawing No. **G-4**

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Santa Paula, CA

File Name: UWCD VFFR C-1 | GJH Dwn. | GJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
SITE PLAN

Project No. 224202210

Scale 1"=20'

Revision Sheet 5 of 24

Drawing No. **C-1**

ORIGINAL SHEET - ANSI D

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD VFFR C-2	GJJH	GJJH	CWS	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
YARD PIPING PLAN

Project No.	Scale
224202210	1"=20'

Revision	Sheet	Drawing No.
	6 of 24	C-2

A SECTION
C-1
SCALE:1"=6'

Revision	By	Appd	YYYY.MM.DD

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VERTICAL SLOT FISH LADDER

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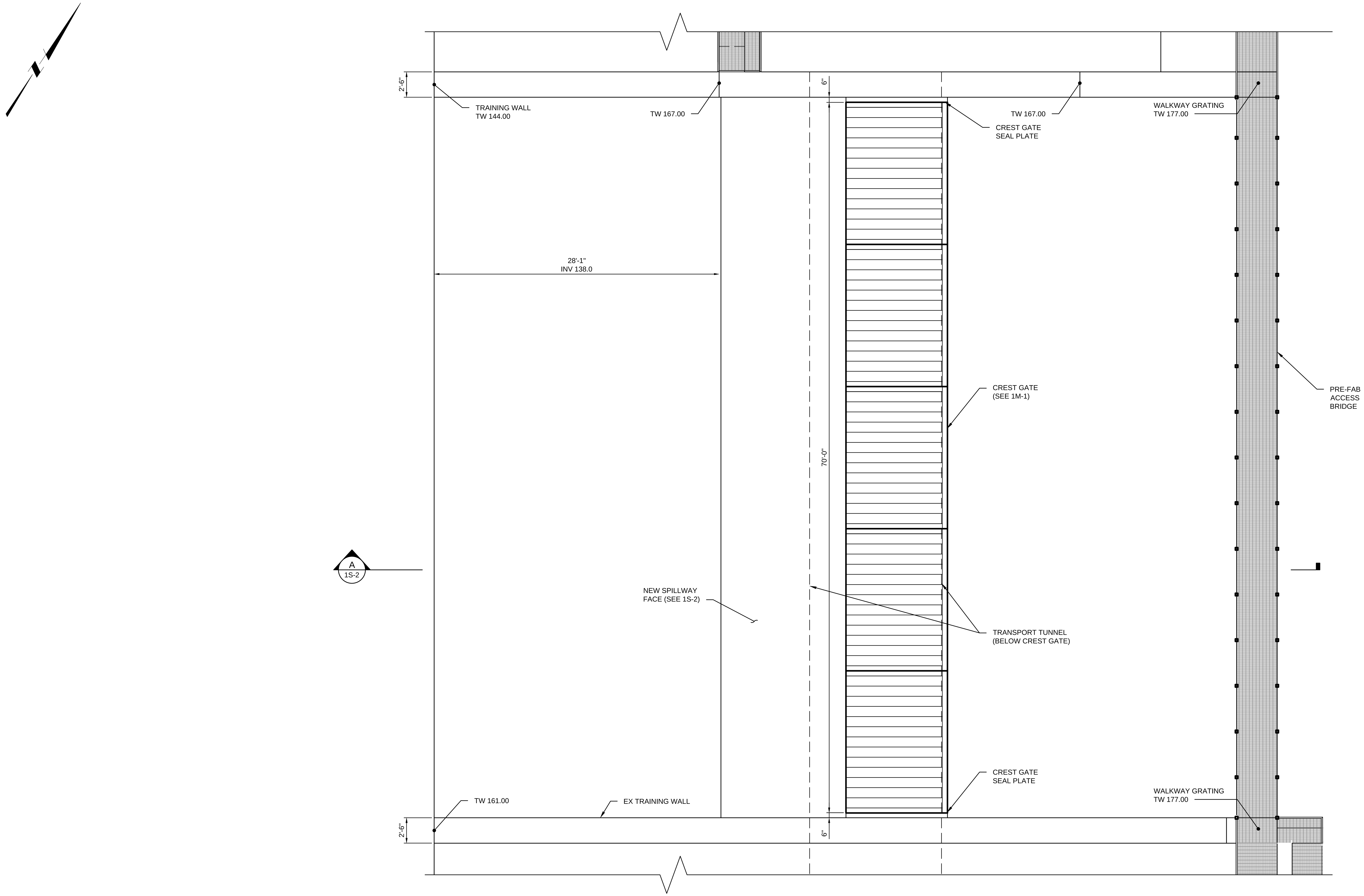
File Name: UWCD VFFR C-3 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
CIVIL SECTION

Project No. 224202210
Scale 1"=6'
Revision
Sheet 7 of 24
Drawing No. **C-3**

ORIGINAL SHEET - ANSI D



CREST GATE AND STILLING BASIN PLAN

SCALE: 3/16"=1'-0"

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VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-1S-1 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
CREST GATE AND STILLING BASIN PLAN

Project No. 224202210

Scale 3/16"=1'-0"

Revision | Sheet 8 of 24

Drawing No. **1S-1**

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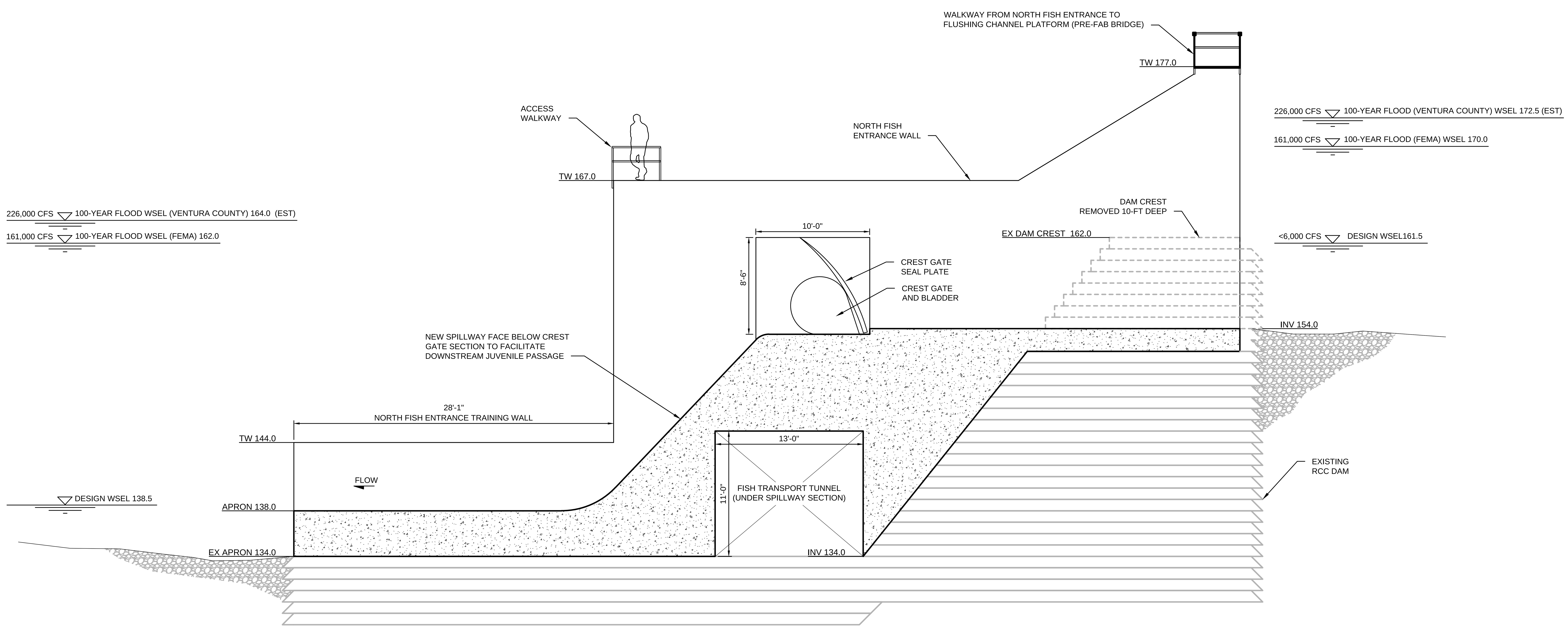

A 1S-1 SECTION
SCALE: 3/16"=1'-0"

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File Name: UWCD-1S-2 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
CREST GATE AND STILLING BASIN SECTION

Project No. 224202210
Scale 3/16"=1'-0"
Revision
Sheet 9 of 24
Drawing No. **1S-2**

ORIGINAL SHEET - ANSI D

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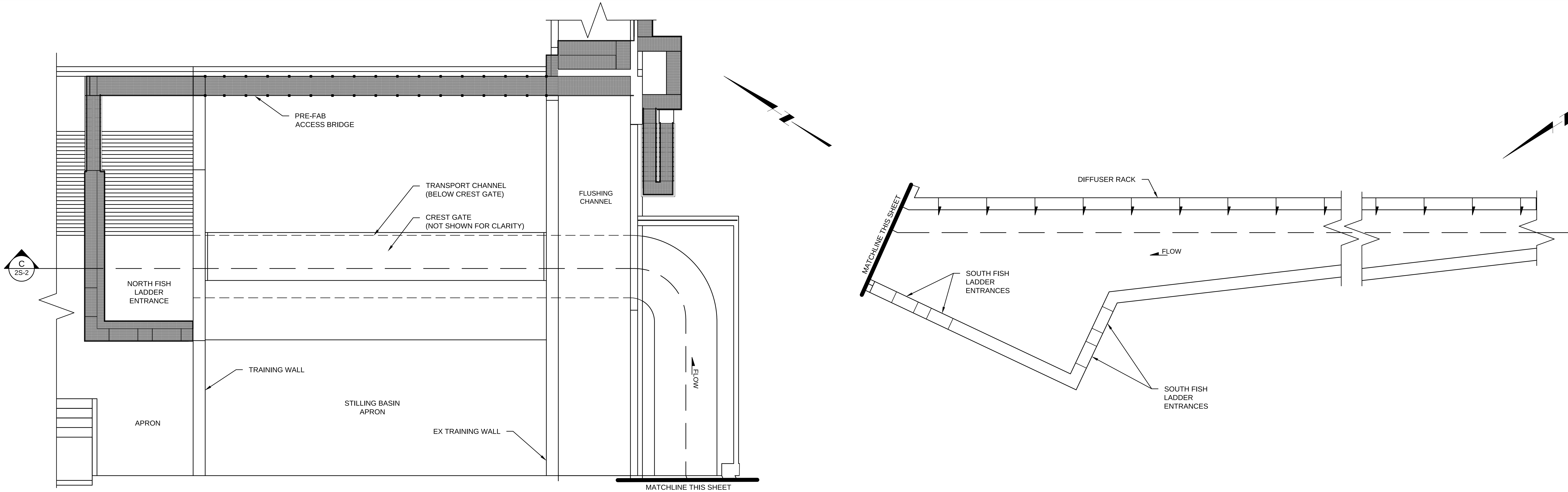
File Name: UWCD-2S-1

GJJH	GJJH	CWS	2019.12.06
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
NORTH FISH LADDER ENTRANCE TOP PLAN AND SECTION

Project No. 224202210
Scale 3/16"=1'-0"
Revision Sheet 10 of 24
Drawing No. **2S-1**



FISH LADDER TRANSPORT TUNNEL TOP PLAN

SCALE: 3/32"=1'-0"

C
2S-2

SECTION

SCALE: 1/8"=1'-0"

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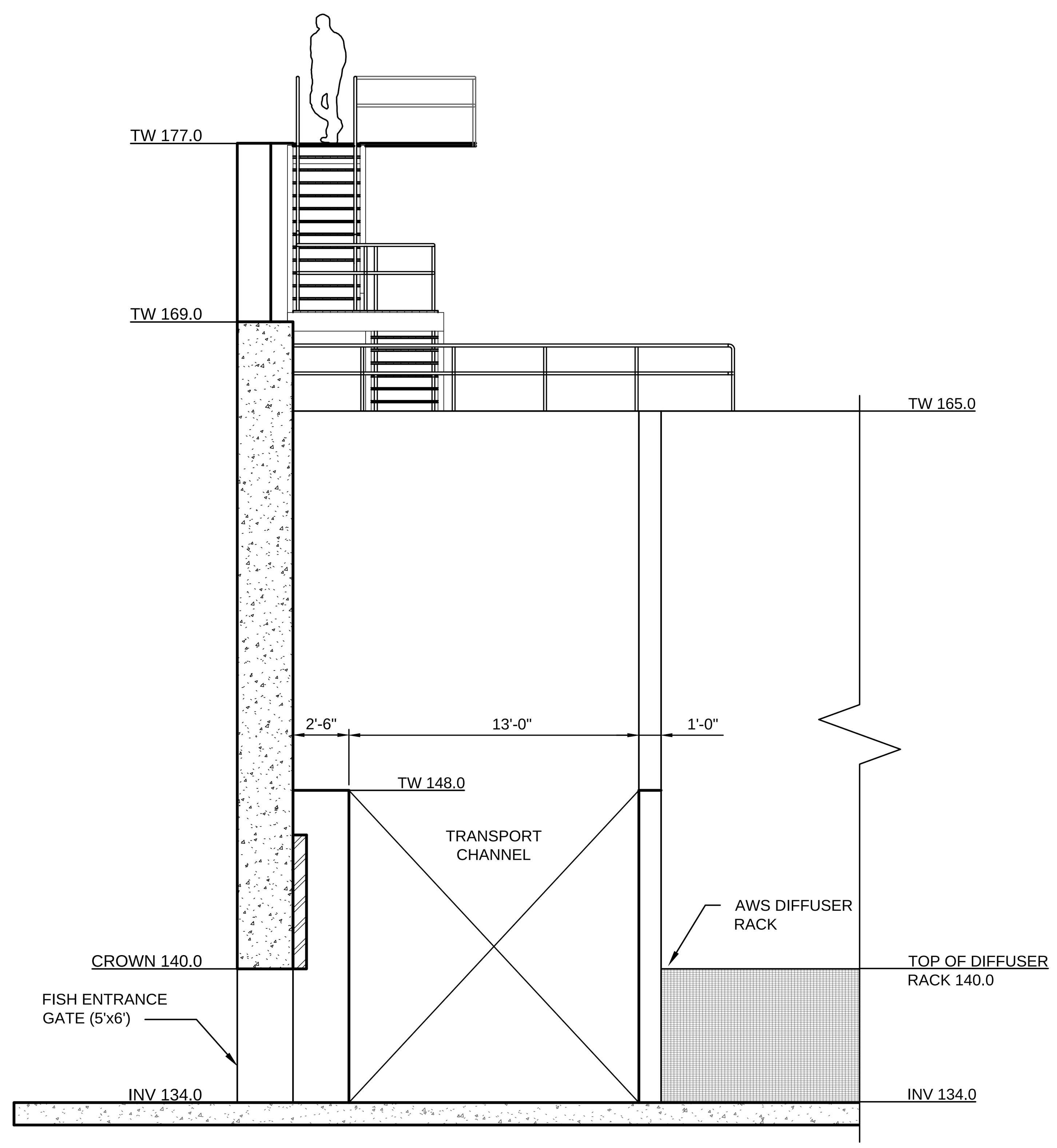
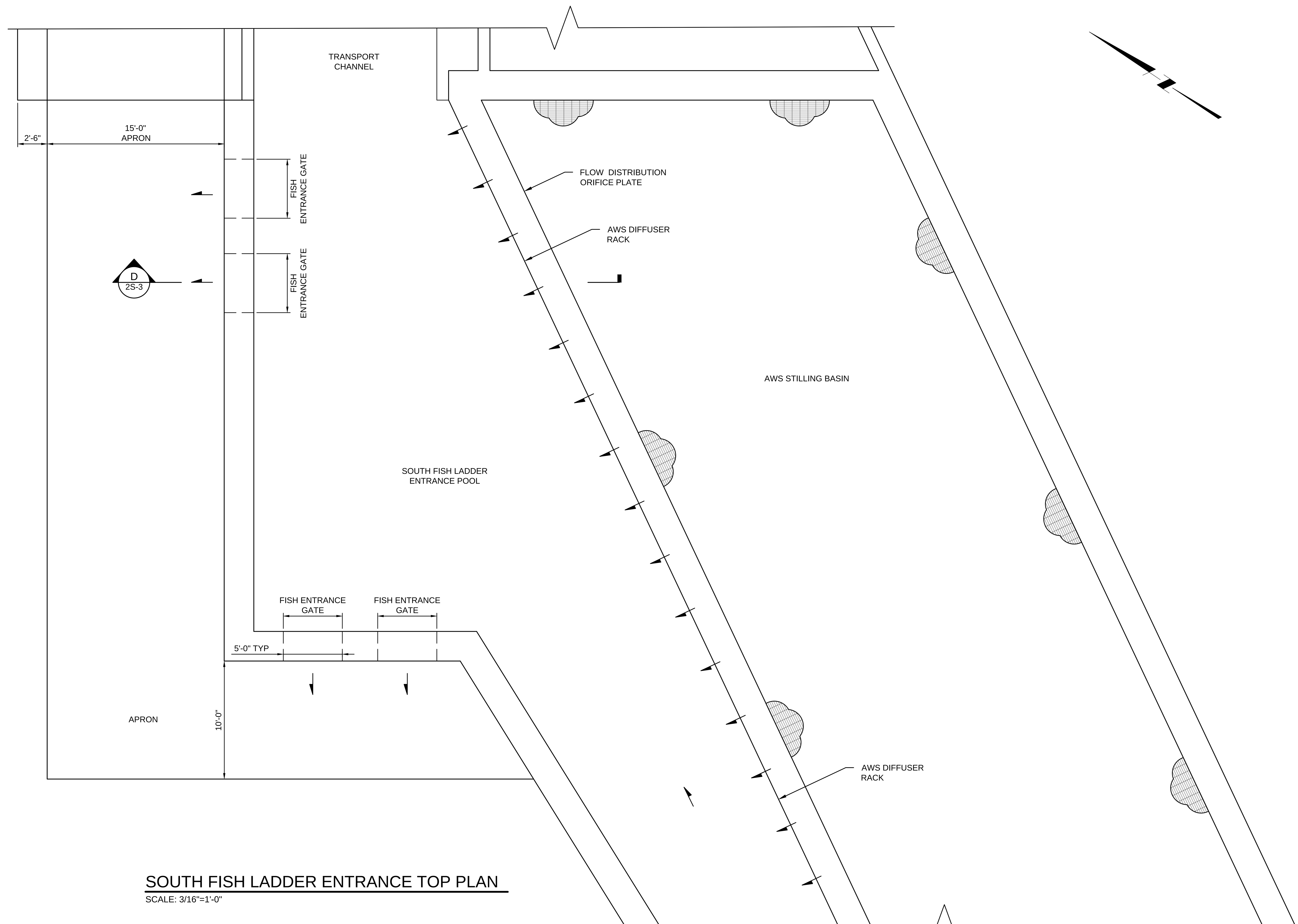
Title
FISH LADDER TRANSPORT TUNNEL
TOP PLAN AND SECTION

Project No. 224202210
Scale VARIES
Revision
Sheet 11 of 24
Drawing No. **2S-2**



D
2S-3
SECTION
SCALE: 3/16"=1'-0"



SOUTH FISH LADDER ENTRANCE TOP PLAN
SCALE: 3/16"=1'-0"

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

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	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
SOUTH FISH LADDER ENTRANCE
TOP PLAN AND SECTION

Project No. 224202210
Scale 3/16"=1'-0"
Revision
Sheet 12 of 24
Drawing No. **2S-3**

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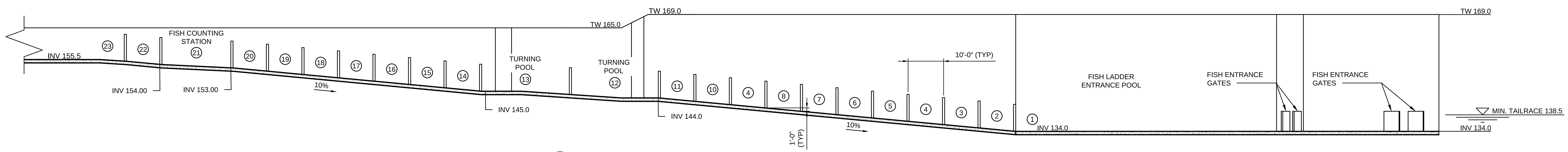

E
2S-4
PROFILE
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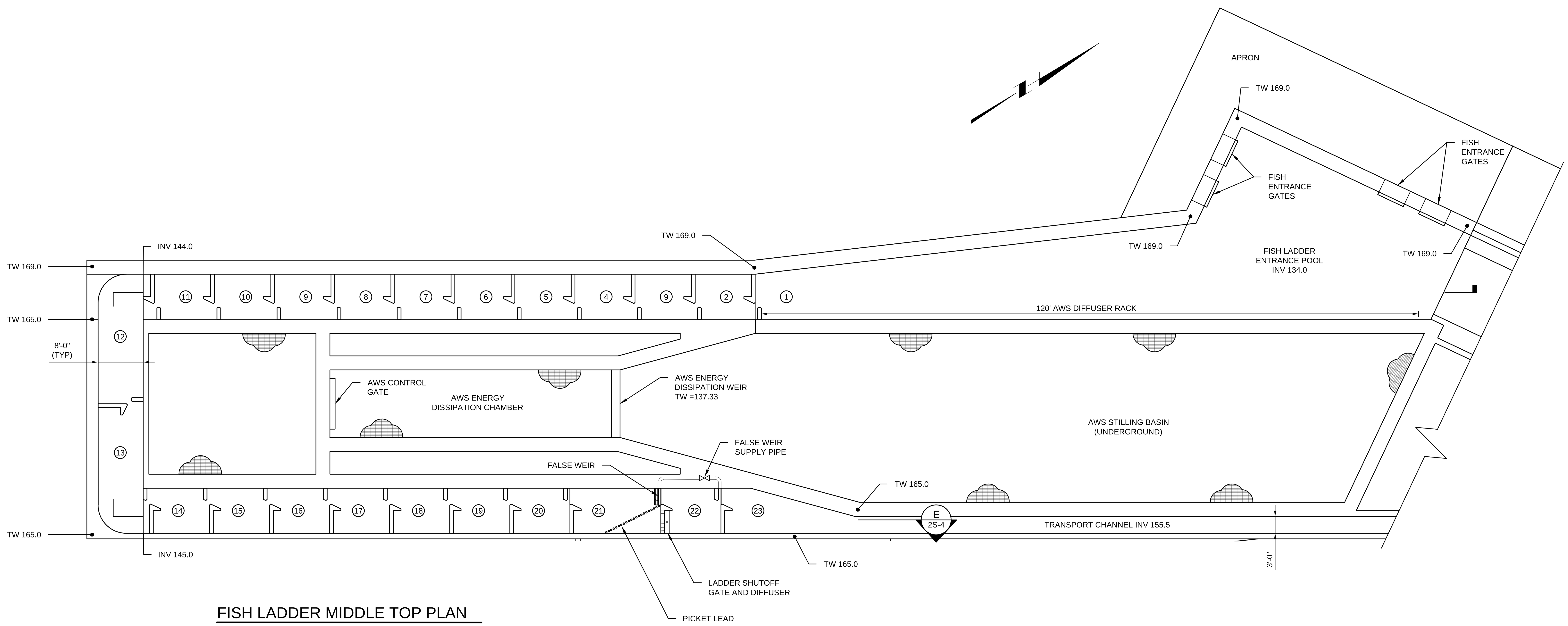

FISH LADDER MIDDLE TOP PLAN
SCALE: 3/32"=1'-0"

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Santa Paula, CA

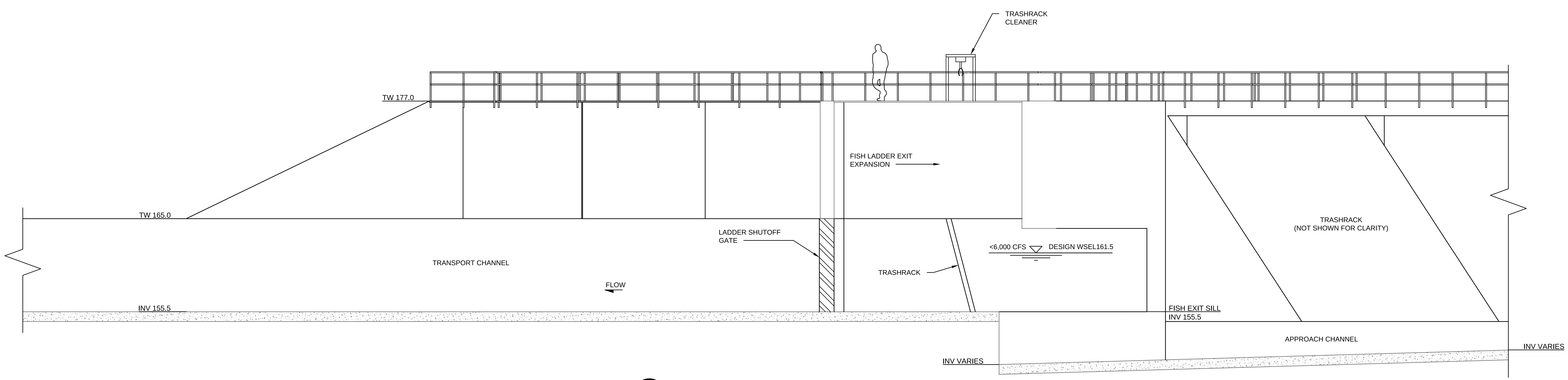
File Name: UWCD-2S-4	DI	GJJH	CWS	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
FISH LADDER MIDDLE TOP PLAN AND SECTION

Project No. 224202210
Scale VARIES
Revision
Sheet 13 of 24
Drawing No. **2S-4**

FISH LADDER EXIT TOP PLAN

SCALE: 3/16"=1'-0"



F 2S-5 SECTION

SCALE: 3/16"=1'-0"

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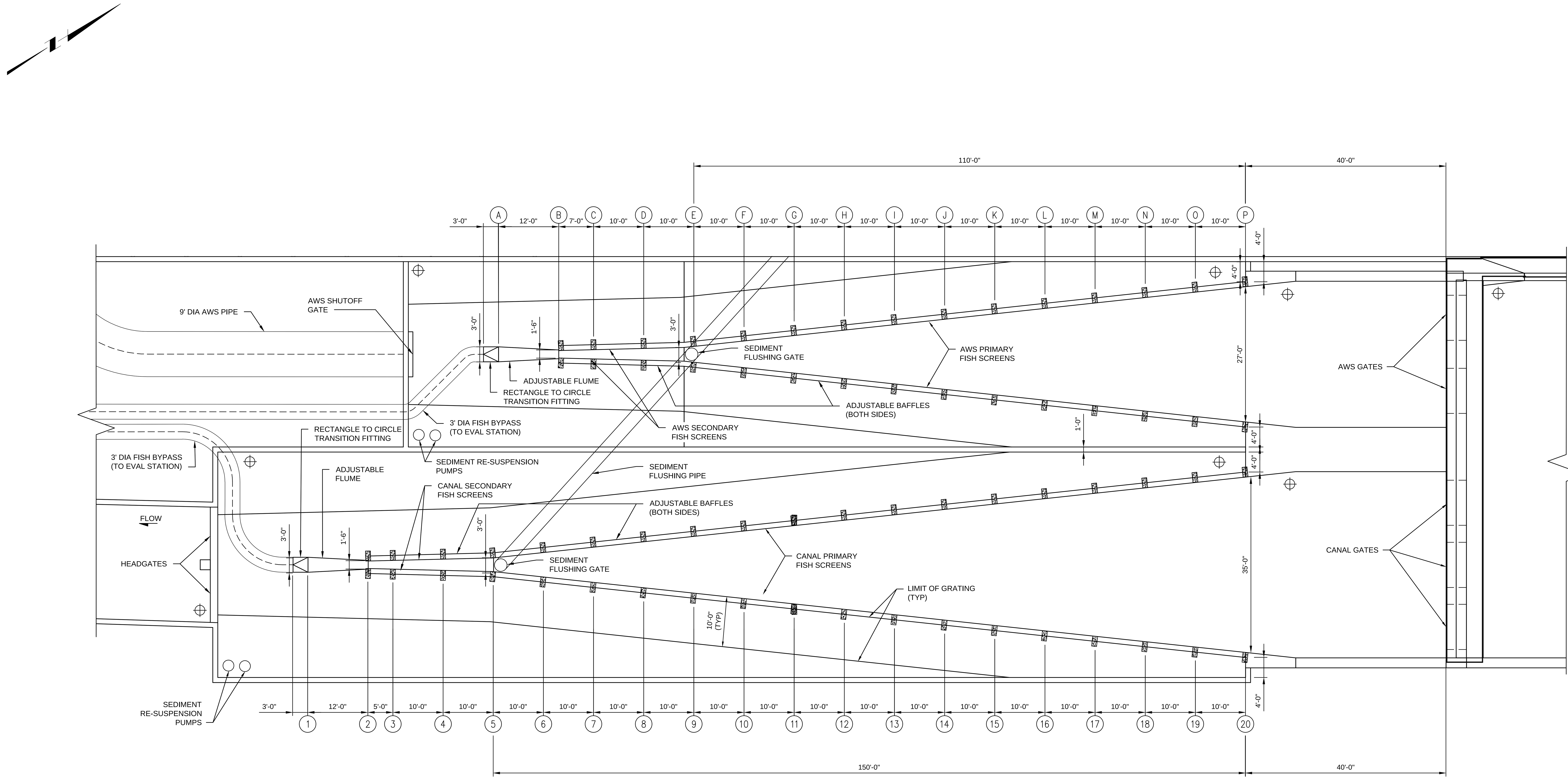
Santa Paula, CA

File Name: UWCD-2S-5	DI	GJJH	CWS	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
FISH LADDER EXIT TOP PLAN AND SECTION

Project No. 224202210
Scale 3/16"=1'-0"
Revision
Sheet 14 of 24
Drawing No. **2S-5**



FISH SCREEN KEY PLAN

SCALE: 3/32"=1'-0"

LEGEND:

⌖ WATER LEVEL SENSOR LOCATIONS

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	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
FISH SCREEN KEY PLAN AND CONTROL

Project No.
224202210

Scale
3/32"=1'-0"

Revision | Sheet
15 of 24

Drawing No.
3S-1

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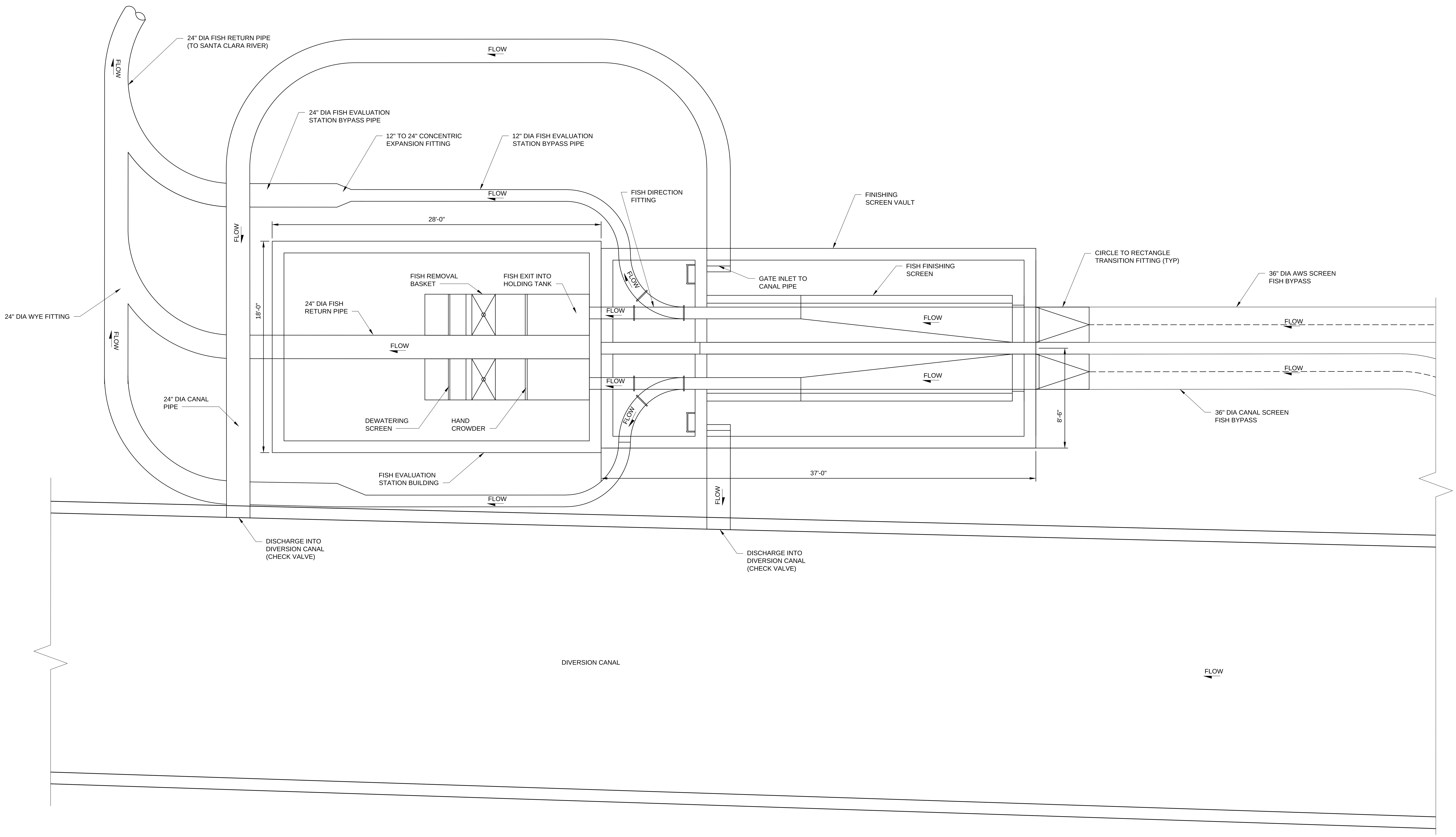

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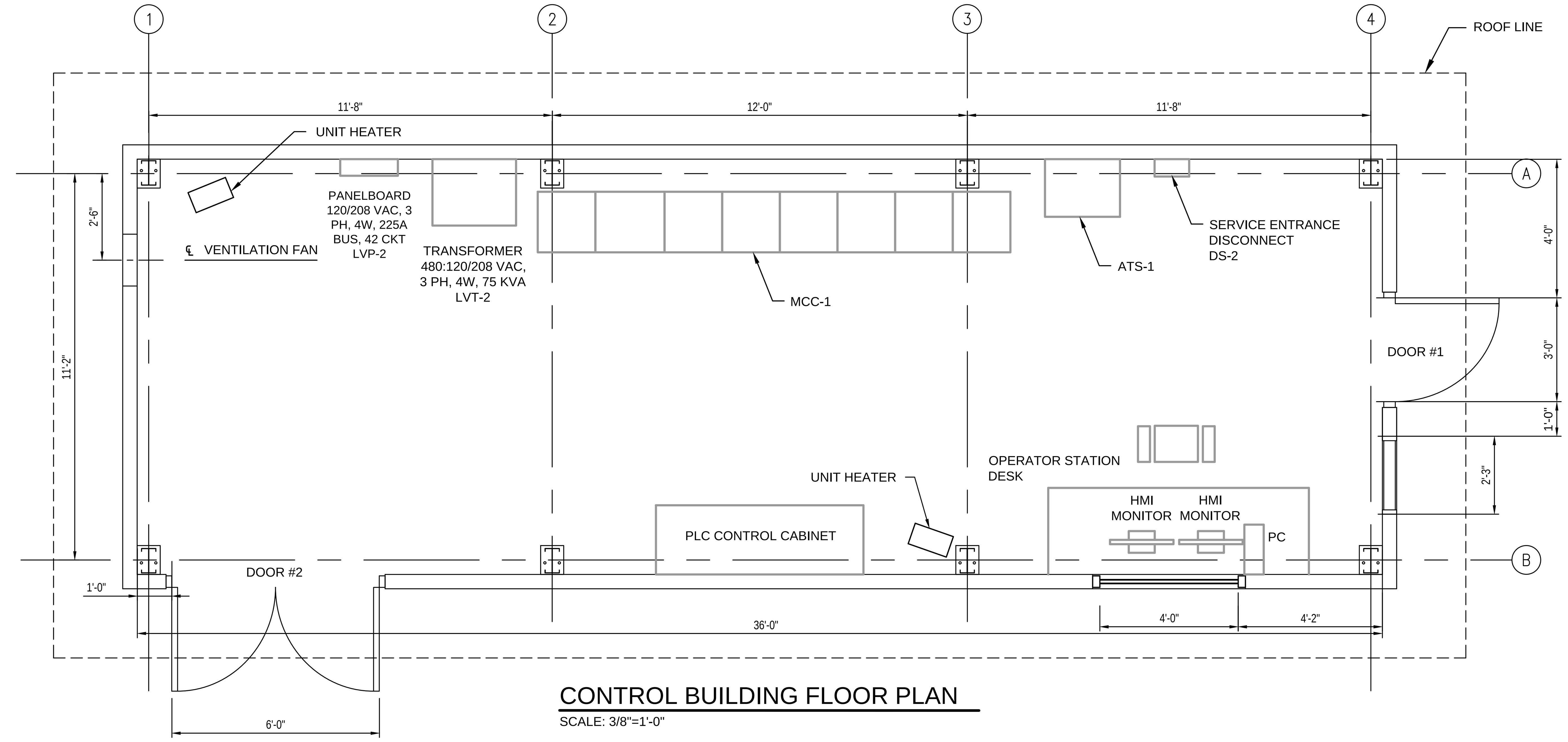
File Name: UWCD-3S-2 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

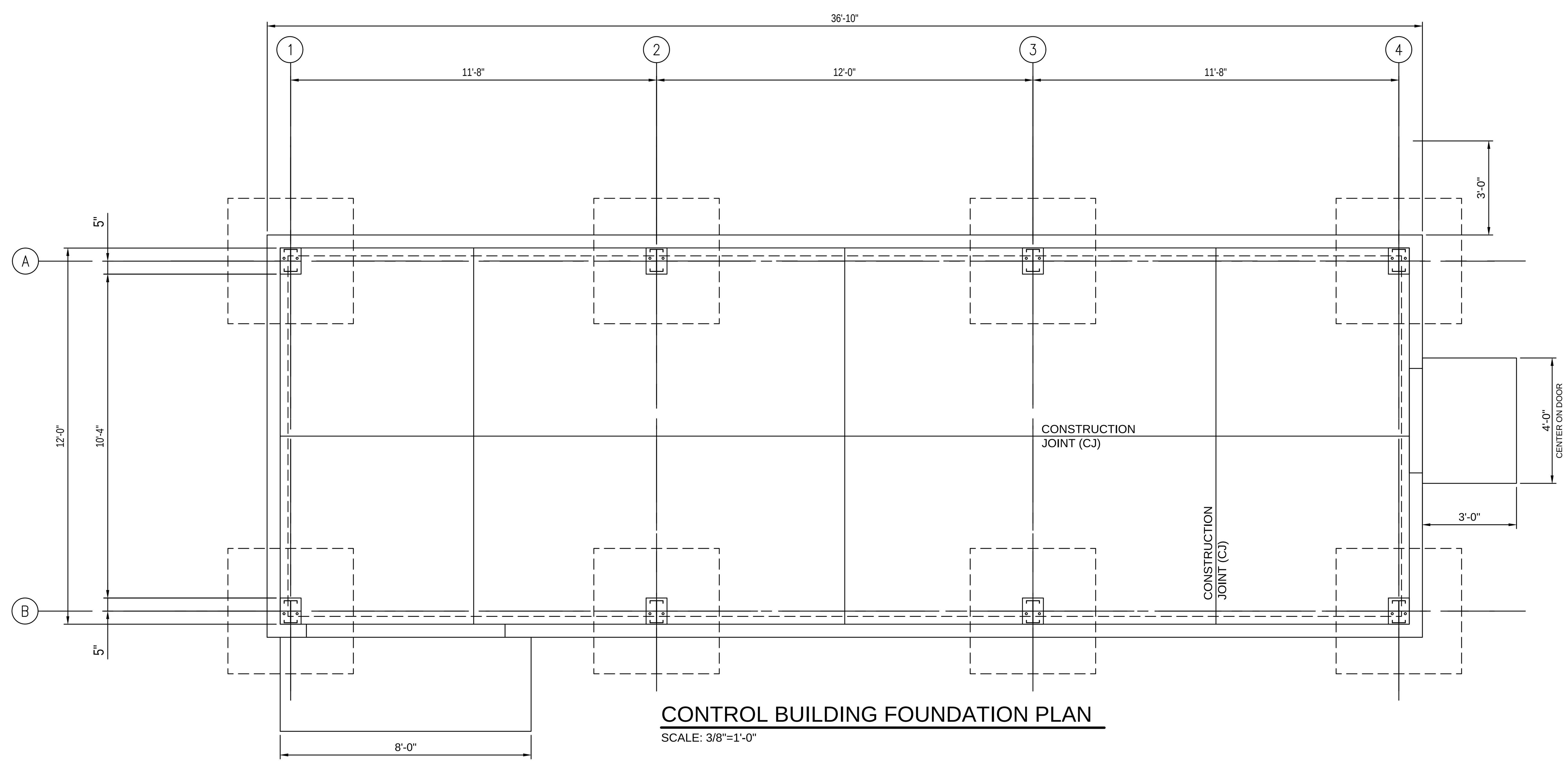
Title
EVALUATION STATION PLAN

Project No. 224202210
Scale 1/4"=1'-0"
Revision
Sheet 16 of 24
Drawing No. **3S-2**



CONTROL BUILDING FLOOR PLAN

SCALE: 3/8"=1'-0"



CONTROL BUILDING FOUNDATION PLAN

SCALE: 3/8"=1'-0"

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Issued | By | Appd | YYYY.MM.DD

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

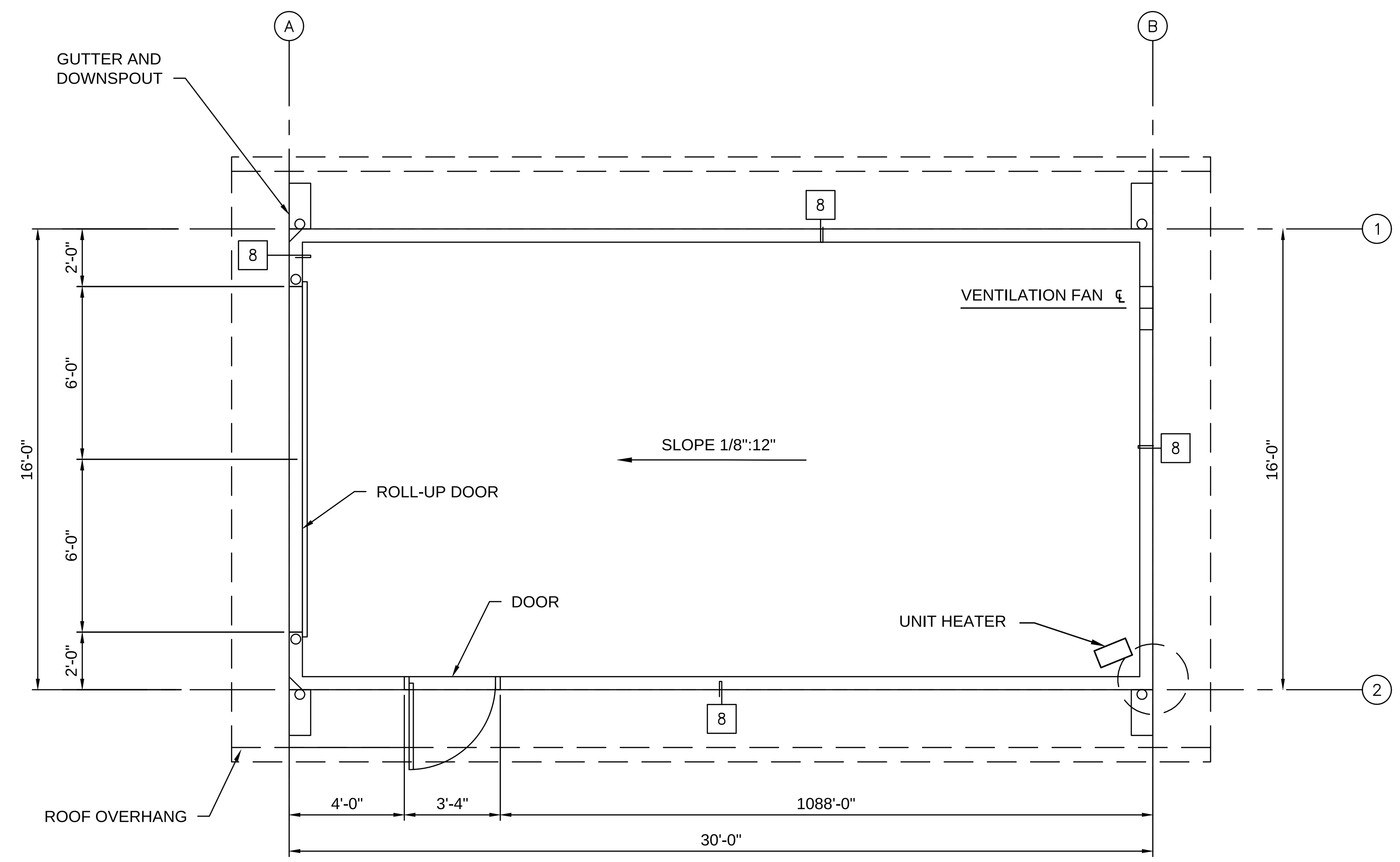
Santa Paula, CA

File Name: UWCD-4S-1 | GJJH Dwn. | GJJH Dsgn. | CWS Chkd. | 2019.12.06 YYYY.MM.DD

Title
CONTROL BUILDING FLOOR AND FOUNADATION PLANS

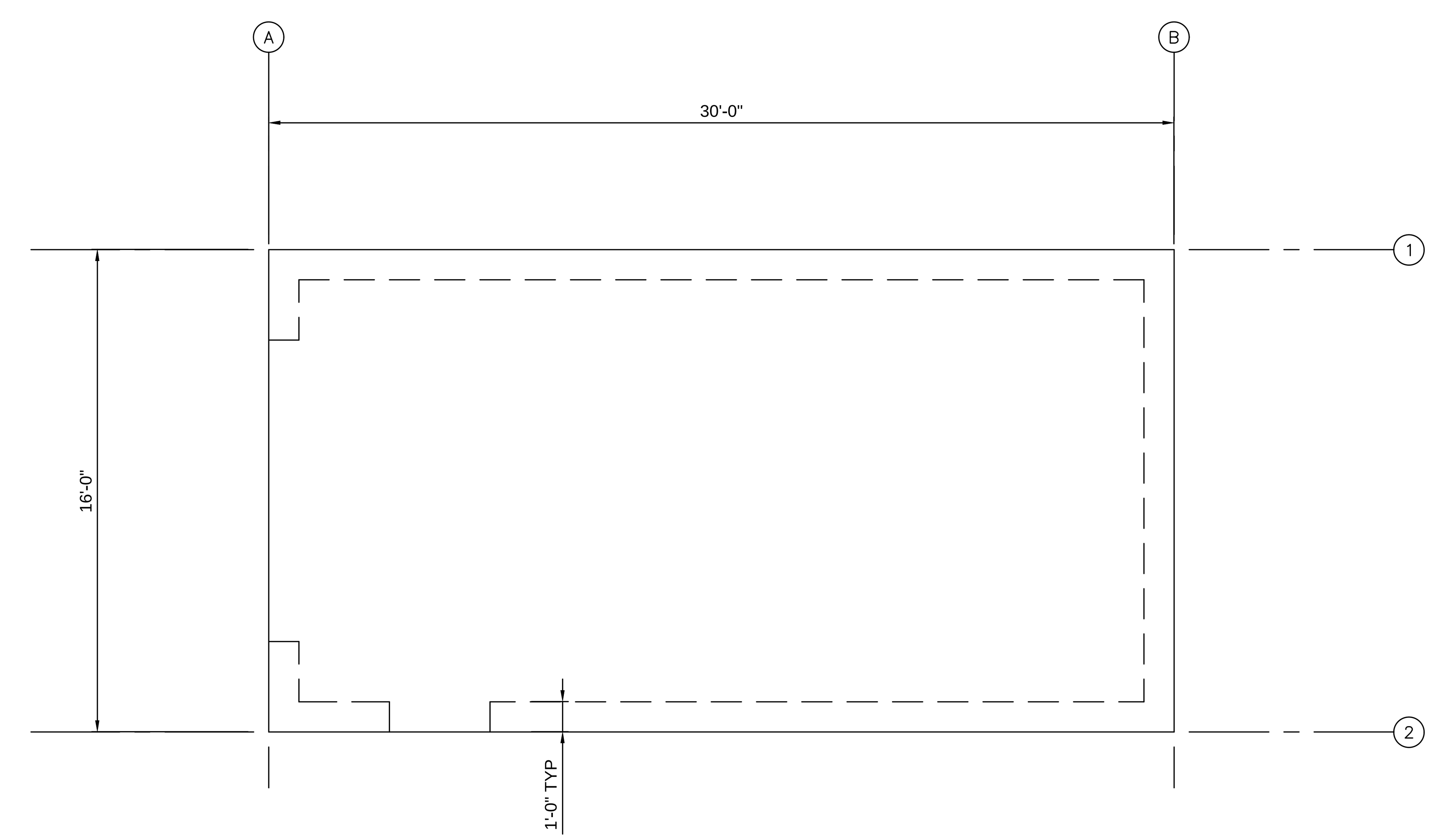
Project No. 224202210
Scale 3/8"=1'-0"
Revision
Sheet 17 of 24
Drawing No. **4S-1**

ORIGINAL SHEET - ANSI D



STORAGE BUILDING FLOOR PLAN

SCALE: 1/4"=1'-0"



STORAGE BUILDING FOUNDATION PLAN

SCALE: 1/4"=1'-0"

Revision	By	Appd	YYYY.MM.DD

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

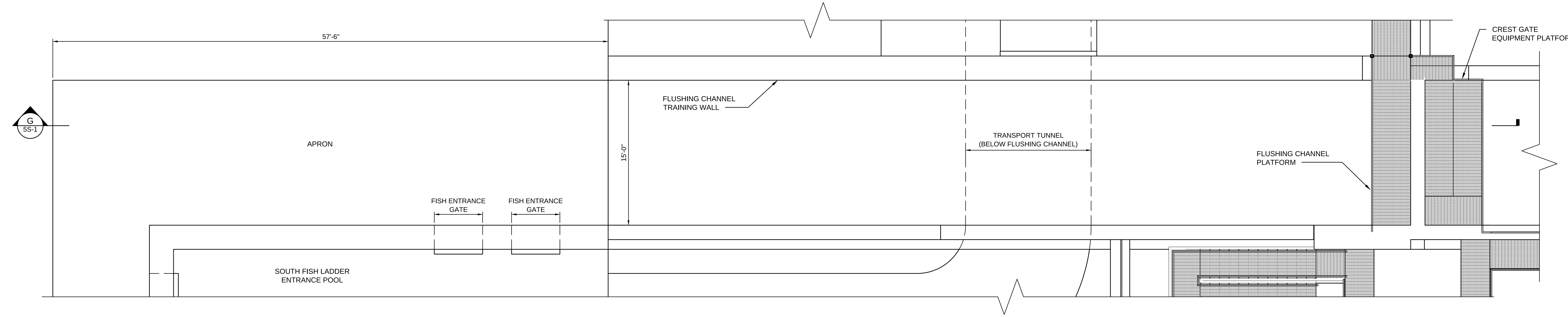
File Name: UWCD-4S-2

GJJH	GJJH	CWS	2019.12.06
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
STORAGE BUILDING FLOOR AND FOUNDATION PLANS

Project No. 224202210
Scale 1/4" = 1'-0"
Revision
Sheet 18 of 24
Drawing No. **4S-2**

ORIGINAL SHEET - ANSI D



FLUSHING CHANNEL PLAN

SCALE: 3/16"=1'-0"

G 5S-1 **SECTION**

SCALE: 3/16"=1'-0"

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Title
FLUSHING CHANNEL
PLAN AND SECTION

Project No. 224202210 | Scale 3/16"=1'-0"

Revision | Sheet 19 of 24 | Drawing No. **5S-1**

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VERN FREEMAN DAM
VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-1M-1	GJJH	GJJH	CWS	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
CREST GATE MECHANICAL PLAN

Project No. 224202210
Scale 1/4"=1'-0"

Revision Sheet 20 of 24
Drawing No. **1M-1**

ORIGINAL SHEET - ANSI D

Revision	By	Appd	YYYY.MM.DD

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VERTICAL SLOT FISH LADDER

Santa Paula, CA

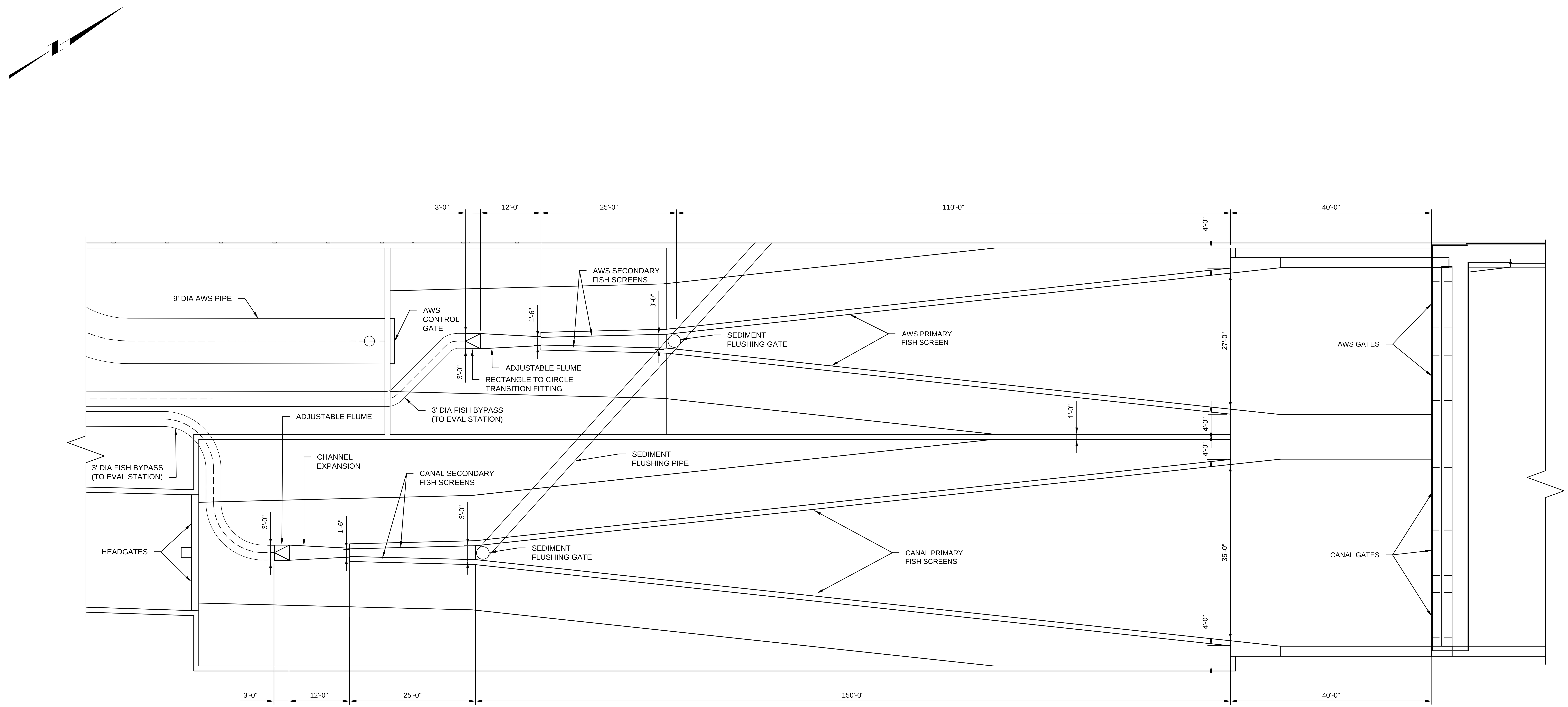
File Name: UWCD-2M-1

GJJH	GJJH	CWS	2019.12.06
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
SOUTH FISH LADDER ENTRANCE
MECHANICAL PLAN

Project No. 224202210
Scale 3/16"=1'-0"
Revision
Sheet 21 of 24
Drawing No. **2M-1**

ORIGINAL SHEET - ANSI D



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Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

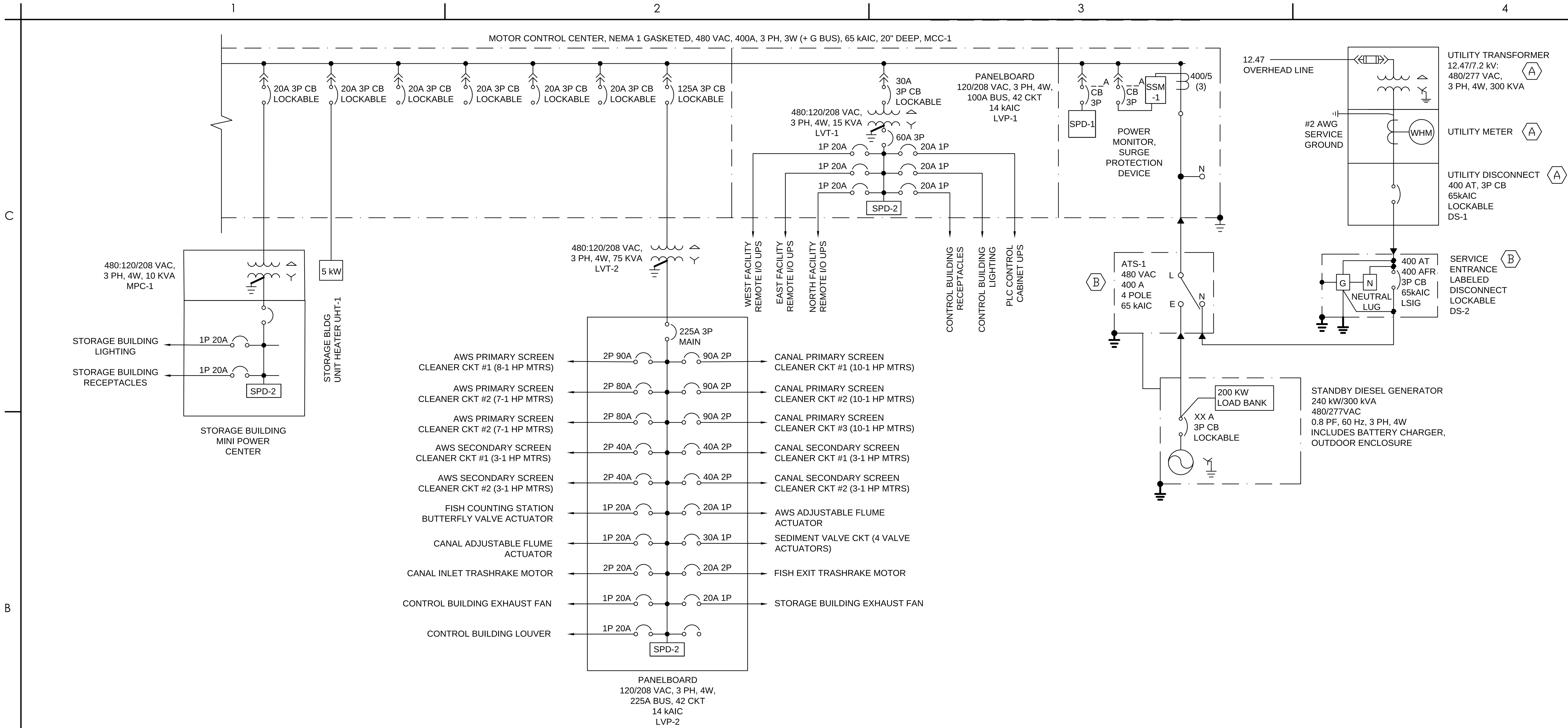
FISH SCREEN MECHANICAL PLAN

Project No. 224202210

Scale 3/32"=1'-0"

Revision Sheet 22 of 24

Drawing No. **3M-1**



GENERAL SHEET NOTES

1. FOR EACH VENDOR PACKAGE PROVIDE ALL RACEWAY, CONDUCTORS, APPURTENANCES, ETC. NOT PROVIDED BY VENDOR FOR A COMPLETE AND OPERABLE SYSTEM.
2. UTILITY TRANSFORMER, METER, AND DISCONNECT SHOWN AS NEW EQUIPMENT. IT IS ASSUMED THAT GIVEN ALL OF THE NEW LOADS A NEW TRANSFORMER WILL NEED TO BE COORDINATED WITH THE UTILITY FOR SUPPLY TO THE PROJECT.
3. INCOMING OVERHEAD LINE IS ASSUMED TO BE 12.47 kV. TO BE CONFIRMED.

SHEET KEYNOTES

A. UTILITY EQUIPMENT LOCATED ON SERVICE POLE.

B. THE SERVICE ENTRANCE DISCONNECT CIRCUIT BREAKER AND AUTOMATIC TRANSFER SWITCH MAY BE PROVIDED AS PART OF THE MOTOR CONTROL CENTER IF THE LINE UP FITS WITHIN THE SPACE SHOWN ON THE PLAN SHEETS.

C. EXISTING EQUIPMENT TO BE REUSED.

ABBREVIATIONS

ACT	-	ACTUATOR	LVP	-	LOW VOLTAGE PANEL
ATS	-	AUTOMATIC TRANSFER SWITCH	LVT	-	LOW VOLTAGE TRANSFORMER
CB	-	CIRCUIT BREAKER	MPC	-	MINI POWER CENTER
CKT	-	CIRCUIT	SPD	-	SURGE PROTECTION DEVICE
DS	-	DISCONNECT SWITCH	STR	-	STARTER
MCC	-	MOTOR CONTROL CENTER	UHT	-	UNIT HEATER

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VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-GE-1 | SAJ Dwn. | CE Dsgn. | JCD Chkd. | 2019.12.06 YYYY.MM.DD

Title
POWER ONE-LINE DIAGRAM

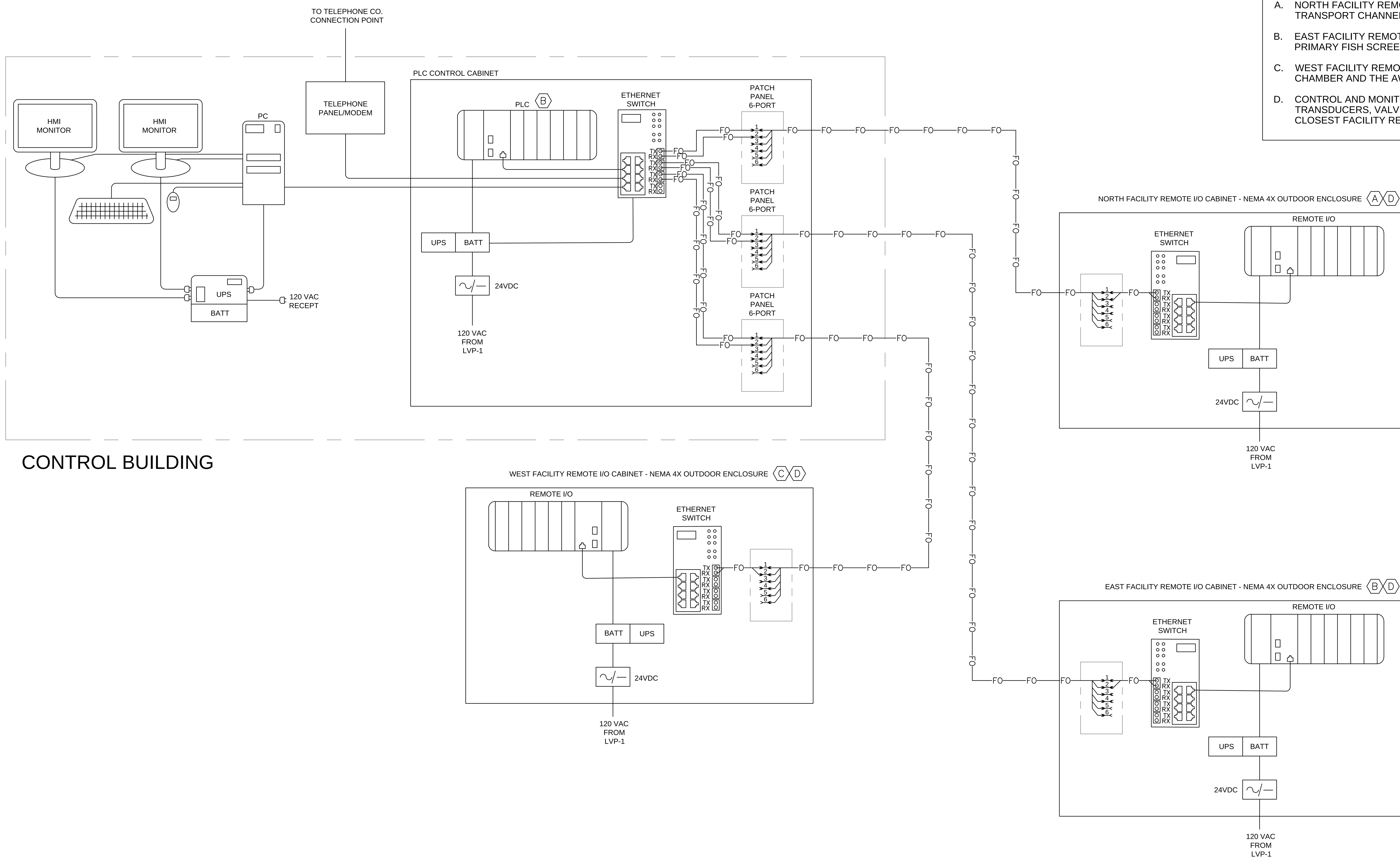
Project No. 224202210

Scale NO SCALE

Revision | Sheet 23 of 24

Drawing No. GE-1

ORIGINAL SHEET - ANSI D



SHEET KEYNOTES

A. NORTH FACILITY REMOTE I/O PANEL TO BE LOCATED BETWEEN CANAL GATES AND TRANSPORT CHANNEL.

B. EAST FACILITY REMOTE I/O PANEL TO BE LOCATED ADJACENT TO THE CANAL PRIMARY FISH SCREENS NEXT TO THE MAINTENANCE ROAD.

C. WEST FACILITY REMOTE I/O PANEL TO BE LOCATED BETWEEN THE AWS DISSIPATION CHAMBER AND THE AWS SECONDARY FISH SCREEN.

D. CONTROL AND MONITORING SIGNALS FOR GATES, SCREEN CLEANERS, WATER LEVEL TRANSDUCERS, VALVES, PUMPS, AIR COMPRESSOR, ETC. SHALL BE HARDWIRED TO CLOSEST FACILITY REMOTE I/O CABINET.

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VERTICAL SLOT FISH LADDER

Santa Paula, CA

File Name: UWCD-GI-1	SAJ	CE	JCD	2019.12.06
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

NETWORK BLOCK DIAGRAM

Project No. 224202210
Scale NO SCALE
Revision
Sheet 24 of 24
Drawing No. **GI-1**

ORIGINAL SHEET - ANSI D

Appendix D.

Assessment of Take of Covered Species from United Water Conservation District's Conjunctive Use Projects and Related Activities

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

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TABLE OF CONTENTS

List of Figures

List of Tables

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1 INTRODUCTION

The purpose of this appendix is to identify and describe the conjunctive-use and related activities conducted by United Water Conservation District (United), and make an assessment of their potential to result in incidental take of steelhead (Oncorhynchus mykiss) and pacific lamprey (Entosphenus tridentatus) based on effects of the activities to Santa Clara River flows. United determined that no other covered species have potential to be affected by the activities described in this appendix. In addition to its surface-water diversion, artificial recharge, and maintenance activities as described in Chapters 3 and 5 of the Multiple Species Habitat Conservation Plan (HCP), United has constructed and operated three conjunctive-use projects over the past 63 years for the purpose of mitigating environmental impacts (i.e., water quality degradation) caused by seawater intrusion in the aquifers of the Oxnard subbasin of the Santa Clara River basin (abbreviated herein to “Oxnard basin”). These three projects are: 1) the Oxnard-Hueneme (O-H) Pipeline project, 2) the Pleasant Valley Pipeline (PVP) project, and 3) the Pumping Trough Pipeline (PTP) project. Locations of these projects are shown on Figure 1. Each of these projects includes several components, including headworks, artificial recharge facilities, water-supply wells, and conveyance infrastructure, that are operated by United in a comprehensive, systematic manner in order to achieve their intended benefits. It should be noted that United’s surface-water diversion and maintenance activities at the Freeman diversion, headworks, and downstream conveyance infrastructure are also components of the PVP, PTP, and O-H Pipeline projects; however, those activities and an assessment of their potential for incidental take are described in Chapters 3, 5, and 7 of the HCP, which are not repeated in this appendix. It should also be noted that the distribution systems located downstream from United’s turnouts on the O-H Pipeline, PTP, and PVP are neither owned nor operated by United and are not discussed in the HCP or this appendix. Much of the water recharged by United for these conjunctive-use projects remains in the Oxnard basin, helping to sustain groundwater levels and mitigating seawater intrusion, but a portion of this stored water is pumped back out at United’s facilities and distributed to coastal areas in order to decrease pumping in key areas, providing further benefit to the basin and more effectively managing water levels in coastal areas where onshore gradients (which drive seawater intrusion) persist. Although United currently has no plans to modify operation of these conjunctive-use projects, United and the Fox Canyon Groundwater Management Agency (FCGMA) have recognized that, at least conceptually, operational adjustments to these conjunctive-use projects could further optimize their beneficial impacts on groundwater quality and sustainable yield of the Oxnard and Pleasant Valley basins. Such optimization efforts are currently envisioned to consist of modifying the timing and volume of surface water deliveries to coastal areas of the basins, so that groundwater extractions in these areas can be reduced.

As defined by the California Department of Water Resources (DWR), “Conjunctive management or conjunctive use refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives” (DWR 2016). The PVP and PTP both meet this definition of conjunctive-use projects, as they deliver diverted surface water for agricultural water supply when surface water is available, supplemented with groundwater during months when surface water is not available for diversion, or as otherwise needed. As will be described in more detail in subsequent sections of this appendix, these surface-water deliveries associated with the PVP and PTP reduce the need for groundwater pumping in areas of the Oxnard basin where seawater intrusion threatens groundwater quality.

A more expansive definition of conjunctive use has been used by the U.S. Department of the Interior: “Many conjunctive-use systems involve artificial recharge of surface water (whether potable, reclaimed, or waste-stream discharge) into the subsurface for purposes of augmenting or restoring the quantity of water stored in developed aquifers” (Peltier 2006). This definition more aptly fits the methods and objectives of the O-H Pipeline project, which does not include direct delivery of surface water to users. Rather, the O-H Pipeline project includes recharge of diverted surface water at the El Rio recharge basins for short-term (e.g., a few weeks) to long-term (e.g., a year or longer) storage and natural filtering in the aquifer prior to extraction, treatment, and conveyance to primarily municipal and industrial (M&I) purveyors and a few agricultural users along the O-H Pipeline (including an extension referred to as the Oceanview Pipeline). The primary goal of the O-H Pipeline system is to provide a source of water to coastal communities in the Oxnard basin (e.g., Oxnard and Port Hueneme) that reduces their reliance on groundwater extraction close to the coastline, where such extractions would exacerbate seawater intrusion. An important secondary benefit of the O-H Pipeline project has been improving groundwater quality in the Forebay area of the Oxnard basin, where many of the small mutual water companies providing water to the disadvantaged community of El Rio are solely dependent on groundwater for municipal supply.

2 DESCRIPTION OF UNITED'S CONJUNCTIVE USE PROJECTS AND RELATED ACTIVITIES

2.1 OXNARD-HUENEME PIPELINE PROJECT

The O-H Pipeline project was designed and constructed in the mid-1950s in response to increasing concerns raised by DWR and United investigators regarding groundwater quality degradation caused by seawater intrusion in the Port Hueneme area. Operation of this project began in 1957 and continues today. The goal of this project was to reduce groundwater pumping near the coast, primarily by municipal water suppliers but also including a few agricultural users, that was exacerbating seawater intrusion, and replace that pumping with groundwater extracted from the El Rio area, about 7 miles inland from the area of seawater intrusion. Pumping at an inland area, such as El Rio, reduces landward hydraulic gradients near the coast that can exacerbate seawater intrusion. Artificial recharge at the El Rio recharge basins has been applied at rates that, over the long term, equal or exceed groundwater extractions for the O-H Pipeline project. However, as discussed in more detail below, during some months recharge rates at El Rio are less than extractions for the O-H Pipeline project; most of these months occur during drought years.

The O-H Pipeline project includes a pipeline from United's Saticoy recharge facility for conveyance of surface water diverted from the Freeman Diversion to the El Rio recharge facility, recharge basins, extraction wells, a water treatment plant (required for municipal water supply), and the O-H Pipeline that conveys extracted groundwater from El Rio to turnouts for the Cities of Oxnard and Port Hueneme, as well as several mutual water companies and farms. Figure 1 shows the locations of the salient features of the O-H Pipeline project, including the El Rio recharge basins, El Rio well field, and O-H pipeline (including the Oceanview and Mugu Lateral extensions of the O-H Pipeline). The artificial recharge applied at El Rio percolates downward to the Oxnard Aquifer, which is the uppermost aquifer pumped for water-supply in the Oxnard basin and one of the hydrostratigraphic units that compose the regional Upper Aquifer System (UAS). Groundwater for the O-H Pipeline project is pumped from 12 United-operated water-supply wells located at El Rio (the El Rio well field); nine of these wells are screened in the UAS and three are screened in the Lower Aquifer System (LAS). The LAS wells are rarely used, except when the UAS wells produce groundwater with high nitrate concentrations, as can occur during droughts as a result of declining groundwater elevations in the Forebay area of the Oxnard basin (Figure 1). For example, the LAS wells were used extensively in 2016 and 2017, due to exceptional drought conditions in the area from 2012 through 2017.

Annual volumes of recharge at the El Rio recharge basins throughout its history of operation are shown on Figure 2. The average annual recharge rate at the El Rio recharge basins from 1991, when the Freeman Diversion was constructed, through 2019, the most recent complete water year, was 23,776 acre-feet per year (AF/yr.). Annual groundwater withdrawals from United's El Rio well field are also shown on Figure 2. The average annual extraction rate from the El Rio well field for the period from 1991 through 2019 was 13,505 AF/yr. As is apparent from these average groundwater recharge and extraction rates, and as illustrated on Figure 2, artificial recharge in the El Rio area substantially exceeds groundwater extractions during most years.

2.2 PLEASANT VALLEY PIPELINE PROJECT

The PVP project was designed and constructed in the 1950s for the purpose of reducing groundwater pumping in the western Pleasant Valley basin and eastern Oxnard basin, where declining groundwater levels and groundwater quality were concerns. As a secondary benefit of the PVP project, it is recognized that by preventing excessive groundwater drawdown in the Pleasant Valley basin, the potential for seawater intrusion in aquifers underlying farmland in the southern Oxnard and Pleasant Valley basins is also reduced.

The PVP project includes a pipeline from United's Saticoy recharge facility for conveyance of diverted surface water from Freeman Diversion to the Pleasant Valley Reservoir, located east of the Camarillo Airport near the City of Camarillo. The delivery of diverted Santa Clara River water to Pleasant Valley County Water District (PVCWD) offsets pumping of irrigation wells in the area. PVCWD operates the Pleasant Valley Reservoir, together with downstream distribution pipelines, to deliver water from the PVP project to farmers in the Pleasant Valley basin and eastern Oxnard basin. Figure 1 shows the locations of the salient features of the PVP project that are owned by United, including the PVP and Pleasant Valley Reservoir (PVCWD operates the Pleasant Valley Reservoir). Downstream from the Pleasant Valley Reservoir, PVCWD owns and operates distribution pipelines, water-supply wells (screened in the LAS), and turnouts, which deliver surface water and groundwater to farms within PVCWD's service area. Those facilities downstream from the Pleasant Valley Reservoir are neither owned nor operated by United. As noted previously, all of United's surface-water diversions, including those that are directed to the PVP for conveyance to PVCWD, are described and assessed in Chapters 3, 5, and 7 of the HCP.

Unlike the O-H Pipeline project described above, United does not own or operate an extraction well field that is dedicated exclusively to supplying groundwater to the PVP. However, from May 2006 through September 2013, an average of 978 AF/yr of water was extracted from United's Saticoy well field (Figure 1) and conveyed to PVCWD via the PVP. The wells of the Saticoy well field are located approximately 3,000 to 5,000 feet southeast of the Santa Clara River, and United's Saticoy recharge facility lies between the well field and the river. The Saticoy well field was constructed in 2003 and first operated in 2007. Annual total withdrawals from United's Saticoy wells for delivery to PVCWD via the PVP are shown on Figure 3, together with withdrawals from the Saticoy well field that are conveyed to the PTP project (as described in Section 2.3, below). All groundwater withdrawals from United's Saticoy well field are shown on Figure 3, and are much smaller than the quantity of water recharged at Saticoy.

United's pumping allocation for its Saticoy well field has been limited by the Fox Canyon Groundwater Management Agency (FCGMA) since 2011. The water extracted at the Saticoy well field for delivery to the PVP project (and the PTP project, as discussed below) is considered temporarily stored surface water, as it consists of surface water from Lake Piru that has been conveyed down the Santa Clara River to Freeman Diversion, where it is diverted and artificially recharged for storage at the Saticoy recharge facility (in addition to United's normal diversion and recharge of surface water from the Santa Clara River). Extractions from the Saticoy well field must conform with FCGMA Resolution 11-2 (FCGMA 2011), referred to as the Saticoy Well Field Storage Program. FCGMA Resolution 11-2 specifies that "After two (2) years, any unrecovered stored water (that was recharged under this Resolution) will no longer be eligible for extraction under this Storage Program." Lake Piru water that is stored and later extracted from the Saticoy well field under this program is directed to both the PVP and the PTP (the PTP project is described in Section 2.3 of this appendix). The total volume of Lake Piru water artificially recharged and temporarily stored under the Saticoy Well Field Storage Program was 33,400 AF, with a total of 11,616 AF extracted for delivery to the PVP and PTP projects during the program's period of operation. Therefore, approximately 22,000 AF more Lake Piru water was recharged than was extracted by United under the Saticoy Well Field Storage Program (a component of both the PVP and PTP projects). In the future, volumes of Lake Piru water recharged at Saticoy will continue to equal or exceed volumes extracted and conveyed to the PTP and PVP under the Saticoy Well Field Storage Program, as required under FCGMA Resolution 11-2, resulting in a neutral to net positive benefit to groundwater levels in the Oxnard Basin.

2.3 PUMPING TROUGH PIPELINE PROJECT

Both the O-H Pipeline and PVP projects (described above) succeeded in reducing groundwater extractions in areas of the Oxnard and Pleasant Valley basins where declining groundwater levels were negatively affecting groundwater quality. However, by the 1970s it was recognized that a major pumping depression or "trough" persisted in the UAS in the agricultural area immediately east of the City of Oxnard. Concerns that seawater could advance as far inland as the Oxnard Forebay prompted the State Water Resources Control Board in 1979 to threaten adjudication of the basin unless local interests could make meaningful progress towards mitigating the persistent overdraft and seawater intrusion problem. In response, United partnered with Ventura County to design and construct the PTP project. The PTP project was designed and constructed in the early 1980s to reduce groundwater pumping from the UAS pumping trough area by delivering surface water directly to farmers in-lieu of them pumping groundwater, similar to the PVP project. For times when surface water supplies are insufficient to meet demand, five LAS wells (the PTP well field) were constructed and are operated by United to supply groundwater for irrigation without pumping from the UAS, which has a more direct impact on seawater intrusion.

The PTP project includes a pipeline from United's Saticoy recharge facility to convey diverted surface water from Freeman Diversion to the pumping trough area, five LAS extraction wells that provide supplemental groundwater when needed, and turnouts for delivering the surface and groundwater to distribution systems owned and operated by agricultural users. The PTP well field is located approximately 4 to 5 miles southeast from the Santa Clara River. In addition, modest volumes of groundwater were supplied to the PTP project by United's Saticoy well field from 2006 through 2013, under the Saticoy Well Field Storage Program, as described in more detail in Section 2.2, above. Figure 1 shows the location of the salient features of the PTP project, including the United's pipeline, and LAS wells, together with the Saticoy recharge basins and well field.

Annual groundwater withdrawals from United's PTP wells are shown on Figure 4. The average annual extraction rate from the PTP wells for the period from 1991 through 2019 was 2,572 AF/yr. Past artificial recharge volumes at the Saticoy recharge facility, together with the modest quantities of groundwater extractions from the Saticoy well field that have been directed to the PTP (under the Saticoy Well Field Storage Program from 2006 through 2013) are summarized in Section 2.2 and shown on Figure 3. In the future, volumes of Lake Piru water recharged at Saticoy will continue to equal or exceed volumes extracted and conveyed to the PTP and PVP under the Saticoy Well Field Storage Program, as required under FCGMA Resolution 11-2, resulting in a neutral to net positive benefit to groundwater levels in the Oxnard Basin.

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3 EFFECTS ASSESSMENT OF UNITED'S CONJUNCTIVE USE PROJECTS AND RELATED ACTIVITIES ON SURFACE WATER CONDITIONS

3.1 GENERAL CONSIDERATIONS

Overall, United artificially recharges far more groundwater than it extracts in the Oxnard and Pleasant Valley basins, where all of its conjunctive use and related activities occur. Figure 5 compares the annual totals for United's artificial recharge to its groundwater pumping in the Oxnard basin since 1955, just before United's first conjunctive-use project began operation (United has never conducted artificial recharge or groundwater pumping activities in the adjacent Mound, Las Posas, or Pleasant Valley basins, and has not conducted such operations in the adjacent Santa Paula basin since 1941). Therefore, the net effect of United's conjunctive-use projects and related activities has been to improve the groundwater balance, which has maintained groundwater elevations in the Oxnard and adjacent basins at higher levels, on average, than would have occurred without these projects. Other beneficial effects of United's conjunctive use projects and related activities include, but are not limited to, improvement of groundwater quality in the Forebay area and in the Pleasant Valley basin, and mitigation of seawater intrusion in the Oxnard basin. If each of United's conjunctive use projects is considered independently, more water has been artificially recharged at the El Rio and Saticoy recharge facilities for the O-H Pipeline and PVP projects than groundwater has been extracted from the associated El Rio and Saticoy well fields. Additionally, although there is not a specific volume of artificial recharge explicitly credited toward groundwater withdrawals for the PTP project, United's total annual average recharge rate in the Forebay area is approximately 10 times greater than the annual average extraction rate from the PTP wells.

From a simple conceptual perspective, it might seem that the net effect of United's operations (greater artificial recharge than groundwater extractions, thus maintaining higher groundwater elevations than would occur otherwise) would tend to increase groundwater discharge to the Santa Clara River. However, except during uncommon periods when multiple years of above-average rainfall and artificial recharge occur with few intervening dry or average years, there is no direct hydraulic connection between the Oxnard Aquifer—which is the uppermost aquifer that receives United's artificial recharge (also the uppermost aquifer that is pumped)—and water flowing in the river. Specifically, the Oxnard Aquifer is decoupled from the river the vast majority of the time. And the other aquifers used for water supply in the Oxnard basin are screened in deeper aquifers that do not intersect the Santa Clara River bed. Groundwater discharge to a river can only occur where the saturated zone of an underlying aquifer intersects the riverbed, without an intervening unsaturated zone. In areas where an unsaturated zone of significant thickness occurs between a river and the water table, the interaction is indirect and effectively one-way—surface water can percolate downward to the aquifer, but groundwater does not reach land surface to add to surface flows. Accordingly, direct hydraulic interaction usually occurs in surface water bodies that are predominantly perennial in nature, whereas ephemeral streams are predominantly decoupled from underlying aquifers because of the presence of an unsaturated zone between the stream channel and the water table, and thus flow only in response to storms (or sometimes artificial influx from sources such as drainage systems and wastewater discharges). The occurrence of coupled versus decoupled stream/aquifer systems fundamentally defines where the potential for impacts to streamflow can arise from upward or downward movement of the water table; perennial reaches are the only stream reaches that receive sustained groundwater discharge over long time periods. Furthermore, if a surface-water body is separated from an aquifer by one or more intervening aquitards and aquifers, then effects of groundwater recharge or pumping in that aquifer on surface flows will be attenuated.

Within the Oxnard basin, the Santa Clara River is perennial only in the reach extending downstream of the Forebay area, from approximately one-quarter mile upstream from U.S. Highway 101 to the mouth of the river (Figure 1). Historical observations from the 1800s indicate that the reach of the Santa Clara River along the north side of the Forebay of the Oxnard basin has always been ephemeral (Beller et al. 2011), except during uncommon periods when multiple high-rainfall years occur in close succession. The locations of the perennial and ephemeral reaches correspond to the presence and absence, respectively, of a semi-perched aquifer and an underlying confining unit known as the Clay Cap, which are present downstream from the Forebay area of the Oxnard basin and in the adjacent Mound basin. The semi-perched aquifer and Clay Cap separate the Oxnard Aquifer from the Santa Clara River by a vertical distance of 100 to 150 feet. In the Forebay area, where the semi-perched aquifer and Clay Cap are absent, the Oxnard Aquifer water table is vertically separated from the Santa Clara River channel by an unsaturated zone that is typically 30 to 90 feet thick (and sometimes as much as 150 feet thick), with groundwater elevations from 10 to 70 feet above mean sea level. In both the Mound basin and the Forebay, the Oxnard Aquifer is decoupled from the Santa Clara River, except during those uncommon periods with multiple high-rainfall years occurring in close succession (as described above), when the Oxnard Aquifer may discharge directly to the Santa Clara River in the Forebay. Therefore, the fact that United recharges more water than it pumps in the Oxnard basin has a negligible, if any, direct impact on streamflow in the Santa Clara River or any other streams in the region, even if conceptually it might seem as if the net excess of recharge should result in increased streamflow.

Along the lower reach of the Santa Clara River where it overlies the confined Oxnard basin, the higher groundwater elevations in the Oxnard Aquifer resulting from United's recharge operations theoretically could reduce the long-term rate of downward leakance of groundwater from the semi-perched aquifer (which is directly hydraulically connected to the Santa Clara River downstream from the Forebay area) to a small degree. Potentially, this effect could slightly raise groundwater elevations in the semi-perched aquifer, and thus increase discharge of groundwater to the Santa Clara River in this reach to a small degree. However, available data show that groundwater elevations in the semi-perched aquifer rise and fall independently of groundwater elevations in the UAS, indicating that the widespread positive effect of United's conjunctive use and related activities on basin groundwater levels does not have a direct or measurable impact on surface water conditions in the Santa Clara River in the Oxnard or adjacent basins, except during those uncommon extremely wet periods when United's artificial recharge may add somewhat to surface flows. Figure 6 compares groundwater elevations measured at shallow wells screened in the semi-perched aquifer near the perennial reach of the Santa Clara River downstream of the Forebay area (Stillwater Sciences 2017) with groundwater elevations measured in a nearby well screened in the Oxnard Aquifer, illustrating this point.

3.2 OXNARD-HUENEME PIPELINE PROJECT

As described in Section 2.1, the total volume of water recharged to the groundwater basin (i.e., the Oxnard Aquifer) in the El Rio area for the O-H Pipeline project has been significantly greater than the total volume of groundwater pumped by United from the basin for the O-H Pipeline project. This excess of recharge compared to extraction results in higher long-term-average groundwater elevations in the Oxnard Aquifer (and, to a lesser extent, deeper aquifers), with or without pumping from the El Rio well field. Recharge of greater quantities of water than are pumped by United for the O-H Pipeline project will continue into the future, as the El Rio recharge basins are United's highest priority for receiving surface-water diversions, and the O-H Pipeline project is a major source of supply for the Cities of Oxnard and Port Hueneme, as well as several other municipal and agricultural users. Applying artificial recharge in the El Rio area is required to maintain suitable groundwater quality for public health at the El Rio well field (United 2008) and other municipal supply wells in the area (operated by entities other than United), and to maintain groundwater elevations at sufficiently high levels to allow the O-H system to operate as designed (e.g., prevent wells from going dry).

Despite the fact that recharge for the O-H Pipeline project exceeds pumping over the long term, during summer and fall, and for a period of 6 years during the exceptional drought beginning in 2012 (Figure 2), United's groundwater withdrawals at the El Rio well field can exceed recharge rates at the El Rio recharge facility. These short-term "deficits" could cause temporary groundwater-level declines that theoretically might exceed those that would have occurred if the O-H Pipeline project had never existed. This hypothetical comparison cannot be directly observed or readily modeled, as the O-H Pipeline has been in operation since 1957 and has impacted pumping patterns by other users in the basin to a significant degree over the past 63 years. However, as discussed in Section 3.1, neither artificial recharge nor pumping from the Oxnard Aquifer (or deeper aquifers) can be expected to have a direct or measurable impact on surface water conditions in the Santa Clara River in the Oxnard or adjacent basins, except during unusually wet periods when groundwater elevations may rise sufficiently high in the Forebay area to intersect the river bed in part due to United's artificial recharge activities. During these periods, the excess recharge at El Rio may contribute slightly to groundwater mounding in the Saticoy area, which can result in some artificially recharged water under the Saticoy recharge basins to immediately flow back into the Santa Clara River.

In addition to comparing annual recharge and pumping at El Rio, as shown on Figure 2, United reviewed pumping and recharge data on a monthly basis from January 1990 (prior to completion of construction of Freeman Diversion) through December 2019 for the El Rio recharge facility and well field, to provide greater temporal resolution of when pumping at El Rio may have exceeded recharge. Months when pumping at El Rio exceeded recharge were compared to months when groundwater elevations at well 02N22W12E04S (the Vulcan well) exceeded 72 feet above mean sea level (msl), which has been conservatively estimated as the minimum groundwater elevation at which groundwater in the Oxnard Aquifer potentially has some degree of interconnection with surface water in the Santa Clara River in the upper (northeast) portion of the Forebay (R2 Resources Consultants, Inc., 2015). As groundwater elevations rise above 72 feet msl at the Vulcan well, the degree of potential interconnection between surface water and groundwater increases and extends southwestward farther into the Forebay below Freeman Diversion. Monthly data for pumping at the El Rio well field are not available in electronic format in United's database prior to January 1990, and expanding the analysis to years prior to construction of Freeman Diversion would not provide relevant information with regard to current conditions on the Santa Clara River; therefore, this analysis only includes the 30-year period from January 1990 through December 2019. Table 1 summarizes the months that groundwater extractions exceeded artificial recharge at United's El Rio facility (and at United's Saticoy facility) while a hydraulic connection between surface water and groundwater potentially existed in the Forebay area, based on groundwater elevations at the Vulcan well. Of the 360 months (30 years) evaluated, groundwater extractions at El Rio exceeded recharge at El Rio during 40 months (11 percent of the total number of months evaluated) when surface water and groundwater were potentially connected. Most of these months occurred during the first, second, or third year after high-rainfall years associated with "El Nino" conditions in the Pacific Ocean (notable El Nino-related high-rainfall years in Ventura County occurred in 1992, 1993 1995, 1998, 2001, and 2005). During these high-rainfall years, groundwater recharge at El Rio was abundant while demand for extracted groundwater was low; therefore, months when groundwater extractions exceeded recharge were uncommon. During most years with average to below-average rainfall, and particularly during extended droughts (e.g., 2012 through 2016), groundwater elevations in the Forebay were generally well below the level at which groundwater and surface water were potentially interconnected; therefore, even if United's monthly groundwater extractions at El Rio exceeded recharge, they could not have impacted surface flows in the Forebay reach of the Santa Clara River. This leaves the 1 to 3 years following high-rainfall years (the "El Nino" years listed above) as the most common years that include months when groundwater extractions at El Rio exceeded recharge and a potential connection existed between surface water and groundwater in the Forebay. Groundwater levels remained high enough in these years to maintain a potential groundwater-surface water connection into spring, while the demand for groundwater on the Oxnard Plain returned to "average-year" rates.

Also shown on Table 1 are the net quantities of recharge (in exceedance of extractions) at El Rio in the season preceding those months when extractions exceeded recharge ("prior wet-season recharge in excess of pumping"). For this analysis, the "prior wet-season" is defined as the period when recharge exceeded recharge every month at El Rio without interruption, up to 12 months. As shown on Table 1, in all but one year, prior wet-season recharge exceeded total extractions in excess of recharge at El Rio by a large margin, typically 10,000 to 30,000 AF. The sum of extractions exceeding recharge at El Rio in each of those years (typically 2,000 to 3,000 AF) can be expected to have a minor impact on groundwater levels in the Oxnard

Aquifer below the Santa Clara River (and, therefore, surface-water flows) compared to these much larger quantities of recharge. In addition, prior wet-season recharge in excess of pumping at Saticoy has typically resulted in an additional 11,000 to 34,000 AF of recharge in the Forebay during years when groundwater is potentially connected with surface water. In 2008, prior wet-season recharge in excess of pumping at El Rio was only 2,061 AF, while pumping at El Rio during February, May, June, and July of 2008 exceeded recharge by 3,977 AF. These 4 months represent just 1 percent of the total (360) months evaluated, thus are highly atypical for operation of the El Rio facility and O-H Pipeline project. Furthermore, this atypical "recharge deficit" at El Rio was countered by a surplus of recharge at Saticoy, which exceeded pumping at the El Rio and Saticoy well fields combined by nearly 3,000 AF. This net excess of recharge compared to pumping by United in 2008 would have raised groundwater elevations in the Oxnard Aquifer in the Forebay area to a much greater extent than the net excess of pumping at El Rio that year would have caused them to decline, yielding a net increase to flows in the Santa Clara River compared to those that would be expected if United's conjunctive-use operations did not exist.

In summary, the net effect on surface flows in the Forebay reach of the Santa Clara River resulting from United recharging more water annually than it extracts at El Rio is, overall, to potentially increase those surface flows to a modest degree, but only when groundwater levels in the Oxnard Aquifer in the Forebay are high enough to intersect land surface. A thick unsaturated zone exists below the Santa Clara River in the Oxnard basin the majority of the time—there is no direct hydraulic connection between the Santa Clara River and the aquifers that are recharged and pumped by United during such times, and United's conjunctive-use operations would not affect surface flows.

3.3 PLEASANT VALLEY PIPELINE PROJECT

As noted in Section 2.2, groundwater recharge and pumping by United (through the Saticoy Well Field Storage Program) are minor components of the PVP project, providing a modest supplement from 2006 through 2013 to the much larger quantities of diverted surface water delivered via the PVP project. Also, as noted in Section 2.2, recharge exceeds pumping for the Saticoy Well Field Storage Program, and this excess of recharge compared to extraction produces long-term-average higher groundwater elevations in the Oxnard Aquifer (and, to a lesser extent, deeper aquifers) than would occur if the Saticoy Well Field Storage Program had never existed, or was halted in the future.

As discussed in Section 3.1, neither artificial recharge nor pumping from the Oxnard Aquifer (or deeper aquifers) can be expected to have a direct or measurable impact on surface water conditions in the Santa Clara River in the Oxnard or adjacent basins, except during unusually wet periods when groundwater elevations may rise sufficiently in the Forebay area to intersect the river bed due to extensive artificial recharge. During these unusually wet periods, it is possible that recharge in the Saticoy area associated with the Saticoy Well Field Storage Project could contribute to groundwater elevations rising in the Oxnard Aquifer under the Forebay reach of the Santa Clara River such that the water table intersects the river bed, contributing a minor amount of additional streamflow. Much larger quantities of groundwater (an order of magnitude or more) that are not associated with the Saticoy Well Field Storage Project would also typically be recharged by United at Saticoy during these wet periods. Therefore, it can be expected that the effects on streamflow resulting from recharge and pumping at Saticoy that contribute to the PVP program would be negligible compared to United's other recharge activities.

Similar to the month-by-month evaluation of recharge and pumping conducted for the El Rio facility, in Section 3.2 above, United reviewed pumping and recharge data for the Saticoy recharge facility and well field on a monthly basis from 2003 (when the Saticoy well field was constructed) through 2019. Months when pumping at Saticoy exceeded recharge were compared to months when groundwater elevations at well 02N22W12E04S (the Vulcan well) exceeded 72 feet msl, which is the minimum groundwater elevation at which groundwater in the Oxnard Aquifer has the potential to have some degree of potential interconnection with surface water in the Santa Clara River in the upper (northeast) portion of the Forebay (R2 Resources

Consultants, Inc., 2015). Table 1 summarizes the months that groundwater extractions exceed artificial recharge at United's Saticoy facility (and at United's El Rio facility) while a potential hydraulic connection between surface water and groundwater exists in the Forebay area. Of the 152 months between the first use of the Saticoy well field (May 2007) through December 2019, groundwater extractions at Saticoy exceeded recharge during just 6 months (4 percent of the total number of months) when surface water and groundwater were potentially interconnected; all of these months occurred in 2007, 2008, and 2011. It should be remembered, however, that the Saticoy well field is only used to pump Lake Piru water that is temporarily "stored" in the Saticoy recharge facility. This water is not natural Santa Clara River surface water. Furthermore, less of this Lake Piru "stored" water is extracted than recharged, resulting in a net total benefit to the aquifer. Finally, during each of years 2007, 2008, and 2011 the total volume of prior wet-season recharge (including both surface water and Lake Piru water) in excess of pumping at Saticoy was approximately 21,000, 35,000, and 32,000 AF on an annual basis.

3.4 PUMPING TROUGH PIPELINE PROJECT

As noted in Section 2.3, groundwater pumping from the LAS by United is a significant component of the PTP project, as a supplement to surface-water deliveries and to reduce pumping by private landowners from the UAS. Because the aquifers of the LAS are not in direct hydraulic communication with the Santa Clara River in the Oxnard basin at any location or time, there is no reason to believe that pumping from United's PTP wells could directly affect surface water in the river. It is theoretically possible, however, that groundwater level drawdown in the LAS could induce downward groundwater movement from the UAS to the LAS, which in turn could provide a weaker inducement for downward groundwater movement from the semi-perched aquifer to the Oxnard Aquifer downstream from the Forebay area. This assumed downward movement from the semi-perched aquifer to the UAS could result in slightly lower groundwater levels in the semi-perched aquifer that could affect streamflow in the perennial reach of the Santa Clara River downstream from the Forebay area. However, groundwater elevation data summarized for the semi-perched aquifer in Section 3.1 indicate that groundwater elevations in the semi-perched aquifer near the Santa Clara River are not discernibly affected by changes in groundwater elevation in the underlying Oxnard Aquifer. The lack of response in the semi-perched aquifer to changes in groundwater elevation in the underlying Oxnard Aquifer indicates that the hydraulic effects of pumping from the LAS by the PTP well field (which is located 5 to 7 miles southeast of the Santa Clara River) are not transmitted through the intervening Mugu, Oxnard, and semi-perched aquifers to a significant degree, and are highly unlikely to affect flow in the Santa Clara River downstream from the Forebay area (where the river is in hydraulic communication with the semi-perched aquifer). Additional pumping and recharge in the Saticoy area as part of the Saticoy Well Field Storage Program have contributed a much smaller volume of water to the PTP project compared to pumping from the PTP well field. Effects of the Saticoy Well Field Storage Program are assessed in Section 3.3, and are not discussed further in this section.

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4 INCIDENTAL TAKE ASSESSMENT

As discussed in Section 3, above, the three conjunctive-use projects and related activities by United in the Oxnard basin are neither known nor expected to have a direct or measurable impact on surface water conditions in the Santa Clara River in the Oxnard or adjacent basins, except during unusually wet periods when groundwater elevations may rise sufficiently high in the Forebay area to intersect the river bed. During these periods, the net excess of United's recharge compared to its extractions may contribute slightly to groundwater mounding in the Saticoy area, which can result in some artificially recharged water under the Saticoy recharge basins discharging back into the Santa Clara River.

The determination of effects weighs several factors which, in the case of United's conjunctive-use projects, focuses on the contribution to surface flows in the affected reach. As described above, the Oxnard Aquifer is most commonly decoupled from the river. This portion of the affected reach is characterized as a losing reach, resulting in dry conditions for substantial portions of the year, beginning approximately 1 mile downstream of the Freeman Diversion and continuing to approximately one-quarter mile upstream of the Highway 101 bridge. The losing reach is a well-documented natural condition of the river, which has always been ephemeral except during uncommon periods when multiple high-rainfall years occur in close succession (Section 3.1). During such uncommon periods, there may be a hydraulic connection between surface flows in the river and the Oxnard Aquifer due to United's artificial recharge activities. However, the resulting groundwater discharge back to the river likely results in, at most, minor changes to surface flows (United 2010). The subsequent extraction of mounded groundwater is not likely to result in quantifiable reductions in surface flows and, as displayed in Table 1, recharge volumes greatly exceed extractions during these periods of groundwater mounding. Therefore, while United's conjunctive-use projects can, during uncommon periods, result in groundwater recharge, which can artificially contribute to surface flows, these inputs are relatively minor and do not constitute an effect to steelhead and lamprey. As noted in Section 1, United determined that no other covered species have potential to be affected by the conjunctive use projects. Based on the conclusions presented in the previous sections related to a net excess of recharge, the effects to riparian habitat are presumed to be positive (i.e., more water available for riparian vegetation). However, due to the typical decoupled state of the Oxnard Aquifer from the river, and the historically ephemeral condition of the critical reach, the conjunctive use projects are presumed to have no measurable effect, positive or negative, on other species.

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5 CONCLUSION

United is not seeking incidental take coverage for on-going conjunctive-use projects. The O-H Pipeline project, the PVP project, and the PTP project each contribute to the groundwater elevations through recharge and extractions. In the context of this assessment, the influence of these operations on surface flows in the river is the primary factor in determining the potential effects to covered species. As detailed in Section 3.4, the PTP project is highly unlikely to influence surface flows in the river due to the PTP well field. The influence of the Saticoy well field from the PTP and PVP projects, as detailed in Section 3.3, on surface flows in the river is limited to unusually wet periods when groundwater elevations may rise sufficiently in the Forebay area to intersect the river bed. While surface flows in the affected reach may be influenced by recharge and pumping activities during these periods, these interactions contribute a minor amount of total surface flows, and a goal of the Saticoy Well Field Storage Program (Section 2.2) is to reduce, and ideally eliminate, the excessive mounding in the Saticoy area that artificially influences surface flows. Therefore, the overall effects from the PVP and PTP projects from the Saticoy well field on surface flows in the Santa Clara River are considered to be negligible. Similarly, the recharge and pumping associated with the O-H Pipeline project from the El Rio well field may influence surface flows during the unusually wet periods described above for the PVP and PTP projects when the recharge at El Rio may contribute slightly to surface flows in the Saticoy area. However, as noted above for the PVP and PTP projects, the effects of recharge at El Rio associated with the O-H Pipeline project on surface flows in the Saticoy area are considered to be negligible.

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6 REFERENCES

Beller, E.E., R.M. Grossinger, M.N. Salomon, S.J. Dark, E.D. Stein, B.K. Orr, P.W. Downs, T.R. Longcore, G.C. Coffman, A.A. Whipple, R.A. Askevold, B. Stanford, and J.R. Beagle. 2011. Historical Ecology of the Lower Santa Clara River, Ventura River, and Oxnard Plain: An Analysis of Terrestrial, Riverine, and Coastal Habitats, prepared for the State Coastal Conservancy, a report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA (report and GIS layers are available on SFEI's website, at: www.sfei.org/projects/VenturaHE).

California Department of Water Resources. 2016. Conjunctive Management and Groundwater Storage—A Resource Management Strategy of the California Water Plan. July.

Fox Canyon Groundwater Management Agency. 2011. Resolution 2011-02 of the Fox Canyon Groundwater Management Agency: A Resolution Creating the United Water Conservation District Saticoy Well Field Storage Program. April.

Fox Canyon Groundwater Management Agency. 2019. Groundwater Sustainability Plan for the Oxnard Subbasin. December.

R2 Resources Consultants, Inc. 2015. Freeman Operations Model Documentation. February.

Stillwater Sciences. 2017. Draft Report, City of Ventura Special Studies—Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California. November.

United Water Conservation District. 2008. Nitrate Observations in the Oxnard Forebay and Vicinity, 1995-2006. July.

United Water Conservation District. 2010. Saticoy Recharge Mound Study. March.

United Water Conservation District. 2018. Ventura Regional Groundwater Flow Model and Updated Hydrogeologic Conceptual Model: Oxnard Plain, Oxnard Forebay, Pleasant Valley, West Las Posas, and Mound Basins, United Water Conservation District Open-File Report 2018-02. July.

U.S. Dept. of the Interior. 2006. Conjunctive Water Management: A Solution to the West's Growing Water Demand? (testimony of Jason Peltier, Deputy Assistant Secretary for Water and Science, U.S. Dept. of the Interior before the U.S. House of Representatives Committee on Government Reform Subcommittee on Energy and Resources. April.

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7 FIGURES

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Figure 1 Location Map, Showing United Conjunctive-Use Project Facilities in Oxnard Basin

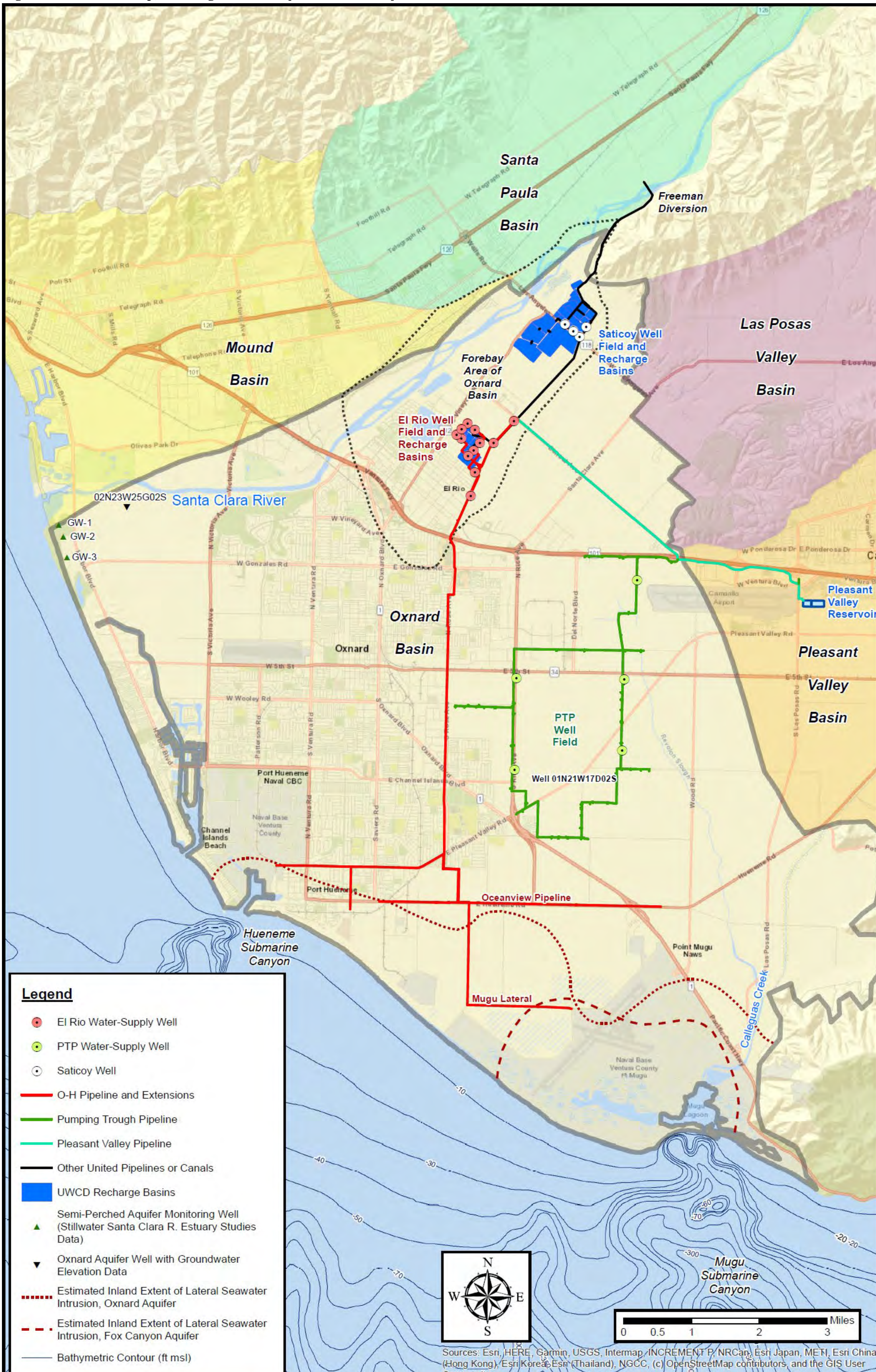

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Figure 2 Groundwater Pumping and Artificial Recharge at United's El Rio Facility for O-H Pipeline Project

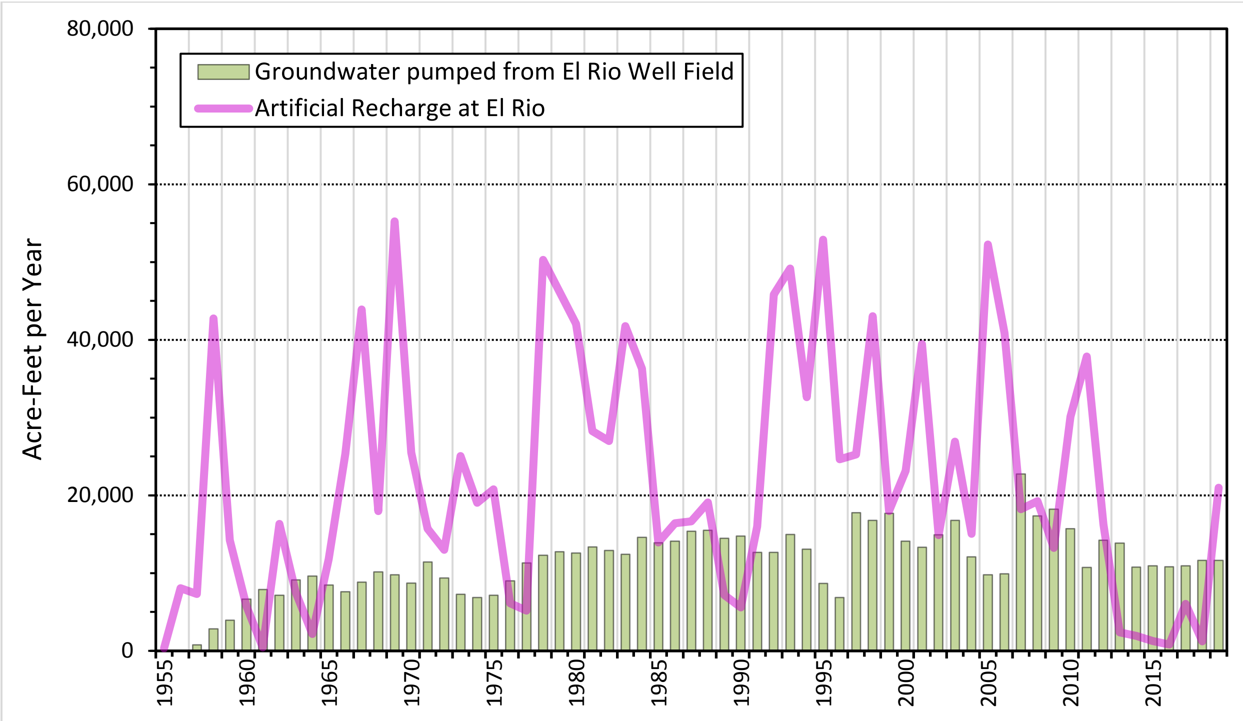


Figure 3 Groundwater Pumping and Artificial Recharge at United's Saticoy Facility for PVP and PTP Projects

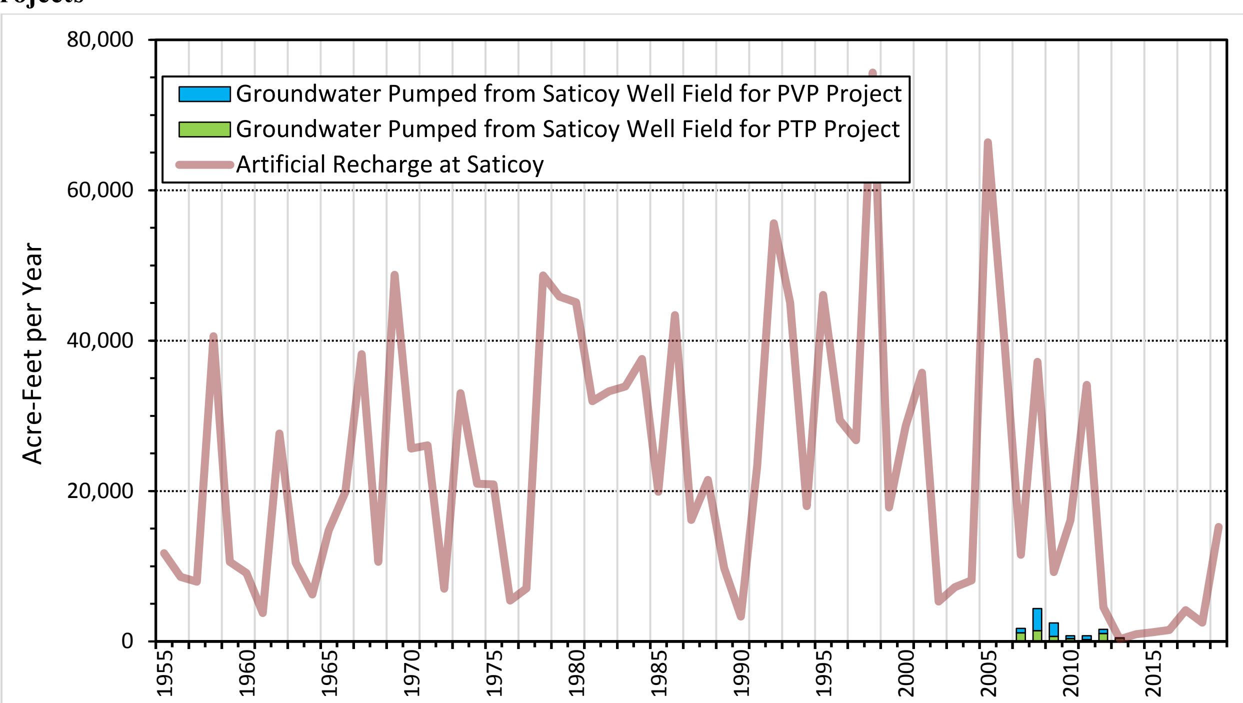


Figure 4 Groundwater Pumping from United's PTP Well Field

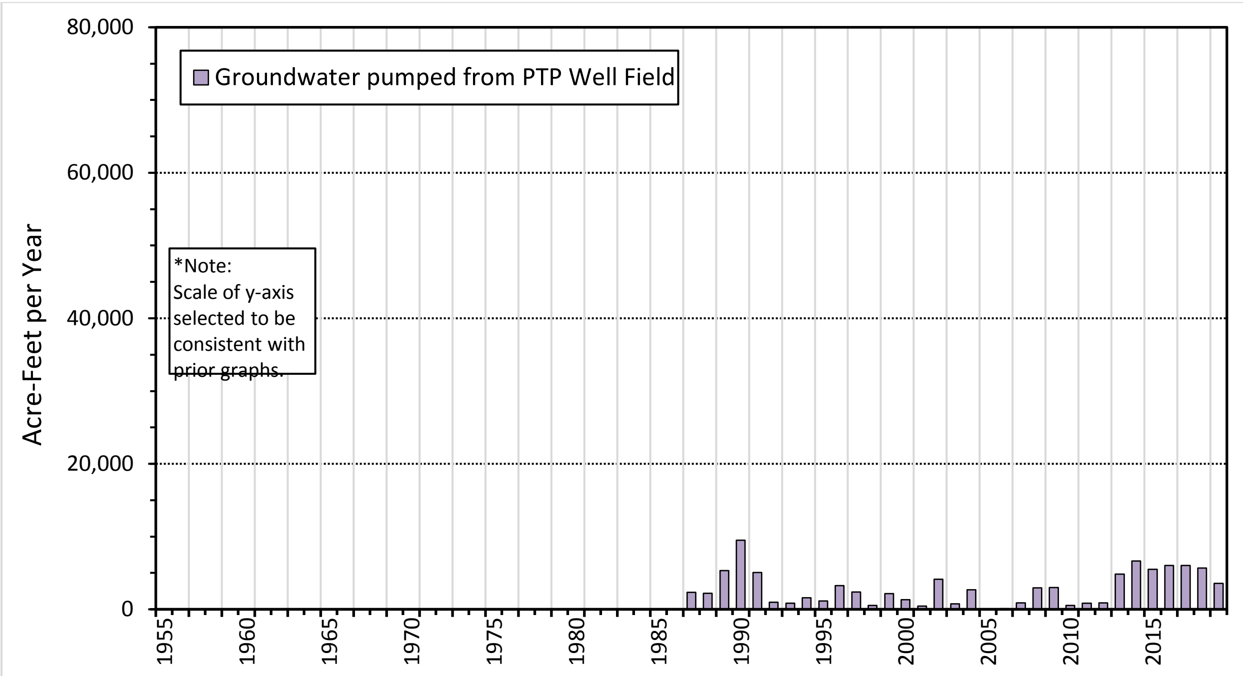


Figure 5 Total United Groundwater Pumping and Artificial Recharge in Oxnard Basin

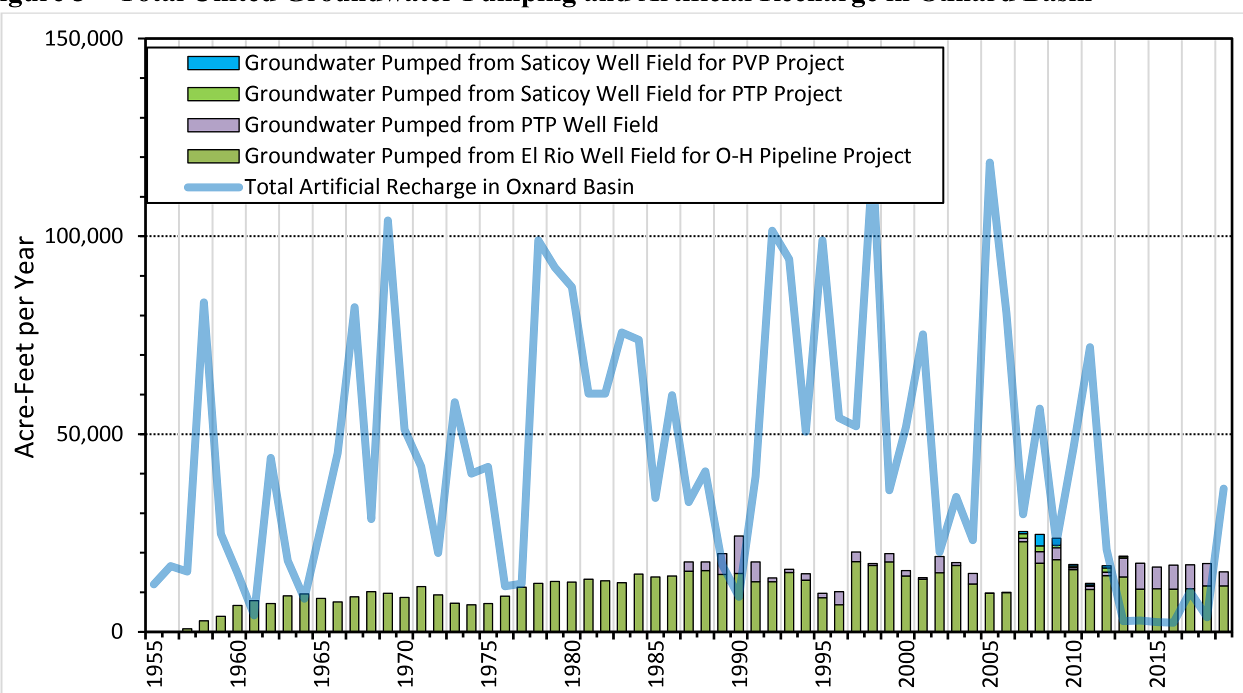
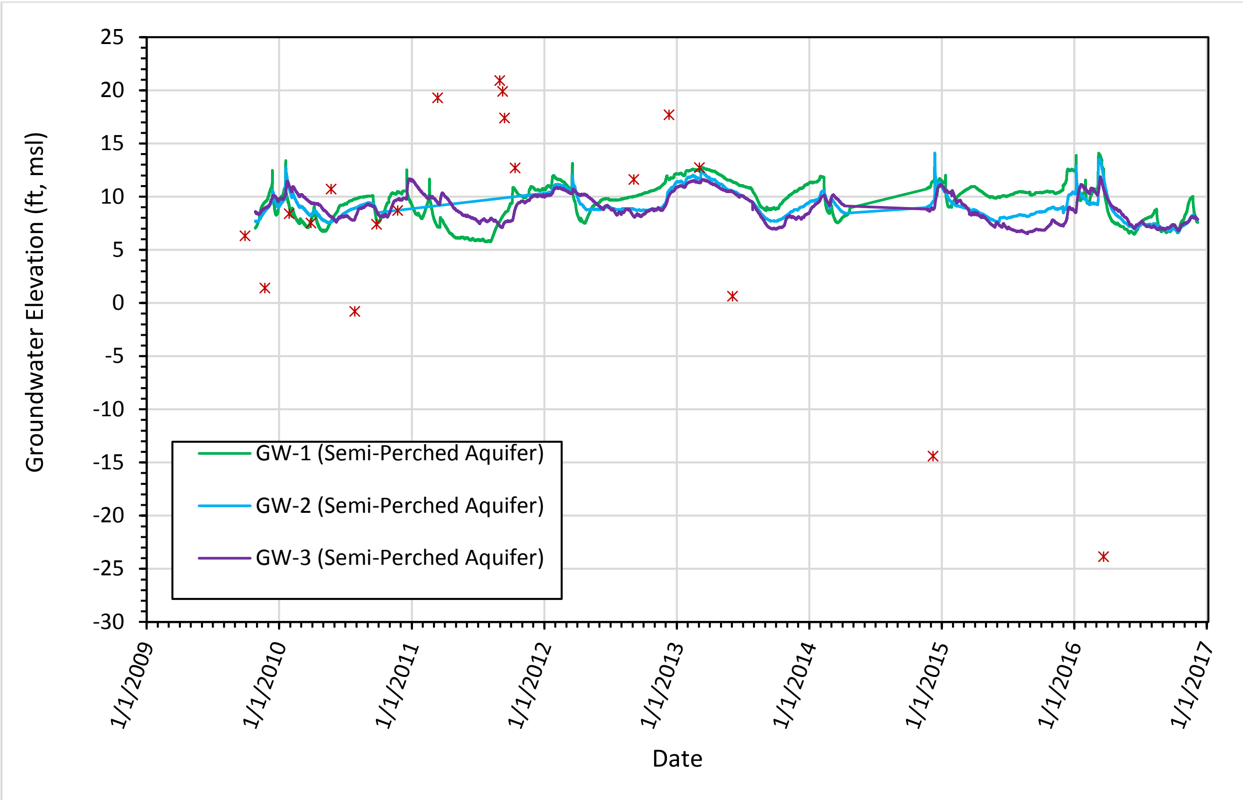


Figure 6 Groundwater Elevations in Semi-Perched Aquifer versus Oxnard Aquifer Below Lower Santa Clara River



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8 TABLE

Table 1. Months When Groundwater Extractions from United's Saticoy and El Rio Well Fields Exceeded Recharge at the Saticoy and El Rio Recharge Facilities, Respectively, and a Hydraulic Connection Existed between the Oxnard Aquifer and the Santa Clara River in the Forebay Area (since 1990)

Month and Year	Saticoy Groundwater Extractions in Excess of Recharge (acre-feet)	Prior Wet Season Recharge in Excess of Pumping at Saticoy (acre-feet)	El Rio Groundwater Extractions in Excess of Recharge (acre-feet)	Prior Wet Season Recharge in Excess of Pumping at El Rio (acre-feet)
Jul 1993	N/A	N/A	1,434	34,326
May 1994	N/A	N/A	247	26,811
Jun 1994	N/A		1,151	
Jul 1994	N/A		1,253	
Aug 1994	N/A		956	
Jun 1996	N/A	N/A	605	40,736
Jul 1996	N/A		659	
Aug 1996	N/A		679	
Sep 1996	N/A		629	
Apr 1997	N/A	N/A	990	15,234
May 1997	N/A		1,569	
Jun 1997	N/A		1,515	
Jul 1997	N/A		1,696	
Aug 1997	N/A		114	
Aug 1998	N/A	N/A	42	21,214
Jun 1999	N/A	N/A	549	17,506
Jul 1999	N/A		1,447	
Aug 1999	N/A		1,600	
Oct 1999	N/A		109	
Nov 1999	N/A		1,185	
Dec 1999	N/A		1,563	
Jan 2000	N/A	N/A	983	8,699
Jul 2000	N/A		1,488	
Aug 2000	N/A		1,350	
Dec 2000	N/A		833	
Jul 2001	N/A	N/A	953	14,663
Aug 2001	N/A		1,215	
Mar 2002	N/A	N/A	484	17,026
Apr 2002	N/A		844	
May 2002	N/A		994	
Jun 2002	N/A		878	
Mar 2007	none	20,800	219	29,754
Apr 2007	none		592	
May 2007	70		1,689	

Month and Year	Saticoy Groundwater Extractions in Excess of Recharge (acre-feet)	Prior Wet Season Recharge in Excess of Pumping at Saticoy (acre-feet)	El Rio Groundwater Extractions in Excess of Recharge (acre-feet)	Prior Wet Season Recharge in Excess of Pumping at El Rio (acre-feet)
Feb 2008	none	34,571	798	2,061
May 2008	108		290	
Jun 2008	714		1,246	
Jul 2008	839		1,643	
Apr 2009	none	11,071	204	9,857
Jul 2011	3	31,996	none	29,756
Aug 2011	none		955	
Dec 2011	19		none	

Notes:

- N/A = Not applicable (Saticoy well field was constructed in 2003)
- "Prior Wet Season Recharge in Excess of Pumping" is calculated as the sum of recharge minus pumping in each of the preceding months when recharge exceeded pumping, up to the first preceding month where pumping exceeded recharge or a maximum of 12 months (if more than 12 months existed with recharge exceeding pumping), whichever occurred first.

Appendix E.

Assessment of Suspended Sediment Effects on Adult Steelhead

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

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Stillwater Sciences
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TECHNICAL MEMORANDUM – REVISED DRAFT

DATE:	January 17, 2020
TO:	Murray MacEachron (Senior Hydrologist) of United Water Conservation District
FROM:	Ethan Bell, M.S. (Senior Ecologist), Katherine Ayres, Ph.D. (Senior Scientist), Matt Drenner, Ph.D. (Senior Biologist), Peter Baker, Ph.D. (Mathematician), Glen Leverich (Senior Geomorphologist) of Stillwater Sciences
SUBJECT:	Assessment of Suspended Sediment Effects on Adult Steelhead: Implications for Limitations on Steelhead Behavior and Physiology in the Santa Clara River - Draft – NOT FOR PUBLIC DISTRIBUTION

1 REGULATORY SETTING

United Water Conservation District (United) is developing a Multiple Species Habitat Conservation Plan (MSHCP) as part of an incidental take permit application under Section 10(a)(1)(B) of the federal Endangered Species Act (ESA). The MSHCP includes design, construction, and operation of a new fish passage system, diversion/instream flow operations, and an effects analysis that analyzes and describes the effects of the covered activities on the covered species in the MSHCP. The federally endangered southern California steelhead (anadromous *Oncorhynchus mykiss*) distinct population segment is one of the covered species in the MSHCP and the National Oceanic and Atmospheric Administration's (NOAA) Fisheries department is responsible for implementing the ESA for southern California steelhead.

On September 7, 2018, United submitted the third administrative draft MSHCP to the federal and state regulatory agencies. The draft included a vertical slot fish passage system as the proposed fish passage project at the Freeman Diversion. The upper flow limit for the fish passage decision was determined using the latest published version of NOAA Fisheries' fish passage engineering design handbook at the time the third draft MSHCP was released as well as historical guidance from NOAA Fisheries. Appendix D in the third draft MSHCP included United's decision making process for the upper flow limit and also included a biological assessment of suspended sediment effects on steelhead to assess if the upper flow limit was consistent with the biology of adult steelhead and what the best available science supported as a reasonable inference for when adult steelhead would be expected to ascend the fish passage system. On February 14, 2019, NOAA Fisheries provided a letter with two enclosures transmitting comments on the third draft MSHCP. The comments included a critique of the analysis in Appendix D and concluded that "the ecological literature provides no unequivocal consistent causal relationship between turbidity and migration."

The mandate of the ESA is to use "the best available scientific and commercial data" and does not require a perfect understanding of the science or unequivocal causal relationships. While the purpose of this scientific review and analysis was to fill information gaps and to decrease scientific uncertainty of assumptions and conclusions in key areas, scientific uncertainty related to key management questions, such as the effects of suspended sediment on steelhead physiology and behavior, will never be totally eliminated regardless of the number of studies or the rigor of their design, execution, and review. Consequently, United's decisions regarding project determination and assumptions for the effects analysis cannot be made with unequivocal science, because that is not possible, but can be made with the best available scientific and commercial data as required by the ESA. A weight of evidence approach can be used to reduce uncertainty where feasible and base management recommendations on those scientific hypotheses that seem best supported and most applicable to the issues at hand.

The description, summary, and inference from the best available science in this memo are consistent with determinations made by NOAA Fisheries for various biological opinions under Section 7 of the ESA, where the best available science regarding suspended sediment (and/or turbidity) impacts was assessed and a determination made by the agency. Projects where biological opinions have made determinations on the effects of suspended sediment on salmonids and/or steelhead include diversion operations, Federal Energy Regulatory Commission permit relicensing, dredging, bridge replacement, dam removals and other stream restoration projects and those determinations were also considered in the current analysis. Often these determinations were made with much less data than what is available for the Santa Clara River. Additionally, in 2010, the Army Corps of Engineers contracted A. A. Rich and Associates to conduct a similar literature review (but different context) for impacts of re-suspended sediments associated with dredging and dredged material placement on fishes in San Francisco Bay, California. We strongly encourage review of that comprehensive document, particularly for a more detailed explanation of the physiological stress response of fish in relation to suspended sediment (A. A. Rich and Associates 2010).

2 FOCAL SCIENTIFIC QUESTIONS

Given the regulatory context, United tasked Stillwater Sciences with assessing the best available scientific and commercial data regarding the potential effects of suspended sediment concentrations (SSC) (also referred to as total suspended solids [TSS])[1] on the upstream migration of adult steelhead in the Santa Clara River with the specific goal of answering the focal scientific questions presented in Table 1 using direct empirical evidence as well as reasonable scientific inference, when empirical data are not available.

Table 1. Four focal scientific questions for evaluation to inform management decisions regarding the covered activities, conservation strategy, and effects analysis of United Water Conservation District's Multiple Species Habitat Conservation Plan.

Question number	Question
1	What are the potential behavioral and physiological effects of SSCs on migrating, adult steelhead?
2	At what range of SSC are migrating, pre-spawning adult steelhead likely to actively swim in an upstream direction in the lower Santa Clara River?
3	At what range of SSC are migrating, pre-spawning adult steelhead not likely to actively swim in an upstream direction in the lower Santa Clara River?
4	What are the ranges of discharge in the Santa Clara River that would be associated with the identified ranges of SSC for Questions 2 and 3?

[1] The analytical methods for estimating SSC and TSS differ. **SSC** data are produced by measuring the dry weight of all the sediment from a known volume of a water-sediment mixture. **TSS** data are produced by several methods, most of which entail measuring the dry weight of sediment from a known volume of a subsample of the original. In this memo the metric used in the source research is used, when identified.

To address Questions 1 through 3, a review of peer reviewed literature, grey literature, expert opinion, and empirical measurements of SSC (as well as turbidity converted to SSC) was conducted to summarize any evidence of known physiological and behavioral effects of SSC on steelhead and characterize empirical and observational relationships between adult steelhead migration behavior and SSC. Where information is lacking for adult steelhead, data regarding other salmonids and other fish are reviewed to assess if reasonable inferences can be made for steelhead. To address Question 4, data correlating SSC and discharge in the Santa Clara River are presented and described, then compared to the ranges of SSC described for Questions 2 and 3.

As a point of clarification, the effects of turbidity on behavior and physiology is not being explored in this report. The focus of this report is suspended sediment, which correlates with turbidity. While the degree to which water loses its transparency due to suspended particulates (turbidity) is not the direct aim of the focal questions, turbidity is often used to infer relative SSC and changes in SSC (i.e., increasing or decreasing). Therefore, turbidity is discussed occasionally as a measure of relative suspended sediment, particularly when direct measurements of SSC were not available. It is understood that turbidity may be associated with behavioral effects (e.g., predation avoidance and effects to visual feeding), but that is not the focus of the current analysis.

3 GEOGRAPHICAL SETTING: SUSPENDED SEDIMENT IN THE SANTA CLARA RIVER

Sediment transport is the movement of organic and inorganic particles by water. Sediment transport is especially influential on the morphology of Santa Clara River because the watershed has extremely high sediment-production rates (Farnsworth and Warrick 2007, Stillwater Sciences 2011). Production and delivery of sediment to the river are driven by the episodic and intertwined effects of tectonic uplift, rainstorms, wildfires, earthquakes, and human and other disturbances. The watershed is in a tectonically active region, with the San Andreas Fault nearby it experiences episodic earthquakes and tectonic uplift at some of the highest rates in the western United States (Hammond et al. 2017). The rapid uplifting triggers landslides, causing the input of sediment into tributary creeks and eventually the mainstem Santa Clara River. Furthermore, the area is highly affected by wildfires, which makes it more susceptible to sediment runoff when vegetation mass is diminished, and soil permeability altered. This decreases slope stability, which causes high rates of dry ravel on hillslopes (Florsheim et al. 1991). Sediment produced by these conditions is delivered by streamflow from the tributaries to the mainstem Santa Clara River, which flows downstream past the Freeman Diversion to the estuary and the Pacific Ocean. Overall, the watershed's sediment-production rate has been calculated at approximately 9.0 million tons per year, or 5,600 tons per square mile per year, averaged across the entire watershed area (Stillwater Sciences 2011). Considering that the dams on Piru, Castaic, and Bouquet creeks intercept water and sediment from nearly one-third of the total watershed, the predicted sediment-production rate for the watershed is approximately 5.6 million tons per year, or 5,400 tons per square mile per year.

Seasonally intense rainfall and the resulting runoff are the primary mechanisms for sediment transport through the drainage network. Rainfall events can change the morphology of the Santa Clara River, which does not change progressively in response to small floods, but instead experiences significant episodic changes associated with much larger floods (Stillwater Sciences 2007). The amount of sediment available to be transported during storms depends on the grain size of sediment delivered to the river, and the amount of sediment already in the stream channel. This is reflected in the grain size distributions of suspended sediment and bedload in tributary streams. Sediment transported in the river includes silts and clays (Stillwater Sciences 2011). Prediction of sediment loading is complicated by the fact that sediment delivery is episodic, depending on the frequency, magnitude, and relative timing of stochastic events such as storms, fires, landslides, and earthquakes (Stillwater Sciences 2011, Downs et al. 2013).

In addition to sediment contributed by natural events, human activities affect sediment transport, particularly in the lower Santa Clara River. Past activities such as aggregate mining, the construction of dams on tributaries, urban growth, and levee development have interrupted the downstream sediment transport process to the estuary. Aggregate mining was the single largest anthropogenic impact that changed the channel form of the lower Santa Clara River (Stillwater Sciences 2011). Prior to the construction of the Freeman Diversion in 1990, aggregate mining and levee development downstream of the Freeman Diversion contributed to narrowing and deepening of the channel. The construction of the Freeman Diversion stabilized the river's bed elevation on the upstream side of the diversion and eliminated historic downcutting that resulted from the mining operations.

Samples of suspended sediment collected from the Santa Clara River near the Freeman Diversion indicate that sediment concentration typically increases with flow magnitude (Warrick and Mertes 2009, Stillwater Sciences 2011, NHC 2015). Sediment concentrations in the river near the Freeman Diversion increase exponentially with discharge, and for a given discharge are higher earlier in the water year[2] than later (i.e., the early storms carry more wash load) (Stillwater Sciences 2011, NHC 2015). Based upon empirical evidence obtained in recent decades, the lower river conveyed approximately 2 million tons of total sediment load annually, with most sediment transport occurring during the largest flood events of 1969, 1978, 1993 and 2005 (Stillwater Sciences 2011). Sediment transport models indicate that the river has the potential to transport a total sediment load of approximately 400,000 tons per day during a 100-year discharge event near the Freeman Diversion, with most of the sediment made up of very fine to coarse sand (AECOM 2016).

The total sediment load of any given river is composed of bedload (coarse sands and gravels), suspended load (fine sands, silts, and clays), and dissolved load (chemical constituents). Studies conducted on the lower Santa Clara River by the USGS in the 1960s and 1970s observed the total sediment load was composed of approximately 10% bedload (coarse sands and gravels) and the remainder being suspended and dissolved load (fine sands, silts, and clays) (Williams 1979). Most of the total sediment load was transported during only a few days of flood flow each year. During the 1968–1975 water years, approximately 55 percent of the total sediment was transported in two days, and 92 percent was transported in 53 days. Suspended sediment measured as suspended sediment concentration (SSC) in the river at the former Montalvo gaging station between 1969 and 1993 ranged from concentrations of 253 to 91,400 mg/L. The sample data showed a general trend of increasing SSCs with increasing discharge. More recent samples of total suspended solids (TSS) by United Water at the Freeman Diversion headworks and fish bay confirmed these general trends and magnitudes of suspended sediment in the river under varied flow conditions. Figure 1 presents measured TSS concentrations at various flows at sample stations along the lower Santa Clara River.

[2] Water year is defined as the 12-month period from October 1 to September 30 and designated by the calendar year in which it ends (e.g., the water year ending September 30, 2019, is referred to as the "2019 water year")

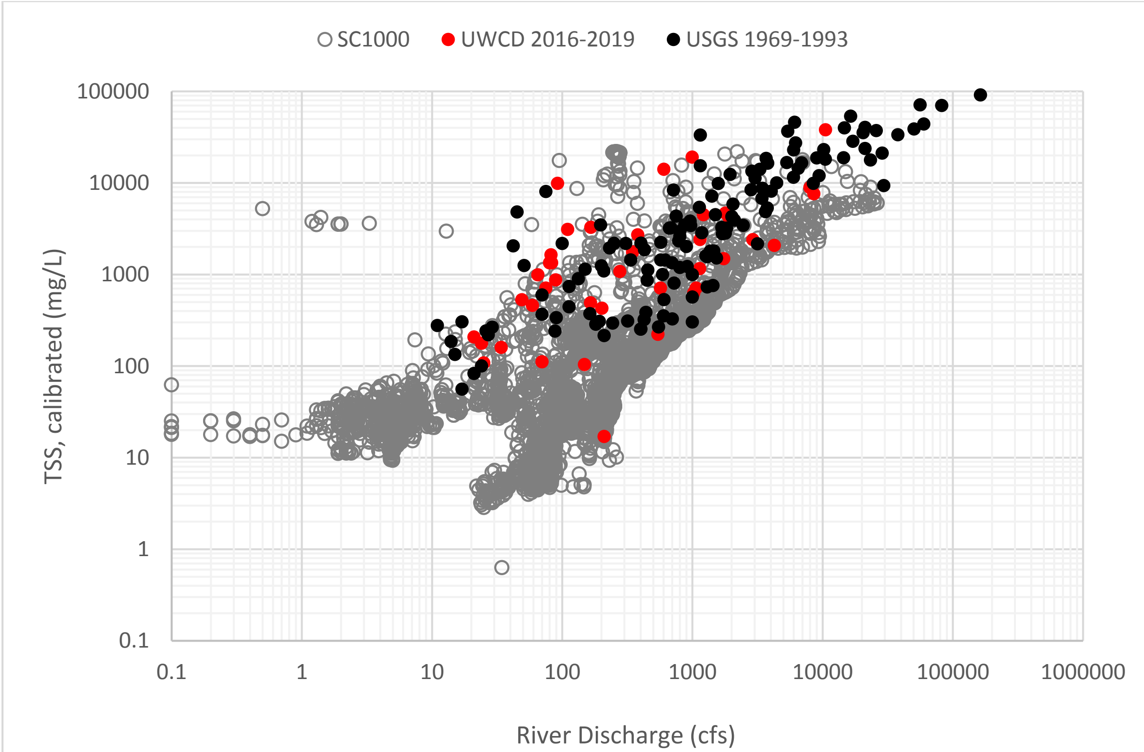

Figure 1. Relationship between measured TSS and Santa Clara River discharge. USGS samples were taken at the Montalvo gaging station (measured in SSC); United samples at the Freeman diversion headworks and fish bay (measured in TSS). SC1000 data were collected by United at the Freeman Diversion since December 2018 (turbidity is measured in NTU and then converted into a measurement of total suspended solids based on empirical relationships; see United 2019)

Sediment transport to the Santa Clara River estuary occurs through both fluvial and littoral processes (Stillwater Sciences 2016). The estuary aggrades and migrates landward during low flows and smaller flood events but can scour and migrate ocean-ward during large flood events. The mouth of the Santa Clara River is often closed with a sand barrier but is breached periodically by high flows during storm events, tidal activity, and anthropogenic breaching. In addition to increased urban developments in the upper watershed, climate change-associated changes in precipitation and fire regimes will likely result in changes to sediment transport in the watershed. The overall sediment transport down the Santa Clara River is expected to decrease because of longer dry periods, but increase during flood events (ESA PWA 2013), especially with increased wildfire frequency and intensity.

4 QUESTION 1: WHAT ARE THE POTENTIAL BEHAVIORAL AND PHYSIOLOGICAL EFFECTS OF SUSPENDED SEDIMENT ON MIGRATING, ADULT STEELHEAD?

4.1 Approach

The goal the current analysis was to fill information gaps and increase certainty in scientific conclusions relevant to addressing the four questions listed in Table 1 while identifying uncertainties. This was accomplished by conducting a review of the best available studies, data, and expert opinion, and synthesizing conclusions from the totality of the information. When information on adult steelhead was not available, then relevant studies on other life stages, other salmonids, and other fish were used to inform the review. While there are marked differences in gross anatomy of fish gills across all types of fishes (Agnathans, Elasmobranchs, and Teleosts), the cellular constituents of the epithelium are remarkably similar (Wilson and Laurent 2002), suggesting comparison among species is informative for understanding suspended sediment effects on gills and respiration across fish taxa.

Behavioral avoidance of physiologically challenging conditions is likely also comparable across taxa; however, steelhead may be even more sensitive to physiological stress compared to other salmonids and may respond accordingly to avoid stress, because they can display iteroparity and have more flexibility in life history strategies (Wingfield and Sapolsky 2003, Øverli et al. 2005, Cook et al. 2014). For these reasons, we feel confident that studies on other salmonids, such as Atlantic salmon, chinook, or coho are informative and relevant for steelhead.

We also considered studies on juvenile salmonids and steelhead if they related to suspended sediment impacts on behavioral and certain relevant physiological end points, such as physiological stress response and respiration. Studies focusing on incubation, juvenile feeding, and juvenile growth were removed from consideration (other than their consideration in review articles), because incubation and juvenile rearing were not relevant to the focal scientific questions. Due to higher sensitivity to suspended sediments, early life stages have been more extensively studied compared to the adult life stage, despite the potential for adverse effects of suspended sediments on the physiology, energetics, and behavior of migrating adult salmonids. In toxicological studies, it is common practice to assume that adults will have higher tolerance for constituents, therefore the synthesis of the information considered that adults may have slightly higher tolerance at each SSC compared to juveniles.

The compiled best available scientific and commercial information that was identified in our review is summarized in Appendix A. Information was classified based on the source (i.e., peer-reviewed, technical report, or expert opinion). All three types of information can inform the best available science with peer-reviewed articles providing the most vetted information in the scientific community, technical reports having less peer vetting but still containing potentially valuable information, and expert opinion demonstrating hypotheses or educated guesses synthesized by experts in the field.

Next, information was categorized by type of study or analysis: experimental manipulation, scientific review/models, and observational/correlational studies. Last, information was evaluated based on the species and life history stage of the fish with more weight given to studies, reports, models, and expert opinion aimed at adult *O. mykiss* (rainbow trout or steelhead). Studies aimed more generally at adult salmonids, studies aimed at juvenile salmonids, and finally general studies of a variety of fish were also considered, but with less weight to inform a better understanding of the broader context of SSC effects on fish, particularly salmonids.

4.2 Results

Based on a review of the scientific literature, the most commonly observed effects of suspended sediment on salmonids include: (1) avoidance of turbid waters in homing adult anadromous salmonids, (2) avoidance or alarm reactions by juvenile salmonids, (3) displacement of juvenile salmonids, (4) reduced feeding and growth, (5) physiological stress and respiratory impairment, (6) damage to gills, (7) reduced tolerance to disease and toxicants, (8) reduced survival, and (9) direct mortality (Newcombe and Jensen 1996). Information regarding reduced feeding and growth was considered irrelevant to the focal study questions and eliminated from further evaluation. The remaining effects are explored in more detail below.

It should be noted that both physiological and behavioral responses of salmonids to suspended sediment are influenced by a variety of factors such as exposure duration and environmental conditions (e.g., temperature, particle size, particle type), both of which are site- and case-specific (Servizi and Martens 1991, Lake and Hinch 1999). Life stage also plays a critical role in the response of salmonids to suspended sediment with adults generally having higher tolerance compared to juvenile and fry stages (Sevizi and Martens 1991), but their tolerance is not infinite.

4.2.1 Physiological Responses

Suspended sediment can influence fish physiology directly (e.g., damage to gills directly affecting respiration) or indirectly by affecting water quality. For example, sediment particles can result in direct gill trauma through abrasion of gills, erosion of gill mucous coating, and accumulation in gill filaments (Berg 1983). Fish can respond to accumulation of sediment in gill filaments by opening and closing the gills (i.e., gill flaring), 'coughing' (interruption in the normal ventilatory cycle, which serves to clean the gills of accumulated particulate matter), and producing additional protective mucous (Berg 1983). Secondary effects from gill trauma include increased energy use and interference with respiration (Berg 1983) and ion exchange (Berg 1983, Redding et al. 1987, Servizi and Martens 1992). Gill tissue injury could also introduce sites where infection could occur. Due to potential impacts of SSCs on gills and associated physiological processes, suspended sediment is considered a stressor (i.e., capable of displacing a fish from homeostasis) and would invoke a physiological stress response in fish. Depending on the magnitude and duration of the stressful event, stress responses can range from minor, short-term changes to physiological process to death (see A.A. Rich and Associates 2010 for a more thorough discussion of stress physiology in general and in fish).

Elevated indices of physiological stress have been shown in salmonids exposed to suspended sediments as indicated by increased corticosteroid, glucose, and hematocrits, and by reduced leukocrit levels (Redding et al. 1987, Lake and Hinch 1999, Berli et al. 2014). The stress response results in secondary effects on fish physiology such as immunosuppression, disruption of ion exchange, and increased energy use, which can reduce growth, reduce reproductive output, and/or ultimately result in mortality (Barton 2002, Schreck et al. 2001). For example, fish exposed to a stressor, such as high concentrations of suspended sediments, may be more susceptible to pathogens that cause disease and ultimately lead to mortality (Redding et al. 1987). Although not well understood, exposure to stressful SSCs may also negatively influence the ability of salmonids to detect olfactory cues used for navigation due to stress-induced damage of the olfactory epithelium or blocking of the nares (i.e., the sensory organ used to detect olfactory cues).

There is an immense body of literature showing that the acute stress response is an adaptive physiological mechanism that allows animals to respond to and cope with acute environmental stressors; while longer term stress responses result in a plethora of poor physiological endpoints, including reproductive suppression, muscle wasting, and impaired immune system function, which can indirectly lead to mortality (Barton 2002, Sapolsky 2004). Being a more long-term impact, chronic stress could affect fish that would otherwise be iteroparous (i.e., a kelt that can reproduce multiple times) versus semelparous (only one reproductive event prior to mortality). If the fish is semelparous, then chronic stress would not change the outcome of the reproductive event, and the fish would likely endure some stress during migration to the spawning grounds as many animals do endure stressful conditions during reproductive effort (e.g., combat for mates, long migrations through adverse conditions, etc.). However, steelhead have been shown to have some level of iteroparity, therefore steelhead may avoid extreme physiological stress when possible, to optimize the chances of spawning later in the current year and/or repeat spawning in subsequent years (Wingfield and Sapolsky 2003, Øverli et al. 2005, Cook et al. 2014).

Suspended sediment also influences water quality, which can have indirect effects on salmonids. Suspended sediment can deplete oxygen in the surrounding water (Bruton 1985, Henley et al. 2000) or can act as a vector for transportation and deposition of contaminants in the environment (Collins et al. 1997). Reduced oxygen concentrations or increased contaminants in water may act cumulatively with other stressors associated with suspended sediment or could attenuate the acute stress response thereby reducing the ability of fish to successfully cope with stress (Lloyd et al. 1987, Barton 2002).

Studies on juvenile rainbow trout have shown that fish may be able to acclimate to elevated SSCs after eight days of exposure and in the absence of physical damage to gills (Michel et al. 2013). Michel et al. (2013) also observed no mortality in rainbow trout exposed to daily pulses of SSCs of 5,000 mg/L after 24 days of exposure, but metabolic changes were observed. There was no observed physical damage to the gills present in Michel et al. (2013) study. However, being a laboratory study, fish were not given the option to respond behaviorally. Avoidance of elevated suspended sediment has been frequently observed in both field and laboratory studies (see ‘Behavioral Responses’ section below for more details) when fish are given the opportunity to behaviorally respond and behavioral avoidance is expected at lower levels of SSC, than the levels that lead to major physiological stress, because animals use behavior to mediate their physiology when needed and when possible.

4.2.2 Behavioral Responses

Some fish have been shown to be attracted to turbid water over clear most likely to avoid predators or to conceal themselves from their prey (Gradall and Swenson 1982, Cyrus and Blaber 1992, both as cited in Wilber and Clarke 2001). Low levels of turbidity can function as cover to reduce predation, not only in riverine, but also in estuary and nearshore marine environments (Gregory and Levings 1998, Wilber and Clarke 2001, Gadomski and Parsley 2005). However, as SSC and turbidity increase, there will be an inherent tradeoff where the camouflaging benefits of turbidity will be outweighed by the physiological impacts of suspended sediment on the fish and fish probably evolved ways to evaluate this tradeoff through olfactory cues that would lead to behavior changes mediated by the physiological stress response.

When salmonids encounter elevated SSCs, they have been shown to display behavioral responses such as avoidance, reduced swimming performance, or cessation of migration depending on exposure magnitude and duration. Studies that have observed increased straying rates during elevated SSCs have hypothesized that increased straying could be caused by avoidance of high suspended sediments rather than an inability to detect olfactory cues (Whitman et al.1982, Leider 1989).

Laboratory experiments have shown that juvenile coho avoid turbid waters (> 70 NTU) in favor of less turbid waters (< 20 NTU) (Berg and Northcote 1985) and swimming performance (U_{crit}) was reduced in juvenile rainbow trout and brown trout exposed to turbidity as low as 13 NTU (~ 110 mg/L SSC) for ~ 1.4 hours (Berli et al. 2014). Based on their results, Berli et al. (2014) inferred that prolonged swimming activity in the wild could be compromised for fish exposed to elevated suspended sediment. In another study that used water choice preference experiments, homing Chinook salmon showed reduced preference for a natal water source when volcanic ash was added at levels of 350 mg/L compared to a non-natal water source with no added volcanic ash (Whitman et al. 1982). These studies used controlled laboratory experiments, which are beneficial for measuring responses to a single variable such as suspended sediment.

Controlled, manipulative field studies that evaluate behavioral responses to suspended sediment in "real-world" conditions are challenging for a variety of reasons: such studies are logistically difficult, statistical power is often limited by low sample sizes, elusive fish behavior in the ocean makes trapping and tagging prior to adult migration challenging, and/or there are permitting challenges for handling threatened or endangered individuals or manipulating their environment. For these reasons, the best available field studies that examine the effects of suspended sediment on fish behavior have been observational rather than experimental.

Additionally, SSCs and flow discharge/velocity are often correlated in real-world systems making it difficult to separate out the effects of suspended sediment from flow. Even with such limitations, the correlations are still informative, particularly because increased flow velocities associated with increased SSCs observed in the field would make a fish work harder during swimming and more strenuous exercise would actually exacerbate the physiological impacts at any given SSC (Barton 2002).

Therefore, we describe the most relevant observational studies below, while acknowledging interpretation limitations, because they represent the best available science to date regarding adult steelhead migration limitations associated with suspended sediment in real-world conditions.

Casitas Municipal Water District (2008) reported that in 2008, the six observed migrating adult steelhead in the Ventura River (adjacent to the Santa Clara River) all migrated upstream following (not during) high flow events, when the turbidity levels at the time of passage ranged from 2 NTU to 22.5 NTU (~100 mg/l SSC). Often high turbidity can limit the effective range of observations in high sediment river systems, but the Vaki Riverwatcher monitoring equipment operated in conditions up to 200 NTU in 2008, meaning no observations of migrating steelhead occurred between 22.6 and 200 NTU despite significant monitoring effort.

Similarly, Thomas R. Payne & Associates (2005) analyzed telemetry tracking data by the CDFW on migration of adult steelhead in the Mad River (northern California) in relation to sediment data from the watershed (collected by Sparkman 2003). From this analysis Thomas R. Payne & Associates (2005) concluded that, "Steelhead movement appeared to be reduced at higher turbidities. There were some movement observations at turbidity values between 400 and 500 NTU while no movement occurred above 500 NTU."

5 QUESTIONS 2 AND 3: AT WHAT RANGE OF SSC ARE MIGRATING, PRE-SPAWNING ADULT STEELHEAD LIKELY TO OR NOT LIKELY TO ACTIVELY SWIM IN AN UPSTREAM DIRECTION IN THE LOWER SANTA CLARA RIVER?

Two alternative hypotheses can explain how steelhead cope with suspended sediment in the Santa Clara River watershed. The first is that southern California steelhead evolved in high sediment systems, and therefore have physiological adaptations that allow them to persist in a high SSC environment. Species- (Kjelland et al. 2015) and population-specific (Berli et al. 2014) responses to suspended sediment have been noted. For example, Berli et al. (2014) exposed one strain of rainbow trout and one strain of brown trout from a common hatchery and a strain of rainbow trout from a different hatchery to elevated suspended sediment and measured behavioral (swimming performance) and related metabolic responses. They found that strains of fish from a common hatchery showed a more similar response to suspended sediment exposure compared to fish of the same species from different hatcheries, which suggests local adaptation to suspended sediment is possible (Berli et al. 2014). However, it should be noted that the study treatments only went up to 440 mg/L. Also, regardless of hatchery origin, all fish in Berli et al. (2014) had decreased swimming performance when exposed to elevated suspended sediment.

An alternative hypothesis is that steelhead have evolved behavioral avoidance of suspended sediment at concentrations that could challenge their survival (e.g., Berg and Northcote 1985, Whitman et al. 1982). It follows, that if a river system demonstrates a correlation between discharge and SSC, there would be ranges of discharge where migrating, pre-spawning, adult steelhead would be expected to: 1) not initiate movement upstream, 2) stop movement upstream and seek refuge, or 3) actively swim in a downstream direction in an attempt to minimize physiological stress, injury, immunosuppression, and/or mortality. Each of these three behaviors would not be compatible with actively swimming in an upstream direction.

Although no studies have experimentally evaluated SSC thresholds specifically for migrating adult steelhead, Newcombe and Jensen (1996) performed a meta-analysis based on 80 published reports of fish responses to suspended sediment in laboratories, streams, and estuaries. Using the 80 studies, Newcombe and Jensen (1996) established a set of six equations that could be used to calculate "severity of ill effect" (SEV) indices (see Table 1 in Newcombe and Jensen 1996), which ranged from zero (no effects) to 14 (80–100% mortality). SEV indices fall under categories for behavioral effects (SEV = 1–3), sublethal effects (SEV = 4–8) and paralethal and lethal effects (SEV = 9–14). The suite of six equations evaluate the effects of suspended sediment (at various concentrations, durations of exposure, and particle sizes) on various taxonomic groups of fishes and life stages of species within those groups. One of the equations is specific to adult salmonids and was based on 63 "experimental units" of testing specific to adult salmonids or similar species.

We applied the equation specific to adult salmonids to predict SEV levels for migrating steelhead across a range of SSCs that are relevant to the Santa Clara River. This analysis assumed a two-day (48-hour) travel time from the ocean to the Freeman Diversion, and therefore an associated two-day exposure duration to a given SSC. Figure 2 shows predicted SEV across SSC based linear regression using adult salmonid data from Newcombe and Jensen 1996 (Table A.1) that was standardized for a two-day exposure duration.

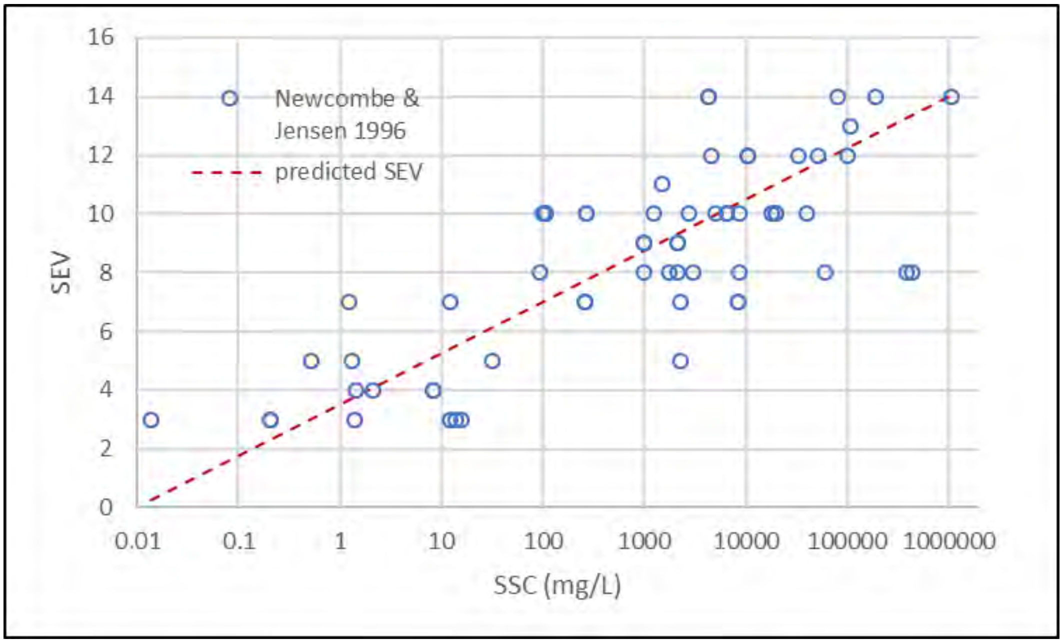

Figure 2 Predicted levels of SEV based on SSCs. Data points represent data for adult salmon taken from Newcombe and Jensen (1996) that were standardized to a two-day (48 hours) exposure duration. The dashed line was fitted using linear regression.

The lowest measured concentrations of suspended sediment in the Santa Clara River are ~3 mg/L, which would equate to an SEV of 4 and is above the level where avoidance responses (SEV 3) are predicted. Most SSC measurements (~ 92%) in the Santa Clara River are greater than 10 mg/L, which is predicted to result in minor physiological stress (SEV 5) with a two-day exposure duration. However, there is scientific literature that suggest that both acclimation and adaptation small to moderate increases in SSC is possible. Also, it is typical for animals to endure some physiological stress during reproductive life history stages, therefore these lower SSCs and associated acute physiological stress probably do not prevent swimming behavior in an upstream direction by a reproductively motivated adult steelhead.

Similarly, moderate physiological stress (SEV 6) and impaired homing (SEV 7) may not stop a reproductively motivated adult fish from swimming upstream during migration, but SSC conditions (40-100 mg/L) that are predicted to have an SEV of 6 or 7 SEV probably require more strenuous effort during swimming for the compared to SSC below 40 mg/L. Under these conditions, repeat reproductive events (kelting) would become less likely if elevated physiological stress does not subside, but adult steelhead would likely still endure even moderate levels of stress when reproductively motivated. This inference is consistent with the data collected by Casitas Municipal Water District that showed adult fish moving through the vertical slot fish ladder when SSC was ~100 mg/L or less.

When exposed to SSC levels at ~500 mg/L for two days (SEV 8), it is inferred that adult salmonids experience major physiological stress. When exposed to SSC levels at ~2,000 mg/L for two days (SEV 9), it is inferred that adult salmonids experience paralethal effects and some mortality may be observed. When exposed to SSC levels at ~ 5,000 mg/L for two days (SEV 10), it is inferred that up to 20% of adult salmonids will experience mortality, with mortality rates inferred to increase as SSC increases above 5,000 mg/L. Major physiological stress is the result of not being able to cope with a stressor and the fish would be on the pathway to mortality unless conditions change or the fish changes its behavior to escape life-threatening conditions. At that juncture, it seems urgent that the fish try to find refuge or swim downstream until it can find safe conditions or the fish risks wasting reproductive effort as well as not having another chance at reproduction. Given that steelhead are likely more sensitive to physiological stress than other salmonids (Cook et al. 2014), they may be even more affected by major physiological stress.

The maximum recorded SSC in the Santa Clara River is ~91,400 mg/L. Up to 60% mortality (SEV 12) is inferred for adult salmonids given two days of exposure at this maximum measured SSC if fish were not able to behaviorally avoid. Physiological feasibility for an adult steelhead to actively swim in an upstream direction in such extreme conditions is highly questionable.

6 QUESTION 4: WHAT ARE THE RANGES OF DISCHARGE IN THE SANTA CLARA RIVER THAT WOULD BE ASSOCIATED WITH THE IDENTIFIED RANGES OF SSC FOR QUESTIONS 2 AND 3?

We applied data collected on discharge and SSC in the Santa Clara River (i.e., all the data points in Figure 1) to estimate ranges of discharge associated with SEV level (n=5,504). Variability is observed across the relationship of SSC and discharge in the Santa Clara River (Figure 1). The unexplained variance is probably a result of natural processes such as differences in sediment mobilization on the rising versus the falling limb of the hydrograph or increased sediment mobilization during storm events that occur earlier in a season or after drought conditions. A range of discharges can carry similar sediment concentrations – which is the variable predictive of SEV effects in this analysis. Hence, there was variability in the relationship between discharge and SEV levels, which is shown in Figure 3 and Table 2.

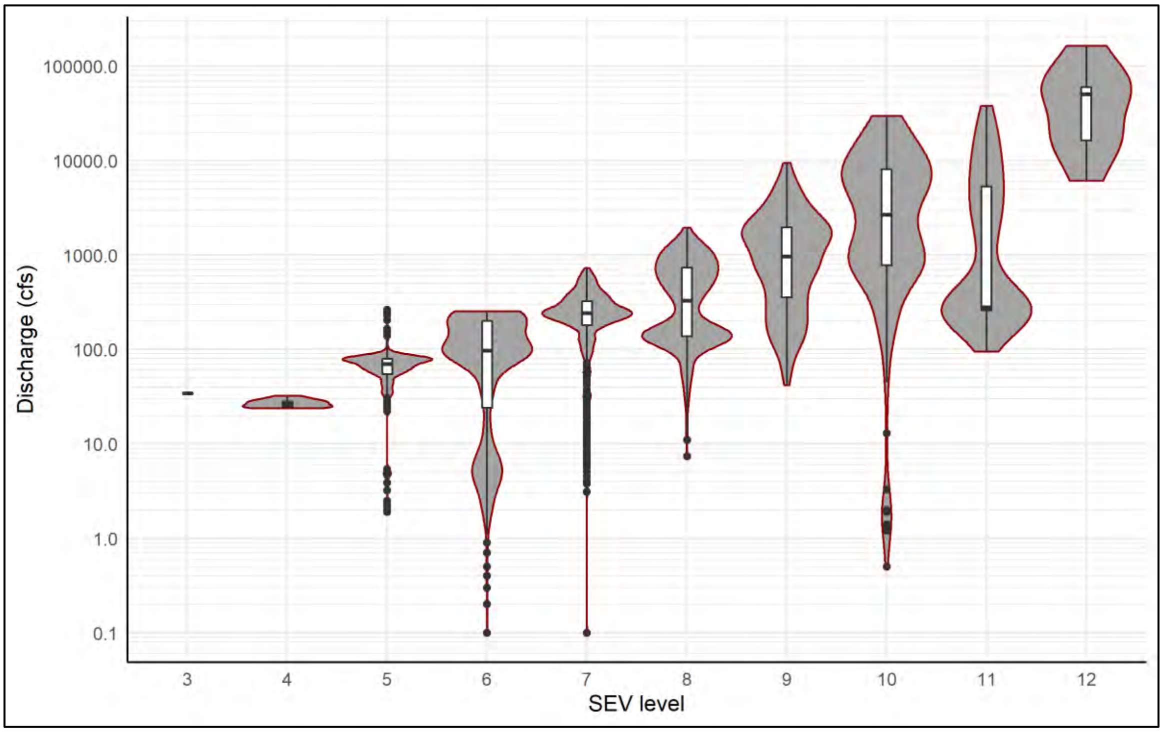

Figure 3. Violin plot showing probability density of discharge in the Santa Clara River associated with each SEV level. Variability in discharge for each SEV level is due to variability in the relationships between discharge and SSC in the Santa Clara River (see Figure 1). The ranges of discharge associated with each SEV level was determined by measured relationships between discharge and SSC in the Santa Clara River. Boxplots within each violin plot show the median and quartiles (all outliers are plotted as individual points).

Table 2. Percentiles of discharge in the Santa Clara River associated with each level of SEV. SEV levels are only presented for those predicted given observed SSC concentrations in the Santa Clara River. A description of each SEV level shown is included.

SEV level	SEV description	Discharge (cfs)				
		5%	25%	50%	75%	95%
3	Avoidance behavior	34	34	34	34	34
4	Sublethal effects begin	24	25	27	28	31
5	Minor physiological stress	5	55	70	80	88
6	Moderate physiological stress	3	24	97	201	235
7	Impaired homing	33	180	242	324	535
8	Major physiological stress	60	138	327	731	1,248
9	Lethal and paralethal effects begin	113	356	960	1,956	4,557
10	0–20% mortality	40	775	2,655	8,130	22,227
11	20–40% mortality	246	260	277	5,300	20,500
12	40–60% mortality	9,540	16,400	50,400	59,800	130,640

Because there is minimal data on adult steelhead migration in the Santa Clara River and there is variability across relationships between SSC and SEV and SSC and discharge, establishing definitive SSC threshold levels (and thus discharge) is challenging. However, using the best available data, we can reasonably infer that migration is less likely when SSC levels result in major physiologic stress (SEV = 8) and especially when there is a risk of mortality (SEV ≥ 9).

Given these assumptions, the above data can be used to interpret ranges of discharge when actively swimming in an upstream direction may be more likely or less likely for adult steelhead in the Santa Clara River. For example, assuming a two-day exposure duration, any discharge above 535 cfs is very likely (95% chance) to be associated with SSC concentrations that would result in impaired homing; any discharge above 1,248 cfs is very likely (95% chance) to be associated with SSC concentrations that would result in major physiological stress; any discharge above 4,557 is very likely (95% chance) to be associated with SSC concentrations that would result in paralethal effects and the onset of lethal effects; and any discharges above 22,227 are very likely (95% chance) to result in some level of mortality (SEV ≥ 10).

However, the flow thresholds are notably lower if we accept the 75% probability as an appropriate level of uncertainty – for example, a discharge above 324 is likely (75% chance) to be associated with SSC concentrations that would result in impaired homing; any discharge above 731 cfs is likely (75% chance) to be associated with SSC concentrations that would result in major physiological stress; any discharge above 1,956 is likely (75% chance) to be associated with SSC concentrations that would result in paralethal effects and the onset of lethal effects; and discharges above 8,130 are likely (75% chance) to result in some level of mortality (SEV ≥ 10).

7 CONCLUSIONS

The goals of this memo were to use the best available scientific and commercial data to answer the four questions in Table 1. Inferences made on the effects of SSC on adult steelhead and associated discharge in the Santa Clara River are summarized in Table 3.

Table 3. Synthesis of quantitative and qualitative conclusions for answers to the focal questions using the best available science

Effect	Suspended sediment concentration (given 2-day exposure time)	Average discharge in the Santa Clara River at Freeman Diversion	Likelihood of adult steelhead actively swimming upstream
Avoidance behavior; minor physiological stress; reduced swimming performance (SEV < 5)	< 40 mg/L	< 500 cfs	Very Likely
Avoidance behavior; moderate physiological stress; reduced swimming performance; impaired homing (SEV 6-7)	40–500 mg/L	88–1,200 cfs	Likely
Avoidance behavior; reduced swimming performance; impaired homing; major physiological stress; reduced tolerance of pathogens; paralethal and lethal effect begin (SEV 8-9)	500–2,000 mg/L	1,200–4,500 cfs	Unlikely
Avoidance behavior; reduced swimming performance; impaired homing; major physiological stress; mortality (SEV >9)	>2,000 mg/L	>4,500 cfs	Very Unlikely

Two types of relationships were explored in this memo: 1) the relationship between SSC and fish response (behavioral and physiological), and 2) the relationship between SSC and discharge in the lower Santa Clara River. Both relationships include uncertainty, with more uncertainty attributed to the relationship between SSC and discharge as observed in Figure 3. Using a 95% confidence level to make inferences from the relationship between SSC and discharge acknowledges uncertainty while providing rigorous guidance for estimating SSC at a given discharge. The best available scientific and commercial data including the meta-analysis by Newcombe and Jensen clearly indicate that fish, including adult steelhead, respond to suspended sediment in their environment. As SSC increases, adult steelhead would experience physiological stress and begin to use behavioral strategies to avoid and minimize stress. However, once SSC exceeds ~1,200 for a duration equivalent to expected transit time between the ocean and the Freeman Diversion (~2 days), it is inferred that adult steelhead would experience major physiological stress, resulting in a high probability that the fish would seek out cleaner water in tributaries, the estuary, or channel margins and cease migrating in an upstream direction until high SSCs subside.

8 REFERENCES

A. A. Rich and Associates. 2010. *Potential Impacts of Re-Suspended Sediments Associated with Dredging and Dredged Material Placement on Fishes in San Francisco Bay, California. Literature Review and Identification of Data Gaps.* Prepared for United States Army Corps of Engineers. San Francisco, CA. July 2010.

AECOM. 2016. *Sediment Transport Analysis Addendum Santa Clara River at Freeman Diversion.* Prepared for United Water Conservation District. Santa Paula, CA. January 2016.

Barton, B. A. 2002. Stress in fish: a diversity of responses with particular references to changes in circulating corticosteroids. Integrative Comparative Biology 42: 517–525

Bash, J., C. H. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. University of Washington Water Center.

Berli, B. I., M. J. Gilbert, A. L. Ralph, K. B. Tierney, and P. Burkhardt-Holm. 2014. Acute exposure to a common suspended sediment affects the swimming performance and physiology of juvenile salmonids. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 176: 1–10.

Berg, L. 1983. Effects of short-term exposure to suspended sediments on the behavior of juvenile coho salmon, MS thesis, Univ. of B.C., Vancouver, Canada.

Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill- flaring, and feeding behaviour in juvenile coho salmon (*Oncohynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1,410–1,417.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. In: Influences of forest and rangeland management on Salmonid fishes and their habitats. American Fisheries Society, Bethesda, MD. Special publication 19: 83–158.

Bruton M. N. 1985. The effects of suspensoids on fish. Hydrobiologia 125: 221–241.

Casitas Municipal Water District. 2008. 2008 Progress Report for the Robles Diversion Fish Passage Facility, Oak View, California.

Clark, T. D., N. B. Furey, E. L. Rechisky, M. K. Gale, K. M. Jeffries, A. D. Porter, M. T. Casselman, A. G. Lotto, D. A. Patterson, S. J. Cooke, A. P. Farrell, D. W. Welch, S. G. Hinch. 2016. Tracking wild sockeye salmon smolts to the ocean reveals distinct regions of nocturnal movement and high mortality. Ecological Applications 26(4): 959–978.

Coats, R., L. Collins, J. Florsheim, and D. Kaufman. 1985. Channel change, sediment transport and fish habitat in a coastal stream: effects of an extreme event. Environmental Management 9: 35–48.

Collins, A. L., D. E. Walling, G. J. L. Leeks. 1997. Source type ascription for fluvial suspended sediment based on a quantitative composite fingerprinting technique. Catena 29: 1–27.

Cook, K. V., G. T. Crossin, D. A. Patterson, S. G. Hinch, K. M. Gilmour, S. J. Cooke. 2014. The stress response predicts migration failure but not migration rate in a semelparous fish. General and Comparative Endocrinology 202: 44–49.

Cyrus, D. P., and S. J. M. Blaber. 1992. Turbidity and salinity in a tropical northern Australian estuary and their influence on fish distribution. Estuarine, Coastal and Shelf Science 35: 545–563.

Downs, P. W., S. R. Dusterhoff, and W. A. Sears. 2013. Reach-scale channel sensitivity to multiple human activities and natural events: lower Santa Clara River, California, USA. Geomorphology 189: 121–134.

ESA PWA (Environmental Science Associates, Phillip Williams & Associates). 2013. Final Coastal Resilience Ventura Technical Report for Coastal Hazards Mapping. Prepared for The Nature Conservancy, Sacramento, California.

Farnsworth, K. L. and J. A. Warrick. 2007. Sources, dispersal, and fate of fine sediment supplied to coastal California: U.S. Geological Survey Scientific Investigations Report 2007–5254.

Florsheim, J., E. A. Keller, and D. W. Best. 1991. Fluvial sediment transport in response to moderate storm flows following chaparral wildlfire, Ventura County, southern California. Geological Society of America Bulletin 103: 504–511.

Gadomski, D. M., and M. J. Parsley. 2005. Effects of turbidity, light level, and cover on predation of white sturgeon larvae by prickly sculpins. Transactions of the American Fisheries Society 134: 369–374.

Gradall, K. S., and W. A. Swenson. 1982. Responses of brook trout and creek chubs to turbidity. Transactions of the American Fisheries Society 111: 392–395.

Gregory, R. S., and C. D. Levings. 1998. Turbidity reduces predation on migrating juvenile Pacific salmon. Transactions of the American Fisheries Society 127: 275–285.

Hammond, W. C., R. J. Burgette, K. M. Johnson, and G. Blewitt. 2017. Uplift of the western Transverse Ranges and Ventura area of southern California: a four-technique geodetic study combining GPS, InSAR, leveling, and tide gauges. Journal of Geophysical Research-Solid Earth, doi: 10.1002/2017JB014499.

Henley W. F., M. A. Patterson, R. J. Neves, A. D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: a concise review of natural resource managers. Reviews in Fisheries Science 8: 125–139.

Herbert, D. W. M., and J. C. Merkens. 1961. The effect of suspended mineral solids on the survival of trout. International Journal of Air and Water Pollution 5/Number 1: 46–55.

Kemp, P., D. Sear, A. Collins, P. Naden, and I. Jones. 2011. The impacts of fine sediment on riverine fish. Hydrological Processes 25: 1,800–1,821.

Kjelland, M. E., C. M. Woodley, T. M. Swannack, and D. L. Smith. 2015. A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioral, and transgenerational implications. Environ. Syst. Decis. 35: 334–350.

Lake, R. G., and S. G. Hinch. 1999. Acute effects of suspended sediment angularity on juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 56: 862–867.

Leider, S. A. 1989. Increased straying by adult steelhead trout (*salmo gardneri*) following the 1980 eruption of Mount St. Helens. Environmental Biology of Fishes 24: 219–229.

Lloyd, D. S., J. P. Koenings, J. D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management 7: 18–33.

Michel C., H. Schmidt-Posthaus, P. Burkhardt-Holm. 2013. Suspended sediment pulse effects in rainbow trout Oncorhynchus mykiss—relating apical and systemic responses. Canadian Journal of Fisheries and Aquatic Sciences 70: 630–641.

Newcombe, C. P., and J. O. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16: 693–727.

Newcombe, C. P., and D. D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11: 72–82.

NHC (Northwest Hydraulic Consultants Inc). 2015. Sediment Transport and Deposition Assessment of the Freeman Diversion Conveyance System. Phase 1: Existing System Performance. Final Report. Project No: 6000088.

NMFS (National Marine Fisheries Service). 2000. Programmatic biological opinion: Proposed regional general permit for stream restoration. NMFS, Northwest Region, Seattle, Washington.

NMFS. 2006. Biological opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation. Interim Operation, Decommissioning, and Removal of the Condit Hydroelectric Project FERC No. 2342 Skamania and Klickitat Counties, Washington. NMFS, Northwest Region, Hydropower Division.

NMFS (National Marine Fisheries Service). 2008a. Final Biological Opinion on the United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility. National Marine Fisheries Service, Southwest Region. 122 pp

NMFS (National Marine Fisheries Service). 2008b. Final Biological Opinion. Issue New License to United Water Conservation District for Operation of the Santa Felicia Hydroelectric Project (P-2153-012). Southwest Region, Long Beach, California.

NMFS (National Marine Fisheries Service). 2012a. Reinitiation of Endangered Species Act Section 7 Formal Consultation for the Elwha River and Fisheries Restoration Project, Clallam County, Washington (5th field HUC 1711002005, Port Angeles Harbor, Strait of Juan de Fuca). NMFS, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2012b. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Meyers Road Bridges Replacement Project, HUC 170300030408 (Yakima River – Town of Zillah),
Yakima County, Washington. NMFS, Northwest Region, Seattle Washington.

NMFS (National Marine Fisheries Service). 2016. Biological Opinion on the Humboldt Bay Federal Navigation Channel Maintenance Dredging. NMFS, West Coast Region, Santa Rosa, California.

Øverli, Ø., S. Winberg, T. G. Pottinger. 2005. Behavioural and neuroendocrine correlates of selection for stress responsiveness in rainbow trout—a review. Integr. Comp. Biol. 45: 463–474.

Pess, G. R., M. L. McHenry, T. J. Beechie, and J. Davies. 2008. Biological impacts of the Elwha River dams and potential salmonid responses to dam removal. Northwest Science 82/Special Issue:72–90.

Redding. J. M., and C. B. Schreck. 1982. Mount St. Helens ash causes sublethal stress responses in steelhead trout. Pages 300–307 *in* Mt. St. Helens: effects on water resources. Washington State University, Washington Water Research Center, Pullman.

Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Transactions of the American Fisheries Society 116: 737–744.

Sapolsky, R. 2004. Why Zebras Don't Get Ulcers (Third Edition). Holt Paperbacks.

Schreck, C. B., W. Contreras-Sanchez, M. S. Fitzpatrick. 2001. Effects of stress on fish reproduction, gamete quality, and progeny. Aguaculture 197: 3–24.

Servizi, J. A., and D. W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. Canadian Journal of Fisheries and Aquatic Sciences 49: 1,389–1,395.

Servizi, J. A., and D. W. Martens. 1991. Effects of Temperature, season, and fish size on acute lethality of suspended sediments to coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 48: 493–497.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113:142-150.

Sparkman, M. D. 2003. Habitat utilization and migration movement of wild and hatchery radio tagged adult winter-run steelhead in the Mad River, Humboldt County, California, November 2001–March, 2003. 2001–2003 Annual Report. CDFG Northcoast Region Project.

Stillwater Sciences. 2007. Santa Clara River Parkway Floodplain Restoration Feasibility Study: analysis of riparian vegetation dynamics for the lower Santa Clara River and major tributaries, Ventura County, California. Prepared for the California State Coastal Conservancy and the Santa Clara River Trustee Council.

Stillwater Sciences. 2011. Geomorphic assessment of the Santa Clara River Watershed, synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, CA. Prepared for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and US Army Corps of Engineers, Los Angeles District.

Stillwater Sciences. 2016. United Water Conservation District Multiple Species Habitat Conservation Plan Study: effects of Freeman Diversion on habitat conditions in the Santa Clara River Estuary. Prepared by Stillwater Sciences, Berkeley, California for United Water Conservation District, Santa Paula, California.

Thomas R. Payne & Associates. 2005. Turbidity and suspended sediment and adult steelhead migration. 19 December 2005 draft report prepared for United Water Conservation District, Santa Paula, California.

USGS (United States Geological Survey). 1979. Sediment Discharge in the Santa Clara Ri ver Basin, Ventura and Los Angeles Counties, California. Water-Resources Investigations 79-78. 51 pages.

United (United Water Conservation District). 2019. Implementation of Continuous Suspended Sediment Monitoring in the Santa Clara River at the Freeman Diversion Headworks. Internal Technical Memo.

Whitman, R. P., T. P. Quinn, and E. L. Brannon. 1982. Influence of suspended volcanic ash on homing behavior of adult chinook salmon. Transactions of the American Fisheries Society 111: 63–69.

Wilber, D. H., and D. G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21: 855–875.

Williams, R. P. 1979. Sediment discharge in the Santa Clara River basin, Ventura and Los Angeles counties, California. U.S. Geological Survey, Menlo Park, California.

Wilson, J. M., and P. Laurent. 2002. Fish gill morphology: inside out. Journal of Experimental Zoology 293: 192–213.

Wingfield, J. C., R. M. Sapolsky. 2003. Reproduction and resistance to stress: when and how. J. Neuroendocrinol 15: 711–724.

Appendices

Appendix A

Best Available Information Related to Suspended Sediment Effects on Salmonids

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
Berg and Northcote 1985	Peer-reviewed	Experiment	Coho	River	Juvenile	Reduced territory defense and increased gill flaring in turbid waters (30 and 60 NTU) compared to lower turbidities (< 20 NTU); (No relation to SSC provided)
Berli et al. 2014	Peer-reviewed	Experiment	Rainbow trout and brown trout	Hatchery	Juvenile	Swimming performance (U_{crit}) reduced when exposed to 13 NTU (~ 110 mg/L) for ~ 1.4 hours
Lake and Hinch 1999	Peer-reviewed	Experiment	Coho	Hatchery	Juvenile	Stress response and gill damage observed after 96-hour exposure to SSC of 40,000 mg/L and mortality observed after exposure to 100,000 mg/L
Michel et al. 2013	Peer-reviewed (Dissertation)	Experiment	Rainbow trout	Hatchery	Juvenile	Rainbow trout can adapt physiologically to 0–5,000 mg/L sediment pulses after 8 days of exposure, and particle pulses over 24 days can cause structural and metabolic changes in rainbow trout, even when gill damage is absent
Redding et al. 1987	Peer-reviewed	Experiment	Steelhead and Coho	Hatchery	Juvenile	Exposure to 2,000-3,000 mg/L for up to 8 days resulted in increased stress levels and reduced tolerance to pathogens
Servizi and Martens 1992	Peer-reviewed	Experiment	Coho	Hatchery	Juvenile; subyearling	Avoidance by 25% of population observed at SSC of 7,000 mg/L for 4 days
Sigler et al. 1984	Peer-reviewed	Experiment	Steelhead	Hatchery	Juvenile	102 mg/L for 336 hours associated with reduced growth rate
Whitman et al. 1982	Peer-reviewed	Experiment	Chinook	Hatchery	Adult	Reduced preference for natal water source when volcanic ash was added at levels of 350 mg/L compared to a non-natal water source with no added volcanic ash
Clark et al. 2016	Peer-reviewed	Observational	Sockeye	River	Juvenile; smolt; migratory	Higher predation rates in clear sections of river compared to turbid sections; hypothesized higher rates of predation by bull trout in clear sections
Newcombe and Jensen 1996	Peer-reviewed	Review/Model	Various Species (including steelhead adults)	Various	Various	Scientific review of SSC on fish; Created models for predicting the severity of ill effects from SSC exposure based on SSC concentrations and exposure duration. Used previously collected data to create model including a model specific to salmonids. Relevant review conclusions from review:

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
						Impaired homing in adult migrating salmonids is predicted at SSC as low as 148 mg/l; adult steelhead exposed to 500 mg/l for 3 hours showed signs of sublethal stress; steelhead exposed to coarse sediment of 2,000 mg/l for one day would experience major physiological stress; exposure up to 10,000 mg/l can be lethal for adult steelhead
Bash et al. 2001	Technical report	Review	Various (including steelhead)	Various	Various	Reviewed literature on SSC effects on fish
Kemp et al. 2011	Peer-reviewed	Review	Freshwater Fish (including steelhead)	River – various	Juvenile and Adult	Literature review of fine sediment effects on riverine fish
Coats et al. 1985	Peer-reviewed	Observational – after a 150-year rain event	Steelhead	River – Zayante Creek, lower San Lorenzo River, CA	Adult	With longer exposures (10 days) to SSCs around 1,600 mg/l, complete avoidance and loss of habitat has been observed
Leider 1989	Peer-reviewed	Observational – following eruption of Mt. St. Helens	Steelhead	River – Columbia River system, WA	Adult	Steelhead bypassed natal streams with high SSC to spawn in upstream tributaries; "Compelling circumstantial evidence suggests that for 1–3 yr after the eruption, large numbers of adult steelhead migrating toward affected tributaries entered two non-affected tributaries flowing into the Columbia River upstream of natal streams."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
Casitas Municipal Water District 2008	Technical Report	Observation	Steelhead (southern California DPS)	River	Adult	Six observed migrating adult steelhead in the Ventura River (adjacent to the Santa Clara River) all migrated upstream following (not during) high flow events, when the turbidity levels at the time of passage through the Robles Diversion ranged from 2 NTU to 22.5 NTU despite the Vaki Riverwatcher monitoring equipment functioning up to 200 NTU; there were no observations of migrating steelhead between 22.6 and 200 NTU (22.5 NTU is associated with ~100 mg/l SSC)
Thomas R. Payne & Associates 2005	Technical Report	Review	Salmonids (including steelhead)	Various	Juvenile and Adult	Review of best available scientific and commercial data as of 2005
Redding et. al. 1987	Technical Report	Experiment	Steelhead	Hatchery	Juvenile	Volcanic ash exposure at 500 mg/L for 3 to 9 hours associated with signs of sublethal stress, blood cell count and chemistry change, elevated plasma cortisol

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
NMFS 2000	Expert Opinion	ESA - Final Biological Opinion for U.S. Army Corps of Engineers Regional General Permit for Stream Restoration	Salmonids	River	Juveniles and Adults	"Elevated Total Suspended Solids (TSS) conditions have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival. Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, and adversely affect survival. Of key importance in considering the detrimental effects of TSS on fish are the frequency and the duration of the exposure (not just the TSS concentration). Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore et al. 1980, Birtwell et al. 1984, Scannell 1988). Salmonids have been observed to move laterally and downstream to avoid turbid plumes (McLeay et al. 1984, 1987, Sigler et al. 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1992). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish need to traverse these streams along migration routes (Lloyd et al. 1987). In addition, a potentially positive reported effect is providing refuge and cover from predation (Gregory and Levings 1988). Turbidity, at moderate levels, has the potential to adversely affect primary and secondary productivity, and at high levels, has the potential to injure and kill adult and juvenile fish, and may also interfere with feeding (Spence et al. 1996). Newly emerged salmonid fry may be vulnerable to even moderate amounts of turbidity (Bjornn and Reiser 1991). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Fine redeposited sediments also have the potential to adversely affect primary and secondary productivity (Spence et al. 1996), and to reduce incubation success (Bell 1991) and cover for juvenile salmonids (Bjornn and Reiser 1991)."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
NMFS 2006	Expert Opinion	ESA – Final Biological Opinion on the Condit Dam Removal	Salmonids, including steelhead	River – White Salmon River, WA	Juveniles and Adults	"Individual salmon and steelhead that cannot avoid the sediment plume during the first 24 hours following dam breaching could experience physiological stress, increase maintenance energy, reduced feeding and growth (juveniles), respiratory impairment, and possibly gill damage (Herbert and Merkens 1961, Redding et al. 1987, Lloyd et al. 1987, Servizi and Martens 1991). The peak TSS concentration is anticipated to last for less than a day in the Columbia River. Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects (Newcombe and MacDonald 1991)."
NMFS 2008a	Expert Opinion	ESA – Final Biological Opinion on United Water Conservation District for Operations of Freeman Diversion Dam	Steelhead	River – Santa Clara River, CA	Adult	"During the wet season, the Santa Clara River is turbid and can exceed 3,000 nephelometric turbidity units… The high turbidity concentrations are of concern because reports suggest high turbidity levels (> 4,000 mg/l) may temporarily halt upstream migration of adult salmonids (Bjornn and Reiser 1991)." Bjornn and Reiser cite Bell (1986), which reported that following a landslide migrating adult salmonids stopped migrating when SSC exceeded 4,000 mg/l. Bell (1990) reports that, "Studies conducted after a natural slide in the Chilcotin River in British Columbia indicated that salmonid fish will not move in streams where the silt content is above 4,000 ppm."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
NMFS 2008b	Expert Opinion	ESA – Final Biological Opinion on United Water Conservation District for Operation of the Santa Felicia Hydroelectric Project	Steelhead	River – Santa Clara River and Piru Creek, CA	Adult	"Low discharge, high water temperature, physical barriers, low dissolved oxygen, and turbidity[3] (high levels) may delay or halt upstream migration of adults and timing of spawning, and downstream migration of juveniles and subsequent entry into the estuary, lagoon, or ocean." Footnote 3: "Defined as "suspended particulate matter affecting the amount of light that is scattered or absorbed by a fluid." With regard to the influence of turbidity on migration of steelhead, the ecological literature provides no unequivocal causal relationship between turbidity and migration. Therefore, whether turbidity in fact influences migration is currently unknown. Challenges related to developing a clear understanding of whether turbidity influences upstream migration of adult steelhead includes (1) the relationship between turbidity and discharge, which can be positively related to one another, and (2) discharge alone has been found to influence migration." "During the wet season, the Santa Clara River is turbid and can exceed 3,000 nephelometric turbidity units. The elevated turbidity probably reflects accelerated inputs of sand and smaller particles due to anthropogenic disturbances throughout the watershed. The high turbidity concentrations are of concern because reports suggest high turbidity levels may temporarily halt upstream migration of adult salmonids (Bjornn and Reiser 1991)."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
NMFS 2012a	Expert Opinion	ESA – Final Biological Opinion on the removal of dams from the Elwha River	Salmonids, including steelhead	River – Elwha River, WA	Juveniles and Adults	"NMFS expects sediment loads to have a serious short-term adverse effect on both winter and (if still extant) summer steelhead populations, particularly those fish residing in the mainstem channel. Suspended sediment loads are expected to increase drastically during the dam removal with in-river peak sediment loads projected to be as high as 51,000 mg/l for 1 to 3 days (Randal et al. 1996), and are expected to be elevated for up to 3 years post dam removal. Sediment loads above 350 mg/l have been shown to increase the rate of straying for Chinook salmon (Whitman et al. 1982, Leider 1989), and may reduce the number of adult returns for spawning for other salmonid species including PS [Puget Sound] steelhead. Loads of 150 mg/l or higher, for [up to an hour], is likely to cause sublethal harm to salmonids within the action area (Newcombe and Jensen 1996). Fish that remain exposed to fine-grained sediment loads above 1000 mg/l for 48 hours or more are likely to experience increased mortality (Newcombe and Jensen 1996)."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
NMFS 2012b	Expert Opinion	ESA – Final Biological Opinion for bridge replacement	Salmonids	River – Yakima River, WA	Juveniles and Adults	"Increased turbidity levels over time can adversely affect the physiology, behavior, and habitat of steelhead. Tissue injury can result from abrasive silt particles entering delicate fish gills, interfering with respiration. Salmon that experience elevated suspended solids have been shown to react with an alarm reaction by abandoning cover and avoiding the area. The resulting stress can affect the parr-smolt transformation, resulting in impaired migratory behavior and reduced early marine survival. Turbidity can also affect feeding rates, reaction distance, prey selection and abundance due to the reduction in visibility. The reduced underwater visual range of fish may either act as a protective cover from predators (e.g. larger fish or piscivorous birds) or reduce the ability of these species to detect predators (Sigler et al. 1984, Bash et al. 2001, Berg and Northcote 1985, Newcombe and Jensen 1996). Elevated turbidity levels that reduce light penetration into water limit primary food production for aquatic life due to lowered photosynthetic activity of algae and rooted plants (Ward 1992)."
NMFS 2016	Expert Opinion	ESA – Final Biological Opinion on dredging in Humboldt Bay	Salmonids	Estuary – Humboldt Bay, CA	Juvenile and Adult	"Concentrations of suspended sediments and associated turbidity that are significantly elevated above the natural level, limit the visibility and successful capture of prey by visual feeders, because prey detection depends on light intensity, water clarity, and prey characteristics such as movement, pigmentation, and size (Clarke and Wilbur 2000, De Robertis et al. 2003)."

Citation	Information type	Experiment/ Observation/ Review/ Model/ Opinion	Species	Origin	Life stage	Relevant results
Berg 1983	Peer-reviewed (Dissertation)	Review	Salmonids	Various	Juvenile	Sediment particles associated with direct gill trauma through abrasion of gills, erosion of gill mucous coating, and accumulation in gill filaments; noted behavioral changes include opening and closing the gills (i.e., gill flaring), 'coughing', and producing additional protective mucous; secondary effects from gill trauma include increased energy use and interference with respiration and ion exchange
Pess et al. 2008	Peer-reviewed	Review/Observational	Salmonids, including steelhead	River – Elwha River, WA	Juvenile and Adult	Sediments released from Elwha dams could lead to increased straying and "barrier" to migration due to turbidity Decrease in spawning habitat quality (short-term)

Appendix F.

Implementation of Continuous Suspended Sediment Monitoring in the Santa Clara River at the Freeman Diversion

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

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IMPLEMENTATION OF CONTINUOUS SUSPENDED SEDIMENT MONITORING IN THE SANTA CLARA RIVER AT THE FREEMAN DIVERSION HEADWORKS

TECHNICAL MEMORANDUM

From: Bram Sercu, Hydrologist

To: Murray McEachron, Senior Hydrologist

Date: August 14, 2019

Introduction

Suspended sediment concentrations in the Santa Clara River are highly variable, ranging from less than 10 mg/L total suspended solids (TSS) during summer baseflow periods, to greater than 10,000 mg/L during peak flows, at the Freeman Diversion facility. Measurement of suspended sediment concentrations at the Freeman Diversion facility is important for quantification of diverted sediment loads as well as for making operational decisions related to halting and resuming diversions ("turning out" and "turning in").

Currently, turnout decisions are partially based on so-called "cone tests", which measure the volume of sediment deposition from a water sample from the Santa Clara River in a sedimentation cone for a given timeframe and after addition of coagulant. However, cone tests are not a standard method, are subject to operator error, and can't provide continuous measurements. Therefore, the feasibility of using optical sensors for measuring suspended sediment concentrations was investigated.

Years ago a continuous optical turbidity sensor (Hach Solitax SC) was installed behind the trash rack at the Freeman headworks. The sensor reports TSS concentrations based on a theoretical conversion calculation. The sensor is serviced quarterly by a Hach technician, including a calibration for turbidity. However, the sensor has frequently reported erroneous data (e.g., constant concentrations during the receding limb), and has not been calibrated using laboratory analysis for TSS.

In December of 2019, the sensor wiper cleaning frequency was increased from once every hour to once every five minutes during storm events, in order to reduce fouling of the sensor at high sediment concentrations and the resulting erroneous readings. Also, the accuracy of the continuous optical sensor measurements were determined by comparing to concentrations obtained from grab samples, collected between 2016 and 2019. Grab samples were analyzed for TSS concentrations by FGL Laboratories, and for turbidity by United staff using a Hach 2100P Portable Turbidimeter.

Results

Figure 1A demonstrates a typical pattern of TSS concentrations during storm events, as reported by the optical sensor prior to 2019. Reported sediment concentrations frequently exhibited step changes, rather than smooth patterns as expected. After increasing the sensor wiper cleaning frequency in 2019, reported sediment concentrations appeared more realistic, in that changes were more gradual (Figure 1B).

Measurements by the optical sensor correlate well with measurements by grab sampling and laboratory analysis, for TSS and turbidity (Figure 2). TSS concentrations measured by the optical sensor were generally slightly higher than those measured by grab sampling. While the exact reason for this discrepancy was not determined, it could be caused by the sampling effects due to slightly different sampling locations, depths and volumes between methods, or by the difference in measurement method (optical vs. gravimetric). Regardless of the cause, the good correlation between the two measurement methods allows for calculation of sediment loads and operation of the Freeman Diversion based on measurements by the optical sensor. An operational rule for turning out has not been defined yet, but based on operations during the 2018-2019 season, it should at minimum include a TSS concentration threshold (e.g. between 5,000 and 20,000 mg/l) in combination with information regarding river flow (magnitude, rising or falling).

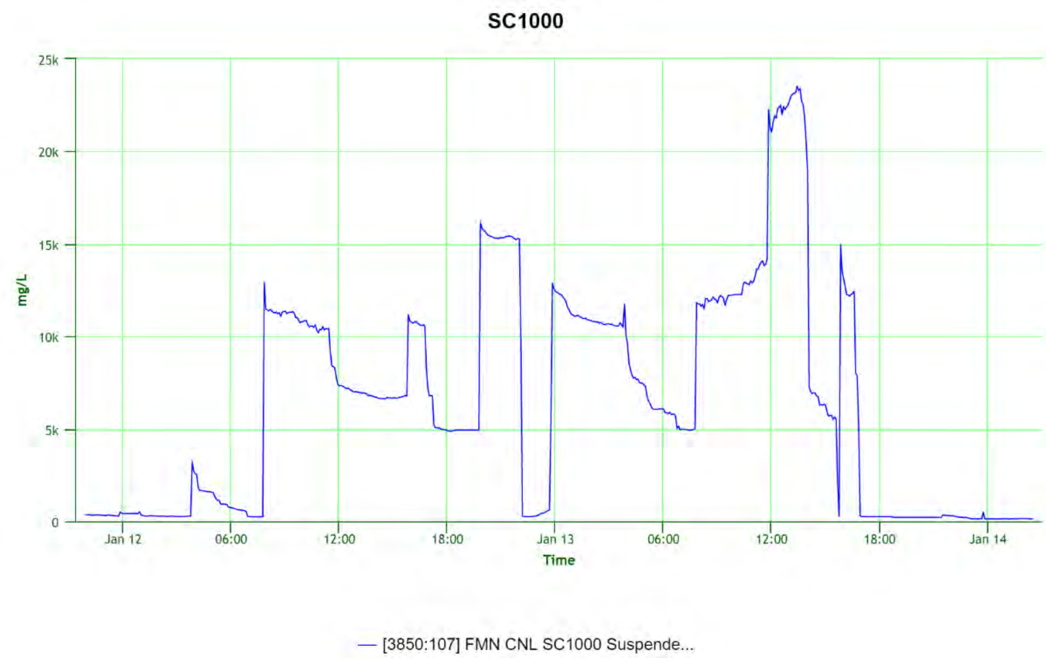
For calculating suspended sediment concentrations and loads, the regression equation shown in Figure 2A can be used. Note that the equation may be updated in the future as more sampling data become available. TSS concentrations measured by the optical sensor could also be used to calculate turbidity based on the equation in Figure 2B, however, this is generally less useful compared to calculating TSS.

Figure 3 illustrates that the optical sensor worked satisfactorily during the 2018-2019 season. Little downtime was experienced, and the TSS concentrations based on grab samples were very close to those reported by the optical sensor.

Conclusions

Continuous measurement of TSS in the Santa Clara River at the Freeman Diversion headworks is feasible using an optical TSS sensor. Sensor measurements are reliable and sufficiently accurate to be incorporated in operational rules for turning out, and for estimating TSS concentrations and loads in the Santa Clara River.

A



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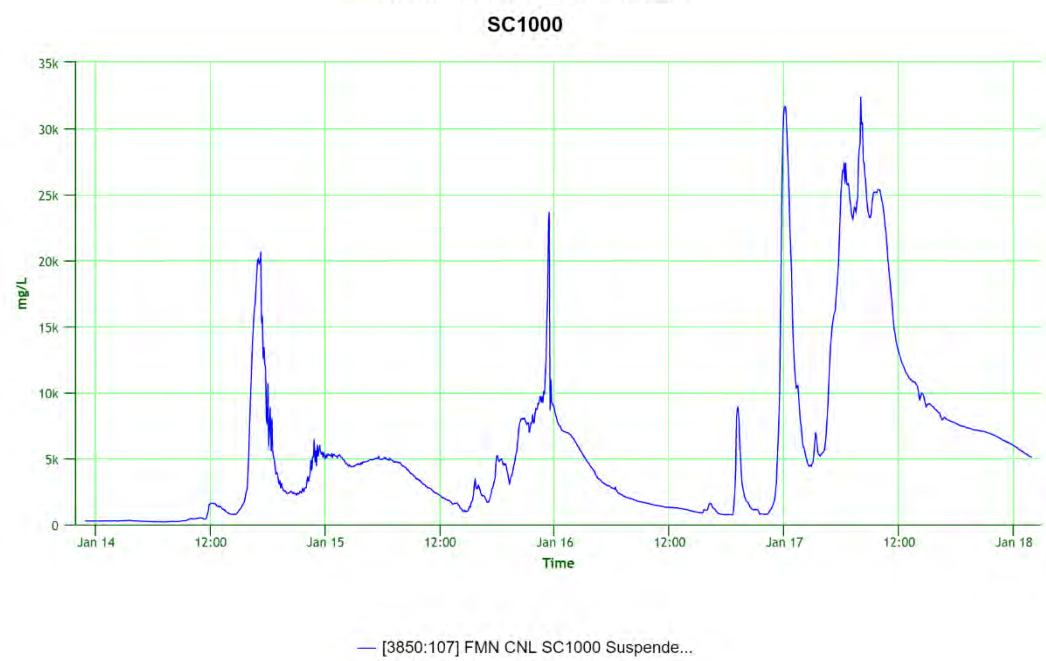
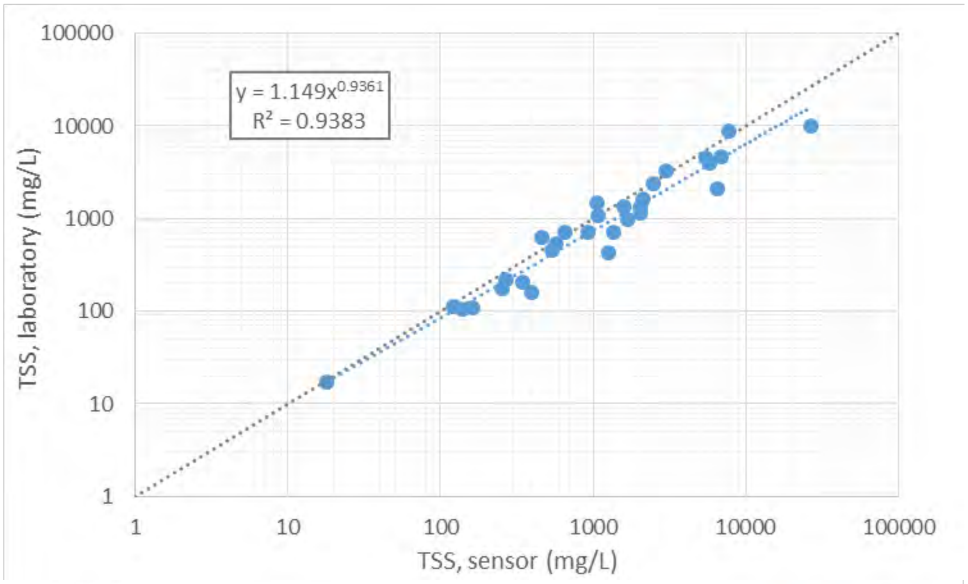


Figure 1. Examples of TSS concentrations reported during storm events by the continuous optical sensor with a one-hour wiper frequency (A) and a five-minute wiper frequency (B).

A



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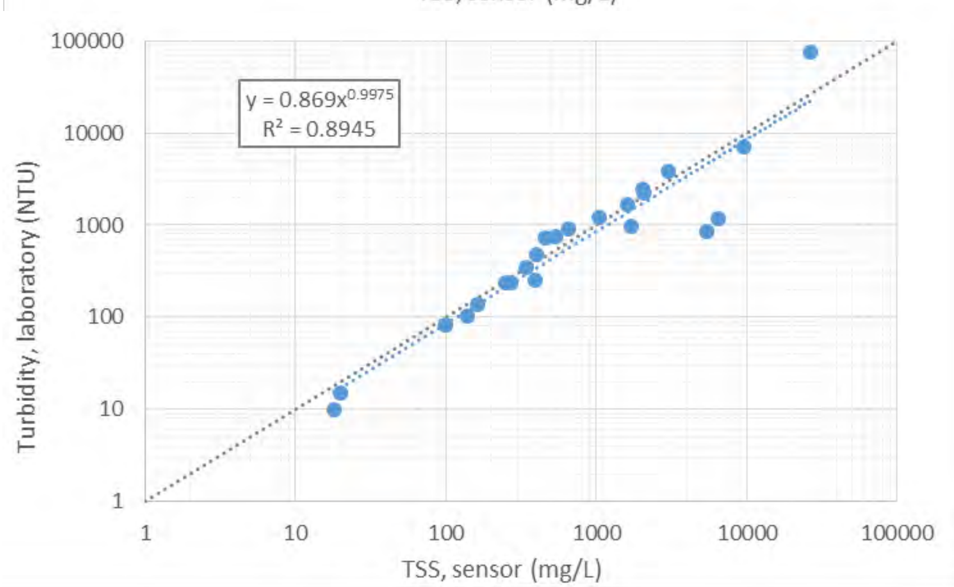

Figure 2. Correlation of measurements by the continuous optical TSS sensor and laboratory measurements of TSS (A) and turbidity (B). Regression curves are indicated by the blue line.

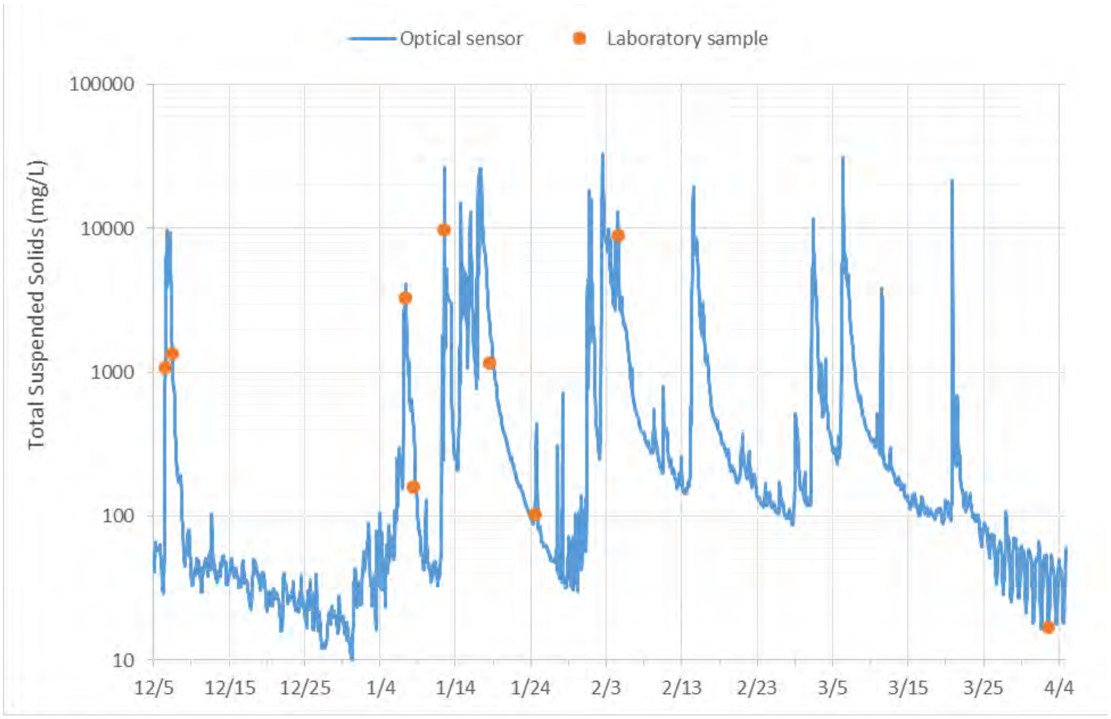

Figure 3. Comparison of TSS concentrations reported by the continuous optical sensor and measurements by grab samples for the 2018-2019 season.

Appendix G

Draft Noise Abatement Protocol

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

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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

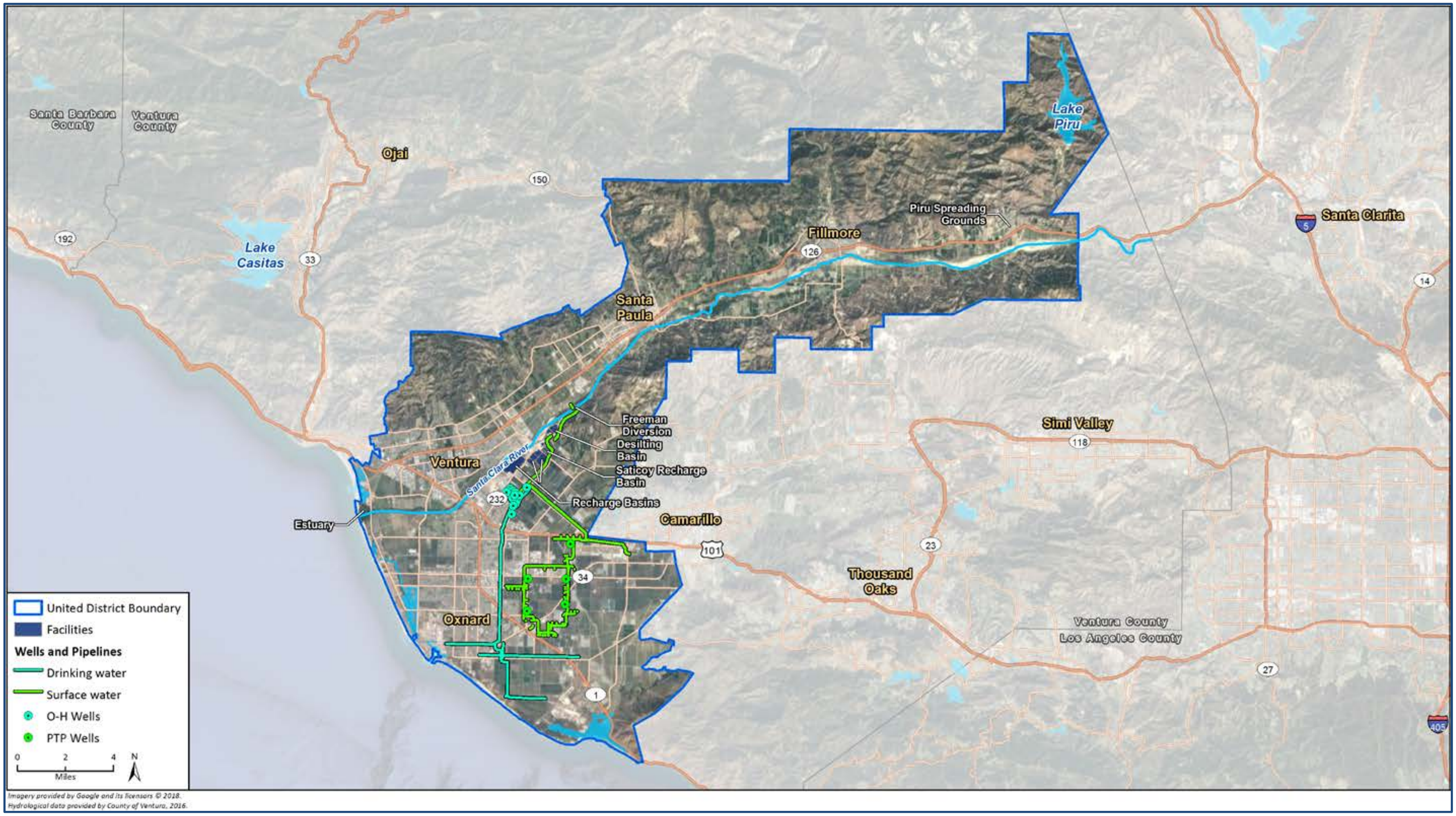
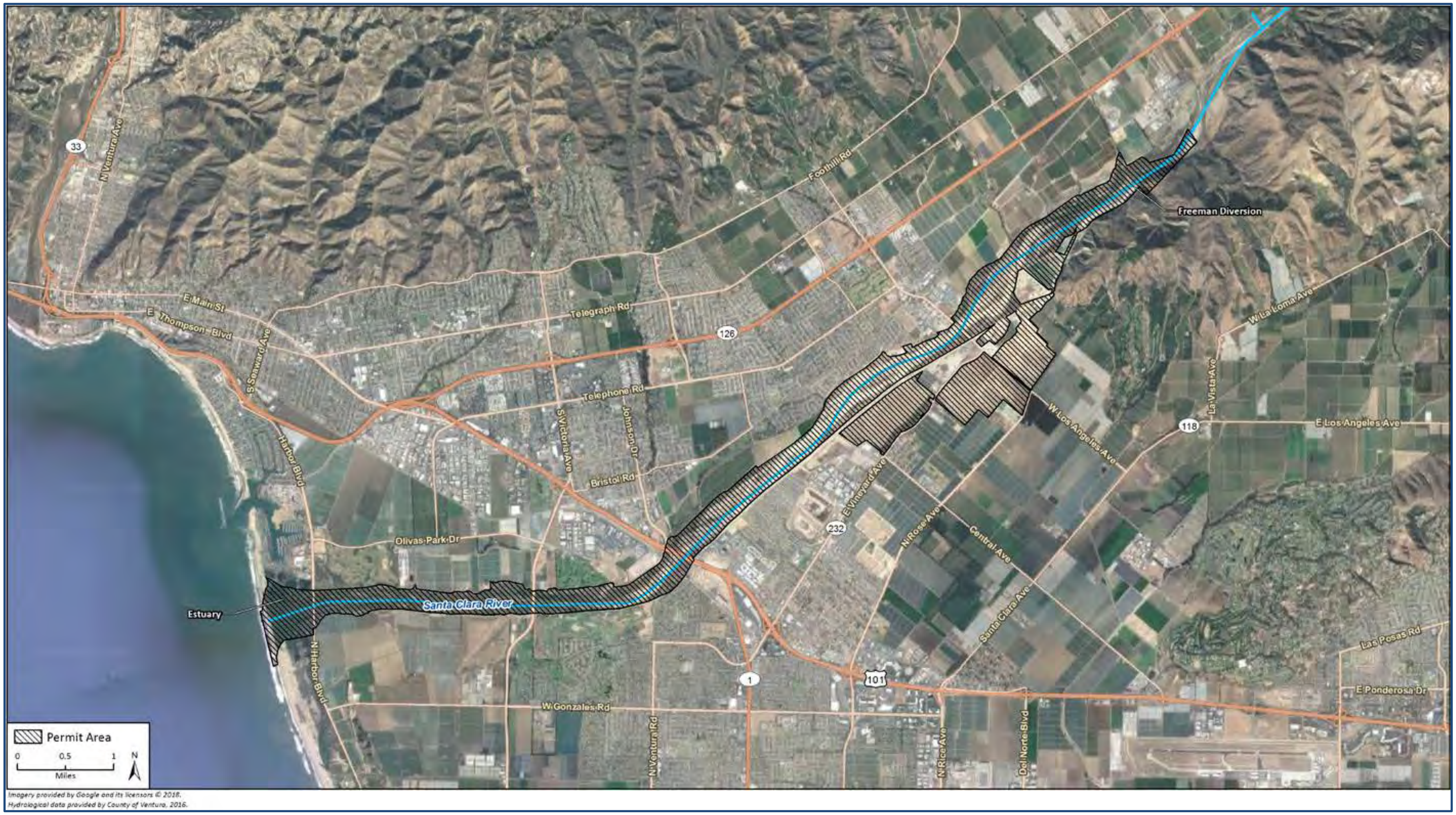


Figure G-2 Plan and Permit Areas



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.

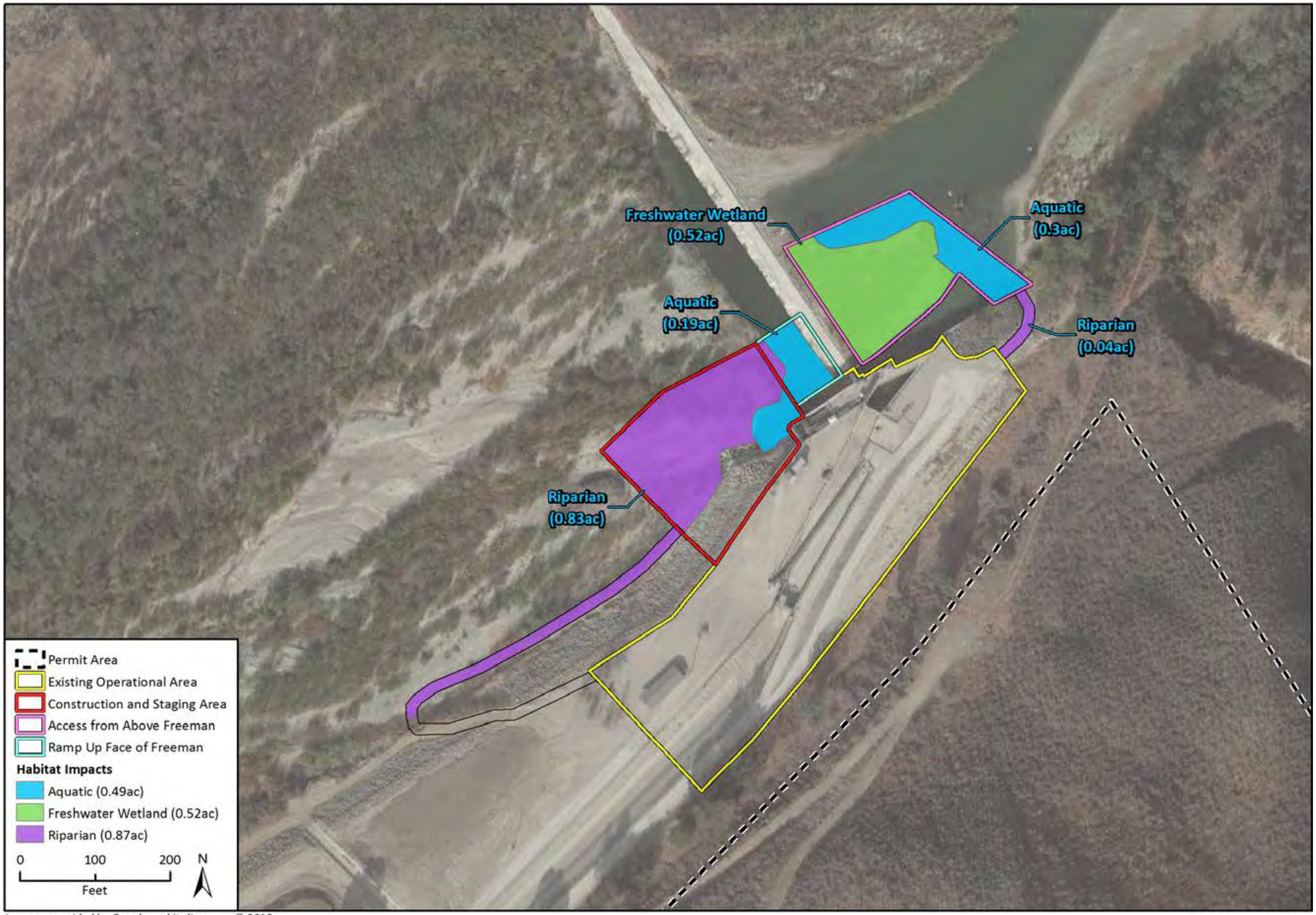
3.1.3 Southern California Steelhead

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



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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.

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			
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

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

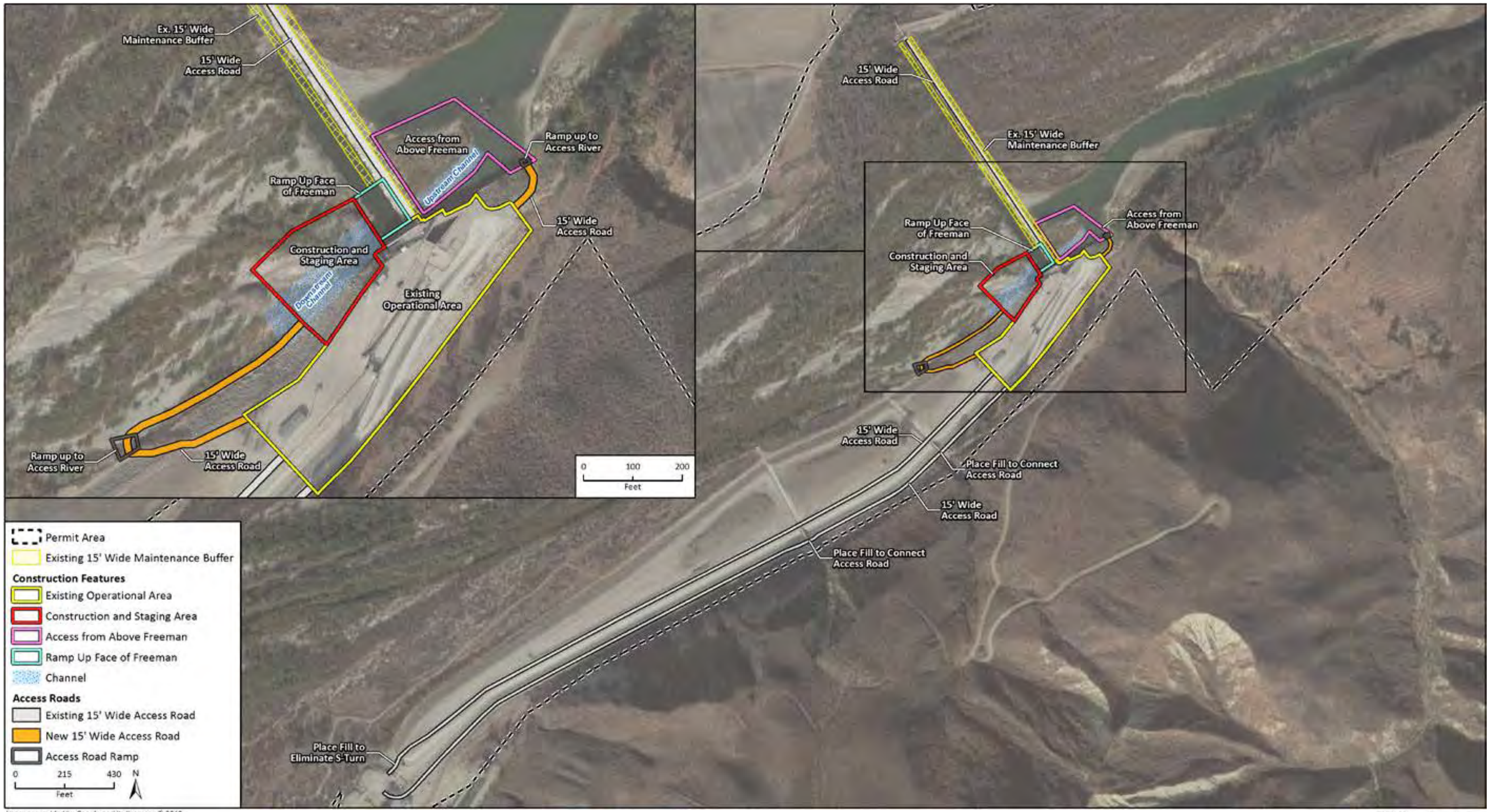
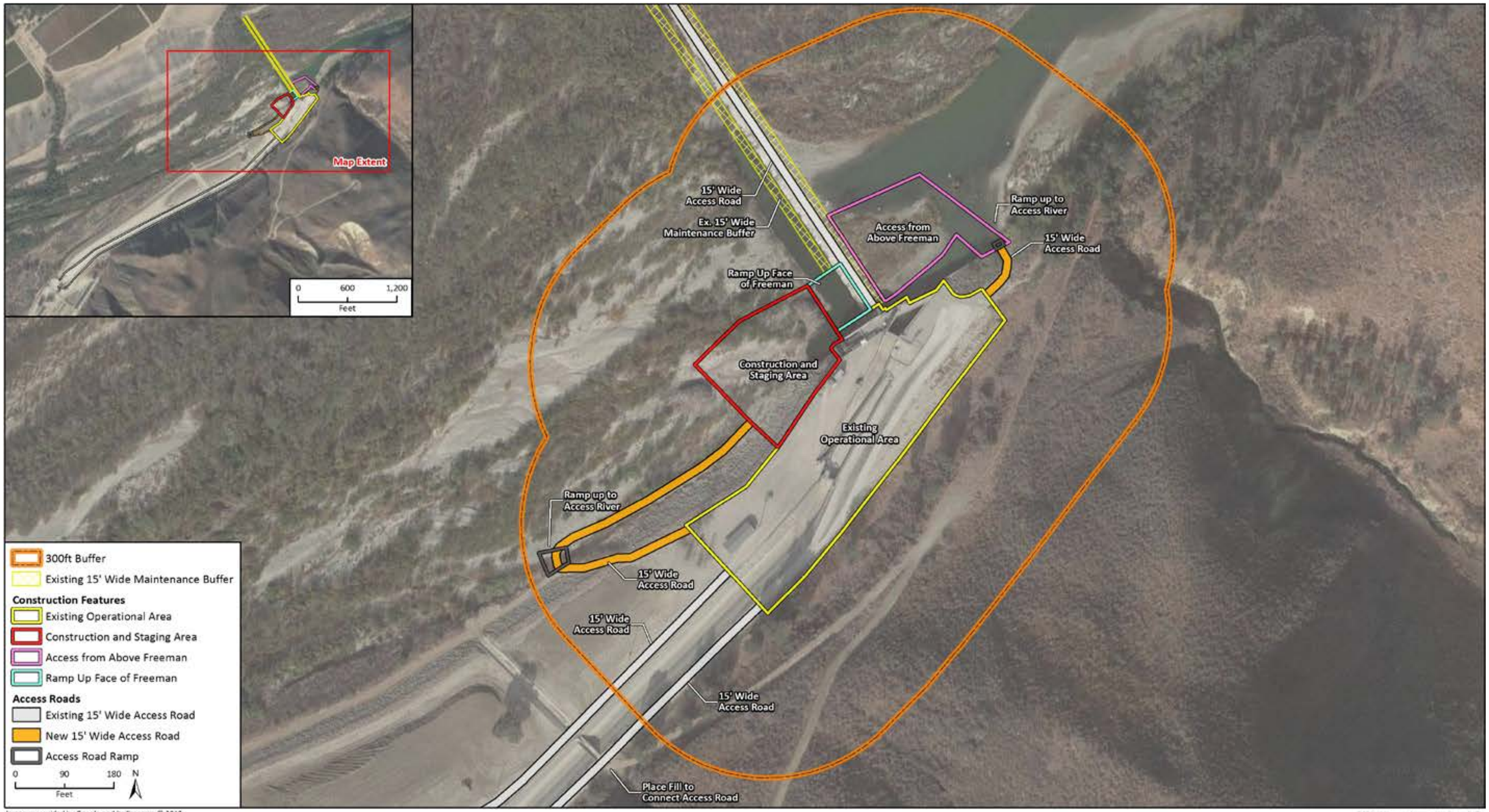


Figure G-5 Construction Area with Integrated 300-foot Resource Buffer



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.

8. REFERENCES

Bowles, A. E. 1995. "Responses of wildlife to noise." *Wildlife and recreationists: Coexistence through management and research.* R. Knight and K. Gutzwiller, eds.. Island Press, Washington, D.C.. 109-156.

Brattstrom, B.H. and M.C. Bondello. 1983. Effects of off-road vehicle noise on desert vertebrates. In R.H. Webb and H.G Wilshire, editors. Environmental effects of Off- Road Vehicles: Impacts and Management in Arid Regions. Springer-Verlag. New York, NewYork, USA

California Department of Transportation (Caltrans). 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Division of Environmental Analysis, Environmental Engineering. Sacramento, CA. November 2, 2015.

Christensen, C. B., Christensen-Dalsgaard, J., Brandt, C. and Madsen, P. T.(2012). Hearing with an atympanic ear: good vibration and poor sound-pressure detection in the royal python, Python regius. J. Exp. Biol. 215, 331-342.

Christensen-Dalsgaard J, C. Brandt, K.L. Willis, C.B. Christensen, D. Ketten D. 2012. "Specialization for underwater hearing by the tympanic middle ear of the turtle, Trachemys scripta elegans." Proceedings of the Royal Society B. *Biological Sciences* 279: 2816–2824.

Cunningham, J. D. 1959. "Reproduction and food of some California snakes." *Herpetologica* 15:17-19.

Dooling, R.J. 1982. "Auditory perception in birds." *Acoustic Communication In Birds (Volume 1*). Academic Press, New York. 95-129.

Federal Highway Administration (FHWA). 2006. *Construction Noise Handbook*. U.S. Department of Transportation, Office of Natural and Human Environment. Washington, D.C.

Francis et al. 2009. "Noise Pollution Changes Avian Communities and Species Interactions", Current Biology 19: 1415-1419

Goodwin, S. E. 2009. *Patch landscape, and soundscape effects on the forest bird community in the USA. National Parks of the National Capital Region*. Unpublished Thesis. University of Delaware, Newark, DE.

Hawkins, A.D., A.N. Popper, and M. Wahlberg, eds. 2008. "International Conference on The Effects of Noise on Aquatic Life." *Bioacoustics* 17:1-350.

Knight, T.A. 1974. "A review of hearing and song in birds with comments on the significance of song in display." *Emu: Austral Ornithology* 74:5-8.

Lovich, Jeff United States Geological Survey. Western Ecological Research Center, Department of Biology, University of California. Riverside, CA 92521- 0427

OGDEN Environmental and Energy Services Company. 1997. Noise Effects on Least Bell's Vireo: Studies of Military Helicopter Activity, Auto Traffic, and Light Rails. Conference on Noise Effects on Passerine Birds. Patrick J. Mock, Ph.D. and Rick Tavares, MSME, MSSE, presenters. San Diego, California January 15, 1997.

Popper, Arthur N. 2005. A Review of Hearing by Sturgeon and Lamprey. Prepared by Environmental BioAcoustics, LLC. Prepared for U.S. Army Corps of Engineers, Portland District. Rockville, MD. August 12, 2005.

Reijnen, R., and R. Foppen. 1995. The effects of car traffic on breeding bird populations in woodland. Influence of population-size on the reduction of density close to a highway. Journal of Applied Ecology 32:481-491.

Reijnen, R., R. Foppen, and H. Meeuwsen. 1996. The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. Biological Conservation 75:255-260.

Rossman, D. A., N. B. Ford, and R. A. Siegel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman. 332pp.

Ruibal, R, L. Tevis, and V. Roig. 1969. The Terrestrial Ecology of the Spadefoot Toad Scaphiopus hammondii. Copeia. 571. 10.2307/1441937.

Sedgwick, J.A., 2000, Willow Flycatcher (Empidonax traillii), in Poole, A., and Gill, F., eds., The Birds of North America, No. 533: The Birds of North America, Inc., Philadelphia, Pennsylvania.

Slabbekoorn, H., and M. Peet. 2003. "Ecology: Birds Sing at a Higher Pitch In Urban Noise - Great Tits Hit the High Notes to Ensure that Their Mating Calls are Heard above the City's Din." *Nature* 424:267-267.

U.S. Fish and Wildlife Service (USFWS). 1999. 64 FR 3915. Endangered and threatened wildlife and plants; proposed threatened status for the Santa Ana sucker. Federal Register 64: 3915-3922

-----. 2000. 65 FR 19868. Endangered and threatened wildlife and plants; threatened status for the Santa Ana sucker. Federal Register 65: 19626-19698

Appendix H.

Freeman Diversion Multiple Species Habitat Conservation Plan – Cost Data

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water
CONSERVATION DISTRICT

"Conserving Water Since 1927"

June 2020

Appendix H MSCHP Cost Data

This appendix provides tables excerpted from the Excel workbooks used to calculate the MSCHP cost estimates presented in Chapter 9, *Funding*. The tables are intended to provide the reader with more detail on the specific assumptions and estimates used in creating the cost estimates.

Tables are organized by the following topics and cost categories:

- **Cost Summary—**Includes a summary of all cost categories below in five-year increments as well as undiscounted total costs. Costs are segmented by capital costs, operating costs, and total program costs. Operating costs are further broken down to show staffing costs for each of the cost categories and other direct conservation measure implementation costs. The cost summary includes line items for the post-permit endowment and the contingency and changed circumstances reserves. All costs are presented in undiscounted current dollars, however the cost summary section also includes a calculation of discounted costs over the 50-year permit term, or net present value.
- **Program Administration—**includes costs not directly related to implementation of the conservation measures, including travel expenses, legal and financial assistance, and costs of published materials, public events, and web development.
- **Migratory Corridor—**Covers CMs 1.1.1 and 1.1.2. Includes capital costs associated with construction of the fish passage facility and long-term costs of its operation and maintenance.
- **Instream Flows and Fish Monitoring—**Covers CMs 1.2.1-1.2.6. Includes staff costs and equipment needed for fish monitoring.
- **Minimizing Species Impacts—**Covers CMs 2.1.1-2.2.2. Includes capital and operating costs for minimizing the impact of building, operation, and maintaining covered projects on covered species.
- **Riparian Restoration and Management—**Covers CMs 2.3.1-2.3.2. Includes habitat restoration activities and implementing the Invasive Brown-headed Cowbird Control Plan.
- **Post-Permit Endowment.** Based on the operations and maintenance costs that will continue beyond the initial 50 years, these tables show the endowment necessary to fund the program in perpetuity, and the annual payments necessary to build the endowment.

The following color coding is used in the cost data appendix to help find important pieces of information.

Total Costs
Endowment Costs
Contingency
Net present value calculations
Staff and Overhead Costs

Freeman Diversion Habitat Conservation Plan Cost Summary

Migratory Corridor Capital Contingency	0%
Construction Contingency	15%
Remaining Contingency	3%

1000s

Total Operating Costs	5-Yr Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Administration	$830	$830	$830	$830	$830	$830	$830	$830	$830	$830	$8,300
Migratory Corridor	$5,681	$6,109	$6,374	$6,149	$6,374	$13,375	$6,374	$6,149	$6,374	$6,149	$69,111
Instream Flows and Fish Monitoring	$1,232	$624	$474	$474	$474	$474	$474	$599	$474	$474	$5,770
Minimizing Species Impact	$1,794	$768	$768	$768	$768	$768	$768	$768	$768	$768	$8,710
Riparian Restoration and Management	$245	$129	$19	$19	$19	$19	$19	$19	$19	$19	$528
Subtotal Staffing & Overhead:	$9,782	$8,461	$8,466	$8,241	$8,466	$15,466	$8,466	$8,366	$8,466	$8,241	$92,419
Average Annual Cost:	$ 1,956	$ 1,692	$ 1,693	$ 1,648	$ 1,693	$ 3,093	$ 1,693	$ 1,673	$ 1,693	$ 1,648	
Endowment Fund	$10	$10	$10	$10	$10	$10	$10	$10	$10	$10	$100
Remaining Contingency	$293	$254	$254	$247	$254	$464	$254	$251	$254	$247	$2,773
Total	$10,086	$8,725	$8,730	$8,498	$8,730	$15,940	$8,730	$8,627	$8,730	$8,498	$95,292

Staffing & Overhead Operating	st by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Administration	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Migratory Corridor	$ 4,417	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 4,392	$ 43,948
Instream Flows and Fish Monitoring	$ 582	$ 474	$ 474	$ 474	$ 474	$ 474	$ 474	$ 599	$ 474	$ 474	$ 4,970
Minimizing Species Impact	$ 1,468	$ 236	$ 236	$ 236	$ 236	$ 236	$ 236	$ 236	$ 236	$ 236	$ 3,590
Riparian Restoration and Management	$ 37	$ 28	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 64
Subtotal Staffing & Overhead:	$ 6,504	$ 5,129	$ 5,102	$ 5,102	$ 5,102	$ 5,102	$ 5,102	$ 5,227	$ 5,102	$ 5,102	$ 52,572
Average Annual Cost:	$ 1,301	$ 1,026	$ 1,020	$ 1,020	$ 1,020	$ 1,020	$ 1,020	$ 1,045	$ 1,020	$ 1,020	

CM Implementation Operating	st by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Administration	$830	$830	$830	$830	$830	$830	$830	$830	$830	$830	$8,300
Migratory Corridor	$1,265	$1,717	$1,982	$1,757	$1,982	$8,983	$1,982	$1,757	$1,982	$1,757	$25,163
Instream Flows and Fish Monitoring	$650	$150	$0	$0	$0	$0	$0	$0	$0	$0	$800
Minimizing Species Impact	$326	$533	$533	$533	$533	$533	$533	$533	$533	$533	$5,120
Riparian Restoration and Management	$208	$102	$19	$19	$19	$19	$19	$19	$19	$19	$464
Subtotal Other Operating Costs:	$ 3,279	$ 3,331	$3,364	$ 3,139	$ 3,364	$ 10,364	$ 3,364	$ 3,139	$ 3,364	$ 3,139	$ 39,847
Average Annual Cost:	$ 656	$ 666	$ 673	$ 628	$ 673	$ 2,073	$ 673	$ 628	$ 673	$ 628	

Capital Costs	st by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Administration	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Migratory Corridor	$86,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$86,000
Instream Flows and Fish Monitoring	$156	$0	$0	$0	$0	$0	$0	$0	$0	$0	$156
Minimizing Species Impact	$1,753	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,753
Riparian Restoration and Management	$80	$0	$0	$0	$0	$0	$0	$0	$0	$0	$80
Subtotal Non-Recurring Capital Costs:	$87,989	$0	$0	$0	$0	$0	$0	$0	$0	$0	$87,989
Average Annual Cost:	$ 17,598	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	
Remaining capital costs	$9,805										
Restoration Construction Contingency	$12	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12
Remaining Contingency	$294	$0	$0	$0	$0	$0	$0	$0	$0	$0	$294
Total Contingency	$306	$0	$0	$0	$0	$0	$0	$0	$0	$0	$306
Total	$88,295	$0	$0	$0	$0	$0	$0	$0	$0	$0	$88,296

Total Program Costs	st by Plan Period										Undiscounted
	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost
Administration	$830	$830	$830	$830	$830	$830	$830	$830	$830	$830	$8,300
Migratory Corridor	$91,681	$6,109	$6,374	$6,149	$6,374	$13,375	$6,374	$6,149	$6,374	$6,149	$155,111
Instream Flows and Fish Monitoring	$1,388	$624	$474	$474	$474	$474	$474	$599	$474	$474	$5,926
Minimizing Species Impact	$3,548	$768	$768	$768	$768	$768	$768	$768	$768	$768	$10,464
Riparian Restoration and Managemen	$325	$129	$19	$19	$19	$19	$19	$19	$19	$19	$608
Grand Total Program Costs:	$97,772	$8,461	$8,466	$8,241	$8,466	$15,466	$8,466	$8,366	$8,466	$8,241	$180,408
Average Annual Cost:	$ 19,554	$ 1,692	$ 1,693	$ 1,648	$ 1,693	$ 3,093	$ 1,693	$ 1,673	$ 1,693	$ 1,648	
Endowment Fund	$10	$10	$10	$10	$10	$10	$10	$10	$10	$10	$100
Restoration Construction Contingency	$12	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12
Remaining Contingency	$588	$254	$254	$247	$254	$464	$254	$251	$254	$247	$3,067
Total Contingency	$600	$254	$254	$247	$254	$464	$254	$251	$254	$247	$3,079
Total	$98,381	$8,725	$8,730	$8,498	$8,730	$15,940	$8,730	$8,627	$8,730	$8,498	$183,587

Discount rate	3%										
Present Value Calculation	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Totals
Capital/One time	$88,295					$ 7,001					$95,296
Annual Recurring	$2,017	$1,745	$1,746	$1,700	$1,746	$1,788	$1,746	$1,725	$1,746	$1,700	$88,291
PV by 5 year increments	$97,534	$5,946	$5,132	$4,310	$3,819	$6,258	$2,842	$2,422	$2,114	$1,775	$132,152

Program Administration Costs

Capital Costs		Pre-Permit Costs	Cost by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	Post Permit Annual Cost
Staff and Overhead													$0	
Vehicle/Mileage Allowance													$0	
Travel													$0	
Legal & Accounting													$0	
Public Relations/Outreach													$0	
Other Administrative Costs													$0	
Capital Subtotal:	**Per Period**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	
	Per Year	NA	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**		

Operational Costs		Pre-Permit Costs	Cost by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	
Staff and Overhead			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Vehicle/Mileage Allowance			$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000	
Travel			$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$300,000	
Legal & Accounting			$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$6,650,000	
Public Relations/Outreach			$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$1,250,000	
Other Administrative Costs			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operational Subtotal:	**Per Period**	**$0**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$8,300,000**	$166,000
	Per Year	NA	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**		

Total Program Administration Costs		Pre-Permit Costs	Cost by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Staff and Overhead			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Vehicle/Mileage Allowance			$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000
Travel			$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$300,000
Legal & Accounting			$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$665,000	$6,650,000
Public Relations/Outreach			$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$1,250,000
Other Administrative Costs			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Program Administration Total:	**Per Period**	**$0**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$830,000**	**$8,300,000**
	Per Year	NA	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	**$166,000**	

Program Administration Costs

Staff and Overhead	Fully Burdened Annual Cost per FTE	Pre-Permit Costs	Number of FTEs by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Project Manager	$303,808		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Hydrology staff member	$330,880		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Associate Ecologist	$228,608		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Field Technician	$225,600		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Staff	$300,800		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Senior Hydrologist	$345,920		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Recharge Worker I	$201,446		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Assistant Ecologist	$214,470		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Environmental Planning & Conservation M	$331,181		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total FTE	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
	Cost per period	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Cost per year	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	

Notes:
Fully burdened annual cost per FTE includes salary and benefits and allowances for salaries and benefits of support staff (e.g. secretaries, IT support) and associated overhead, including space and utility costs, office furniture, equipement, and supplies.

Other Administrative Costs

Vehicle/Mileage Allowance Assumptions:	ost per period	Pre-Permit Costs	Total Cost Per 5-Year Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
annual mileage allowance ($/yr)	$2,000		$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000
annual vehicle allowance ($/yr)													

annual cost based on actual ECCC HCP experience through 2016

Travel Assumptions:	ost per period	Pre-Permit Costs	Total Cost Per 5-Year Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
annual travel expense ($/yr)	$6,000		$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$300,000

annual cost based on actual ECCC HCP experience through 2016

Legal & Accounting Assumptions:	ost per period	Pre-Permit Costs	Total Cost Per 5-Year Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
annual cost for legal assistance	$100,000		$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$5,000,000
annual cost for financial assistance	$13,000		$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	
annual cost for financial audits	$20,000		$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	
cost review/model updates													

annual cost assumption used in ECCC HCP

Public Relations/Outreach Assumptions:	ost per period	Pre-Permit Costs	Total Cost Per 5-Year Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
annual cost for published materials	$5,000		$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$250,000
annual cost for public events	$10,000		$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	
annual cost for web development	$10,000		$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	

annual cost assumption used in ECCC HCP

Other Administrative Costs Assumptions:	ost per period	Pre-Permit Costs	Total Cost Per 5-Year Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Other1			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Migratory Corridor

Capital Costs

		Pre-Permit	Cost by Plan Period										Undiscounted	Post Permit
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost	Annual Cost
Staff and Overhead													$0	
Design/Enviro/Permitting		$0	$7,896,055	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,896,055	
Construction		$0	$78,103,945	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,103,945	
O&M													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Capital Subtotal:	**Per Period**	$0	$86,000,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$86,000,000	
	Per Year	NA	$17,200,000	$0	$0	$0	$0	$0	$0	$0	$0	$0		

Operational Costs

		Pre-Permit	Cost by Plan Period										Undiscounted	
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost	
Staff and Overhead		$0	$4,416,888	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$43,948,091	
Design/Enviro/Permitting													$0	
Construction													$0	
O&M		$0	$1,264,530	$1,717,017	$1,982,017	$1,757,017	$1,982,017	$8,982,561	$1,982,017	$1,757,017	$1,982,017	$1,757,017	$25,163,225	$521,775.37
Empty													$0	
Empty													$0	
Empty													$0	
Operational Subtotal:	**Per Period**	**$0**	**$5,681,417**	**$6,109,373**	**$6,374,373**	**$6,149,373**	**$6,374,373**	**$13,374,917**	**$6,374,373**	**$6,149,373**	**$6,374,373**	**$6,149,373**	**$69,111,316**	
	Per Year	NA	**$1,136,283**	**$1,221,875**	**$1,274,875**	**$1,229,875**	**$1,274,875**	**$2,674,983**	**$1,274,875**	**$1,229,875**	**$1,274,875**	**$1,229,875**		

Total Migratory Corridor Costs

		Pre-Permit	Cost by Plan Period										Undiscounted
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost
Staff and Overhead		$0	$4,416,888	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$4,392,356	$43,948,091
Design/Enviro/Permitting		$0	$7,896,055	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,896,055
Construction		$0	$78,103,945	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,103,945
O&M		$0	$1,264,530	$1,717,017	$1,982,017	$1,757,017	$1,982,017	$8,982,561	$1,982,017	$1,757,017	$1,982,017	$1,757,017	$25,163,225
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Migratory Corridor Total:	**Per Period**	**$0**	**$91,681,417**	**$6,109,373**	**$6,374,373**	**$6,149,373**	**$6,374,373**	**$13,374,917**	**$6,374,373**	**$6,149,373**	**$6,374,373**	**$6,149,373**	**$155,111,316**
	Per Year	NA	**$18,336,283**	**$1,221,875**	**$1,274,875**	**$1,229,875**	**$1,274,875**	**$2,674,983**	**$1,274,875**	**$1,229,875**	**$1,274,875**	**$1,229,875**	

Migratory Corridor **2 of 3**

Staff and Overhead	Fully Burdened Cost per FTE	Pre-Permit Costs	Number of FTEs by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Project Manager	$303,808	0.00	0.67	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
Hydrology staff member	$330,880	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Associate Ecologist	$228,608	0.00	0.10	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
Field Technician	$225,600	0.00	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	
O&M Staff	$300,800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Senior Hydrologist	$345,920	0.00	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
O&M Recharge Worker I	$201,446	0.00	2.01	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	
Assistant Ecologist	$214,470	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Environmental Planning & Conservation Manager	$331,181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Field Assistants	$45,120	0.00	0.05	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
Senior Ecologist	$331,181	0.00	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
Senior Environmental Scientist	$304,710	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Assistant General Manager	$542,944	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Chief Engineer	$455,110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Chief Operations Officer	$430,144	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Chief Water Treatment Operator	$304,410	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Dam Operator	$250,867	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
District Safety Officer/Recharge O&M II	$249,965	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Facilities Maintenance Worker II	$151,904	0.00	0.21	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	
Hydrologist	$261,395	0.00	0.06	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
Instrument & Electrical Technician	$273,126	0.00	0.13	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
Lead Recharge O&M Worker	$256,282	0.00	0.13	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
O&M Manager	$405,178	0.00	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Recharge O&M Worker II	$224,096	0.00	0.15	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Senior Water Treatment Operator	$266,509	0.00	0.09	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
Supervising Instrument & Electrical Tech	$291,776	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Water System Electrician	$249,965	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Water Treatment Operator II	$228,608	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
Water Treatment Operator III	$228,608	0.00	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
Staff Hydrogeologist	$228,909	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Crew	$150,400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total FTE	**0.00**	**3.86**	**4.02**	**4.02**	**4.02**	**4.02**	**4.02**	**4.02**	**4.02**	**4.02**	**4.02**	
	Cost per period	**$0**	**$4,416,888**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$4,392,356**	**$43,948,091**
	Cost per year	**$0**	**$883,378**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	**$878,471**	

Notes:

Fully burdened annual cost per FTE includes salary and benefits and allowances for salaries and benefits of support staff (e.g. secretaries, IT support) and associated overhead, including space and utility costs, office furniture, equipement, and supplies.

Migratory Corridor 3 of 3

Sum of Migratory Corridor Project Costs	Cost Type	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Design/Enviro/Permitting	Capital	$0	$7,896,055	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,896,055
Construction	Capital	$0	$78,103,945	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,103,945
O&M	Operational	$0	$1,264,530	$1,717,017	$1,982,017	$1,757,017	$1,982,017	$8,982,561	$1,982,017	$1,757,017	$1,982,017	$1,757,017	$25,163,225
Total Capital		$0	$86,000,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$86,000,000
Total Operational		$0	$1,264,530	$1,717,017	$1,982,017	$1,757,017	$1,982,017	$8,982,561	$1,982,017	$1,757,017	$1,982,017	$1,757,017	$25,163,225

Cost estimates of individual CM elements

Vertical Slot Fish Passage Facility		Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Design	Design/Enviro /Permitting		$6,300,000										$6,300,000
CEQA	Design/Enviro /Permitting		$586,913										$586,913
NEPA	Design/Enviro /Permitting		$644,200										$644,200
Other Permitting (404/401/LSAA, CESA ITP, CGP)	Design/Enviro /Permitting		$164,942										$164,942
Construction Permits	Design/Enviro /Permitting		$200,000										$200,000
Construction	Construction		$78,103,945										$78,103,945
Maintenance Permits	O&M		$4,582	$4,582	$4,582	$4,582	$4,582	$4,582	$4,582	$4,582	$4,582	$4,582	$45,818
Maintenance--Dewatering, flow rerouting	O&M		$320,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$3,920,000
Routine Maintenance (sediment removal)	O&M		$400,000	$660,000	$700,000	$700,000	$700,000	$700,000	$700,000	$700,000	$700,000	$700,000	$6,660,000
Routine Maintenance (General)	O&M		$429,948	$537,435	$537,435	$537,435	$537,435	$537,435	$537,435	$537,435	$537,435	$537,435	$5,266,863
Routine Maintenance (Veg control)	O&M		$20,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$245,000
Routine Maintenance (bank stabilization/repair)	O&M		$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$90,000	$900,000
Non-routine Maint. (channel bottom)	O&M				$225,000		$225,000		$225,000		$225,000		$900,000
Non-routine Maint. (Fish Screen Replacement)	O&M							$6,300,000					$6,300,000
Non-routine Maint. (Obermeyer gate system)	O&M							$925,544					$925,544

*note all maintenance starts in year 3

Pacific Lamprey Passage Facility		Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Design	Capital		28000										$28,000
empty	empty	$0											$0
empty	empty	$0											$0
empty	empty	$0											$0

NOTES: VS--assume fish screen replacement and obermeyer gate system replacement at year 25. assume repair of channel bottom every 10 years.
Assume 1.5 sediment control events per 5-year period

Instream Flows and Fish Monitoring **1 of 2**

Capital Costs	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	Post Permit Annual Cost
Staff and Overhead												$0	
Design/Enviro/Permitting	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Construction	$0	$156,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$156,000	
O&M												$0	
Empty												$0	
Empty												$0	
Empty												$0	
Empty												$0	
Capital Subtotal: Per Period	**$0**	**$156,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$156,000**	
Per Year	**$0**	**$31,200**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**		

Operational Costs	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	
Staff and Overhead	$0	$581,903	$473,615	$473,615	$473,615	$473,615	$473,615	$473,615	$598,790	$473,615	$473,615	$4,969,617	
Design/Enviro/Permitting												$0	
Construction												$0	
O&M	$0	$650,000	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$800,000	$16,000
Empty												$0	
Empty												$0	
Empty												$0	
Empty												$0	
Operational Subtotal: Per Period	**$0**	**$1,231,903**	**$623,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$598,790**	**$473,615**	**$473,615**	**$5,769,617**	
Per Year	**$0**	**$246,381**	**$124,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$119,758**	**$94,723**	**$94,723**		

Total Instream Flows Costs	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Staff and Overhead	$0	$581,903	$473,615	$473,615	$473,615	$473,615	$473,615	$473,615	$598,790	$473,615	$473,615	$4,969,617
Design/Enviro/Permitting	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction	$0	$156,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$156,000
O&M	$0	$650,000	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$800,000
Empty	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Instream Flows Total: Per Period	**$0**	**$1,387,903**	**$623,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$598,790**	**$473,615**	**$473,615**	**$5,925,617**
Per Year	**$0**	**$277,581**	**$124,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$119,758**	**$94,723**	**$94,723**	

Instream Flows and Fish Monitoring 2 of 2

Staff and Overhead	Fully Burdened Cost per FTE	Pre-Permit Costs	Number of FTEs by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Project Manager	$303,808	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	
Hydrology staff member	$330,880	0.00	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Associate Ecologist	$228,608	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Field Technician	$225,600	0.00	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	
O&M Staff	$300,800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Senior Hydrologist	$345,920	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Recharge Worker I	$201,446	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Assistant Ecologist	$214,470	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Environmental Planning & Conservation M	$331,181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total FTE	**0.00**	**0.49**	**0.41**	**0.41**	**0.41**	**0.41**	**0.41**	**0.41**	**0.49**	**0.41**	**0.41**	
	Cost per period	**$0**	**$581,903**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$473,615**	**$598,790**	**$473,615**	**$473,615**	**$4,969,617**
	Cost per year	**$0**	**$116,381**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$94,723**	**$119,758**	**$94,723**	**$94,723**	

Notes:
Fully burdened annual cost per FTE includes salary and benefits and allowances for salaries and benefits of support staff (e.g. secretaries, IT support) and associated overhead, including space and utility costs, office furniture, equipement, and supplies.

Sum Instream Flows Costs	Cost Type	Pre-Permit Costs	Cost by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Design/Enviro/Permitting	Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction	Capital	$0	$156,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$156,000
O&M	Operational	$0	$650,000	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$800,000
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Cost estimates of individual CM elements

		Pre-Permit Costs	Cost by Plan Period: Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Radio Telemetry equipment	Construction		$56,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$56,000
PIT telemetry equipment	Construction		$100,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$100,000
radio telemetry consultant	O&M		$400,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$400,000
PIT telemetry consultant	O&M		$100,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$100,000
mobile DIDSON surveys, eDNA, other--consultant	O&M		$150,000	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$300,000

Minimizing Species Impact **1 of 2**

Capital Costs

		Pre-Permit	Cost by Plan Period										Undiscounted	Post Permit
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost	Annual Cost
Staff and Overhead														
Design/Enviro/Permitting													$0	
Land Acquisition													$0	
Construction		$0	$1,753,300	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,753,300	
O&M													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Capital Subtotal:	**Per Period**		**$1,753,300**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,753,300**	
	Per Year		**$350,660**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**		

Operational Costs

		Pre-Permit	Cost by Plan Period										Undiscounted	
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost	
Staff and Overhead		$0	$1,468,367	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$3,590,395	
Design/Enviro/Permitting													$0	
Land Acquisition													$0	
Construction													$0	
O&M		$0	$326,000	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$5,120,000	$102,400
Empty													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Operational Subtotal:	**Per Period**	**$0**	**$1,794,367**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$8,710,395**	
	Per Year		**$358,873**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**		

Total Minimizing Species Impact Costs

		Pre-Permit	Cost by Plan Period										Undiscounted
		Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Total Cost
Staff and Overhead		$0	$1,468,367	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$235,781	$3,590,395
Design/Enviro/Permitting		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Land Acquisition		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction		$0	$1,753,300	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,753,300
O&M		$0	$326,000	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$5,120,000
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Min. Species Impact Total:	**Per Period**		**$3,547,667**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$768,448**	**$10,463,695**
	Per Year		**$709,533**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	**$153,690**	

Minimizing Species Impact 2 of 2

0.08

Staff and Overhead	Fully Burdened Annual Cost per FTE	Pre-Permit Costs	Number of FTEs by Plan Period										Undiscounted Total Cost
			Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	
Project Manager	$303,808	0.00	0.90	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	$2,734,272
Hydrology staff member	$330,880	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Associate Ecologist	$228,608	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Field Technician	$225,600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Staff	$300,800	0.00	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	$856,123
Senior Hydrologist	$345,920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Recharge Worker I	$201,446	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Assistant Ecologist	$214,470	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Environmental Planning & Conservation I	$331,181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total FTE	**0.00**	**0.97**	**0.16**	**0.16**	**0.16**	**0.16**	**0.16**	**0.16**	**0.16**	**0.16**	**0.16**	
	Cost per period	**$0**	**$1,468,367**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$235,781**	**$3,590,395**
	Cost per year	**$0**	**$293,673**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	**$47,156**	

Notes:

Fully burdened annual cost per FTE includes salary and benefits and allowances for salaries and benefits of support staff (e.g. secretaries, IT support) and associated overhead, including space and utility costs, office furniture, equipement, and supplies.

Sum of Minimizing Species Impact Project Costs	Cost Type	Pre-Permit Costs	Cost by Plan Period										Undiscounted Total Cost
			Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	
Design/Enviro/Permitting	Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction	Capital	$0	$1,753,300	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,753,300
O&M	Operational	$0	$326,000	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$5,120,000
Total Capital		$0	$1,753,300	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,753,300
Total Operational		$0	$326,000	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$532,667	$5,120,000

Cost estimates of individual CM elements

		Pre-Permit Costs	Cost by Plan Period										Undiscounted Total Cost
			Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	
2.1.1 BMP: QSP Staff for SWPP monitorin	Construction		$50,400										$50,400
2.1.2 WEAT pamphlet	Construction		$3,600										$3,600
2.1.2 WEAT initial session	Construction		$1,200										$1,200
2.1.2 WEAT as-need construction	Construction		$9,600										$9,600
2.1.2 WEAT maintenance sessions	O&M		$14,400	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$230,400
2.1.3 all species surveys (bird, terr., fish a	Construction		$41,200										$41,200
2.1.3 all species surveys (bird, terr., fish a	O&M		$168,000	$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$280,000	$2,688,000
2.1.5 Noise Monitoring equipment	Construction		$22,000										$22,000
2.1.5 Noise Monitoring equipment	O&M		$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$60,000
2.1.5 Straw bale walls	Construction		$82,500										$82,500
2.1.5 Straw bale walls	O&M		$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000
2.1.6 Biological Monitoring	Construction		$846,800										$846,800
2.1.6 Diversion Check	Construction		$32,480										$32,480
2.1.6 Diversion Check	O&M		$5,800	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$92,800
2.1.6 WQ monitoring	Construction		$32,480										$32,480
2.1.6 WQ monitoring	O&M		$5,800	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$9,667	$92,800
2.1.6 WQ ESA check	Construction		$32,480										$32,480
2.1.6 WQ ESA check	O&M		$29,000	$48,333	$48,333	$48,333	$48,333	$48,333	$48,333	$48,333	$48,333	$48,333	$464,000
2.1.6 WQ Nesting bird monitoring	Construction		$598,560										$598,560
2.1.6 WQ Nesting bird monitoring	O&M		$87,000	$145,000	$145,000	$145,000	$145,000	$145,000	$145,000	$145,000	$145,000	$145,000	$1,392,000

Riparian Restoration and Management **1 of 2**

Capital Costs		Pre-Permit Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	Post Permit Annual Cost
			Cost by Plan Period											
Staff and Overhead														
Design/Enviro/Permitting													$0	
Land Acquisition			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Construction		$0	$80,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$80,000	
O&M													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Capital Subtotal:	**Per Period**	**$0**	**$80,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$80,000**	
	Per Year	NA	**$16,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**		

Operational Costs		Pre-Permit Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost	
			Cost by Plan Period											
Staff and Overhead		$0	$36,544	$27,578	$0	$0	$0	$0	$0	$0	$0	$0	$64,122	
Design/Enviro/Permitting			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Land Acquisition													$0	
Construction													$0	
O&M			$208,200	$101,700	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$463,500	$3,840
Empty													$0	
Empty													$0	
Empty													$0	
Empty													$0	
Operational Subtotal:	**Per Period**	**$0**	**$244,744**	**$129,278**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$527,622**	
	Per Year	NA	**$48,949**	**$25,856**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**		

Total Restoration and Management Costs		Pre-Permit Costs	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
			Cost by Plan Period										
Staff and Overhead			$36,544	$27,578	$0	$0	$0	$0	$0	$0	$0	$0	$64,122
Habitat Restoration		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Land Acquisition		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction		$0	$80,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$80,000
O&M		$0	$208,200	$101,700	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$463,500
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rest/Mgmt Total:	**Per Period**	**$0**	**$324,744**	**$129,278**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$19,200**	**$607,622**
	Per Year	NA	**$64,949**	**$25,856**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	**$3,840**	

Riparian Restoration and Management

Staff and Overhead	Fully Burdened Annual Cost per FTE	Pre-Permit Costs	Number of FTEs by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40 (0.08)	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Project Manager	$303,808	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Hydrology staff member	$330,880	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Associate Ecologist	$228,608	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Field Technician	$225,600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Staff	$300,800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Senior Hydrologist	$345,920	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
O&M Recharge Worker I	$201,446	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Assistant Ecologist	$214,470	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Environmental Planning & Cons	$331,181	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total FTE	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
	Cost per period	**$0**	**$36,544**	**$27,578**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$64,122**
	Cost per year	**$0**	**$7,309**	**$5,516**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	

Notes:
Fully burdened annual cost per FTE includes salary and benefits and allowances for salaries and benefits of support staff (e.g. secretaries, IT support) and associated overhead, including space and utility costs, office furniture, equipement, and supplies.

Sum of Restoration and Management	Cost Type	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Design/Enviro/Permitting	Capital	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction	Capital	$0	$80,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$80,000
O&M	Operational	$0	$208,200	$101,700	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$463,500
Total Capital		$0	$80,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$80,000
Total Operational		$0	$208,200	$101,700	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$463,500

Cost estimates of individual CM elements

Restoration and Management Costs	Cost Type	Pre-Permit Costs	Cost by Plan Period Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20	Yrs 21-25	Yrs 26-30	Yrs 31-35	Yrs 36-40	Yrs 41-45	Yrs 46-50	Undiscounted Total Cost
Grading and site prep	Construction	$0	$2,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,000
Temp irrigation	Construction	$0	$10,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,000
Plant and Seed materials	Construction	$0	$40,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$40,000
Invasive Brown-headed Cowbir	Construction	$0	$28,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$28,000
Maintenance (3x per year @13,	O&M	$0	$165,000	$82,500	$0	$0	$0	$0	$0	$0	$0	$0	$247,500
CM2.3.1 Reporting (contracted	O&M	$0	$24,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$24,000
CM2.3.1 Monitoring (contracte	O&M	$0	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$19,200	$192,000
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
empty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Post-Permit Endowment

Nominal Rate of Return	4.0%
Inflation Rate	2.0%
Real Rate of Return	4.0%
Post-Permit Withdrawal %	3.8%

Table 9-31

Cost Category	Annual post-permit cost
Administration	$166,000
Migratory Corridor	$522,000
Instream Flows	$16,000
Minimizing Species Impact	$102,000
Restoration and Management	$4,000
TOTAL	$810,000

Post Permit Annual Expenditure in 2020 $	$ 810,000
Post Permit Annual Expenditure (w contingency)	$834,300
Post Permit Annual Expenditure (w contingency) accounting for 2% ir	**$2,479,315**
Initial Year of HCP	2023

mark	**$64,462,187**
annual payment to meet target value	**$406,000**

Endowment Funding — Assumes Contributions and Withdrawals occur at beginning of each period.

Plan Year	Beginning Balance	Contributions	Withdrawals	Investment Return	Ending Balance
1	$0	$406,000	$0	$16,240	$422,240
2	$422,240	$406,000	$0	$33,130	$861,370
3	$861,370	$406,000	$0	$50,695	$1,318,065
4	$1,318,065	$406,000	$0	$68,963	$1,793,028
5	$1,793,028	$406,000	$0	$87,961	$2,286,989
6	$2,286,989	$406,000	$0	$107,720	$2,800,709
7	$2,800,709	$406,000	$0	$128,268	$3,334,978
8	$3,334,978	$406,000	$0	$149,639	$3,890,617
9	$3,890,617	$406,000	$0	$171,865	$4,468,482
10	$4,468,482	$406,000	$0	$194,979	$5,069,462
11	$5,069,462	$406,000	$0	$219,018	$5,694,480
12	$5,694,480	$406,000	$0	$244,019	$6,344,500
13	$6,344,500	$406,000	$0	$270,020	$7,020,520
14	$7,020,520	$406,000	$0	$297,061	$7,723,581
15	$7,723,581	$406,000	$0	$325,183	$8,454,765
16	$8,454,765	$406,000	$0	$354,431	$9,215,195
17	$9,215,195	$406,000	$0	$16,240	$422,240
18	$422,240	$406,000	$0	$33,130	$861,370
19	$861,370	$406,000	$0	$50,695	$1,318,065
20	$1,318,065	$406,000	$0	$68,963	$1,793,028
21	$1,793,028	$406,000	$0	$87,961	$2,286,989
22	$2,286,989	$406,000	$0	$107,720	$2,800,709
23	$2,800,709	$406,000	$0	$128,268	$3,334,978
24	$3,334,978	$406,000	$0	$149,639	$3,890,617
25	$3,890,617	$406,000	$0	$171,865	$4,468,482
26	$4,468,482	$406,000	$0	$194,979	$5,069,462
27	$5,069,462	$406,000	$0	$219,018	$5,694,480
28	$5,694,480	$406,000	$0	$244,019	$6,344,500
29	$6,344,500	$406,000	$0	$270,020	$7,020,520
30	$7,020,520	$406,000	$0	$297,061	$7,723,581
31	$7,723,581	$406,000	$0	$325,183	$8,454,765
32	$8,454,765	$406,000	$0	$354,431	$9,215,195
33	$9,215,195	$406,000	$0	$384,848	$10,006,044
34	$10,006,044	$406,000	$0	$416,482	$10,828,526
35	$10,828,526	$406,000	$0	$449,381	$11,683,907

36	$11,683,907	$406,000	$0	$483,596	$12,573,503
37	$12,573,503	$406,000	$0	$519,180	$13,498,684
38	$13,498,684	$406,000	$0	$556,187	$14,460,871
39	$14,460,871	$406,000	$0	$594,675	$15,461,546
40	$15,461,546	$406,000	$0	$634,702	$16,502,248
41	$16,502,248	$406,000	$0	$676,330	$17,584,579
42	$17,584,579	$406,000	$0	$719,623	$18,710,202
43	$18,710,202	$406,000	$0	$764,648	$19,880,850
44	$19,880,850	$406,000	$0	$811,474	$21,098,325
45	$21,098,325	$406,000	$0	$860,173	$22,364,498
46	$22,364,498	$406,000	$0	$910,820	$23,681,318
47	$23,681,318	$406,000	$0	$963,493	$25,050,811
48	$25,050,811	$406,000	$0	$1,018,272	$26,475,084
49	$26,475,084	$406,000	$0	$1,075,243	$27,956,327
50	$27,956,327	$406,000	$0	$1,134,493	$29,496,821 << End of Permit

Post-Permit Endowment

Plan Year	Beginning Balance	Contributions	Withdrawals	Investment Return	Ending Balance	
51	$29,496,821	$0	-$2,479,315	$1,080,700	$28,098,206	<< Begin of Post-Permit
52	$28,098,206	$0	-$2,479,315	$1,024,756	$26,643,647	
53	$26,643,647	$0	-$2,479,315	$966,573	$25,130,905	
54	$25,130,905	$0	-$2,479,315	$906,064	$23,557,654	
55	$23,557,654	$0	-$2,479,315	$843,134	$21,921,472	
56	$21,921,472	$0	-$2,479,315	$777,686	$20,219,844	
57	$20,219,844	$0	-$2,479,315	$709,621	$18,450,150	
58	$18,450,150	$0	-$2,479,315	$638,833	$16,609,669	
59	$16,609,669	$0	-$2,479,315	$565,214	$14,695,568	
60	$14,695,568	$0	-$2,479,315	$488,650	$12,704,903	
61	$12,704,903	$0	-$2,479,315	$409,024	$10,634,612	
62	$10,634,612	$0	-$2,479,315	$326,212	$8,481,509	
63	$8,481,509	$0	-$2,479,315	$240,088	$6,242,282	
64	$6,242,282	$0	-$2,479,315	$150,519	$3,913,485	
65	$3,913,485	$0	-$2,479,315	$57,367	$1,491,537	
66	$1,491,537	$0	-$2,479,315	-$39,511	-$1,027,289	
67	-$1,027,289	$0	-$2,479,315	-$140,264	-$3,646,868	
68	-$3,646,868	$0	-$2,479,315	-$245,047	-$6,371,230	
69	-$6,371,230	$0	-$2,479,315	-$354,022	-$9,204,567	
70	-$9,204,567	$0	-$2,479,315	-$467,355	-$12,151,237	
71	-$12,151,237	$0	-$2,479,315	-$585,222	-$15,215,774	
72	-$15,215,774	$0	-$2,479,315	-$707,804	-$18,402,892	
73	-$18,402,892	$0	-$2,479,315	-$835,288	-$21,717,495	
74	-$21,717,495	$0	-$2,479,315	-$967,872	-$25,164,683	
75	-$25,164,683	$0	-$2,479,315	-$1,105,760	-$28,749,758	
76	-$28,749,758	$0	-$2,479,315	-$1,249,163	-$32,478,235	
77	-$32,478,235	$0	-$2,479,315	-$1,398,302	-$36,355,852	
78	-$36,355,852	$0	-$2,479,315	-$1,553,407	-$40,388,574	
79	-$40,388,574	$0	-$2,479,315	-$1,714,716	-$44,582,604	
80	-$44,582,604	$0	-$2,479,315	-$1,882,477	-$48,944,396	
81	-$48,944,396	$0	-$2,479,315	-$2,056,948	-$53,480,659	
82	-$53,480,659	$0	-$2,479,315	-$2,238,399	-$58,198,373	
83	-$58,198,373	$0	-$2,479,315	-$2,427,108	-$63,104,796	
84	-$63,104,796	$0	-$2,479,315	-$2,623,364	-$68,207,475	
85	-$68,207,475	$0	-$2,479,315	-$2,827,472	-$73,514,261	
86	-$73,514,261	$0	-$2,479,315	-$3,039,743	-$79,033,319	
87	-$79,033,319	$0	-$2,479,315	-$3,260,505	-$84,773,140	
88	-$84,773,140	$0	-$2,479,315	-$3,490,098	-$90,742,553	
89	-$90,742,553	$0	-$2,479,315	-$3,728,875	-$96,950,742	
90	-$96,950,742	$0	-$2,479,315	-$3,977,202	-$103,407,260	
91	-$103,407,260	$0	-$2,479,315	-$4,235,463	-$110,122,037	
92	-$110,122,037	$0	-$2,479,315	-$4,504,054	-$117,105,406	
93	-$117,105,406	$0	-$2,479,315	-$4,783,389	-$124,368,110	
94	-$124,368,110	$0	-$2,479,315	-$5,073,897	-$131,921,322	
95	-$131,921,322	$0	-$2,479,315	-$5,376,025	-$139,776,662	
96	-$139,776,662	$0	-$2,479,315	-$5,690,239	-$147,946,216	
97	-$147,946,216	$0	-$2,479,315	-$6,017,021	-$156,442,553	
98	-$156,442,553	$0	-$2,479,315	-$6,356,875	-$165,278,742	
99	-$165,278,742	$0	-$2,479,315	-$6,710,322	-$174,468,379	
100	-$174,468,379	$0	-$2,479,315	-$7,077,908	-$184,025,602	

Appendix I.

Assessment of Potential Effects to from the Proposed Dam Notch Fish Passage Improvements, Revised Draft

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

June 2020

Stillwater Sciences
895 Napa Ave., Suite B-4, Morro Bay, CA 93442
phone 805-570-7499

TECHNICAL MEMORANDUM - REVISED

DATE:	August 31, 2019
TO:	Katherine Ayres (Senior Ecologist) of United Water Conservation District
FROM:	Ethan Bell (Senior Ecologist), Nate Butler (Environmental Engineer), Glen Leverich (Senior Geomorphologist), and Bruce Orr (Senior Ecologist) of Stillwater Sciences
SUBJECT:	Assessment of Potential Effects to Biological Resources Upstream and Downstream of Freeman Diversion from the Proposed Dam Notch Fish Passage Improvements, Revised Draft – NOT FOR PUBLIC DISTRIBUTION

1 INTRODUCTION

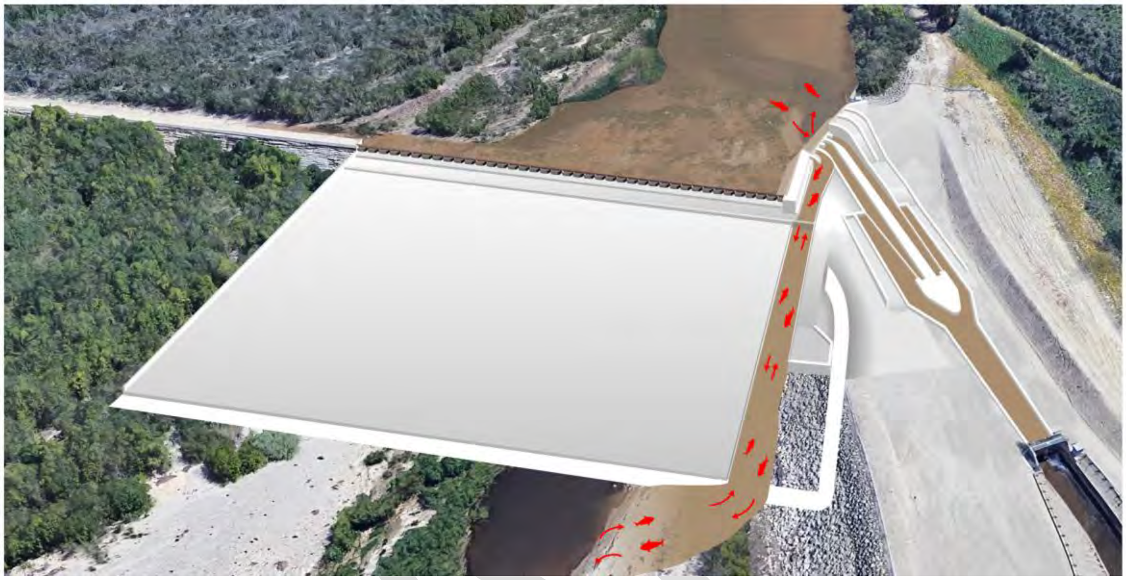
United Water Conservation District (United) tasked Stillwater Sciences to assess the potential effects to riparian and aquatic habitats upstream and downstream of the Vern Freeman Diversion Dam (Freeman Diversion) from the proposed "Dam Notch Fish Passage Improvements." The proposed improvements include modifying Freeman Diversion to improve fish passage while minimizing impacts to water diversion quantities and operations. This assessment evaluates the effects to habitat and species that could potentially result from changes in the river hydraulics and morphology caused during and following implementation of the Dam Notch design. Specifically, potential effects to avian and amphibian habitat uses and fish migration near (but not directly at) the proposed facilities are discussed. The basis of the assessment was limited to review of technical documents related to the study area or prepared in direct support of United's Habitat Conservation Plan (HCP) development.

2 ASSESSMENT

2.1 Design Description

The Freeman Diversion facility currently consists of a 1,200-foot long, 20-foot high concrete diversion structure that has spanned the Santa Clara River since its construction in 1991 (United 2018). The salient features of the proposed Dam Notch design, as detailed in NHC's Draft Hydraulic Basis of Design Report (NHC 2019), include a 400-foot wide, 10-foot high notch with pneumatic gates in the existing dam and a 400-foot wide, 400-foot long rock ramp constructed immediately downstream of the dam. The notch and ramp would be positioned along the south, or river-left, side of the existing dam adjacent to a new low-flow fishway (LFF) and diversion-intake structure. The Dam Notch design is intended to provide fish passage at flows up to 6,000 cubic feet per second (cfs) through the mechanically operated notch-crest gates which, when open, would reduce the effective dam height by half. When closed, the top of the gates would be equivalent to the existing dam crest elevation. Diversion operations would direct flows through the LFF when the notch-crest gates are closed and water is being diverted. On the few days of a given water year when riverflow exceeds the notch-opening threshold of 2,375 cfs, the notch-crest gates would open and flows would move down the rock ramp. At riverflows greater than the notch capacity, water would move through the open notch and over the un-notched diversion dam crest. Two conceptual views of the Dam Notch design during low-flow and high-flow conditions (i.e., less-than and more-than 2,375 cfs) are shown for reference in Figure 1.

a) Notch Design Low Flow



b) Notch Design High Flow

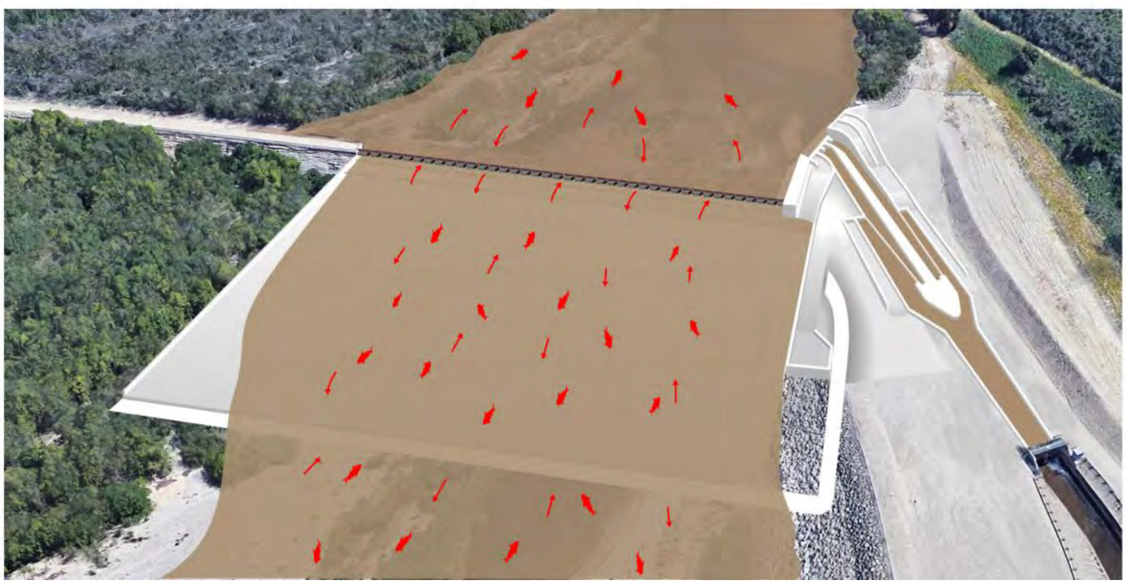


Figure 1. Conceptualized views of the proposed Dam Notch design during low (a) and high (b) river flows (images source: United). The obliquely oriented view is looking east (upstream) toward Freeman Diversion. Brown-colored areas represent riverflow extent and red-colored vectors and fish symbols represent the fish-migration pathways during the respective flow conditions. Notch and gate dimensions are not drawn to scale.

2.2 Literature Review

Several documents were reviewed to assist with the assessment of potential effects to existing and future riverine habitat conditions. The primary documents reviewed are listed in Table 1.

Table 1. Key technical documents reviewed for this assessment.

Title (listed in order of newest to oldest publication date)	Prepared By	Prepared For	Date	Relevancy
Vern Freeman Diversion Dam notch fish passage improvements, draft hydraulic basis of design report	NHC	United	Jun 2019	Engineering and hydraulics details on the 30%-level Dam Notch design
Vegetation mapping of the Santa Clara River, Ventura and Los Angeles counties	Stillwater	WFVZ	Apr 2019	Vegetation mapping and characterization of the entire river corridor
The status of the Least Bell's vireo and four other riparian bird species at United Water Conservation District, Saticoy and Piru, California, in 2018	Griffith Wildlife Biology	United	Dec 2018	Riparian bird surveys near Freeman Diversion
Vern Freeman Diversion, refined notch analysis, final report	NHC	United	Jul 2018	Engineering and hydraulics details on original concept of the Dam Notch design
United Water Conservation District Multiple Species Habitat Conservation Plan study: effects of Freeman Diversion on riparian vegetation in the Santa Clara River	Stillwater	United	Sep 2016	Assessment of proposed Freeman Diversion operations on riparian vegetation
Freeman Diversion dam removal sediment transport modeling, Santa Clara River	Stillwater	CalTrout	Jan 2013	Analysis of sediment-transport changes resulting from hypothetical retrofit of Freeman Diversion
Conceptual-level examination of Vern Freeman Diversion Dam removal alternatives	Stillwater	SCC	Sep 2011	Assessment of hypothetical retrofit and removal of Freeman Diversion
Geomorphic assessment of the Santa Clara River watershed, synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties	Stillwater	VCWPD, LADPW, USACE	Apr 2011	Geomorphic characterization of the entire watershed, including near Freeman Diversion
Vern Freeman Dam fish passage conceptual design report	Vern Freeman Dam Fish Passage Panel	United	Sep 2010	Assessment of fish-passage improvement concepts at Freeman Diversion

Abbreviations: WFVZ=The Western Foundation of Vertebrate Zoology; SCC=State Coastal Conservancy; VCWPD=Ventura County Watershed Protection District; LADPW=Los Angeles County Department of Public Works; USACE=U.S. Army Corps of Engineers (LA District)

2.3 Anticipated Physical Changes to the River Corridor

The lower Santa Clara River is a compound channel having two modes of geomorphic operation: a single meandering channel at low flow and a broad braided channel at higher flows (Stillwater Sciences 2011a, Downs et al. 2013). The watershed's episodic runoff events and stochastic nature of sediment-delivery rates together result in substantial variability in the river morphology, which effectively resets to a new planform state during larger flood events, such as those experienced in 1969 and 2005 (Stillwater Sciences 2011a). The reach crossed by Freeman Diversion has been progressively narrowed by floodplain developments, historic gravel mining, and flood-protection levees (Beller et al. 2011). Since its construction in 1991, the diversion dam has effectively locked-in the river-bed elevation causing sediment to deposit upstream, thereby restoring the historic elevation upstream of the diversion dam, but forming a 20–30-foot high step at the diversion dam (NHC 2018), as depicted by the black-colored line shown in Figure 2.

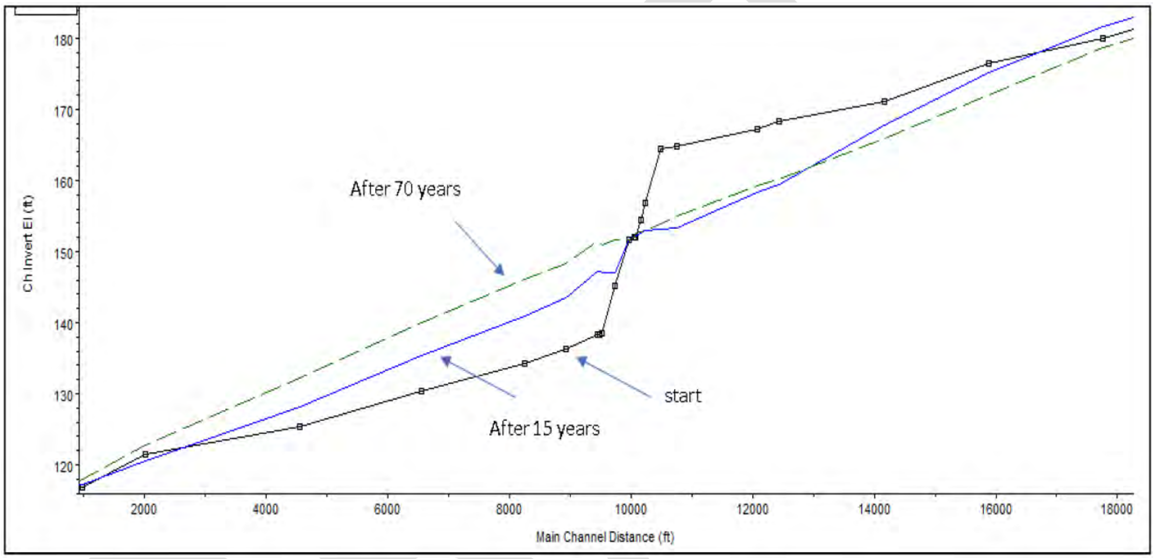


Figure 2. Comparisons of river-bed elevation profiles modeled under existing conditions (black-solid line), after 15 years following Dam Notch construction (blue-solid line), and after 70 years following Dam Notch construction (green-dashed line) (source: Figure 3.12 in NHC 2018).

As summarized in the Refined Notch Analysis (NHC 2018) and Hydraulic Basis of Design Report (NHC 2019) reports, the Dam Notch design would change local hydraulics and river-channel morphology upstream and downstream of Freeman Diversion. One of the primary changes would be the notch structure would have the capacity to convey river flows approximately between the 10-year (~59,200 cfs) and 25-year (~109,400 cfs) recurrence-interval flood peaks without overtopping the diversion dam crest (NHC 2018); flows greater than the 25-year recurrence-interval peak would, however, overtop the dam crest[1]. Another hydraulic change would be fixing the low flows along the south (river left) side with the LFF. The hydraulic modeling consistently found that the LFF would have the highest velocities under the range of flows modeled (i.e., 10 feet/sec at 6,000 cfs, 7 feet/sec at 3,000 cfs, 6 feet/sec at 1,600 cfs, and 5

[1] Peak flood discharge recurrence intervals were estimated by AECOM to be 2-year≈9,800 cfs, 5-year≈32,500, 10-year≈59,200, 25-year≈109,400, 50-year≈160,700, and 100-year≈226,000 cfs (see Table 2-2 in AECOM 2016).

feet/sec at 1,000 cfs). Overall, computed velocities of riverflows approaching the notched portion of Freeman Diversion during larger runoff events would be larger prior to significant bed adjustments upstream.

The effective lowering of the dam crest within the notch when the notch-crest gates open during higher flow events would allow sediment currently stored behind Freeman Diversion to erode and transport downstream. This change in sediment-transport dynamics is expected to cause a general erosion condition upstream of Freeman Diversion and deposition condition downstream (NHC 2019). The bed-lowering process would episodically propagate upstream by approximately 2 miles within 70 years (NHC 2018). Concurrently, the river-bed downstream of the ramp structure would progressively aggrade that, together with the upstream bed-lowering, would lead to a significantly more level river-bed slope intersecting with Freeman Diversion, as depicted by the blue-colored (15 years in the future) and green-colored (70 years in the future) lines shown in Figure 2.

NHC's two-dimensional modeling predicted long-term, cumulative bed-level changes throughout the river corridor extending at least 2-miles upstream and at least 1-mile downstream of Freeman Diversion (NHC 2018) (see Figure 3 below). Wide expanses of upstream erosion and downstream aggradation resulting in bed-elevation changes of 1 to 10 feet is predicted to occur throughout much of the active river channel and floodplain over a 70-year period following project construction. The hydraulic analyses further estimated that the upstream erosion may lead to reduced riverbank strength along the margins of bed-lowering even where ponded waters are maintained behind the closed notch-crest gates during non-storm periods.

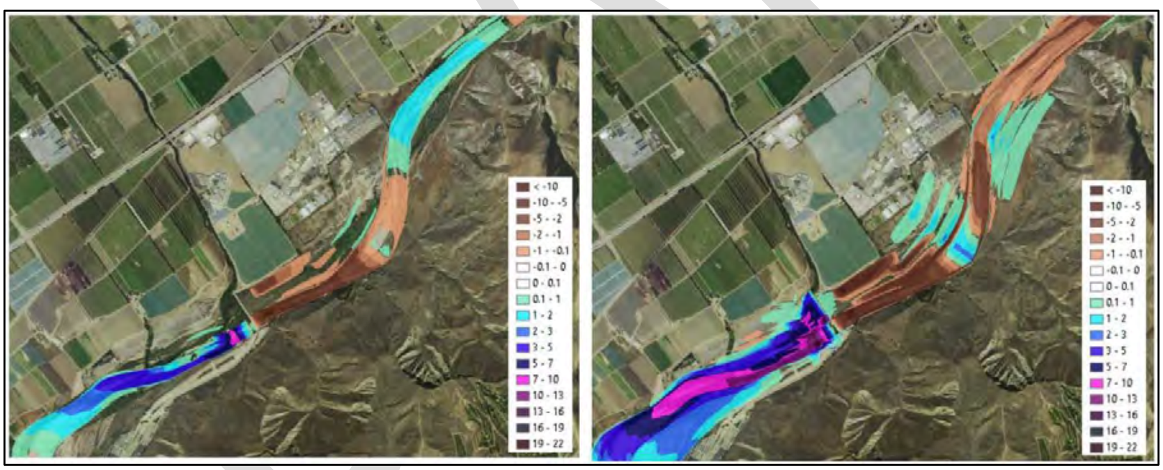


Figure 3. Two-dimensional computations of cumulative bed changes modeled for 15 years (left) and 70 years (right) after construction of the Dam Notch design (source: Figure 3.13 in NHC 2018). Brown-colored areas are meant to represent predicted erosion (bed-lowering) and blue to pink-colored areas represent predicted deposition (bed aggradation).

The spatial extents of upstream erosion and downstream deposition predicted by the NHC modeling were further evaluated by Stillwater Sciences in a GIS to ascertain the potential effect to parcels of the Santa Clara River Parkway Project—a joint effort between the State Coastal Conservancy, the Nature Conservancy (TNC), private landowners, and local governments to acquire and protect floodplain lands for habitat conservation. As depicted in Figure 4, the downstream deposition extent would not overlap with any "acquired" Parkway parcels (dark green-colored polygons), but the upstream erosion extent would overlap with approximately 140 acres of acquired parcels referred to by TNC as the "Hanson" and "Villanueva" properties, which have been actively managed for riparian restoration (NewFields 2012). As studied previously by Stillwater Sciences, this segment of the river has experienced channel-position adjustments over the past two decades and even larger river-floodplain adjustments since the early 20th century (see Figures 3 and 8 in Stillwater Sciences 2016). Thus, it can be reasonably assumed that this river segment will continue to evolve absent any constructed changes at Freeman Diversion.

a)

b)

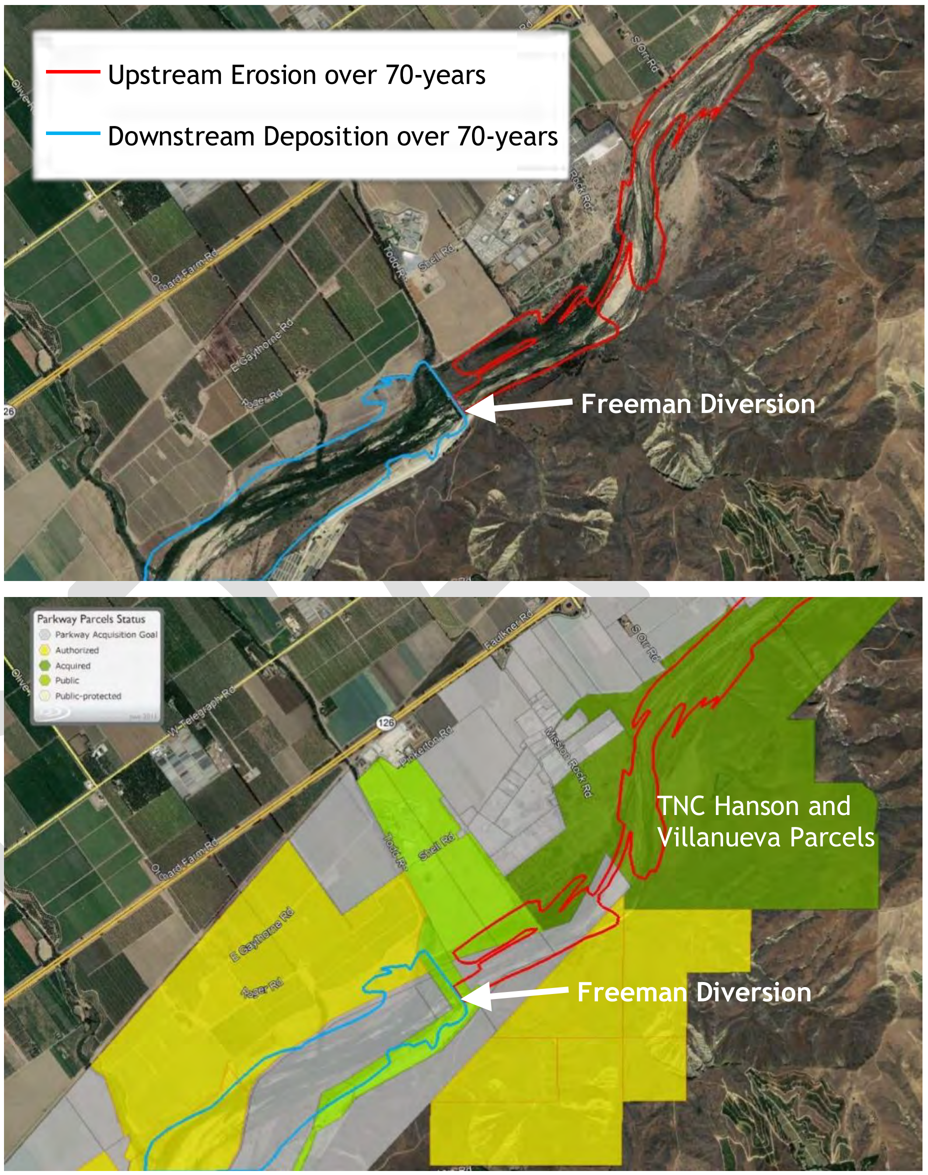


Figure 4. Repeat views of the Project reach showing the spatial extents of predicted long-term upstream erosion and downstream deposition near Freeman Diversion (a) and their overlap with Parkway conservation parcels (dark-green colored areas) (b). Geomorphic changes based on NHC's two-dimensional modeling (see Figure 3 above) and Parkway parcels based on Coastal Conservancy's Parkway online mapviewer.

The Dam Notch design would also likely affect local groundwater depths and water quality conditions near Freeman Diversion, though these issues were not directly modeled in the Refined Notch Analysis (NHC 2018) and Hydraulic Basis of Design Report (NHC 2019) reports. During non-storm periods, which account for the vast majority of any given water year, impoundment of water behind the closed notch-crest gates would be managed similar to existing operations in order to meet water-diversion needs (NHC 2019). As such, the water-surface elevation of impounded waters would be fairly similar to existing conditions, although some leakage through the 20 notch gates might occur, especially during drier periods, which would result in some dewatering of the impounded water zone (reservoir pool) upstream of the diversion (M. McEachron, pers. comm., August 2019). Thus, the upstream bed-lowering created by the initial excavation coupled with the subsequent scour that is predicted to occur would be expected to cause the reservoir pool behind the dam to become deeper, at least during wet to normal water years.

Maintaining the water-surface elevation through much of the year would suggest the local water table elevation, which supports the riparian vegetation communities, would remain fairly similar to existing conditions, although there might be short periods when localized groundwater levels immediately upstream of the diversion, especially around the edges of the reservoir pool, would begin to drop while the notch-crest gates are open. However, such fluctuations in groundwater levels during the winter in most years would be expected to be of somewhat limited spatial and temporal extent. In addition, soil moisture is likely to remain fairly high during these periods of brief groundwater fluctuations since they would immediately follow stormy weather that produced the higher flows requiring the gates to be opened, and would typically occur during the winter when evapo-transpirational demands on soil moisture are relatively low. Groundwater depths near the diversion prior to the facility's construction in 1991 ranged from 1 to 19 feet below the riverbed, and in 2013 and 2016 ranged from 2 to 3.5 feet below the riverbed (GEI 2019). The areal extent of the reservoir pool would potentially be much broader across the channel width and extending upstream. Water quality conditions, such as temperature and dissolved oxygen, in ponded waters above the diversion would potentially change as the reservoir pool deepens and other scoured depressions form farther upstream.

2.4 Anticipated Effects to Biological Resources

2.4.1 Vegetation

The approximately 3-mile long reach of the Santa Clara River near Freeman Diversion predicted by the two-dimensional modeling to experience long-term erosion and deposition currently supports a mixed assemblage of riparian vegetation communities (see Figure 4a above). The reach's channel morphology and shallow water table have been effectively stabilized by the diversion dam over the past three decades, which has allowed these vegetation communities to persist (Stillwater Sciences 2011a, 2016). The most prevalent vegetation community alliances mapped in the reach include *Baccharis salicifolia* Shrubland Alliance, *Heterotheca (oregona, sessiliflora)* Herbaceous Alliance, *Phragmites australis - Arundo donax* Herbaceous Semi-Natural Alliance, *Salix exigua* Shrubland Alliance, *Salix laevigata* Woodland Alliance, and *Salix lasiolepis* Shrubland Alliance (Stillwater Sciences 2019).

The proposed Dam Notch design has the potential to affect riparian vegetation communities, along with state and federally listed fish and wildlife species known to inhabit these areas, upstream and downstream of Freeman Diversion. While the river and its dependent biological resources would continue to evolve absent any constructed changes at Freeman Diversion, the simplest means to assess the Dam Notch effects is through overlapping the areal extents of the proposed facilities (i.e., rock ramp and LFF) and modeled future channel adjustments with existing vegetation communities. Through a GIS analysis, the spatial overlap of these features was queried by Stillwater Sciences to quantify acreages of existing vegetation communities that currently lie within the areas of future upstream erosion and future downstream deposition (see erosion and deposition extents shown in Figure 4 above).

The results of the GIS analysis help to illustrate which vegetation communities may be affected by the proposed Dam Notch design (Table 2). The construction of the rock ramp and LFF would directly disturb approximately 4 acres of existing stands of herbaceous and woodland communities. Over the modeled period of 70 years, approximately 400 acres evenly distributed upstream and downstream of Freeman Diversion would potentially be disturbed through the anticipated channel-bed adjustments. Similarly, roughly 200 acres total would likely be disturbed during the initial 15 years. In the upstream erosion areas, the existing stands of mature vegetation could potentially be scoured as the riverbed progressively lowers. In the downstream deposition areas, existing vegetation communities could potentially be buried as sediment accumulates and raises the riverbed. In both cases, upstream scour and downstream deposition, the physical changes in topography are likely to result in an increased depth to groundwater in some locations, which is likely to result in loss of the more mesic cottonwood-willow riparian vegetation types and potentially increase more xeric shrubland types (such as *Artemisia californica*, *Baccharis pilularis*, and *Eriogonum fasciculatum* shrublands seen in drier areas along the river, see Stillwater Sciences 2007a and 2016).

Availability of shallow groundwater is an important control on riparian vegetation establishment, which could potentially change following several years of channel adjustments. During normal to wetter periods, it is expected that the shallow groundwater upstream of the proposed facility should remain relatively unchanged even as bed-lowering occurs because the reservoir pool impounded behind Freeman Diversion would be controlled fairly similar to current operations. Downstream of the dam, however, the rising of the riverbed from anticipated sediment deposition has the potential to deepen shallow groundwater available to riparian species, which could limit establishment of some native riparian species. The Draft Hydraulic Basis of Design Report (NHC 2019) elaborates upon this latter point by acknowledging the possibility that reduced riparian vegetation downstream could in turn reduce lateral channel stability and compound future geomorphic changes.

Table 2. Areas of Dam Notch structure and longer-term channel adjustments overlaying existing vegetation communities.

Vegetation Community Alliance	Area of Overlap (acres)				
	Dam Notch Structure Footprint	Upstream Erosion		Downstream Deposition	
		After 15 yrs	After 70 yrs	After 15 yrs	After 70 yrs
Agriculture	--	--	--	2.2	20.5
Artemisia californica Shrubland Alliance	--	--	--	0.4	22.5
Baccharis salicifolia Shrubland Alliance	--	29.8	71.2	14.7	43.1
Bromus (diandrus, hordeaceus) - Brachypodium distachyon Herbaceous Semi-Natural Alliance	--	1.1	9.1	--	--
Bromus rubens - Schismus (arabicus, barbatus) Herbaceous Semi-Natural Alliance	--	--	1.6	--	--
Developed	0.1	--	--	0.0	0.9
Disturbed	--	--	1.7	--	0.5
Eucalyptus spp. - *Ailanthus altissima - Robinia pseudoacacia* Woodland Semi-Natural Alliance	--	--	0.8	--	--
Heterotheca (oregona, sessiliflora) Herbaceous Alliance	0.2	3.5	5.6	1.6	2.6
Non-native Grass and Forb Mapping Unit	--	--	--	--	1.8
Phragmites australis - Arundo donax Herbaceous Semi-Natural Alliance	--	3.3	9.1	2.2	8.1
Populus trichocarpa Forest Alliance	--	3.2	7.6	--	--
Riverwash	--	--	--	7.5	8.0
Riverwash herbaceous	--	1.4	1.4	1.5	1.5
Salix exigua Shrubland Alliance	--	10.0	8.9	1.0	4.0
Salix laevigata Woodland Alliance	4.0	25.6	34.7	66.0	100.1
Salix lasiolepis Shrubland Alliance	--	14.3	47.0	0.1	5.8
Salvia leucophylla Shrubland Alliance	--	--	0.4	--	--
Typha (angustifolia, domingensis, latifolia) Herbaceous Alliance	--	0.9	0.9	--	--
Water	0.2	--	--	--	0.2
Total	**4.5**	**93.2**	**199.9**	**97.1**	**219.5**

During drier periods, and especially during multi-year droughts, there may be a more pronounced dewatering of the reservoir pool and substantial lowering of the groundwater level for periods of a duration sufficient to affect vigor and survival of established woody riparian vegetation. The native trees and shrubs can likely withstand small fluctuations (e.g., 1-2 ft) if they are of short duration (a few days to a week or two) and occur during the winter when plants are in a more dormant state and local weather is more likely to maintain some degree of moisture in soils above the groundwater table. However, more pronounced fluctuations in depth to water of greater magnitude and duration are likely to occur under some conditions and could have a significant impact on vigor and mortality of woody riparian vegetation. For example, the thalweg of the river upstream of the diversion is predicted to incise over time. If this incision is coupled with some decrease in reservoir pool water surface elevation (and therefore local groundwater elevation) under the dam-notch alternative, it could result in creation of cut banks and increased depth to groundwater upstream of the diversion. This might create conditions that are similar to current conditions downstream of the diversion where the river has incised, creating a healthy riparian zone along the main channel, bordered by cut-banks up to 15-ft tall (M. McEachron, pers. comm., August 2019). This would result in a notable reduction in the amount of mesic cottonwood-willow riparian habitat in the upstream reach, including some areas currently targeted for conservation or restoration on The Nature Conservancy's Hanson-Villaneuva parcels, and an increase in more xeric vegetation types on the higher terraces.

Although riparian vegetation should, in general, be able to adapt to changed conditions following project implementation, the expected near-term (15 years) and long-term (70 years) adjustments in channel longitudinal profile (thalweg) and planform caused by associated episodes of scour and deposition during high flow events are likely to result in a more dynamic shifting mosaic of riparian habitats and a net reduction in mid to late seral or more mature riparian vegetation due to more frequent resetting of established vegetation patches when compared to expected conditions under a no project alternative (i.e., maintenance and operation of the current diversion). These changes have the potential to affect fish and wildlife, which are discussed below.

2.4.2 Wildlife

The riparian vegetation communities near Freeman Diversion are known to host several federal and state-listed bird species. Avian surveys conducted in the reach by Griffith Wildlife Biology (GWB) since 2012 have documented the presence of Least Bell's vireo, southwestern willow flycatcher, yellow-breasted chat, and yellow warbler, all of which have been most commonly found nesting and foraging in the denser tree and shrub vegetation stands. To estimate the potential impact of the Dam Notch design to avian habitat, another GIS analysis was conducted by Stillwater Sciences to quantify the number of bird observations within the future upstream erosion and future downstream deposition areas (Table 3). The dataset from GWB is based on total observations, which likely includes some duplicate counting of the same individuals. The results reveal that the number of special-status birds that have been observed within the upstream erosion and downstream deposition areas is significant, with the yellow warbler being the most numerous.

Table 3. Number of bird observations species observations overlapping with areas of Dam Notch structure and longer-term channel adjustments.

Bird Species Observed during 2012-2018	Number Observed within Area Modeled to Experience Upstream Erosion After 70 yrs	Number Observed within Area Modeled to Experience Downstream Deposition After 70 yrs
Least Bell's vireo (*Vireo bellii pusillus*)	124	178
Southwestern willow flycatcher (*Empidonax traillii extimus*)	--*	4
Yellow-breasted chat (*Icteria virens*)	81	86
Yellow warbler (*Setaphaga petechia*)	351	600
Total	**559**	**880**

*Although not included in the Griffith dataset, there were reports of southwestern willow flycatchers on the Hanson in property in 2014 and some previous years. They have not been observed there since.

The shifting mosaic of riparian habitats anticipated in the near-term (15 years) and long-term (70 years) after project implementation has the potential to remove established vegetation patches and reduce suitable habitat for the covered riparian bird species when compared to expected conditions under a no project alternative (i.e., maintenance and operation of the current diversion). For example, after each disturbance event that resets the vegetation (i.e., removes established vegetation through scour or substantial sediment deposition), it may take approximately 3–10 years to re-establish early to mid-seral riparian vegetation suitable for the four covered bird species known to occur in this area. Aside from likely short-term local impacts, this may also have potential adverse impacts on the metapopulations of these species along the Santa Clara River riparian corridor since the project area provides important habitat that is somewhat isolated, by drier reaches with less suitable habitat (see Figure 2 in Stillwater Sciences 2016), from upstream areas (e.g., the historic East Grove area upstream of Santa Paula) and downstream areas (e.g., the lower river and estuary downstream of Highway 101) known to provide higher value habitat (Beller et al. 2011 and 2015, Stillwater Sciences 2007a,b, 2016, 2019).

Western pond turtles (*Emys marmorata*) have been observed upstream and downstream of Freeman Diversion and are likely to use still or slow moving waters and adjacent shoreline in the reservoir pool area for foraging, basking, and possibly overwintering in the muddy sediments (Stillwater Sciences 2007b; see also chapter 4 in United 2018). Adults and juveniles are typically active from February through November, and in warmer areas in southern California they may be active year-round (Stillwater Sciences 2007b, United 2018). Given this life history phenology and habitat use, there is a risk that rapid changes in flow velocity associated with notch-gate lowering during high flows could wash turtles downstream resulting in potential injury or mortality. This would result in short-term adverse impacts and, potentially, affect longer term population dynamics and viability in the project area.

2.4.3 Fish

The reservoir pool expected to enlarge upstream of Freeman Diversion with the Dam Notch design would potentially affect migrating steelhead and lamprey in their downstream approach to the diversion. Although downstream migrating salmonids have been observed to be delayed in migration from the formation of reservoirs (Budy et al. 2002, Connor et al. 2003), it is unlikely that the reservoir pool formed upstream of Freeman Diversion would be of sufficient width, simplicity (i.e., access to channel margin with), or depth to significantly delay downstream-migrating steelhead (or lamprey) in the Santa Clara River. Upstream migration of adult steelhead and lamprey can be impacted by reservoirs (Keefer et al. 2004), though delays to adults migrating upstream through the reservoir pool above Freeman Diversion are unlikely to be significant due to its small size. Increased predation of downstream migrating smolts from non-native species within the reservoir pool could potentially increase, which is common in impounded waters (Moyle 2002).

The reservoir pool would have a longer residency time than a free-flowing river, and therefore could increase water temperature and decrease DO relative to existing conditions. This could reduce potential suitability of potential rearing habitat for native fish (and increase suitability for invasive species), particularly during the warmer period of late spring, summer, and fall.

Under existing conditions fish passage conditions downstream of Freeman Diversion are challenged by the formation of critical riffles in a meandering gravel-bedded river system (R2 2016. With the construction of Dam Notch significant aggradation of the riverbed would be likely to occur, resulting in increased risk of temporary (potentially several years) loss of a defined, dominant channel within which fish can migrate or rear. This dynamic currently occurs within the reach downstream of Freeman Diversion and would likely be exacerbated by increased aggradation.

3 CONCLUSIONS

The proposed Dam Notch design facilities would change river conditions over at least 2 miles upstream and 1 mile downstream of Freeman Diversion through inducing geomorphic adjustments over several decades. Over the modeled period of 70 years, approximately 400 acres of existing riparian communities evenly distributed upstream and downstream of Freeman Diversion would potentially be disturbed through the anticipated channel-bed adjustments. Furthermore, approximately 140 acres of Santa Clara River Parkway parcels actively managed for riparian restoration would potentially experience bed-lowering over a 70-year period. However, the vegetation, fish, and wildlife species native to the Santa Clara River are well adapted to the river's dynamic nature where channel-resetting events occur on decadal timeframes. Therefore, the processes that currently support the riparian vegetation communities and dependent fish and wildlife habitats would likely remain unchanged by the proposed design, aside from the approximately 4 acres of direct habitat loss from construction of the rock ramp. Specifically, the same geomorphic processes and vegetation recruitment processes would continue unaltered with implementation of the design. Vegetation recruitment should generally be able to keep pace with the channel adjustments anticipated with the design; however, the frequency and extent of vegetation reset (i.e., scouring of established vegetation back to bare earth to reset vegetation successional processes) is expected to create a more dynamic riparian system which is expected to reduce net availability of suitable habitat for covered bird species in the project area. Changes in the depth to shallow groundwater available to riparian plants would likely increase in some key areas both upstream and downstream of Freeman Diversion, which is likely to limit the spatial extent of native woody riparian vegetation recruitment and reduce the total amount of suitable cottonwood-willow habitat for native wildlife. Suitability of habitat for native aquatic species would likely be reduced from the formation of an impounded pool upstream of Freeman Diversion, and downstream of Freeman Diversion from increased channel aggradation.

4 REFERENCES

AECOM. 2016. Freeman Diversion fish passage hardened ramp design, 60% hydraulic basis of design report, draft. Prepared for United Water Conservation District, Santa Paula, CA. June.

Beller, E.E., R.M. Grossinger, M.N. Salomon, S.J. Dark, E.D. Stein, B.K. Orr, P.W. Downs, T.R. Longcore, G.C. Coffman, A.A. Whipple, R.A. Askevold, B. Stanford, J.R. Beagle. 2011. Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA.

Beller, E.E., P. W. Downs, R.M. Grossinger, B.K. Orr, and M.N. Soloman. 2015**.** From past patterns to future potential: using historical ecology to inform river restoration on an intermittent California river. Landscape Ecology, DOI 10.1007/s10980-015-0264-7.

Budy, P., G. P. Thiede, N. Bouwes, C. E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22: 35–51.

Connor, W. P., H. L. Burge, J. R. Yearsley, and T. C. Bjornn. 2003. Influence of flow and temperature on survival of wild subyearling fall Chinook salmon in the Snake River. North American Journal of Fisheries Management 23: 362–375.

Downs, P. W., S. R. Dusterhoff, and W. A. Sears. 2013. Reach-scale channel sensitivity to multiple human activities and natural events: lower Santa Clara River, California, USA. Geomorphology 189: 121–134.

GEI (GEI Consultants). 2019. Vern Freeman Diversion Dam fish passage dan notch alternative preliminary geotechnical desktop study, Saticoy area in Ventura County, California. Prepared for Northwest Hydraulic Consultants), Pasadena, CA. June.

GWB (Griffith Wildlife Biology). 2018. The status of the Least Bell's vireo and four other riparian bird species at United Water Conservation District, Saticoy and Piru, California in 2018. Prepared for United Water Conservation District, Santa Paula, CA. December.

Keefer, M. L., C. A. Perry, T. C. Bjornn, M. A. Jepson, and L. C. Stuehrenberg. 2004. Hydrosystem, dam, and reservoir passage rates of adult Chinook salmon and steelhead in the Columbia and Snake rivers. Transactions of the American Fisheries Society 133: 1413–1439.

Moyle, P. B. 2002. Inland fishes of California. Second edition. University of California Press, Berkeley.

NewFields. 2012. Hanson-Villanueva property habitat restoration, enhancement, and creation plan. Prepared for The Nature Conservancy, Ventura, CA. June.

NHC (Northwest Hydraulic Consultants). 2018. Vern Freeman Diversion, refined notch analysis, final report. Prepared for United Water Conservation District, Santa Paula, CA. July.

NHC. 2019. Vern Freeman Diversion Dam notch fish passage improvements, draft hydraulic basis of design report. Prepared for United Water Conservation District, Santa Paula, CA. June.

R2 Resource Consultants. 2016. Riverine Effects Analysis of Freeman Diversion Flow Releases on Steelhead and Pacific Lamprey. Prepared for United Water Conservation District, Santa Paula, California.

Stillwater Sciences. 2007a. Santa Clara River Parkway Floodplain Restoration Feasibility Study: analysis of riparian vegetation dynamics for the lower Santa Clara River and major tributaries, Ventura County, California. Prepared for the California State Coastal Conservancy and the Santa Clara River Trustee Council. October.

Stillwater Sciences. 2007b. Santa Clara River Parkway Floodplain Restoration Feasibility Study: Focal species analysis and habitat characterization for the lower Santa Clara River and major tributaries, Ventura County, California. Prepared for the California State Coastal Conservancy and the Santa Clara River Trustee Council. October.

Stillwater Sciences. 2011a. Geomorphic assessment of the Santa Clara River Watershed, synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, CA. Prepared for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and US Army Corps of Engineers, Los Angeles District. April.

Stillwater Sciences. 2011b. Conceptual-level examination of Vern Freeman Diversion Dam removal alternatives. Prepared for California State Coastal Conservancy, Oakland, CA. September.

Stillwater Sciences. 2013a. Freeman Diversion dam removal sediment transport modeling, Santa Clara River, CA, draft technical memorandum. Prepared for California Trout, Ventura, CA. January.

Stillwater Sciences. 2013b. Addendum to Freeman Diversion dam removal sediment transport modeling, Santa Clara River, CA. Technical memorandum, prepared for California Trout, Ventura, CA. June.

Stillwater Sciences. 2016. United Water Conservation District Multiple Species Habitat Conservation Plan study: effects of Freeman Diversion on riparian vegetation in the Santa Clara River. Prepared for United Water Conservation District, Santa Paula, CA. September.

Stillwater Sciences. 2019. Vegetation mapping of the Santa Clara River, Ventura County and Los Angeles County, California. Prepared for the Western Foundation of Vertebrate Zoology, Camarillo, CA. April.

United (United Water Conservation District). 2010. Vern Freeman Dam fish passage conceptual design report, final. Prepared by the Vern Freeman Dam Fish Passage Panel for United Water Conservation District, Santa Paula, CA. September.

United. 2018. United Water Conservation District Multiple Species Habitat Conservation Plan, administrative draft. Prepared by United Water Conservation District, Santa Paula, CA. September.