LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

FINAL LICENSE APPLICATION

ATTACHMENT E
APPLICANT-PREPARED BIOLOGICAL ASSESSMENT FOR CALIFORNIA CENTRAL VALLEY STEELHEAD (*ONCORHYNCHUS MYKISS*) DISTINCT POPULATION SEGMENT

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List of Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
ac-ft	acre-feet
AFLA	amendment to the Final License Application
AFRP	Anadromous Fish Restoration Program
AN	above normal
BA	Biological Assessment
BN	below normal
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CCV	California Central Valley
CDFG	California Department of Fish and Game (as of January 2013, Department of Fish and Wildlife)
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CEC	California Energy Commission
CEPA	California Environmental Protection Agency
CFR	Code of Federal Regulations
cfs	cubic feet per second
CI	confidence interval
cm	centimeter
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
Districts	Turlock Irrigation District and Modesto Irrigation District
DLA	Draft License Application
DO	dissolved oxygen
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ERP	Ecosystem Restoration Program

ESA............................Federal Endangered Species Act
ESU............................Evolutionary Significant Unit
FERC..........................Federal Energy Regulatory Commission
FLA............................Final License Application
FPA............................Federal Power Act
ft^2................................square foot
IPCC...........................Intergovernmental Panel on Climate Change
ISR.............................Initial Study Report
LGDD.........................La Grange Diversion Dam
M&I............................municipal and industrial
mg/L...........................milligrams per liter
MID............................Modesto Irrigation District
mm.............................millimeters
MSA...........................Magnuson-Stevens Act
MW............................megawatt
n.................................number
NEPA.........................National Environmental Policy Act
NMFS.........................National Marine Fisheries Service
NOAA........................National Oceanic and Atmospheric Administration
NTU...........................nephelometric turbidity unit
M&I............................municipal and industrial
mm.............................millimeter
MW............................megawatt
NMFS.........................National Marine Fisheries Service
NWIS.........................National Water Information System
PCE............................Primary Constituent Elements
PM&E........................Protection, Mitigation and Enhancement
PRV............................pressure reduction valve
RM.............................River Mile
RPA............................reasonable and prudent alternative
RSP............................Revised Study Plan
SD..............................standard deviation
SD2............................Scoping Document 2

SJR ....San Joaquin River
SJRRP ....San Joaquin River Restoration Program
SPD ....Study Plan Determination
STORET ....EPA storage-and-retrieval water quality database
SWRCB......................State Water Resources Control Board
TID ....Turlock Irrigation District
TMDL ....Total Maximum Daily Load
UOWTI ....upper optimal water temperature index
USACE ......................U.S. Army Corps of Engineers
USFWS ......................U.S. Department of the Interior, Fish and Wildlife Service
USGS .........................U.S. Department of the Interior, Geological Survey
USR............................Updated Study Report
UTWTI.......................upper tolerance water temperature index
W&AR ....Water and Aquatic Resource
WTI ....water temperature index
WUA ....weighted usable area
7DADM ....seven-day average of the daily maximum

1.0 INTRODUCTION

1.1 Purpose of the Biological Assessment

This document contains the Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) Draft Biological Assessment (BA) for the La Grange Hydroelectric Project (Project; FERC No. 14581). This Draft BA assesses Project-related effects on threatened and endangered species listed under the Endangered Species Act of 1973, amended in 1988, 16 U.S.C. § 1531-1544 (ESA), as well as their designated critical habitat. This BA is part of the La Grange Hydroelectric Project Final License Application submitted to the Federal Energy Regulatory Commission (FERC or Commission) in accordance with an application for an original license for hydropower generation at the La Grange Diversion Dam (LGDD). FERC is the federal agency authorized to issue licenses for the construction, operation, and maintenance of the nation's non-federal hydroelectric facilities.

The ESA requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of such species. When a federal action agency authorizes, funds, or carries out an action, it must consult with the National Marine Fisheries Service (NMFS) and/or the U.S. Fish and Wildlife Service (USFWS) if the agency determines that the action may affect ESA-listed species. The issuance of an original license to generate hydropower is a federal action that requires FERC to consult with the NMFS under Section 7 of the Endangered Species Act (ESA)[1]. Consultation is required to make certain that FERC's action (i.e., issuance of an original license for hydropower generation) does not jeopardize the continued existence of Central California Valley (CCV) steelhead (*Oncorhynchus mykiss*) and its designated critical habitat[2] in the Tuolumne River downstream from the LGDD to the confluence with the tailrace channel of the Project powerhouse as well as a tailrace channel (i.e., the Action Area for this BA; see Section 2.2).

This Draft BA is intended to serve as the basis for consultation under Section 7 of the ESA for ESA-listed species under the jurisdiction of NMFS. Further, the Magnuson-Stevens Act (MSA) requires an assessment of Project-related effects on designated Essential Fish Habitat (EFH) for fall-run Chinook Salmon (*Oncorhynchus tshawytscha*). An EFH assessment is included as Attachment A of this BA.

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[1] As related to elements of the proposed action that require the discharge of fill material below the ordinary high water mark of the Tuolumne River, the U.S. Army Corps of Engineers is an additional federal action agency, pursuant to their regulatory authority (i.e., Discharge Authorization) under Section 404 of the Clean Water Act.

[2] Critical habitat is designated to include the areas defined in specific CALWATER Hydrologic Units. Relative to the Tuolumne River, this includes the *Montpelier Hydrologic Sub-area 553560.* Outlet(s) = Tuolumne River (Lat 37.6401, Long –120.6526) upstream to endpoint(s) in: Tuolumne River (37.6721, –120.4445). NMFS defines the lateral extent of designated critical habitat as the width of the stream channel defined by the ordinary high water line as defined by the COE in 33 CFR 329.11. In areas for which ordinary high-water has not been defined pursuant to 33 CFR 329.11, the width of the stream channel shall be defined by its bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain (Rosgen 1996) and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series (Leopold et al. 1992).

1.2 Proposed Action and FERC Authority

In accordance with the Federal Power Act (FPA), FERC is able to issue hydropower generation licenses for a period not less than 30 years, but no more than 50 years. Under the FPA, FERC issues licenses that are best adapted to a comprehensive plan for improving or developing a waterway. As the federal "action agency," FERC must also comply with the requirements of the National Environmental Policy Act (NEPA), under which FERC must define the specific action it is considering and the purpose and need for the Proposed Action. In the case of the Project, the Proposed Action under review by FERC is the issuance of an original license to Districts to authorize the continued generation of renewable hydroelectric power at a powerhouse just downstream of the LGDD. Also included under the Proposed Action is the implementation of three Protection, Mitigation and Enhancement (PM&E) measures proposed by the Districts for the purpose of protecting anadromous salmonids and monitoring dissolved oxygen in the Project vicinity.

During NEPA scoping conducted by FERC for issuance of an original license for hydropower generation at the Project, issues were raised regarding the effects of the Proposed Action on species listed under the federal ESA and their designated critical habitat. One ESA-listed fish has the potential to occur in the Tuolumne River near the existing Project site - the threatened California CCV Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*) (also referred to as CCV steelhead).

It should be noted that non-Project facilities are those operated by the Districts to achieve the primary purposes of the La Grange Project, which is diverting water from the Tuolumne River for irrigation and municipal and industrial (M&I) uses. Hydroelectric generation is a secondary purpose of the La Grange Project. Water diversions at the La Grange Project are not dependent on the issuance of a FERC license and will occur with or without the licensing of the hydroelectric facilities. The distinction between La Grange Project (i.e., surface water diversion for M&I) and the "La Grange Hydroelectric Project", or "Project", is important because the "Project" is the Proposed Action requested for consultation in this BA.

1.2.1 Regulatory Framework

Under provisions of Section 7(a)(2) of the ESA, FERC is required to consult with NMFS regarding the issuance of an original license for the Project to ensure that the Districts' Proposed Action and PM&E measures (see Section 2.0) will not jeopardize the continued existence of CCV steelhead or adversely modify the species' critical habitat (16 United States Code [U.S.C.] Section 1536(c)).

This BA recommends determinations of effects for the Proposed Action on CCV steelhead and their critical habitat. Based on the conclusions contained herein, NMFS will either prepare a concurrence letter or issue a Biological Opinion (BO) presenting NMFS' determination as to whether or not the Proposed Action and PM&E measures are likely to jeopardize CCV steelhead or adversely modify critical habitat in the Action Area. If a "jeopardy" or "adverse modification" determination is made, the BO must identify any reasonable and prudent alternative (RPA) actions that avoid jeopardizing the continued existence of endangered or threatened species or destroying or modifying their critical habitats.

If NMFS issues either a "no jeopardy" opinion or a "jeopardy" opinion that includes RPAs, the BO may include an incidental take statement. NMFS must anticipate the quantity of take that could result from the Proposed Action and authorize such take along with a statement that the CCV steelhead DPS will not be jeopardized. The incidental take statement would contain terms and conditions designed to reduce the effect of the anticipated take. These terms and conditions would then be considered by FERC and, if adopted, become conditions of the license.

1.3 Project Background

TID and MID own the LGDD located on the Tuolumne River in Stanislaus County, California (Figure 1.3-1). LGDD is 131 feet high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the headpond formed by the diversion dam. Under normal river flows, the headpond formed by the diversion dam extends for approximately two miles upstream. When not in spill mode, the water level upstream of the diversion dam is between elevation 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the headpond storage is estimated to be approximately 100 acre-feet of water. During non-spill conditions, the headpond has a surface area of approximately 29.2 acres.

The Districts constructed LGDD from 1891 to 1893, and replaced Wheaton Dam, which was built by other parties in the early 1870s. LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. LGDD provides no flood control benefits, and there are no recreation facilities currently associated with the Project or the La Grange headpond.

The La Grange powerhouse, originally constructed in 1924 and located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River, is owned and operated by TID. The powerhouse has a current capacity of approximately 4.7 megawatts (MW) and was put into service in 1924, thirty years after construction of the LGDD. The La Grange powerhouse operates in a run-of-river mode. The electricity produced by the powerhouse is used as part of TID's portfolio of electric power generation to serve its retail customers. Under non-spill conditions, water not diverted by TID and/or MID for water supply purposes is passed downstream. Waters passed downstream benefits aquatic resources in the lower Tuolumne River. Water introduced into the lower Tuolumne River downstream of the Project is passed through one or both of the turbine-generator units located in the powerhouse and/or one or more of three separate flow conduits located at the Project. If the powerhouse units are not able to be used, water not diverted for water supply purposes is passed downstream via one or more of the available flow conduits at the Project. In the event that the La Grange powerhouse trips offline (i.e., unexpectedly stops generating) and water stops flowing through the powerhouse, the TID sluice gate(s) open immediately to maintain flows to the river. In addition, TID currently maintains in an open position an 18-inch pipe that continuously delivers flow to the sluice gate channel. The exact flow quantity is not measured, but is roughly estimated to be 5 to 10 cubic feet per second (cfs) (TID/MID 2017a).

Don Pedro Dam, owned jointly by the Districts, is located approximately two miles upstream of LGDD. Water released from Don Pedro Reservoir is either diverted by TID or MID at LGDD for the purposes of irrigation or M&I water supply or passes to the lower Tuolumne River through one of the flow conduits available at the Project. MID's diversion tunnel intake is located at the west (looking downstream, river right) end of the dam, and TID's irrigation diversion tunnel intake is located at the east (river left) end of the dam. TID’s diversion tunnel and intake are non-Project facilities as their primary purpose is to divert Tuolumne River flows to the TID irrigation system. Project facilities are discussed in detail in the following sections.

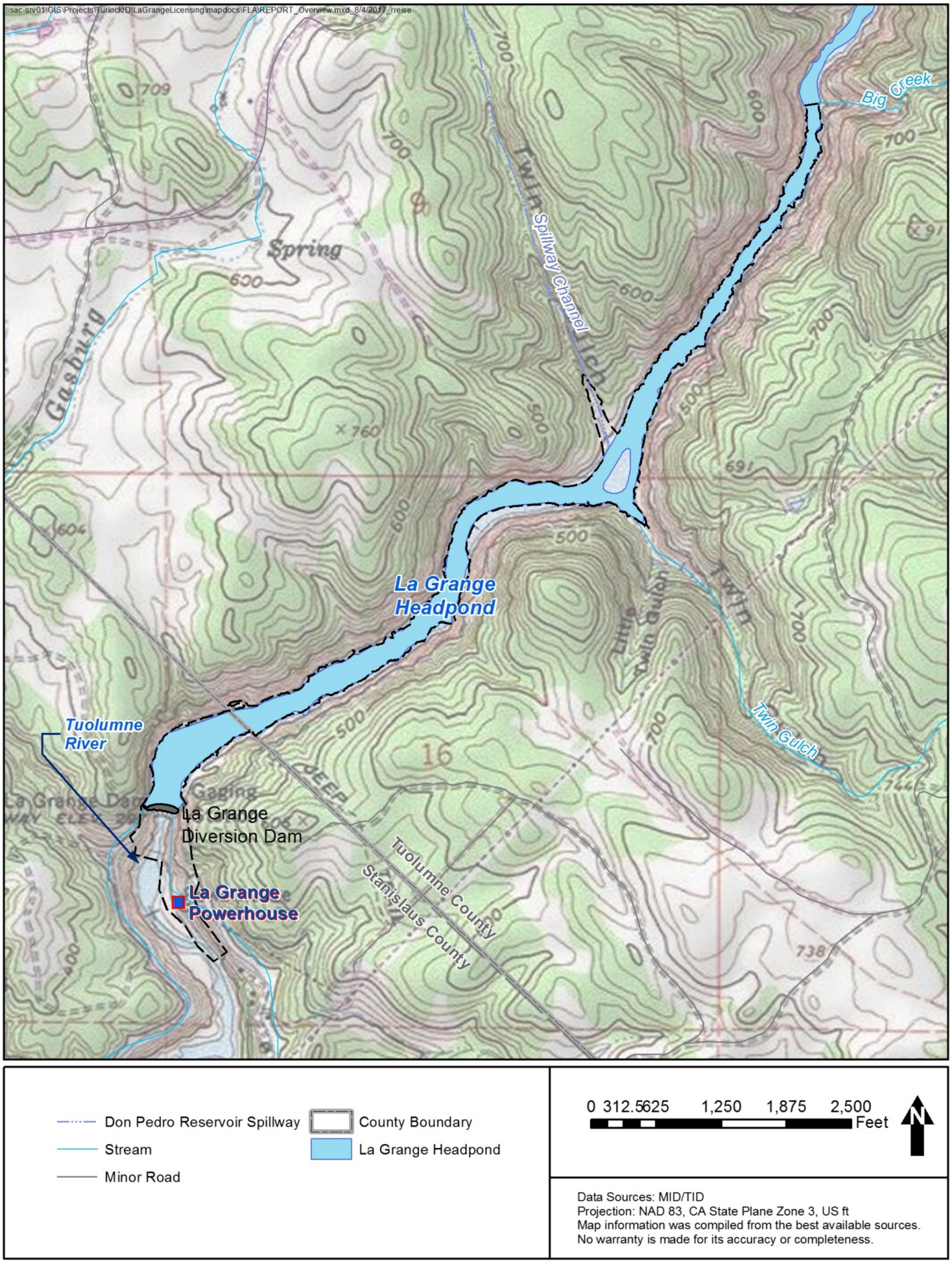

Figure 1.3-1. La Grange Hydroelectric Project location map.

1.3.1 Project Facilities and Project Boundary

The Project includes the LGDD, its impoundment, and certain facilities and structures dedicated to the support of hydroelectric power generation. Project facilities serving hydropower generation include a penstock intake structure with trashracks, two penstocks, a powerhouse, an excavated tailrace channel, and a substation. The penstock intakes for the TID powerhouse are located just upstream of TID's non-Project Upper Main Canal headworks. Under current powerhouse operations, other structures necessary for the safe and effective operation of power generation are the sluice gate structure located just upstream of and conjoined with the penstock intake structure, two sluice gates contained in the sluice gate structure, and an 18-inch pipeline at the base of the structure. No FERC-jurisdictional transmission lines are associated with the Project (see Section 1.3.1.6). The location of the Project and its primary facilities are shown in Figure 1.3-2. The Proposed Action considered in this BA includes three PM&E measures discussed further in Section 2.1.2.

The Project Boundary includes a number of Project facilities and structures that occupy upland and/or riverine habitats. Upland habitats are either steep-sided rock hillsides or made land containing project structures (e.g., intakes, penstocks, powerhouse and substation). Riverine habitat within the Project Boundary includes the sluice gate channel and the tailrace channel, which flows for a distance of approximately 650 feet from the powerhouse to its confluence with the mainstem Tuolumne River. The Project Boundary also includes a 475 feet reach of the mainstem Tuolumne River from LGDD downstream to the MID Hillside Discharge location. Land within the Project Boundary is jointly owned by the Districts. In addition, the Bureau of Land Management administers land within the Project Boundary, and a parcel within the Project Boundary is owned by the Coleman Ranch. While the Project Boundary includes the LGDD and associated headpond, the dam's primary purpose is to divert water for irrigation and M&I use. Absent power generation, LGDD will continue to be operated for water supply purposes just as it is currently.

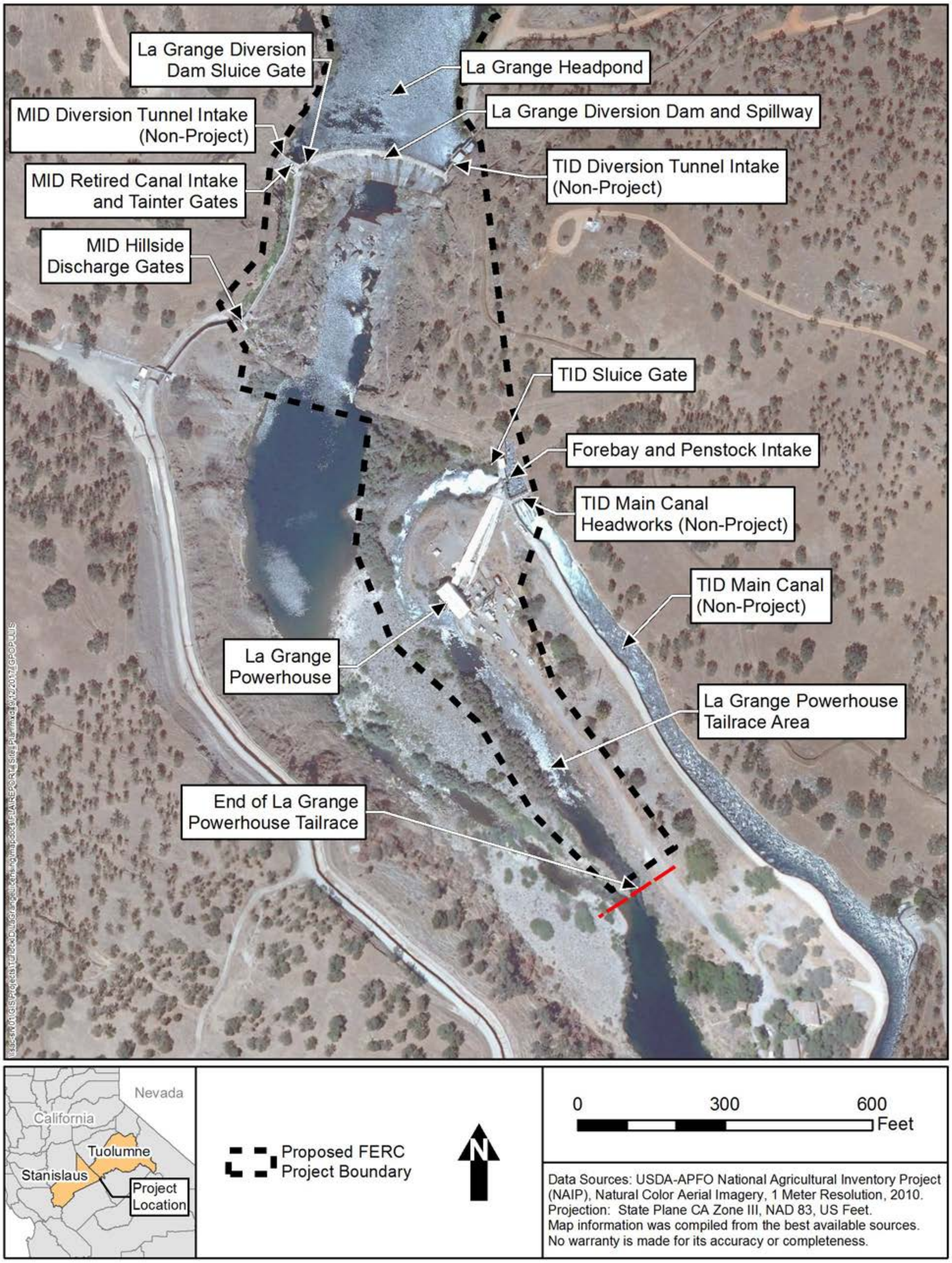

Figure 1.3-2. La Grange Project site plan, showing Project and non-Project facilities.

1.3.1.1 Diversion Dam and Spillway

The original 127.5-foot-high arched dam placed in service in 1893 was constructed of boulders set in concrete and faced with roughly dressed stones from a nearby quarry. In 1923, an 18-inch-high concrete cap was added, and in 1930, an additional 24-inch-high concrete cap was added, resulting in the final and current height of 131 feet. The crest elevation was raised to increase the flows that could be diverted to each of the Districts' irrigation canals. There have been no significant modifications to LGDD and spillway since 1930, except for routine maintenance and repairs.

The dam was constructed such that the top of the dam is almost entirely an uncontrolled overflow spillway. The spillway crest is at elevation 296.5 feet (all elevations are referenced to 1929 National Geodetic Vertical Datum) and has a length of 310 feet.

1.3.1.2 Headpond

The diversion dam was constructed for the purpose of raising the level of the Tuolumne River to a height that enabled gravity flow of diverted water into the Districts' irrigation systems. When not in spill mode, the water level above the diversion dam is between 294 feet and 296 feet approximately 90 percent of the time.

Based on hydraulic modeling performed by the Districts[3], the upper end of the headpond formed by LGDD under non-spill conditions terminates approximately two miles above the diversion dam. This creates a shoreline length of approximately two miles and a surface area of approximately 29.2 acres. The headpond has a maximum depth of 35 feet, a mean depth of approximately 11 feet, a gross storage capacity of approximately 340 acre-feet (ac-ft), and a usable storage capacity of less than 100 ac-ft.

1.3.1.3 Penstock and Sluice Gates

Flows entering TID's non-Project irrigation intake and tunnel discharge nearly 600 feet downstream into a concrete forebay structure (Figure 1.3-3) that contains the sluice gate and penstock intake as well as the headworks structure for delivering water to the TID Upper Main Canal. The penstock intake structure contains a trashrack and three 7.5-foot-wide by 14-foot-high concrete intake bays that deliver water to the two penstocks. The penstock for Unit 1 is a 235-foot-long, 5-foot-diameter steel pipe. The penstock for Unit 2 is a 212-foot-long, 7-foot-diameter steel pipe. Manually operated steel gates are used to shut off flows to the penstocks. Immediately adjacent to the penstock intakes are two automated 5-foot-high by 4-foot-wide sluice gates that discharge water over a steep rock outcrop at the head of the sluice gate channel that feeds water to the tailrace channel.

[3] The backwater study was submitted to the Commission under Docket UL11-1 (TID 2011) as part of the Commission's deliberations related to the jurisdictional status of the La Grange powerhouse.

Figure 1.3-3. Sluice gate channel and penstock intake. In the photo, flow is being discharged from the sluice gates to the sluice gate channel.

1.3.1.4 Powerhouse

The TID-owned and operated powerhouse was built in 1924 and is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River (Figure 1.3-4). Water diverted through the TID intake and tunnel to the forebay can enter the two penstocks that deliver flow to the powerhouse. The powerhouse is a 72-foot by 29-foot structure with a reinforced concrete substructure and steel superstructure. The powerhouse contains two turbine-generator units. Unit 1 is a Francis turbine rated at 1,650 hp at 140 cfs and 115 feet of net head. Unit 2 is a Francis turbine rated at 4,950 hp at 440 cfs and 115 feet of net head. Both turbines are fitted with straight-drop vertical draft tubes. The combined generator rated output is approximately 4,700 kW.

1.3.1.5 Tailrace Channel

Turbine discharges at the La Grange powerhouse flow into a tailrace that joins the lower Tuolumne River about 0.5 miles below LGDD. The two sluice gates in the TID forebay can also discharge flows into the tailrace.

1.3.1.6 Substation and Transmission Line

The transmission line connecting the La Grange powerhouse to the grid originates at the 4.16/69 kilovolt transformer in the substation located on the east side of the powerhouse. The transmission line connects to both TID's Tuolumne Line No. 1 and its Hawkins Line. In the event that the Project powerhouse is decommissioned in the future, this transmission line would need to be retained to provide power needed to operate the Main Canal Headworks associated with the irrigation canal systems and the sluice gates. Therefore, under FERC's transmission line jurisdictional criteria, the transmission line currently serves as part of the existing distribution/transmission grid and would not fall within FERC jurisdiction. As such, it is a non-Project element and operation of the transmission line is not part of the Proposed Action.

Figure 1.3-4. Aerial view of penstock and sluice gate intake structure, penstocks, sluice gate channel, powerhouse, tailrace and substation.

1.3.2 Powerhouse Operations

The Project powerhouse generates electricity using a portion of the flows released by the upstream Don Pedro Project. Absent a FERC license to continue operating TID's two turbine-generator units, these flows would continue to be passed downstream at LGDD to the tailrace. A portion of the flows that are passed at LGDD to the river are releases made at the Don Pedro Project over and above flow amounts needed to be diverted by LGDD for water supply purposes, including flows released at Don Pedro to meet its FERC license requirements. These flows are normally passed downstream at LGDD via the TID intake and tunnel, penstocks and powerhouse units. Turbine discharges at the La Grange powerhouse flow into a tailrace channel that joins the lower Tuolumne River about 0.5 miles below LGDD. The two sluice gates adjacent to the penstock intake can also discharge flows into the tailrace via the sluice gate channel.

Operation of TID's La Grange powerhouse is monitored around-the-clock from TID's Control Center. Although remote start-up is possible, for safety reasons, operators are generally dispatched to the Project to check conditions following a station trip and to start the unit(s). If a unit or the station trips, Control Center operators immediately open the two sluice gates to make certain flows continue downstream without disruption. The impact of a station trip on downstream flow as measured at the USGS La Grange gauge was examined by the Districts at the request of NMFS and FERC as part of the Don Pedro Project relicensing. Recorded stage changes in fifteen minutes were less than two inches (0.17 feet) up or down 99.4 percent of the time, less than four inches (0.33 feet) 99.9 percent of the time, and less than eight inches (0.67 feet) 99.99 percent of the time. One hour stage change is less than two inches up or down 96.6 percent of the time, less than four inches 99.0 percent of the time, and less than eight inches 99.8 percent of the time (TID/MID 2014b).

1.3.3 Other Project Operations

All flows released at the Don Pedro Dam are either diverted at LGDD by TID and/or MID, spilled over the LGDD spillway, and/or pass through one of the LGDD's outlet structures. Diverted water is delivered to each District's water supply delivery systems through non-Project facilities. On the MID side of the river, in addition to water diversions for water supply purposes, slide gates (Hillside Gates) located about 300 feet downstream of the LGDD can safely discharge water from the retired MID open channel irrigation canal down a rock hillside to the plunge pool below the LGDD. Currently, MID releases a flow of approximately 5 to 10 cfs from the Hillside Gates to the river, this being sufficient to maintain dissolved oxygen and cold water in the plunge pool. The Portal No. 1 gate located in the LGDD also can be used to discharge flows to the plunge pool area. On the TID side of the river, water can flow to the tailrace, and thence to the river, either through the powerhouse units or through the 5-foot-wide by 4-foot-high sluice gates located adjacent to the penstock intakes.

1.4 Licensing Process and Studies to Date

In 2014, the Districts commenced the pre-filing process for the licensing of the Project by filing a Pre-Application Document with FERC[4]. On September 5, 2014, the Districts filed their Proposed Study Plan to assess Project effects on fish and aquatic resources, recreation, and cultural resources in support of their intent to license the Project. On January 5, 2015, in response to comments from licensing participants, the Districts filed their Revised Study Plan (RSP) containing three study plans: (1) Cultural Resources Study Plan; (2) Recreation Access and Safety Assessment Study Plan; and (3) Fish Passage Assessment Study Plan[5].

[4] On December 19, 2012, Commission staff issued an order finding that the La Grange Hydroelectric Project is required to be licensed under Section 23(b)(1) of the Federal Power Act. Turlock Irrigation District and Modesto Irrigation District, 141 FERC ¶ 62,211 (2012), aff'd Turlock Irrigation District and Modesto Irrigation District, 144 FERC ¶ 61,051 (2013). On May 15, 2015, the U.S. Court of Appeals for the District of Columbia Circuit denied the Districts' appeal and affirmed the Commission's finding that the La Grange Hydroelectric Project requires licensing. Turlock Irrigation District, et al., v. FERC, et al., No. 13-1250 (D.C. Cir. May 15, 2015).

[5] The Fish Passage Assessment Study Plan contained a number of individual, but related, study elements.

On February 2, 2015, FERC issued the Study Plan Determination (SPD), approving or approving with modifications six studies (Table 1.4-1). Of those six studies, five had been proposed by the Districts in the RSP. The Districts note that although FERC's SPD identified the Fish Passage Barrier Assessment, Fish Passage Facilities Alternatives Assessment, and Fish Habitat and Stranding Assessment below La Grange Diversion Dam as three separate studies, all three assessments are elements of the larger Fish Passage Assessment as described in the RSP. The sixth study approved by FERC, Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River, was requested by the National Marine Fisheries Service (NMFS) in its July 22, 2014 comment letter.

Table 1.4-1. Studies approved or approved with modifications in FERC's Study Plan Determination.

No.	Study	Approved by FERC in SPD without Modifications	Approved by FERC in SPD with Modifications
1	Recreation Access and Safety Assessment		X
2	Cultural Resources Study		X
3	Fish Passage Barrier Assessment		X[1]
4	Fish Passage Facilities Alternatives Assessment		X
5	Fish Habitat and Stranding Assessment below La Grange Dam		X
6	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River	X[2]	

[1] Page A-1 of Appendix A of FERC's SPD states that FERC approved with modifications the Fish Passage Barrier Assessment. However, the Districts found no modifications to this study plan in the SPD and page B-7 of the SPD states "no modifications to the study plan are recommended."

[2] FERC directed the Districts to conduct the study plan as proposed by NMFS.

In the SPD, FERC recommended that, as part of the Fish Passage Facilities Alternatives Assessment, the Districts evaluate the technical and biological feasibility of the movement of anadromous salmonids through the La Grange headpond and the Don Pedro Reservoir if the results from Phase 1 of that study indicate that the most feasible concept for fish passage would involve fish passage through Don Pedro Reservoir or La Grange headpond. On September 16, 2016, the Districts filed the final study plan with FERC. On November 17, 2016, the Districts filed a letter with FERC after consulting with fish management agencies (i.e., NMFS and the California Department of Fish and Wildlife [CDFW]) regarding the availability of test fish and a determination that no fish would be available to support conducting this study in 2017. On January 12, 2017, the Districts filed a letter with FERC stating that with FERC's approval, they intend to conduct the study in 2018 if the results from the Fish Passage Facilities Alternatives Assessment indicate that upstream or downstream fish passage at LGDD and the Don Pedro Project would require anadromous fish transit through one or both reservoirs.

In addition to the six studies noted in Table 1.4-1, the SPD required the Districts to develop a plan to monitor anadromous fish movement in the vicinity of the Project's powerhouse draft tubes to determine the potential for injury or mortality from contact with the turbine runners. The Districts filed the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes study plan with FERC on June 11, 2015, and on August 12, 2015, FERC approved the study plan as filed.

On February 2, 2016, the Districts filed the Initial Study Report (ISR) for the La Grange Hydroelectric Project. The Districts held an ISR meeting on February 25, 2016, and on March 3, 2016, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 4, 2016. One new study request was submitted; NMFS requested a new study entitled Effects of La Grange Hydroelectric Project Under Changing Climate (Climate Change Study). On May 2, 2016, the Districts filed with FERC a response to comments received from licensing participants and proposed modifications to the Fish Passage Facilities Alternatives Assessment and the La Grange Project Fish Barrier Assessment, and a revised pre-filing schedule. On May 27, 2016, FERC filed a determination on requests for study modifications and new study. The May 27, 2016 determination approved the Districts' proposed modifications and did not approve the NMFS Climate Change Study, and accepted the Districts' revised pre-filing schedule.

On February 1, 2017, the Districts filed the Updated Study Report (USR) for the La Grange Hydroelectric Project. The Districts held a USR meeting on February 16, 2017, and on March 3, 2017, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 3, 2017. Comments on the USR were received from the Central Sierra Environmental Resource Center on February 27, 2017, from NMFS on April 3, 2017, and from CDFW on April 13, 2017. On May 2, 2017, the Districts filed with FERC a response to comments received from licensing participants.

On April 24, 2017, the Districts filed the Draft License Application (DLA) for the La Grange Hydroelectric Project. Comments on the Draft License Application were received from NMFS on May 12, 2017, from FERC on July 18, 2017, and from CDFW on August 18, 2017. The Districts' response to these comments is included in the La Grange Hydroelectric Project Final License Application (FLA). The FLA was filed with FERC on October 11, 2017, in accordance with the Districts' Request for Extension of Time granted by FERC on September 1, 2017.

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Proposed Action

As presented in Section 1.2, the Proposed Action under review by FERC is the issuance of an original license to the Districts to authorize the continued generation of hydroelectric power at the Project, and the implementation of three water resource PM&E measures. As generally described in FERC's Scoping Document 2 (SD2) issued on September 5, 2014, any actions proposed to mitigate the Project's effects (i.e., PM&E measures) must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydropower generation at the Project.

It should be noted that this Draft BA addresses the Proposed Action, which is FERC's issuance of an original license to continue operation of the Project. If FERC does not issue an original license, power generation facilities would cease to operate at the Project. Exhibit E of the FLA (TID/MID 2017d) provides a description of the "No Action" alternative (i.e., FERC does not issue a license and power generation ceases). Under the No Action alternative, flows released from the upstream Don Pedro Project that are not needed to be diverted for water supply purposes would continue to be passed downstream at the LGDD as they currently are; however, power would no longer be generated. Under the No Action alternative, the powerhouse would be retrofitted to allow flows to pass through the facility without generation.

2.1.1 Hydropower Generation

Tuolumne River flows passed downstream at LGDD may flow through TID's two-unit powerhouse up to the plants hydraulic capacity of 580 cfs (at 115 feet of net head). Powerhouse flows are discharged through the turbine runners to vertical draft tubes and then into the Project tailrace. The tailrace extends for approximately 650 feet where it joins the mainstem Tuolumne River. The rated capacity of the two-unit powerhouse is 4.7 MW. The minimum hydraulic capacity of Unit 1 is approximately 75 cfs and that of Unit 2 approximately 150 cfs.

Under typical Project operations, the MID Hillside Gates and the TID powerhouse are the preferred conduits used to pass undiverted flows at LGDD. If the powerhouse is out of service for maintenance or repairs, then typically the TID sluice gates are put in use, followed by the Portal No.1 gate. If there is a unit or station trip at the TID powerhouse, a TID Control Center operator immediately opens the sluice gates. This remote gate opening provides flow to the tailrace channel in less than one minute (J. Guignard, FISHBIO, pers comm, 8/1/2017) and makes certain flows continue downstream with minimal interruption. Studies conducted during the Don Pedro Project relicensing and reported in the Don Pedro Updated Study Report and the amendment to the Don Pedro amended Final License Application (AFLA) show that under conditions of a station trip, fluctuations in stage as recorded at the nearby USGS gage are less than 2 inches 99.4 percent of the time, less than two inches (0.17 feet) up or down 99.4 percent of the time, less than four inches (0.33 feet) 99.9 percent of the time, and less than eight inches (0.67 feet) 99.99 percent of the time. One hour stage change is less than two inches up or down 96.6 percent of the time, less than four inches 99.0 percent of the time, and less than eight inches 99.8 percent of the time.

2.1.2 Proposed Aquatic PM&E Measures

As noted above, the Districts propose three PM&E measures under the Proposed Action. These measures would be implemented below LGDD, within the Action Area. One measure is intended to monitor dissolved oxygen in the Action Area and the remaining two are designed to benefit *O. mykiss* and their habitat, as well as habitat for fall-run Chinook Salmon (*O. tshawytscha*). The environmental benefit of these enhancements is discussed in Section 5.2. An EFH Assessment for Pacific Coast Salmon, including fall-run Chinook Salmon in the Action Area, is presented as Attachment A.

2.1.2.1 Sluice Gate Fish Barrier Installation

Under the Proposed Action, the Districts would construct a fish barrier near the downstream end of the existing sluice gate channel and close (but not remove) the 18-inch pipe that continuously releases a flow of 5 to 10 cfs to the channel. These actions would prevent fish from being attracted into or entering the sluice gate channel at all times except extreme high flow events. Although there is no evidence of stranding of *O. mykiss* juveniles in the channel under current conditions (TID/MID 2017a), this PM&E measure would prevent access to the channel under Project operations. Over the last two decades, two fall-run Chinook have been found dead in the sluice gate channel; one potentially due to dewatering (prior to the open pipe flow being provided) and one due to predation (TID/MID 2017a). The sluice gate channel is a constructed, non-natural, channel built to carry water from the TID forebay to the constructed tailrace. The upper part is a waterfall, and the lower part is a steep rock, boulder and cobble channel.

Once installed, the barrier, designed to NMFS salmonid screening criteria, would also allow the Districts to conduct inspections of its water supply tunnel and forebay (non-Project elements) without the need for fish salvage. Following barrier installation, except during powerhouse outages, the Districts would no longer discharge surface water into the sluice gate channel. The 18-inch pipe would no longer release a constant flow of 5 to 10 cfs of surface water into the sluice channel. Attachment B to this BA shows the preliminary functional design of the barrier.

The proposed fish barrier would consist of a concrete weir with a maximum height of 8 feet above foundation level abutting the steep bank on channel-left and tying into an existing rock berm on channel-right. The berm would be raised (see Attachment B) to prevent flows from entering the sluice gate channel during spill periods less than 7,000 cfs. Based on gauge data from the Tuolumne River just below LGDD (water years 1971-2012, USGS gauge 11289650), and anticipated flow management strategies to maintain spills below 7,000 cfs, spillway flows greater than 7,000 cfs are anticipated to occur approximately once every 5 years. During these periods, salvage efforts would occur as described below.

Construction

Fish Barrier Construction Approach

The fish barrier would be constructed in the dry, and a temporary sandbag cofferdam would be placed between the barrier location and the tailrace channel to prevent powerhouse flows or minor spills from entering the construction area. The construction would take approximately two months to complete, starting in mid-July and completed by mid-September, following issuance of the FERC license.

Prior to construction activities, a team of biologists would observe initial dewatering and relocate any fish from the sluice gate channel in-water work isolation area. The Districts would conduct fish salvage in the sluice gate channel by herding fish in the downstream direction from the channel into the tailrace using dip nets and a series of block nets once a reach has been sufficiently inspected. A barrier block net would be installed at the downstream terminus of the in-channel construction area upon completion of salvage, the sluice gate would then be closed, and a temporary sand bag cofferdam would be installed. If salvage were to require electrofishing, an electrofisher would be used in accordance with NMFS (2000) guidelines. All salvaged fish would be relocated to the tailrace channel.

At the beginning of construction, a channel connecting the LGDD plunge pool area with the tailrace would be constructed to maintain flow into the tailrace throughout construction. Following the completion of the channel connection, the powerhouse would be turned off to avoid the occurrence of station trips. A temporary sandbag dike (cofferdam) would be placed in the mainstem at the downstream end of the plunge pool with a pipe through it to maintain control of the elevation of the plunge pool while also maintaining flow to the mainstem. The connecting channel would be sized to approximately 75 cfs. Prior to opening the channel connecting the plunge pool with the tailrace, a turbidity curtain would be installed upstream of where the channel connects to the tailrace. The temporary bypass would be opened incrementally to reduce the downstream sediment pulse into the tailrace channel. During fish barrier construction, the MID Hillside gate would be placed into operation at the appropriate flow rate, depending on the required instream flow (based on water year type), and water would be released into the LGDD plunge pool. The MID Hillside gate has the flow capacity to release up to 350 cfs (TID/MID 2017b). Following construction, the sandbag cofferdams would be removed.

Once the fish barrier is in place, the sluice gate channel would typically be dry except during periods when the powerhouse trips and the sluice gate is manually opened. During these periods, as soon as the powerhouse comes back on line, the sluice gate would be closed, and the sluice gate channel would again be dewatered.

Construction Timing

Construction of the fish barrier, including fish salvage and in-water work isolation, would occur over approximately eight weeks from mid-July 15 to mid-September. This window is consistent with in-water work periods established by NMFS, USFWS, and the U.S. Army Corps of Engineers (USACE) for instream work in the Central Valley (USACE et al. 2006) and is supported by spawning studies conducted near the Action Area. Researchers conducting redd surveys in the reach of the Tuolumne River immediately downstream of the Action Area (RM 52.0 – 47.4) during the 2014-2015 spawning season observed fall-run Chinook salmon redds from late October through December, with peak spawning in mid-November. During this study, *O. mykiss* redds were observed between January and April, with peak observations in late February (TID/MID 2015). No redds were observed in the sluice gate channel. Given these observations, the July 15 through mid-September in-water work window would avoid sensitive salmonid life histories including spawning adults, eggs, and alevins in the Action Area.

Impact Minimization Measures

The following impact minimization measures are considered part of the Proposed Action and will be implemented during construction of the fish barrier and during fish salvage operations in the sluice gate channel when flows exceed 7,000 cfs following fish barrier installation:

- The proposed sluice gate channel fish barrier would be designed to meet NMFS screening and approach velocity and leaping criteria to prevent the upstream movement of fish into the sluice gate channel.
- In-water work to install the fish barrier in the sluice gate channel will occur from July 15 – mid September.
- To the extent practicable, machinery used for in-water elements will be operated atop bedrock to limit substrate compaction and downstream sedimentation. During sandbag installation, equipment may be driven in flowing water.
- Following placement of the temporary sandbag cofferdam, equipment will not operate in active flow as the sluice gate will be shut, and the cofferdam will prevent water from the tailrace channel to enter the construction area.
- The sandbag cofferdam will be removed from the sluice gate channel and mainstem by the end of September. All instream spoils will be removed from the isolated work area prior to sandbag removal.
- Prior to opening the connecting channel connecting the plunge pool with the tailrace, a turbidity curtain will be installed at the downstream exit to the tailrace. The temporary bypass will be opened incrementally to reduce any potential downstream sediment pulse.
- Temporary spoils from connecting channel excavation will be stored adjacent and upslope of the connecting channel and covered with plastic sheeting. Existing riparian vegetation will be protected to the extent possible. Vegetated areas disturbed along the connecting channel area will be restored with native species.
- During initial connecting channel backfill, a turbidity curtain will again be placed at the downstream exit of the connecting channel to the tailrace channel.
- Following connecting channel backfill, adjacent reaches of the mainstem pool and tailrace channel will be returned to pre-construction contours.
- To prevent spread of invasive species/disease the appropriate field gear disinfection protocol will be adhered to for instream equipment use (e.g., nets, hip boots, equipment).

- Because the construction area will be small and dry, no significant seepage is anticipated. If needed, diesel or electric sump pumps will be used to capture seepage flow from the cofferdam area.
- A pollution and erosion control plan will be prepared and carried out by the Contractor to prevent pollution related to construction activities. The pollution and erosion control plan will also contain specific information regarding emergency spill and preventative measures. The pollution and erosion control plan will address equipment and materials storage sites, fueling operations, staging areas, hazardous materials, spill containment and notification, and debris management.
- Immediately prior to initiating construction activities, qualified fisheries biologists will remove and relocate all fish from the immediate area in accordance with the procedures outlined above.

Sluice Gate Channel Operations and Fish Salvage at High Flows (>7,000 cfs)

As discussed above, when flows exceed 7,000 cfs, surface water would overtop the rock berm and spill into the sluice gate channel. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Opening of the 18-inch pipeline would prevent dewatering of the sluice channel, but any fish that accessed the sluice channel during high flows would be isolated from the tailrace channel.

During these periods (approximately once every 5 years), fish salvage operations would follow the same procedure as defined above for initial fish barrier construction. This is because the powerhouse must be shut down to avoid the sluice gates having to be opened upon a station trip. Therefore, a temporary channel connecting the plunge pool below LGDD to the tailrace would serve to keep the tailrace wetted and flowing during these salvage operations. Excavation of the connection channel would require temporary sandbagging of the main channel at the exit from the plunge pool to raise and control the elevation of the pool. A pipe would be inserted in the sandbags to continue flow to the mainstem.

Upon completion, the fish barrier would allow the sluice gate to operate without concern for any fish making their way into the sluice channel and then being dewatered or stranded. There would be no need to keep the 18-inch pipe open; however, it would be opened any time salvage operations are necessary following high (i.e., >7,000 cfs) flow events.

2.1.2.2 Continuous Surface Water Release to LGDD Plunge Pool

Under the Proposed Action, the Districts would formalize an operation that is now implemented voluntarily. Currently, with the exception of spring spill events when water flows over LGDD, water not diverted for water supply purposes is routed through the Project powerhouse (river left). The powerhouse tailrace receives approximately 95 percent of flows outside of spring spill season. Because resident fish occupy the plunge pool downstream of the LGDD, the Districts have been voluntarily releasing 5 to 10 cfs of surface water to the plunge pool to maintain dissolved oxygen and cool water temperatures. As discussed in Section 1.3.3, this 5 to 10 cfs is typically routed to the plunge pool via the river-right MID Hillside gate(s) (Figure 2.2-1), via Portal No. 1 in the dam, or over the spillway.

Under the Proposed Action, the Districts would formalize this voluntary action as a standard operating condition and continuously release 5 to 10 cfs to the mainstem Tuolumne River plunge pool downstream of the LGDD. The release would occur 24-hours a day, every day of the year. Similar to existing conditions, surface water would be released into the plunge pool below the MID Hillside, Portal No. 1 in the dam, or the LGDD spillway.

2.1.2.3 Dissolved Oxygen Monitoring

The Districts have collected temperature, turbidity, and dissolved oxygen data in the tailrace channel as part of the Fish Barrier Assessment, all of which indicate satisfactory conditions for aquatic life (TID/MID 2017e). During the first year of the assessment (2015), there was a brief period from late September through October during which daily instantaneous measurements of dissolved oxygen below 8.0 mg/L were recorded at the tailrace channel weir location. The low instantaneous dissolved oxygen levels appeared to be a localized event as dissolved oxygen levels at the main channel weir remained above 8.0 mg/L during the same period of time. To further evaluate the potential cause of this spatially and temporally isolated event, the Districts propose to monitor dissolved oxygen from September 1 to November 30 each year for the first 2 years of a new operating license. Monitoring equipment will collect dissolved oxygen information at 15 minute intervals at three locations; the Project forebay, immediately below the powerhouse, and at the lower end of the tailrace channel. At the end of the monitoring period each year, these data will be compiled, analyzed, and submitted as an annual report to FERC. If results indicate a specific cause for low dissolved oxygen exists, the Districts will develop and submit an action plan to FERC in year 3 of the license.

2.2 Action Area

Section 7 of the ESA requires the identification of an Action Area for use in determining the environmental baseline and evaluating the potential effects of an action on federally listed species. The Action Area is defined as the geographic area likely to be affected by the direct[6] and indirect[7] effects of the Proposed Action (50 Code of Federal Regulation [CFR] § 402.02; USFWS and NMFS 1998), and considers the effects of interrelated and interdependent actions. The action considered in the BA is FERC's issuance of an original license for hydropower generation at the Project. FERC licenses a "complete unit of development" that consists of all dams, reservoirs, other engineered structures necessary for operation and maintenance of a project (i.e., Project Boundary). Therefore, for this BA, the aquatic portion of the Action Area includes: (1) the upstream extent of the Project Boundary, including the LGDD and its impoundment; (2), the main channel of the Tuolumne River from the LGDD downstream to its confluence with the powerhouse tailrace channel near RM 51.8; (3) the tailrace channel from the powerhouse exit to the confluence with the mainstem Tuolumne River; and, (4) and the TID sluice gate channel. The terrestrial portion of the Action Area includes the Project powerhouse,

[6] Direct effect: the direct or immediate effects of the project on the species or its habitat (Final ESA § 7 Handbook at 4-25).
[7] Indirect effects: those effects that are caused by or will result from the Proposed Action and are later in time, but are still reasonably certain to occur [50 CFR § 402.02].

the forebay, penstocks, and substation on river-left, and the MID Hillside Discharge on river-right (Figure 2.2-1).

All surface water passing through the Project powerhouse would be routed downstream of the LGDD regardless of the Proposed Action. Therefore, the downstream extent of the Action Area is defined based on the extent of hydraulic impacts (i.e., turbulence) attributed to release of surface water from the powerhouse to the tailrace. The downstream extent of the Action Area also considers construction-related effects during installation of the fish barrier and occasional fish salvage upstream of the new barrier following high flows (>7,000 cfs). When compared to the environmental baseline, the effects of hydroelectric power generation on the environment are not measurable downstream of the confluence of the mainstem Tuolumne River with the tailrace.

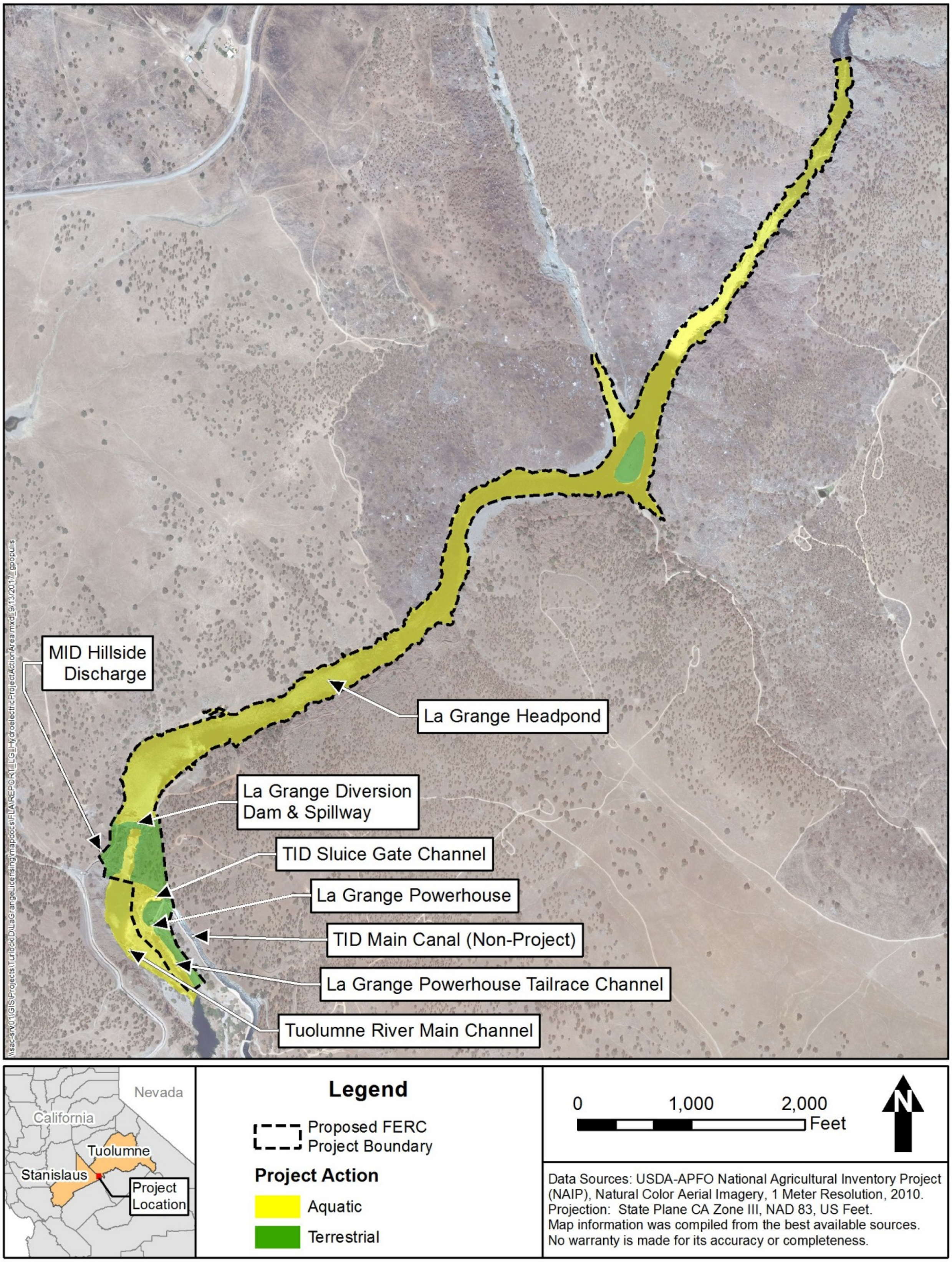

Figure 2.2-1. La Grange Hydroelectric Project Action Area (aquatic and terrestrial portions).

Although the forebay, LGDD and the impoundment are part of Project Boundary, and therefore part of the Action Area, each structure has independent utility, and their primary purpose is to convey water diverted for irrigation. Hydropower generation at the Project is a secondary purpose of the LGDD. Non-Project irrigation and M&I surface water diversion is the primary purpose of the LGDD, which would exist regardless of the Proposed Action.

2.3 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification (50 CFR § 402.02), whereas interdependent actions are actions with no independent utility apart from a Proposed Action (50 CFR § 402.02). If a private activity would not occur in the absence of a proposed federal action, the effects of that private activity are interdependent and/or interrelated with the Proposed Action, and the effects of the private activity are considered attributable to the proposed federal action for consultation purposes.

In contrast, actions that occur with or without the occurrence of the Proposed Action are not interdependent or interrelated with the Proposed Action. The USFWS and NMFS (1998) state that if a project would exist independent of a Proposed Action, it cannot be considered "interrelated" or "interdependent" and included in the effects of the Proposed Action.

As noted above, the Proposed Action is the issuance of an original FERC license for the continuation of the hydroelectric generation at the La Grange Hydroelectric Project. Water diversion for the Districts' water supply purposes is the Project's primary purpose, i.e., the diversion of water for irrigation using non-Project facilities and M&I uses for the Districts are not dependent on the issuance of a FERC license for the Project, and would occur with or without the licensing of the Proposed Action. In addition, as with every diversion dam, waters not being diverted must be passed safely downstream. Any of the flow conduits associated with LGDD may be used to safely pass flows downstream, including the powerhouse whether or not use of the turbine-generator units are authorized by FERC.[8] As such, these primary purposes are *not* interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are consulting with NMFS on the Proposed Action, analysis of the potential effects associated with the aforementioned non-hydropower uses are addressed only in the context of cumulative effects in the Action Area, i.e., there are no direct or indirect effects. This BA does include an analysis of the direct effects on *O. mykiss* associated with the Districts' proposed PM&E measures, which are specifically designed to benefit *O. mykiss* and other aquatic resources in the Action Area.

[8] If continuation of power generation is not authorized by FERC, the Districts would be able to replace the turbines with pressure relief valves in the powerhouse to continue to pass water through the powerhouse.

3.0 CALIFORNIA CENTRAL VALLEY STEELHEAD DPS

3.1 ESA Listing of the CCV Steelhead[9]

The CCV steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and human-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, except for steelhead from San Francisco Bay and San Pablo Bay and their tributaries (63 FR 13347; 71 FR 860). Within the range of CCV steelhead, juvenile *O. mykiss* are putative steelhead and therefore part of the listed population. CCV steelhead also include anadromous *O. mykiss* from two artificial propagation facilities, the Coleman National Fish Hatchery and the Feather River Hatchery, as explained below.

NMFS proposed to list CCV steelhead (anadromous *O. mykiss*) as endangered on August 9, 1996 (61 FR 41541). NMFS concluded that the ESU was in danger of extinction because of habitat degradation and destruction, loss of access to historical freshwater habitats, water allocation issues, genetic introgression resulting from widespread stocking of hatchery steelhead and the potential ecological interaction between introduced stocks and native stocks, and because steelhead had been extirpated from most of their historical range.

On March 19, 1998, NMFS listed the CCV steelhead as a threatened species (63 FR 13347), based on the observation that threats to steelhead had diminished since the completion of the 1996 status review and because of recently implemented state conservation efforts and federal management programs (e.g., Central Valley Project Improvement Act [CVPIA] Anadromous Fish Restoration Program [AFRP], CALFED Bay-Delta Program [CALFED]) that address key factors for the decline of the species (NMFS 2016). NMFS also found that additional actions benefiting CCV steelhead included efforts to enhance fisheries monitoring and conservation measures to address artificial propagation.

On September 8, 2000, pursuant to a July 10, 2000 rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), statutory take restrictions that apply to listed species began to apply, with certain limitations, to CCV steelhead (65 FR 42422) (NMFS 2016). On June 28, 2005, NMFS announced its final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204), and on January 5, 2006, NMFS reaffirmed the threatened status of CCV steelhead and decided to apply the joint USFWS-NMFS DPS policy (61 FR 4722) rather than the NMFS ESU policy to populations of West Coast steelhead (NMFS 2016). This policy requires a DPS to be discrete from other con-specific populations and significant to its taxon. A group of organisms is considered to be discrete if it is ‘‘markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors” (61 FR 4722).

Based on the January 5, 2006 listing determination, NMFS concluded that two of the four CCV steelhead artificial propagation programs are considered to be part of the DPS: the Coleman National Fish Hatchery and Feather River Hatchery steelhead programs. NMFS determined that

[9] The status of Central Valley steelhead in the Action Area is described in Section 4.0.

these stocks are no more divergent from local natural population(s) than what would be expected between closely related natural populations within the DPS (NMFS 2016). The CCV steelhead hatchery programs at Nimbus Fish Hatchery and Mokelumne River Hatchery were not included in the DPS because of the ongoing use of out-of-basin broodstock (NMFS 2016). In 2011, NMFS completed a status review of CCV steelhead and determined that available information continued to support inclusion of the Coleman National Fish Hatchery and Feather River Hatchery steelhead stocks as part of the DPS, while continuing to exclude stocks from Nimbus Fish Hatchery and Mokelumne River Hatchery. However, the most recent status review (NMFS 2016), indicates that steelhead from the Mokelumne River Hatchery are nearly genetically identical to those from the Feather River Hatchery (Pearse and Garza 2015). This is because the Mokelumne River Hatchery received all of its eggs from the Feather River Hatchery in the final years before it terminated the acquisition of eggs from out-of-basin sources. Because steelhead from the Feather River Hatchery are listed as part of the DPS, NMFS (2016) recommended that the Mokelumne River Hatchery steelhead be added to the CCV DPS. As of this writing, Mokelumne River Hatchery steelhead have not been formally included as part of the listed DPS.

In 2014, NMFS released its Recovery Plan for the Evolutionarily 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. In 2016, NMFS completed its Central Valley Recovery Domain 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment and Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act (conclusions of which are cited previously and subsequently, as appropriate).

3.1.1 Status of the CCV Steelhead DPS

It is difficult to estimate historical CCV steelhead run sizes due to insufficient data. By the early 1960s, however, the overall run size is estimated to be about 40,000 (McEwan and Jackson 1996). In 1996, NMFS estimated that the total Central Valley run size had probably declined to fewer than 10,000 individuals. During the past three decades, steelhead populations in the upper Sacramento River have declined substantially (NMFS 2014).

As noted, there is a paucity of steelhead population monitoring data available for most Central Valley river systems (NMFS 2010). Lindley et al. (2007) stated that there are almost no data upon which to base a status assessment of any of the CCV steelhead populations, except for those in Battle Creek and the Feather, American, and Mokelumne rivers (due to hatchery programs in those systems).

NMFS (2016) determined that the status of CCV steelhead has changed little since the 2011 status review, in which the Technical Recovery Team concluded that the DPS was in danger of extinction. Several hatcheries in the Central Valley have experienced increased steelhead returns in recent years. In addition, there has been a minor increase in the percentage of wild steelhead found during salvage operations at fish facilities in the south Delta (NMFS 2016). The catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which confirms that natural production of steelhead throughout the Central Valley remains low.

3.1.2 Life History and Ecology

Resident *O. mykiss* are generally referred to as rainbow trout. Steelhead is the name applied to the anadromous form of *O. mykiss*. Steelhead spend one to five years in freshwater prior to smolting and then spend up to three years in the ocean prior to returning to freshwater to spawn. CCV steelhead are considered a winter-run (i.e., ocean maturing) reproductive type, but in the past, before the construction of large dams, the summer-run type might also have been present in the Central Valley (Moyle 2002). Zimmerman et al. (2008) suggested that in the Central Valley, resident rainbow trout can produce anadromous progeny (i.e., smolts) and vice versa. However, the overwhelming majority of *O. mykiss* examined by Zimmerman et al. (2008) were the progeny of resident rainbow trout.

For the purposes of annual fishing regulations, CDFW considers steelhead as any *O. mykiss* larger than 16 inches found in any of California's anadromous waters (NMFS 1996; CDFW 2017a). To date, however, there has been very little analysis of resident/anadromous adults in the Tuolumne River to confirm anadromy based on size alone[10]. Zimmerman et al. (2008) evaluated strontium-to-calcium (Sr:Ca) ratios in 147 otoliths from *O. mykiss* collected in the Tuolumne River, and detected a single fish expressing a steelhead migratory history (i.e., increased Sr:Ca ratios in older otolith growth regions) and eight additional individuals with maternal steelhead origin. A review of that data shows that 38 of the fish sampled were ≥400 millimeters (mm) (roughly 16 inches), including the single steelhead detection (455 mm, or 17.9 inches). Over 97 percent (37 out of 38) of Tuolumne River *O. mykiss* individuals that were 400 mm or greater (≥ 16 inches) in length had low Sr:Ca ratios, and were classified as having a resident life history (see Appendix 1, Zimmerman et al. 2008). This study demonstrates that size alone is not a reliable indicator of *O. mykiss* anadromy in the Tuolumne River.

Characterizations of steelhead life history in the Central Valley are derived primarily from studies conducted in the Sacramento River basin (Hallock et al. 1961; McEwan 2001). Almost no information is available to document the life-history strategies of CCV steelhead in the San Joaquin River (SJR) basin (Busby et al. 1996). In addition, much of the data used to describe behavior and habitat use are derived from steelhead studies conducted in smaller stream systems (e.g., Everest and Chapman 1972; Everest et al. 1986). Therefore, descriptions of life history for SJR rivers are not well founded. Tuolumne River-specific studies of thermal preferences for *O. mykiss* suggest local adaptation to warmer summer temperatures. In a study of thermal performance of wild *O. mykiss* in the Tuolumne River below LGDD, Verhille et al. (2016, see also TID/MID 2016a) tested the hypothesis that the Tuolumne River *O. mykiss* population below LGDD is locally adapted to the relatively warm thermal conditions that exist in the river during the summer. In their study, Verhille et al. (2016) reported that all fish tested from 13 degrees Celsius (°C) to 24°C recovered quickly from an exhaustive swim test and then were successfully returned to the river. The authors concluded that the thermal range over which the Tuolumne River *O. mykiss* population can maintain 95 percent of their peak aerobic capacity is 17.8°C to 24.6°C. These results support the hypothesis that the thermal performance of wild *O. mykiss* from the Tuolumne River represents an exception to that expected based on the seven-day

[10] Based on the findings of Zimmerman et al. (2008), the Districts do not agree that size alone (i.e., > 16 inches in length) is indicative of anadromy in *O. mykiss*.

average of the daily maximum (7DADM) criterion established by EPA (2003) for Pacific Northwest *O. mykiss*. Based on the results of this study, Verhille et al. (2016, see also TID/MID 2016a) recommended a conservative upper aerobic performance limit of 22°C, instead of 18°C, be considered in re-determining a 7DADM for this population.

3.1.2.1 Adult Upstream Migration and Spawning

CCV steelhead use the Sacramento River as a migration corridor to access spawning grounds in tributaries. Historically, steelhead probably used the Sacramento River downstream from the current location of Shasta Dam, and the Feather River below the current location of Oroville Dam, solely as migration corridors. According to NMFS (2014), CCV steelhead are reported to spawn downstream of dams on every major tributary in the Sacramento and San Joaquin river basins.

Adult steelhead typically immigrate into Central Valley rivers from August through March (McEwan 2001; NMFS 2004), and peaks in January and February (Moyle 2002). Optimal immigration and holding temperatures have been reported to range from 8°C to 11°C (46-52 degrees Fahrenheit [°F]) (CDFW 1991, as cited in NMFS 2014). However, the few large *O. mykiss* (≥400 mm or roughly 16 inches) observed at an existing lower Tuolumne River weir (at RM 24.5) from 2011-2016 passed at temperatures ranging from 11.6 C to 20.5 C. These temperatures were the instantaneous readings on the day of passage (FISHBIO 2011, 2012, 2013, 2014, 2015, 2016a).

During studies conducted to support the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework process, steelhead thermal preferences in the Tuolumne River were estimated based upon a comprehensive literature review of regional and site-specific information to inform the selection of water temperature index (WTI) in the reaches of the upper Tuolumne River. For steelhead migration in the upper Tuolumne River, the Framework Temperature Criteria Matrix review identified 17.8°C (64°F) and 20°C (68°F) for Upper Optimal and Upper Tolerance values, respectively (Bratovich et al. 2012; TID/MID 2017l). The Upper Optimal WTI reflects the temperature at which physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature, while the Upper Tolerance WTI identifies the sustained (chronic) tolerance/no tolerance boundary.

Female steelhead select spawning sites with ample inter-gravel flow and dissolved oxygen. The female excavates a redd with her tail, typically in the coarse gravel of riffles and pool tailouts. Eggs are deposited while being fertilized by the male. Fertilized eggs in the excavated redd are then covered with loose gravel. Water velocities over redds typically range from 20 to 155 centimeters per second (cm/sec) (0.7-5.2 feet/second), and depths range from 10 to 150 cm (0.3-4.9 feet) (Moyle 2002). For steelhead spawning in the upper Tuolumne River, the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework Temperature Criteria Matrix review identified 12.2°C (54°F) and 13.9°C (57°F) for Upper Optimal and Upper Tolerance values, respectively (Bratovich et al. 2012; TID/MID 2017l).

Post-spawn survival is assumed to be about 40 percent for resident *O. mykiss* (Satterthwaite et al. 2009) and steelhead. This rate is similar to that found during steelhead kelt reconditioning programs conducted at the Coleman National Fish Hatchery on Battle Creek (Provencher 2012, as cited in NMFS 2014).

3.1.2.2 Egg Incubation and Fry Emergence

CCV steelhead eggs survive in water temperatures ranging from 2 to 15°C (35.6-59°F), but egg survival is reported to be highest at water temperatures ranging from 7 to 10°C (44.6-50.0°F) (Myrick and Cech 2001, as cited in NMFS 2014). The eggs hatch in three to four weeks at 10 to 15°C (50-59°F), and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954). For steelhead embryo incubation and emergence in the upper Tuolumne River, the Framework Temperature Criteria Matrix identified 12.2°C (54°F) and 13.9°C (57°F) for Upper Optimum and Upper Tolerable values, respectively (Bratovich et al. 2012; TID/MID 2017l). At 13.9°C (57°F), embryonic mortality increases sharply and development severely degrades at incubation temperatures greater than or equal to 13.9°C (57°F).

3.1.2.3 Freshwater Rearing and Smolt Outmigration

Regardless of life history strategy (i.e., anadromy versus residency), *O. mykiss* typically spend their first one to two years of life in cool, clear, fast-flowing streams and rivers. Preferred streams have gradients at which riffles predominate over pools, there is abundant cover provided by riparian vegetation and/or undercut banks, and invertebrate food sources are abundant (Moyle 2002). The smallest fish are typically found in riffles, intermediate size fish in runs, and larger fish in pools. Predators also influence microhabitat selection by juvenile *O. mykiss*, increasing the juveniles' affinity for areas located near cover (NMFS 2014).

Juvenile steelhead occur where daytime water temperatures range from near freezing to 27°C (81°F), although mortality may result at low (i.e., <4°C [39°F]) or high (i.e., ≥23°C [73°F]) temperatures if fish have not been acclimated (Moyle 2002, as cited in NMFS 2014). For steelhead fry and juveniles rearing in the upper Tuolumne River, the Framework Temperature Criteria Matrix identified 20°C (68°F) and 22.2°C (72°F) for Upper Optimal and Upper Tolerance values, respectively (Bratovich et al. 2012; TID/MID 2017l).

A swim tunnel study conducted on the lower Tuolumne River (Verhille et al. 2016) generated high quality field data on the physiological performance of Tuolumne River *O. mykiss* acutely exposed to a temperature range of 13 to 25°C (55.4°F to 77°F). The data indicated that wild juvenile *O. mykiss* represents an exception to the expected 7DADM criterion for juvenile rearing established by EPA (2003) for Pacific Northwest *O. mykiss*. The study recommended a conservative upper aerobic performance limit of 71.6°F, instead of 64.4°F (EPA 2003), be considered for the 7DADM for this population. The recommended thermal range for peak performance for Tuolumne River *O. mykiss* corresponds to local high river temperatures, but represents an unusually high temperature tolerance compared with conspecifics and congeneric species from northern latitudes (Verhille et al. 2016).

Juvenile steelhead typically outmigrate from April through June, with peak migration through the Delta in March and April (Reynolds et al. 1993). Outmigration appears to be more closely linked to fish size than age. Larger, faster-growing parr tend to smolt earlier than smaller members of the same cohort (Peven et al. 1994). Hallock et al. (1961) found that juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak emigration period occurs in spring, with a much smaller peak in autumn.

3.1.2.4 Ocean Phase

Steelhead grow more rapidly in the ocean than in freshwater (Shapovalov and Taft 1954; Barnhart 1991). Most steelhead spend one to three years in the ocean, with individuals that leave freshwater as smaller smolts tending to remain in the ocean longer than those that leave as larger smolts (Chapman 1958; Behnke 1992). Larger smolts typically have higher ocean survival rates than smaller smolts (Ward and Slaney 1988). Steelhead in the southern part of the species' range tend to remain close to the continental shelf, whereas populations in the north can migrate throughout the northern Pacific Ocean (Barnhart 1991). In some regions of the ocean, steelhead do not appear to form schools, although coordinated behavior has been documented in some studies (McKinnell et al. 1996).

3.1.2.5 Anadromy Versus Residency in *Oncorhynchus mykiss*

O. mykiss exhibit the most complex life history variation of all *Oncorhynchus* species (Quinn 2005). The expression of a given life history type is a selected behavior potentially influenced by both genetic (Martyniuk et al. 2003; Beakes et al. 2010; Thrower et al. 2004; Prince et al. 2017) and environmental (Zimmerman and Reeves 2000; Sloat 2013; McMillan et al. 2012; Beakes et al. 2010) factors. In addition, the relatively low survival rate of any emigrating smolts can contribute to the relative abundance of resident variants in a population regardless of its genetic predisposition towards residency (Beakes et al. 2010; Satterthwaite et al. 2010). As stated in Section 3.1.2, CDFW defines adult steelhead as any rainbow trout larger than 16 inches found in any of California's anadromous waters (NMFS 1996), whether they are anadromous or not. However, as discussed in Section 3.1.2, a review of otolith data from Zimmerman et al (2008) demonstrates that size alone (i.e., *O. mykiss* greater than 16 inches are steelhead) is not a reliable indicator of anadromous life history. Further, CDFW (2017b) confirmed that there is no empirical evidence of a self-sustaining run or population of steelhead in the lower Tuolumne River.

The probability of *O. mykiss* smolting has been shown to vary with parental (i.e., anadromous versus resident) origin, water temperature, and food availability (Satterthwaite et al. 2010). In one recent study, *O. mykiss* held in warm thermal regimes had higher rates of smolting because they were able to grow to larger total sizes but had lower body lipid stores than fish held in cold thermal regimes (Sloat 2013). These findings relate to both fish size (larger fish tend to survive at higher rates in the ocean than smaller fish) as well as fat stores (fish with higher lipid content have higher energy reserves required for sexual maturation). McMillan et al. (2012) found that higher body lipid stores were significantly correlated with an increased probability of maturation in freshwater. In other words, if a juvenile *O. mykiss* has sufficient lipid reserves to allow maturation in freshwater, there may be no need to undergo smoltification and migrate to the ocean to gain sufficient lipid stores to mature (TID/MID 2017h). It appears that flow and temperature management downstream of many dams in the Central Valley may have the potential to influence the relative rates of residency and anadromy, preferentially selecting for resident rainbow trout over anadromous steelhead where flows are more stable and summer temperatures are cooler than they would be in the absence of reservoir releases (TID/MID 2013d). NMFS (2014) reports that a large resident rainbow trout population has developed in the upper Sacramento River possibly as a result of management actions undertaken for coldwater species.

3.1.3 Historical and Current Distribution of CCV Steelhead

The historical range of the CCV steelhead is believed to have extended from the upper Sacramento and Pit river basins south to the Kings and possibly the Kern river basins. Steelhead were found in both eastside and westside Sacramento River tributaries (Yoshiyama et al. 1996). Lindley et al. (2006) estimates there were at least 81 CCV steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin rivers.

The California Advisory Committee on Salmon and Steelhead (California Department of Fish and Game [CDFG] 1988) stated that there has been a reduction in CCV steelhead habitat from about 6,000 river miles historically to approximately 300 miles under current conditions. Currently, wild populations of CCV steelhead exist in the upper Sacramento River and its tributaries, including Cottonwood, Antelope, Deer, and Mill creeks and the Yuba River. Other populations may exist in Big Chico and Butte creeks, and a few wild steelhead occur in the American and Feather rivers (McEwan 2001). Recent information indicates that steelhead are present in Clear Creek and Battle Creek (NMFS 2014).

Until recently, steelhead were thought to be extirpated from the San Joaquin River system (McEwan 2001). A few *O. mykiss* greater than 16 inches (~406 mm) in length have been observed in the Tuolumne River (Zimmerman et al. 2008; TID/MID 2015) and in the Merced River (NMFS 2014). Since 2009, a total of six *O. mykiss* greater than 16 inches have been detected at the Districts adult counting weir (J. Guignard, FISHBIO, pers comm., 8/16/17). However, as discussed in Section 3.1.2, a review of otolith data from Tuolumne River *O. mykiss* by Zimmerman et al (2008) demonstrates that size alone (i.e., greater than 16 inches) is not a reliable indicator of anadromous life history. Over 97 percent (37 out of 38) of Tuolumne River *O. mykiss* individuals greater than or equal to 400 mm (≥ 16 inches) were classified as having a resident life history (see Appendix 1, Zimmerman et al. 2008). The findings of Zimmerman et al. (2008) demonstrate that size alone is not a reliable indicator of *O. mykiss* anadromy in the Tuolumne River.

A hatchery-supported population of steelhead occurs in the Mokelumne River, which flows directly into the Delta between the Sacramento and San Joaquin rivers (NMFS 2014).

3.1.4 Designated Critical Habitat for CCV Steelhead

NMFS proposed critical habitat for CCV steelhead on February 5, 1999 (64 FR 5740) in compliance with Section 4(a)(3)(A) of the ESA, which requires that, to the maximum extent prudent and determinable, NMFS must designate critical habitat concurrently with a determination that a species is endangered or threatened. On February 16, 2000, NMFS published a final rule (65 FR 7764) designating critical habitat for CCV steelhead. Critical habitat was designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. For the Tuolumne River, critical habitat includes the Tuolumne River (Lat 37.6401, Long –120.6526 [confluence with the San Joaquin River) upstream to endpoint(s) in: Tuolumne River (37.6721, –120.4445 [LGDD]) (70FR 52605) (Figure 3.1-1).

NMFS (70FR 52522) defines the lateral extent of designated critical habitat as the width of the stream channel defined by the ordinary high water line as defined by the USACE in 33 CFR 329.11. This approach is consistent with the specific mapping requirements described in agency regulations at 50 CFR 424.12(c). In areas for which ordinary high-water has not been defined pursuant to 33 CFR 329.11, the width of the stream channel is defined by its bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain (Rosgen 1996) and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series (Leopold 1992 as cited in 70 FR 52522; Leopold 1994).

The designation establishes protection of Primary Constituent Elements (PCE), i.e., areas essential for supporting one or more life stages of the DPS (i.e., sites for spawning, rearing, migration, and foraging). Areas of critical habitat have characteristics essential to the conservation of the DPS, such as suitable spawning gravels, water quality, rearing microhabitats, and food availability.

Critical Habitat PCEs that have the potential to be present in the Action Area are limited to those related to freshwater spawning, rearing and migration, as follows:

- Freshwater spawning sites with water quantity and quality and substrate supporting spawning, incubation, and larval development.
- Freshwater rearing sites with (1) water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility, (2) water quality and forage supporting juvenile fish development, and (3) 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.
- 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 fish mobility and survival.

The degree to which conditions in the Action Area are consistent with the characterizations listed above is discussed in Section 4.8. It should be noted that the Districts recognize that the USFWS and NMFS have removed the term "primary constituent elements" from designated critical habitat regulations (50 CFR 424.12) and have returned to the statutory term "physical or biological features" (PBFs; 79 FR 27066). Considering this, the previous term, PCE, will be replaced henceforth with PBF to describe the physical and biological features that define critical habitat for listed species (81 FR 7214). As noted in 81 FR 7214, "the shift in terminology does not change the approach used in conducting a 'destruction or adverse modification' analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or both."

3.1.5 Stressors and Limiting Factors

Widespread degradation, destruction, and blockage of freshwater habitats within the Central Valley, and continuing habitat impacts due to water management are identified by NMFS (2014) as reasons for the listing of CCV steelhead under the ESA (61 FR 41541, August 9, 1996; 63 FR 13347, March 19, 1998). Threats to CCV steelhead have been brought about by loss of historical spawning habitat, degradation of remaining habitat, and threats to the genetic integrity of wild spawning populations from hatchery steelhead programs. In addition, climate change is considered a current and future threat to the species and its recovery (see Section 5.6).

According to NMFS (2014), primary stressors to the CCV steelhead DPS include (1) fish passage impediments and barriers, (2) warm water temperatures during juvenile rearing, (3) introgression from and competition with hatchery stocks (4), limited quantity and quality of physical rearing habitat, (5) predation, including that resulting from introduced piscivorous fish species, and (6) entrainment. Also, according to NMFS (2014), relevant stressors to steelhead that spend a portion of their life cycle in the Tuolumne River basin include (1) limited habitat availability for spawning and juvenile rearing, (2) lack of access to historical habitat because of an absence of fish passage at LGDD and Don Pedro Dam, (3) entrainment at the Jones and Banks Pumping Plants, (4) losses from predation, and (4) inadequate summer flow in the Tuolumne River.

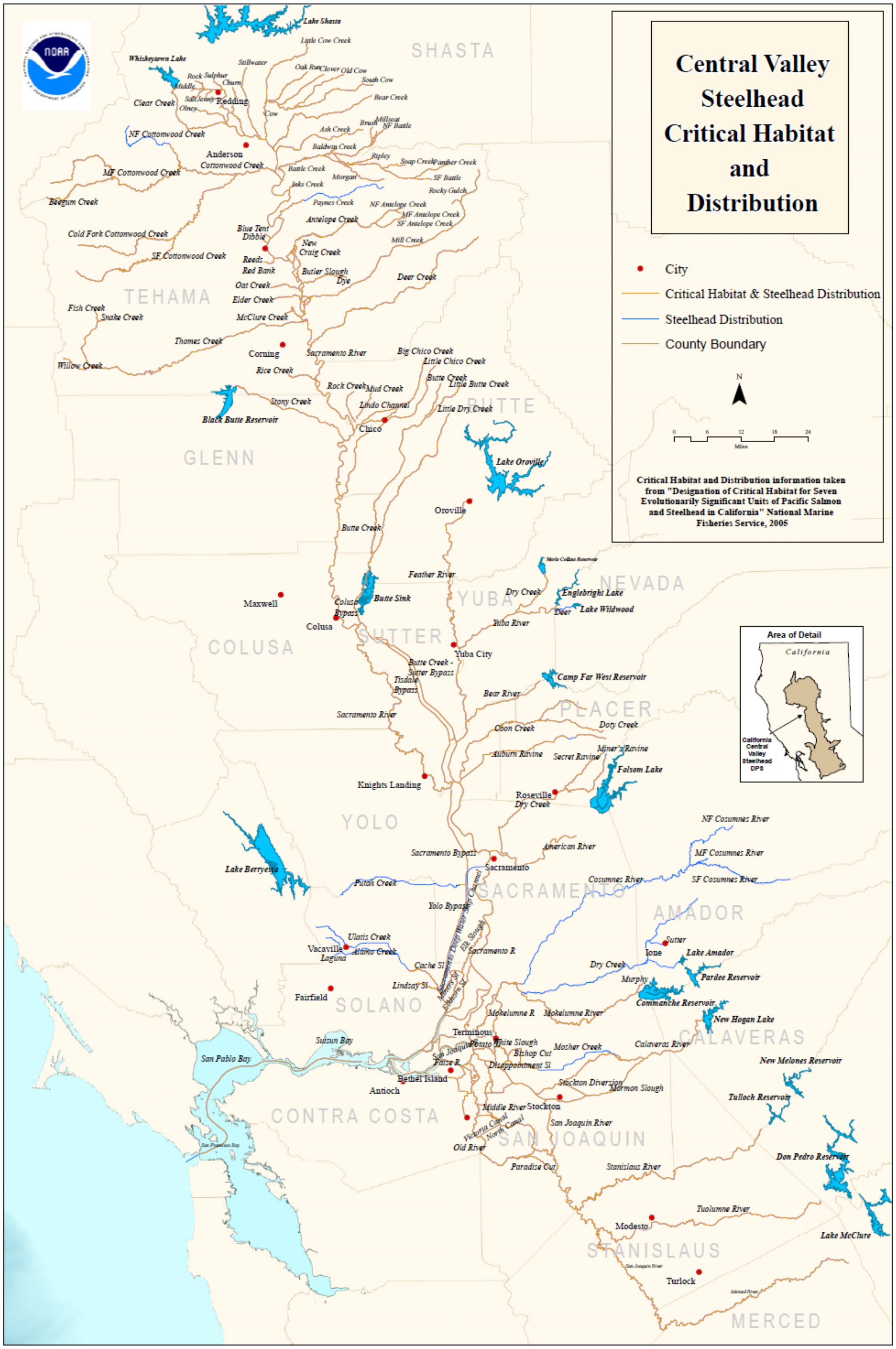

Figure 3.1-1. CCV steelhead designated critical habitat and distribution (NMFS 2014).

3.1.6 Recovery Criteria

The Final Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) includes recovery criteria to address the five ESA listing factors: (1) current or potential destruction or modification of the species' habitat or curtailment of its range, (2) overuse for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) inadequate regulatory mechanisms, and (5) other natural or human-induced factors affecting the species' continued existence. The purpose of these threat-based criteria is to attempt to address the factors that caused the species to become threatened, with the ultimate aim of delisting the species.

NMFS (2016) ESU/DPS level criteria call for the establishment of two CCV steelhead populations at low risk of extinction within the Southern Sierra Diversity Group (which includes any steelhead in the Tuolumne River). The criteria specify that for a steelhead population to be at low risk of extinction it must be characterized by (1) a census population size greater than 2,500 adults or an effective population size greater than 500[11], (2) an absence of apparent productivity decline, (3) an absence of catastrophic events within the past 10 years, and (4) a low level of hatchery influence.

3.1.7 Conservation Initiatives

The CALFED Program, which commenced in June 1995, was aimed at developing a "long-term Bay-Delta solution" (NMFS 2014). A primary component of the CALFED Program is the Ecosystem Restoration Program (ERP), which was developed to provide a foundation for long-term ecosystem and water quality restoration and protection. Among the non-flow factors targeted by the program to reduce adverse effects on steelhead are unscreened diversions, wastewater discharges, other water pollution, poaching, land-derived salts, introduced species, fish passage barriers, channel alterations, and loss of riparian wetlands.

Approximately $15 million per year of CVPIA restoration funds are to be used to protect, restore, and enhance special-status species and their habitats in areas directly or indirectly affected by the CVPIA. Through the AFRP, federal funding was allocated for spawning gravel augmentation, instream flow management (i.e., use of 800 thousand acre feet of water from the CVPIA), and habitat restoration projects, including the Bobcat Flats project on the Tuolumne River. The AFRP also includes elements aimed at obtaining funds for fish screening projects.

The San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam and releases of water from Friant Dam to the confluence of the Merced River. Although this SJRRP is focused on spring-run Chinook salmon, it also has the potential to improve habitat for steelhead. The first flow releases from Friant Dam as part of the SJRRP occurred in October 2009. All high priority channel and structural construction activities were to be completed by December 2013, and full

[11] Effective population size is the size of an idealized population considered to lose genetic heterozygosity at a rate equivalent to that of the larger, observed population. A population characterized by a high level of heterozygosity for a given genetic trait contains much genetic variability for that trait.

restoration flows were to be released by 2014. However, the complexity of habitat restoration and the ongoing drought have delayed these goals (NMFS 2016). There is a small population of resident *O. mykiss* in the San Joaquin River below Friant Dam, so additional flow and increased connectivity to the ocean have the potential to reestablish steelhead in this section of the San Joaquin River (NMFS 2016).

California WaterFix would, if implemented, represent an attempt to modernize California's water delivery system to save water and thereby provide opportunities to protect sensitive fish species (NMFS 2016). A proposed CWF water conveyance system would include new points of diversion in the north Delta together with improvements to the water export system in the south Delta. Actions being discussed include operation of a dual conveyance system and measures to reduce other stressors to the Delta ecosystem.

California EcoRestore is an initiative under development to help coordinate and advance short-term habitat restoration in the Delta. This restoration is not associated with any habitat restoration required as part of the construction and operation of any new Delta water conveyance.

To protect wild steelhead in California, all hatchery steelhead receive an adipose fin-clip, although they are not coded-wire tagged, so hatchery of origin and straying rates for particular stocks cannot be discerned (NMFS 2014). The State of California also works closely with NMFS to review and improve inland fishing regulations (NMFS 2014). These include zero bag limits for unmarked steelhead, gear restrictions, closures, and size limits designed to protect smolts.

4.0 ENVIRONMENTAL BASELINE IN THE ACTION AREA

The La Grange Hydroelectric Project and its potential environmental effects have undergone both required and voluntary studies since 2013, and the Project Action Area has been the subject of continuous study and evaluation since the early 1970s as part of the upstream Don Pedro Project. The Districts, in cooperation with state and federal resource agencies and environmental groups, have conducted over 200 individual resource investigations since the Don Pedro Project began commercial operation in 1971, many of which involved the lower Tuolumne River. A summary of these studies is presented in the following subsections.

4.1 Studies Related to *O. mykiss* in the Action Area

On an annual basis, the Districts file with FERC, and share with the Tuolumne River Technical Advisory Committee, results of ongoing monitoring on the lower Tuolumne River downstream of LGDD and in and downstream of the Project Action Area. The up-to-date record created by the continuous process of environmental investigation and resource monitoring has produced detailed baseline information. As part of the FERC licensing process for the Project, and FERC relicensing of the Don Pedro Project, the Districts conducted the following studies that pertain specifically to *O. mykiss* in the Action Area.

4.1.1 La Grange Hydroelectric Project Fish Barrier Assessment Progress Report

This study was conducted as part of the Fish Passage Facilities Assessment implemented by the Districts to help define the nature and degree to which the LGDD and powerhouse are barriers or impediments to the upstream migration and productivity of anadromous salmonids. During this study, two temporary fish counting weirs were installed in the Tuolumne River in the Action Area and operated from September 23, 2015 through April 14, 2016 and again from September 15, 2016 to January 1, 2017. One weir was placed just downstream of the plunge pool below LGDD in the Tuolumne River main channel, and the second weir was placed just below the La Grange powerhouse in the tailrace channel (Figure 4.1-1). Each weir consisted of rigid panels that directed fish passage through a passing chute that was continuously monitored by a video system. Daily boat surveys were conducted in both channels from LGDD to 0.3 miles downstream of the weir locations to document potential fish stacking or pre-spawn mortality. Overall the tailrace video system recorded video footage for 97.3 percent of the monitoring period, and the main channel video system recorded footage for 91.2 percent of the monitoring period. Average daily water temperatures and flows were also recorded at each weir site during the study. The purpose of the study was to determine the number of fall-run Chinook salmon and *O. mykiss* exhibiting persistent migrating upstream to LGDD and the La Grange powerhouse during the 2015/2016 and 2016/2017 migration seasons, and to document any pre-spawn mortality in the study area.

This study also reported on data collected at the fish counting weir at RM 24.5, which has been seasonally operated by the Districts since 2009. This weir is located downstream of the fall Chinook salmon and *O. mykiss* spawning reach. Monitoring at this weir location was conducted to: 1) determine the annual escapement of fall-run Chinook salmon, and, 2) determine the presence and movement of *O. mykiss* through direct counts of passage at the weir.

Figure 4.1-1. Location of main channel counting weir and tailrace channel weir (FISHBIO 2017).

4.1.2 Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework

Through a series of workshops conducted in 2015 and 2016, the Districts, in an attempt to promote collaboration with licensing participants, broadened the scope of the Fish Passage Facilities Alternatives Assessment to include the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework process (Framework). Information describing the structure and function of the Framework is attached to the Final License Application and the Districts' USR. The Framework process was intended to provide an opportunity for obtaining and discussing information in a transparent and open forum by determining appropriate values for biological and engineering parameters.

The Framework process introduced by the Districts is consistent with guidance provided in Anderson et al. (2014), *Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery*. This peer-reviewed journal article authored by the NMFS Northwest Fisheries Science Center in collaboration with state fish and wildlife agencies, stresses the need for implementing a broad evaluation process that describes benefits, risks, and constraints prior to implementing a fish introduction or reintroduction program.

During studies conducted to support the Framework, steelhead thermal preferences were estimated based upon a comprehensive literature review of regional and site-specific information to inform the selection of WTI values to be used to evaluate water temperature-related reintroduction potential in the reaches of the upper Tuolumne River. The data developed as part of the Framework was reviewed and approved by licensing participants as part of the Fish Passage and Reintroduction task. As part of Framework studies, WTIs for specific steelhead life histories (e.g., spawning, rearing) were grouped into one of two suitability categories. The first category included "upper optimal water temperature index" (UOWTI) values, and the second suitability category included the upper tolerance water temperature index (UTWTI) value. The upper optimal WTI is the temperature at which physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature, while the upper tolerance WTI identifies the sustained (chronic) tolerance/no tolerance boundary.

4.1.3 Fish Habitat and Stranding Assessment below La Grange Diversion Dam

As part of the Fish Presence and Stranding Assessment (TID/MID 2017a), surveys of the main channel of the Tuolumne River from the base of LGDD downstream to its confluence with the powerhouse tailrace channel near RM 51.8, the length of the tailrace channel, and the length of the TID sluice gate channel were performed to observe occurrences of stranding within the Action Area. Twice-daily fish observation surveys occurred over two monitoring seasons, generally from late September through middle of April (2015/2016 and 2016/2017). This study was intended to document fish observations in the vicinity of LGDD, La Grange powerhouse tailrace, and TID sluice gate channel during the fall-run Chinook salmon and steelhead migration period for the 2015/2016 and 2016/2017 seasons. Specific objectives of the assessment included:

- daily observations of fish in the immediate vicinities of LGDD, La Grange powerhouse, and within the sluice gate channel;
- if the La Grange powerhouse trips offline, conduct a survey of the sluice gate channel to record fish presence and, if necessary, conduct relocation activities; and
- observation and documentation of any redds that became dewatered and the duration of any dewatering due to changes in powerhouse operations.

4.1.4 Salmonid Habitat Mapping in Project Action Area

The Salmonid Habitat Mapping study (TID/MID 2016b) is one of the four study components of the Fish Habitat and Stranding Assessment below LGDD implemented by the Districts in accordance with FERC's SPD. The goal of this study was to collect information to aid in the evaluation of the potential for Project operations to affect anadromous fish habitat in the Tuolumne River in the vicinity of the LGDD and Project facilities. Specific objectives of the study included:

- map substrate and habitat in the main channel and tailrace, delineating the presence of pools, runs, high- and low-gradient riffles, step-pools, and chutes;
- map patches of spawning-sized gravels in the tailrace and main channel that are greater than two square meters (21.5 square feet); and,
- conduct pebble counts in riffles, runs, and pool tailouts to document substrate particle size distribution in these habitats.

Other components of the Fish Habitat and Stranding Assessment study included topographic surveying of longitudinal channel profiles to assess water depth and potential stranding in the main channel, tailrace channel, and sluice gate channel. These study results are provided in a separate report entitled Topographic Survey Technical Memorandum (TID/MID 2017k).

4.1.5 Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes

In accordance with the SPD, from 2015 to 2016 the Districts monitored anadromous fish movement in the vicinity of the powerhouse draft tubes. The goal of this study (hereinafter referred to as the Draft Tube Study; TID/MID 2017c) was to evaluate the potential impact of certain La Grange powerhouse facilities on adult fall-run Chinook Salmon and *O. mykiss*. The goal of this study was to:

- document adult resident *O. mykiss* and adult anadromous salmonid behavior in the vicinity of the La Grange powerhouse discharge during the fall 2015 (fall-run Chinook Salmon) to spring 2016 (*O. mykiss)* migration season;
- identify anadromous fish reaching the La Grange powerhouse;
- describe behavioral activities of fish in relation to La Grange powerhouse operations; and determine if fish are moving directly into the draft tubes of operating units.

An imaging sonar unit (ARIS Explorer 1800, Sound Metrics) was installed at the outlet from the La Grange powerhouse on September 1, 2015 for operation during the 2015/2016 migration season to determine if fish were attempting to access the La Grange powerhouse or enter the powerhouse draft tubes, and to assess their behavior in relation to powerhouse operations. The Districts processed and analyzed subsets of the imagery data to encompass periods during the fall-run Chinook Salmon migration/spawning period (October through December 2015) and during the period of *O. mykiss* spawning (January through May 2016).

4.1.6 Spawning Gravel in the Lower Tuolumne River (W&AR-04)

In 2012, the Districts conducted a spawning gravel survey (TID/MID 2013e) of the lower Tuolumne River. The reach evaluated included the Tuolumne River from just downstream of LGDD at RM 52.1 to RM 23, which accounts for the extent of riffle habitats documented in historical surveys (TID/MID 1992). The spawning gravel survey involved the application of a variety of analyses and modeling to (1) estimate average annual sediment yield to Don Pedro Reservoir, (2) estimate changes in the volume of coarse bed material in the lower Tuolumne River channel from 2005 to 2012, (3) map fine bed material in the lower Tuolumne River and compare the results with previous surveys, (4) develop a reach-specific coarse sediment budget to evaluate the Project’s contribution to cumulative effects on river sediment in the lower Tuolumne River, and (5) map current riffle, spawning gravel, and suitable spawning habitat areas in the lower Tuolumne River and compare the results with previous surveys.

4.1.7 Salmonid Population Information Integration and Synthesis (W&AR-05)

The Districts conducted a Salmonid Population Information Integration and Synthesis Study in 2012 (TID/MID 2013d) to collect, compile, and summarize existing information to characterize *O. mykiss* populations in the Tuolumne River and develop hypotheses related to factors potentially affecting those populations. The study area included the lower Tuolumne River from LGDD (RM 52.2) downstream to the confluence with the San Joaquin River (RM 0), the lower San Joaquin River from the Tuolumne River confluence (RM 84) to Vernalis (RM 69.3), the Delta, the San Francisco Bay/San Pablo Bay estuary, and the Pacific Ocean. The study included snorkel surveys from 2001-2011 conducted downstream of LGDD.

4.1.8 Salmonid Redd Mapping (W&AR-08)

The Salmonid Redd Mapping study (TID/MID 2015) documented the spatial distribution of *O. mykiss* redds to assist with quantifying the current spawning capacity and redd/recruit relationships of the lower Tuolumne River. The study area, which extended from LGDD (RM 52.2) to Santa Fe Bridge (RM 22), was divided into four reaches, which correspond to reach designations used by CDFW. Bi-weekly redd mapping surveys were conducted to evaluate redd characteristics, redd status, redd superimposition, and fish presence on or near redds. Surveys were conducted during the 2012-2013 and 2014-2015 spawning seasons (TID/MID 2015).

4.1.9 Temperature Criteria Assessment (W&AR-14)

The Temperature Criteria Assessment (Farrell et al. 2017) included the following tasks related to *O. mykiss*: (1) a literature review of available temperature tolerances of *O. mykiss*, (2) an empirical study of local acclimation of temperature tolerance of wild *O. mykiss* juveniles in the lower Tuolumne River, (3) an analysis of existing empirical information on the spatial distribution of juvenile *O. mykiss* in response to temperature, and (4) a study of wild juvenile *O. mykiss* behavior and metabolic capability in reaches with a range of water temperatures (FISHBIO 2016b).

The results of the empirical study of metabolic capability of wild Tuolumne River *O. mykiss* are provided in the report entitled Thermal Performance of Wild Juvenile *Oncorhynchus mykiss* in the lower Tuolumne River: A Case for Local Adjustment to High River Temperature (Farrell et al. 2017). The purpose of this study was to investigate the thermal performance of juvenile *O. mykiss* from the lower Tuolumne River in response to seasonal maximum water temperatures that they experience during the summer months. The study tested the hypothesis that Tuolumne River *O. mykiss* population below LGDD is locally adapted to the relatively warm thermal conditions that exist in the river during summer. Wild juvenile *O. mykiss* used in the study were locally caught and tested and then returned safely to the Tuolumne River within approximately one day of capture.

4.1.10 *O. mykiss* Scale Collection and Age Determination (W&AR-20)

In 2012, the Districts conducted the *Oncorhynchus mykiss* Scale Collection and Age Determination Study (TID/MID 2013c). Fish scales were used to estimate the age-at-length relationship of *O. mykiss* in the lower Tuolumne River. Fish were collected in the reach that extends from LGDD (RM 52.2) to Turlock Lake (RM 42), and a single sample was taken from the rotary screw trap deployed near Waterford (RM 30).

4.1.11 Tuolumne River Flow and Water Temperature Model: Without Dams Assessment

Jayasundara et al. (2014) conducted the Tuolumne River Flow and Water Temperature Model: Without Dams Assessment study to develop a flow and water temperature model to simulate water temperatures in the Tuolumne River without the existing Hetch Hetchy (including Cherry and Eleanor reservoirs), Don Pedro, and La Grange projects in place. The model was developed to complement detailed temperature models developed for Don Pedro Reservoir and the lower Tuolumne River, including La Grange headpond (TID/MID 2017i, 2017j). Supporting data characterized long-term flow and meteorological conditions to assess flow and water temperatures over a multi-decade period, i.e., 1970-2012. In its December 2011 Study Plan Determination, FERC indicated that EPA (2003) temperature guidance would be considered to be applicable to the lower Tuolumne River, absent the availability of site-specific, empirical information on the aquatic resources of the Tuolumne River. The "without dams" model developed by this study, along with results of the Temperature Criteria Assessment (Farrell et al. 2017) provides such site-specific, empirical information.

4.2 Fish Assemblages in Action Area

4.2.1 LGDD Headpond

In October 2012, the Districts collected baseline information on the fish community in the reach of the Tuolumne River between La Grange Diversion Dam (52.2) and Don Pedro Dam (RM 54.8) (TID/MID 2013a). This study characterized the fish assemblage in this reach of the river and supplemented the limited information previously available from a single sampling event that occurred in 2008 (Stillwater Sciences 2009a). The study area included the LGDD headpond portion of the Action Area.

In total, 133 fish consisting of 86 rainbow trout (*O. mykiss*) and 47 prickly sculpin (*Cottus asper*) were collected during the boat electrofishing sampling effort conducted in the study area. Rainbow trout made up 64.7 percent of the overall catch in the study area and lengths ranged from 85 mm to 344 mm with a mean length of 153.5 mm. Results indicated that rainbow trout were proportionally more abundant in the lower reaches of the study area.

4.2.2 Action Area Downstream of LGDD

Both fall-run Chinook Salmon and *O. mykiss* were observed during 2015/2016 weir monitoring of the tailrace channel. Fall-run Chinook Salmon were observed in the mainstem Tuolumne River portion of the Action Area; *O. mykiss* were not observed in the mainstem portion of the Action Area. Other fish species observed near the La Grange facilities during 2015/2016 monitoring included bluegill (*Lepomis macrochirus*), carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), largemouth bass (*Micropterus salmoides*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and striped bass (*Morone saxatilis*) (TID/MID 2017e) (Table 4.2-1).

Table 4.2-1. Non-target fish species observed passing the tailrace and main channel weirs during the 2015/2016 monitoring.

Species	Location	Estimated Length Range (cm)	First Passage Date	Last Passage Date	Passage Events	
					# Up	# Down
Striped bass	Tailrace	45-90	9/18/15	4/7/16	701	682
Carp/goldfish	Tailrace	20-90	12/24/15	4/11/16	645	407
Sacramento pikeminnow	Tailrace	15-90	9/23/15	4/15/16	277	267
	Main channel	20-40	9/27/15	2/25/16	9	5
Bluegill/sunfish	Tailrace	5-20	9/21/15	2/21/16	67	13
	Main channel	10-20	9/27/15	10/28/15	12	1
Sacramento sucker	Tailrace	45-60	10/2/15	1/24/16	3	4
Largemouth bass	Tailrace	25-60	11/2/15	2/26/16	3	1
Unidentified adult	Tailrace	30-90	10/2/15	4/13/16	212	102
	Main channel	30-50	10/21/15	10/31/15	7	5
Unidentified juvenile	Tailrace	10-25	9/22/15	3/25/16	57	36
	Main Channel	10-25	9/23/15	4/13/16	52	110

Previous monitoring on the Tuolumne River documented non-native centrachids (bluegill and largemouth bass) below RM 48.0, with striped bass observed upstream to RM 51.8 (Stillwater

Sciences 2012b). The 2015/2016 monitoring study (TID/MID 2017e) provided the first formal documentation of these three species directly below La Grange powerhouse. On multiple occasions during the monitoring period, attempted predation events by striped bass were observed within the tailrace weir passing chute. Striped bass were observed holding in the tailrace passing chute and video monitoring shows these fish making multiple predation attempts (quick, darting actions) at juvenile fish (likely *O. mykiss* and/or pikeminnow).

4.3 Existing Physical Habitat Conditions in the Action Area

Physical habitat conditions in the Action Area (i.e., LGDD dam and headpond, Tuolumne River from LGDD to the confluence with the tailrace, tailrace channel, and sluice gate channel) have been affected by a wide range of human actions conducted over many decades and are described below.

4.3.1 Instream Habitats in Action Area

4.3.1.1 LGDD Headpond

Riverine and lacustrine habitats occur in the reach of the Tuolumne River between the LGDD and Don Pedro dams. In the upper portions of the reach below Don Pedro Dam, riverine habitat with large substrate dominated by boulders and a lack of rooted macrophyte beds are common. In these upper reaches, there exists little habitat complexity as bedrock cliffs with sparse overhead vegetation dominate the shoreline. The riverine habitat extends downstream to below the Twin Gulch area. Below this location, the Action Area becomes more lacustrine in nature due to influences of LGDD. Nearer LGDD, currents are no longer visible, and substrate is dominated by small cobbles and gravels with numerous boulders. The frequency of rooted macrophyte beds increases nearest the LGDD. Habitat complexity is limited in the lacustrine reach, and consists of bedrock cliffs and sparse overhead vegetation cover.

4.3.1.2 Mainstem Tuolumne River

Downstream of the LGDD, the Tuolumne River has an average gradient of about 3 feet/mile. Habitat mapping studies (TID/MID 2016b) indicate that the mainstem Tuolumne River channel in the Action Area is dominated by pool habitat, including a plunge pool immediately downstream of the LGDD, a large mid-channel extension of the plunge pool adjacent to the MID Hillside Discharge, and two small pools in the lower portion of the channel (Table 4.3-1; Figure 4.3-1). Three small low-gradient riffles with no suitable spawning substrate for salmonids occur in the lower portion of the main channel, along with one glide associated with the tailout of the large pool, and a bedrock outcrop separating the large extension of the pool from the plunge pool immediately below LGDD. The estimated average channel width downstream of the large mid-channel pool is approximately 35 feet, while the mid-channel pool width is estimated to be approximately 176 feet. The aerial extent of the mid-channel pool was calculated as 134,483 ft^2, representing 74 percent of the total area comprising the main channel habitats. Depths of the habitats found in the main channel were generally from 1–4 feet, with the mid-channel pool and plunge pool depths estimated as greater than 10 feet.

4.3.1.3 Tailrace Channel

The tailrace channel includes two riffles, one of which includes substrate suitable for fall-run Chinook Salmon spawning; however, substrates are too large for *O. mykiss* spawning. This reach also include one run habitat in the lower portion of the channel (Table 4.3-1, Figure 4.3-1). The upper portion of the tailrace channel includes a single pool with turbulent flow from the La Grange powerhouse discharge along with a glide associated with the tailout of this pool. Estimated average width of habitats in the tailrace channel is approximately 50 feet. The TID sluice gate channel is a high-gradient step-pool that originates at the TID canal (a non-Project feature) and empties into a pool at the upstream end of the tailrace channel. Estimated average width of the sluice gate channel is approximately 30 feet (TID/MID 2016b).

Table 4.3-1. Summary of mesohabitat mapping results.

Mesohabitat	Total Number	Total Length (feet)	Percent of Channel
Main Channel			
Riffle	3	523	30%
Glide	1	122	7%
Pool	4	1,022	58%
Outcrop, bedrock	1	106	6%
Total	**9**	**1,773**	**100%**
Tailrace Channel			
Riffle	2	400	57%
Glide	1	49	7%
Pool	1	152	22%
Run	1	98	14%
Total	**5**	**699**	**100%**
Sluice Gate Channel			
Step-pool	1	383	100%
Total	**1**	**383**	**100%**

Source: TID/MID (2016b).

Figure 4.3-1. Habitat types downstream of La Grange Diversion Dam (TID/MID 2016b).

4.3.2 Substrates in the Action Area

TID/MID (2016b) mapped substrates in portions of the Action Area downstream of LGDD (Table 4.3-2, Table 4.3-3, and Figure 4.3-2) and conducted pebble counts on four samples collected in select sediment facies units (Table 4.3-4). Overall, substrate in the Action Area was mapped predominately as gravel-boulder-cobble (41 percent), sand-bedrock-cobble (30 percent), and boulder-gravel-cobble (11 percent) (see Table 4.3-3).

The sluice gate and tailrace channels (facies units 1 through 7) are predominately cobble-bedded with varying proportions of gravel- and boulder-size substrates, along with some bedrock outcrops in the sluice gate channel. The three pebble-count samples collected here exhibited a well-graded (poorly sorted) texture, with measurable sizes varying between sand (~2 mm) and bedrock (>4,096 mm). The results also support the observation of a downstream-fining trend along the channels' total length. Substrates in the sluice gate channel (facies units 1 and 2) are the coarsest in the Action Area, being composed of cobbles, boulders, and bedrock with some coarse gravel. The La Grange powerhouse tailrace channel (facies units 4 through 7) is composed of cobble with varying proportions of gravel- and boulder-size substrates. A minor fraction of sand was observed in the lower-most facies unit of the tailrace channel (at sample PC3).

The thalweg of the Tuolumne River main channel (facies units 10, 11, 13, 14, 17, 18, 20, 22, 24, and 25), is also predominately composed of cobble-sized sediments, with varying proportions of gravel- and boulder-size substrates, and some bedrock outcrops. The pebble-count sample collected along the thalweg near the confluence with the tailrace channel (in facies unit 10) exhibited a well-graded (poorly sorted) texture, with measurable sizes varying between fine gravel (~7 mm) and fine boulder (460 mm). The substrates within the large and deep pool unit downstream of LGDD, mapped as facies unit 22, appeared to be very well graded (i.e., very poorly sorted), with sizes ranging from sand (~2 mm) to bedrock (>4,096 mm).

Floodplains within the Action Area (facies units 8, 12, 19, and 23) are composed of a mixture of sediment facies types similar to that present in the tailrace and main river channel.

Table 4.3-2. Substrate (sediment-facies) mapping results.

Sediment Facies[1]		Channel / Feature	Corresponding Mesohabitat[2]	Area (ft^2)	Grain Size Fractions (mm)[3]		
Unit No.	Type				D_{84}	D_{50}	D_{16}
1	cobble-boulder-Bedrock (cbBr)	Sluice gate channel	Step-pool (unit 11)	8,813	N/A	N/A	N/A
2	gravel-boulder Cobble (gbC)			8,598	320	180	90
3	gravel-cobble-Boulder (gcB)	Sluice gate levee	N/A	17,603	800	400	200
4	boulder-gravel-Cobble (bgC)	Tailrace channel	Pool (unit 12)	9,624	300	110	50
5	boulder-gravel-Cobble (bgC)		Glide, Riffle, Run (units 13, 14, 15)	14,573	200	110	50
6	boulder-gravel-Cobble (bgC)		Riffle (unit 16)	11,606	150	70	23
7	gravel-boulder-Cobble (gbC)			2,039	250	150	50

Sediment Facies[1]		Channel / Feature	Corresponding Mesohabitat[2]	Area (ft^2)	Grain Size Fractions (mm)[3]		
Unit No.	**Type**				D_{84}	D_{50}	D_{16}
8	boulder-gravel-Cobble (bgC)	River medial floodplain	N/A	2,583	150	70	25
9	unknown	River channel	Riffle and Pool (unit 1)	69,714	N/A	N/A	N/A
10	gravel-boulder-Cobble (gbC)		Riffle (units 1 and 2)	6,356	240	160	80
11	gravel-boulder-Cobble (gbC)		Riffle (unit 2)	5,932	240	170	90
12	gravel-boulder-Cobble (gbC)	River lateral floodplain	N/A	54,173	300	200	80
13	gravel-boulder-Cobble (gbC)	River channel	Riffle (unit 2)	4,061	300	150	50
14	gravel-cobble-Boulder (gcB)		Pool (unit 3)	5,337	800	500	200
15	bedrock-cobble-Boulder (brcB)	River lateral floodplain (talus slope)	N/A	8,662	N/A	N/A	N/A
16	Bedrock (Br)	River lateral floodplain (outcrop)		2,645	N/A	N/A	N/A
17	gravel-boulder-Cobble (gbC)	River channel	Riffle (unit 4)	2,628	300	200	80
18	bedrock-gravel-Cobble (brgC)		Pool (unit 5)	1,258	N/A	N/A	N/A
19	gravel-boulder-Cobble (gbC)	River medial floodplain	N/A	103,572	300	200	100
20	boulder-gravel-Cobble (bgC)	River channel	Riffle and Glide (units 6 and 7)	11,176	250	100	50
21	gravel-cobble-Boulder (gcB)	River lateral floodplain (talus slope)	N/A	6,911	800	500	200
22	sand-bedrock-Cobble (sbrC)	River channel	Pool (unit 8)	137,118	N/A	N/A	N/A
23	boulder-cobble-Gravel (bcG)	River lateral floodplain	N/A	20,822	200	50	20
24	gravel-boulder-Bedrock (gbBr)	River channel	Outcrop (unit 9)	7,919	N/A	N/A	N/A
25	Bedrock (Br)		Pool (unit 10)	6,648	N/A	N/A	N/A

Source: TID/MID (2016b).

1 See Figure 4.3-2 for location of sediment facies units.

2 See Figure 4.3-2 for location of mesohabitat units.

3 Size fractions: D_{84} and D_{16} represent the grain sizes for which 84 percent and 16 percent of the distribution is finer, respectively; D_{50} represents the median grain size.

Table 4.3-3. Summary of sediment-facies mapping results.

Sediment Facies Type[1]	Area (ft^2)	Percent of Mapped Area
boulder-cobble-Gravel (bcG)	20,822	5%
boulder-gravel-Cobble (bgC)	49,562	11%
bedrock-gravel-Cobble (brgC)	1,258	0%
gravel-boulder Cobble (gbC)	187,359	41%
sand-bedrock-Cobble (sbrC)	137,118	30%
gravel-cobble-Boulder (gcB)	29,851	6%
bedrock-cobble-Boulder (brcB)	8,662	2%
gravel-boulder-Bedrock (gbBr)	7,919	2%
cobble-boulder-Bedrock (cbBr)	8,813	2%
bedrock (Br)	9,293	2%

Source: TID/MID (2016b)

[1] List order based on smallest to largest sediment/bedrock sizes; does not include "unknown" facies type from unit 9.

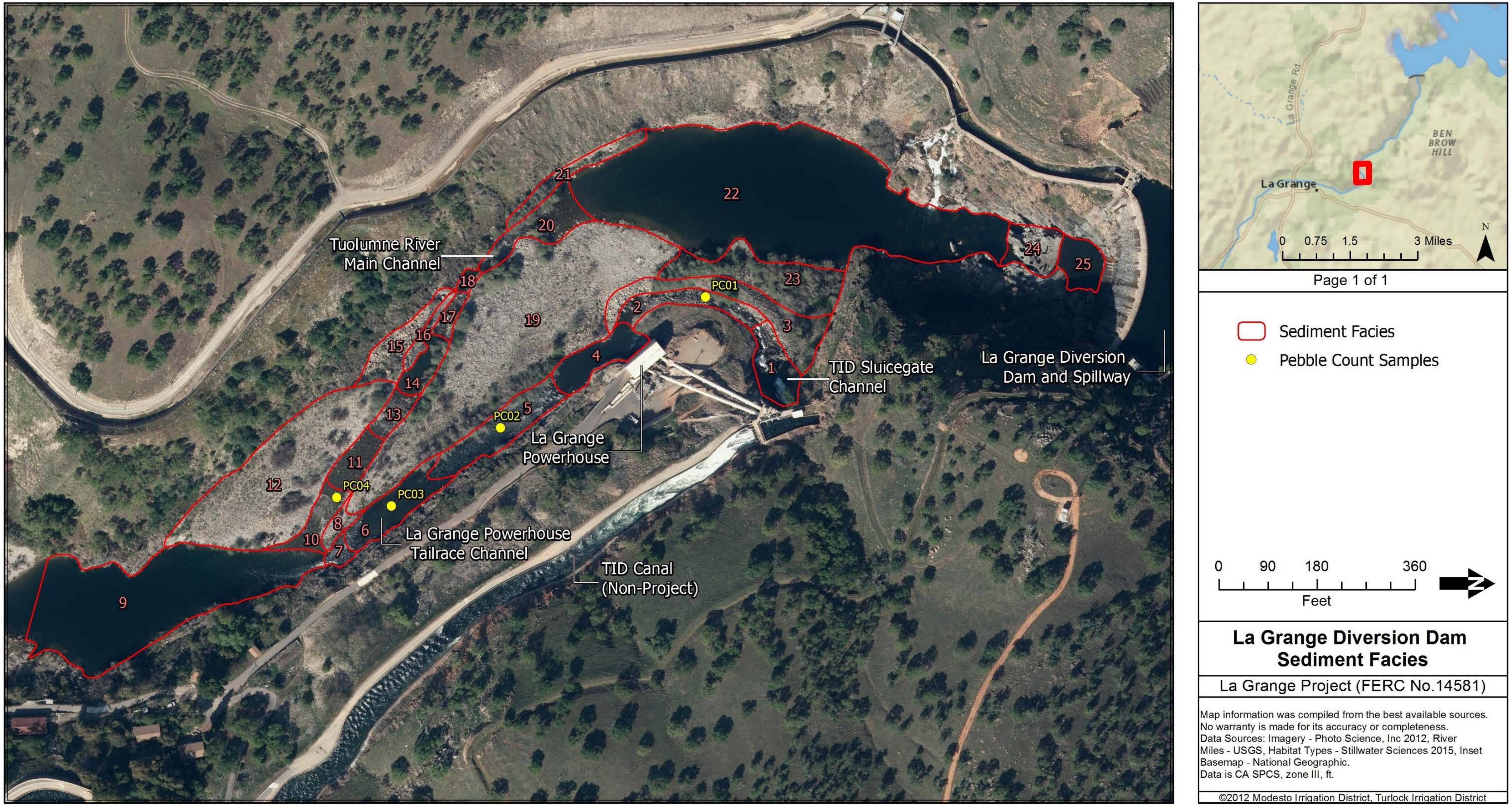

Figure 4.3-2. Sediment facies mapped downstream of La Grange Diversion Dam (TID/MID 2016b).

Table 4.3-4. Summary of pebble-count measurement results.

Pebble Count Sample[1]	Sediment Facies Unit No.	Grain Size Fractions (mm)[1]				Degree of Bed Sorting[2]
		D_{84}	D_{50}	D_{16}	D_G	
PC1	2	320	180	90	176	2.2
PC2	5	200	110	50	101	1.9
PC3	6	150	70	23	53	3.1
PC4	10	240	160	80	126	2.0

Source: TID/MID (2016b).

1 Size fractions: D84 and D16 represent the grain sizes for which 84 percent and 16 percent of the distribution is finer, respectively; D50 represents the median grain size; DG represents the geometric mean of the distribution.

2 Bed sorting describes the measure of non-uniformity of sediment mixtures (i.e., high values indicate well-graded [poorly sorted] conditions) and is computed as the geometric standard deviation: σG=(D84/D16)0.5 (Julien 2002).

4.3.3 Large Woody Debris

It is unlikely that the alluvial portions of the Tuolumne River downstream of LGDD historically supported large wood or boulder features that are more typically found in high gradient streams of the Central Valley and along the coasts of California and Oregon (Stillwater Sciences 2013).

In general, the lower Tuolumne River has limited large wood (TID/MID 2017g). This trend is exhibited in the Action Area. In 2012, a total of 118 pieces of wood were observed in the 16,905 linear feet of habitat surveyed, which when extrapolated to the reach extending from RM 39 to RM 52, is an estimated 453 pieces (TID/MID 2017g). This translates into about 35 pieces per mile. Nearly all the catalogued pieces of wood were less than 26 feet long, most pieces were less that 13 feet long, and more than half of the pieces were less than 8 inches in diameter. Based on many common indices, much of the wood observed would not qualify as large woody debris (TID/MID 2017g). Similarly, woody debris trapped above Don Pedro Dam was determined to be of insufficient size to serve a biological function for aquatic resources in the lower Tuolumne River (TID/MID 2014a).

4.3.4 Riparian Vegetation

Fragmented patches of narrow bands of riparian vegetation are present along both the tailrace channel and the mainstem Tuolumne River downstream of the large plunge pool downstream of the LGDD. Riparian vegetation is established along gravel bars in the mainstem, which are typically dry during non-spill periods at LGDD.

The 2012 lower Tuolumne River Riparian Information and Synthesis Study (TID/MID 2013b) reported that native riparian vegetation occupies 2,691 acres along a nearly continuous but variable-width band along the lower Tuolumne River corridor (TID/MID 2013b). The highest relative abundance of native riparian vegetation per river mile was mapped along the 12 miles immediately downstream of LGDD.

4.4 Hydrology in the Action Area

The Tuolumne River derives much of its flow from snowmelt. Using estimates of natural flow, Don Pedro reservoir and La Grange headpond would normally receive about 88 percent of their inflow from January through July. However, because of upstream regulation, the pattern of inflow does not reflect a typical snow-melt driven hydrograph. Mean monthly flows in the lower Tuolumne River below LGDD from 1970-2016 are shown in Table 4.4-1. Records for this location are available from the U.S. Geological Survey (USGS) National Water Information System website for October 1, 1970 to November 2016.

Table 4.4-1. Mean monthly flows from 1970-2016 in the lower Tuolumne River below La Grange Diversion Dam.

Month	Flow below La Grange Diversion Dam (cfs)
January	1,330
February	1,590
March	1,670
April	1,670
May	1,500
June	867
July	456
August	283
September	423
October	555
November	333
December	803

Source: USGS gauge 11289650, located about 0.3 miles below LGDD.

Water releases from Don Pedro Reservoir pass through the La Grange headpond and a portion of these flows are subsequently discharged to the lower Tuolumne River through the Project powerhouse. These flows benefit fish and aquatic resources in the lower Tuolumne River. Flows from Don Pedro Reservoir that are not intended to be diverted at LGDD for water supply purposes pass downstream at LGDD through either the TID powerhouse, one of four flow conduits, or pass over the LGDD spillway.

FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of certain lower Tuolumne River instream flow provisions as contained in the 1995 settlement agreement between the Districts, the City and County of San Francisco, resource agencies, and environmental groups. The revised continuous instream flows in the lower Tuolumne River range from 50 to 300 cfs, depending on water year hydrology and time of year. The FERC-required flows also specify certain pulse flows, the amount of which also varies with water-year type. The current downstream flow schedule is shown in Table 4.4-2. Outside of the spill season, these flows typically account for 95 percent of the surface water passed downstream of the LGDD. Don Pedro Reservoir releases may be routed through the Project powerhouse, and into the powerhouse tailrace channel.

Table 4.4-2. Schedule of flow releases to the lower Tuolumne River by water year type contained in FERC's 1996 order.

Schedule	Units	# of Days	Critical and Below	Median Critical[1]	Interm. CD[1]	Median Dry	Interm. D-BN	Median Below Normal	Interm. BN-AN[2]	Median Above Normal	Interm. AN-W	Median Wet/Max
Occurrence	%		6.4%	8.0%	6.1%	10.8%	9.1%	10.3%	15.5%	5.1%	15.4%	13.3%
October 1–15	cfs	15	100	100	150	150	180	200	300	300	300	300
	ac-ft		2,975	2,975	4,463	4,463	5,355	5,950	8,926	8,926	8,926	8,926
Attraction Pulse	ac-ft		none	none	None	none	1,676	1,736	5,950	5,950	5,950	5,950
October 16–May 31	cfs	228	150	150	150	150	180	175	300	300	300	300
	ac-ft		67,835	67,835	67,835	67,835	81,402	79,140	135,669	135,669	135,669	135,669
Outmigration Pulse Flow	ac-ft		11,091	20,091	32,619	37,060	35,920	60,027	89,882	89,882	89,882	89,882
June 1–September 30	cfs	122	50	50	50	75	75	75	250	250	250	250
	ac-ft		12,099	12,099	12,099	18,149	18,149	18,149	60,496	60,496	60,496	60,496
Volume (total)	ac-ft	365	94,000	103,000	117,016	127,507	142,502	165,003	300,923	300,923	300,923	300,923

Source: FERC 1996.

[1] Critically dry.

[2] Between a Median Critical Water Year and an Intermediate Below Normal (BN)-Above Normal (AN) Water Year, the precise volume of flow to be released by the Districts each fish flow year is to be determined using accepted methods of interpolation between index values.

Daily flow was recorded during fish weir monitoring in the Tuolumne River main channel, and in the tailrace channel downstream of the La Grange powerhouse. During fish weir monitoring from September 23, 2015 through April 14, 2016 (see Section 4.1.1), average daily flows at La Grange ranged from 91 to 175 cfs. River flow through the main channel weir came from the MID hillside discharge and was estimated to be approximately 25 cfs throughout the study period. Instantaneous water velocity recorded in the main channel fish counting weir passage chute ranged from 0.3 to 2.4 feet per second (feet/sec) (mean 0.9 ft/sec). The remainder of the flow recorded at the La Grange gauge originated from the powerhouse and/or TID sluice gate channel and flowed through the tailrace channel fish counting weir.[12] Instantaneous water velocity recorded at the tailrace channel fish counting weir passage chute ranged from 0.6 feet/sec to 4.7 feet/sec (mean 2.6 feet/sec).

4.5 Temperature and Water Quality in the Action Area

4.5.1 Temperature

Based on historical temperature data collected on the lower Tuolumne River (TID/MID 2017j), monthly seven-day average daily maximum (7DADM) temperatures observed at the LGDD are summarized below in Table 4.5-1.

Table 4.5-1. Monthly 7DADM temperatures at USGS 11289650 Tuolumne River below La Grange Dam, RM 51.8 (November 2001-October 2012).[1]

Month	Temperature (°C)		
	Mean	High	Low
January	10.9	11.6	10.4
February	10.8	11.2	10.1
March	10.8	11.6	9.7
April	10.8	11.7	9.9
May	11.3	12.0	10.4
June	12.0	12.9	11.1
July	12.4	13.3	11.7
August	12.7	13.4	12.1
September	12.7	13.3	12.2
October	12.3	12.8	12.0
November	11.5	12.0	10.9
December	11.2	11.6	10.7

1 Monthly averages of the 7DADM over the period of record are summarized in the table. Mean, high, and low monthly 7DADM values over the period of record are indicative of the high temperatures in the river by month.

Instream temperatures were recorded during fish weir monitoring in the Tuolumne River main channel, and in the tailrace channel directly below the La Grange powerhouse. Average daily water temperatures recorded at each weir site ranged from 10.1°C to 17.9°C (50.1°F to 64.2°F) in the tailrace channel and 9.3°C to 19.7°C (48.7°F to 67.4°F) in the main channel during the September 23, 2015 through April 14, 2016 monitoring period.

12 During the 2015/2016 monitoring season, TID maintained an 18-inch pipe in an open position that continuously delivers flow of approximately 5 to 10 cfs to the channel downstream of the sluice gates. This water flows into the tailrace just upstream of the powerhouse.

Based on mean daily temperature readings at the La Grange gauge below the LGDD, average monthly instream temperatures from May 2016 to September 2016 ranged from approximately 10.0°C (50°F) in May to 13.2°C (55.8°F) in September. Maximum temperatures from October 2016 through April 2017 ranged from 12.3°C (54.1°F) in late October 2016 to approximately 9.2°C (48.6°F) in March 2017 (USGS 2017). The average summer diurnal temperature variation at the La Grange gauge was about 1.1°C in the summer of 2011, and about 0.9°C in the summer of 2012 (TID/MID 2013i).

4.5.2 Water Quality

Discrete water quality parameters were recorded during fish weir monitoring in the Tuolumne River main channel, and in the tailrace channel just below the La Grange powerhouse. During the September 23, 2015 through April 14, 2016 monitoring period, instantaneous turbidity ranged from 0.69 nephelometric turbidity units (NTU) to 14.06 NTU (mean 2.82 NTU) in the tailrace channel and from 0.54 NTU to 11.96 NTU (mean 2.44 NTU) in the main channel. Instantaneous dissolved oxygen ranged from 4.03 milligrams per liter (mg/L) to 13.93 mg/L (mean 9.34 mg/L) in the tailrace channel and from 8.96 mg/L to 14.24 mg/L (mean 10.97 mg/L) in the main channel (TID/MID 2017e). The low instantaneous dissolved oxygen levels reported during the 2015/2016 monitoring season appeared to be a localized event associated with high levels of aquatic vegetation in the La Grange powerhouse forebay & penstock intake. Instantaneous readings below 8.0 mg/L were recorded 35 times between 9/23 and 11/3. These low levels were only in the tailrace channel, as levels in the main channel during the same period ranged from 9.1-11.1 mg/L. Daily instantaneous dissolved oxygen (DO) readings downstream at RM 24.5 during the same time period ranged from 7.1 to 9.8 mg/L (mean 8.5 mg/L), supporting the hypothesis that low DO levels in the tailrace channel were a localized issue. No low dissolved oxygen levels were observed during the 2016 monitoring season as instantaneous readings ranged from 7.06 to 10.88 mg/L (J. Guignard, FISHBIO, pers comm, 8/1/2017).

The lower Tuolumne River comprises the Tuolumne River subarea delineated by the Basin Plan (Central Valley Regional Water Quality Control Board [CVRWQCB] 1998). The Tuolumne River subarea extends downstream from the Stanislaus- Tuolumne county line and upstream of the Shiloh Road Bridge. The CVRWQCB has adopted water quality objectives for the Tuolumne River subarea to protect beneficial. The objectives are primarily narrative, incorporating California's numeric Title 22 drinking water standards by reference, although some (i.e., bacteria, DO, pH, temperature, and turbidity), are numeric.

Surface water quality data has been collected in the Tuolumne River at the Old La Grange Bridge, just downstream of Action Area at RM 51.4 (Table 4.5-2).

Table 4.5-2. Summary of water quality data from Old La Grange Bridge (1952-1988; 2003-2004) at RM 51.4 of Tuolumne River.

Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	pH	Nitrate Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)
7.0-15.0	0-18	7.3-12.7	6.4-8.4	0.01-1.20	0.00-0.20	0.00-0.46	0.00-0.10

Sources: EPA storage-and-retrieval water quality database (STORET) 2010; CVRWQCB 2010.

Section 303(d) of the federal Clean Water Act (CWA) requires each state to submit to the EPA a list of rivers, lakes, and reservoirs for which pollution control and/or requirements have failed to provide adequate water quality. Based on a review of this list, the lower Tuolumne in the Action Area is identified by the State Water Resources Control Board (SWRCB) as CWA § 303(d) State Impaired (Table 4.5-3). No Total Maximum Daily Load (TMDL) plans have been approved for the Tuolumne River, and the EPA (2003) did not identify any unsuitable temperatures for *O. mykiss* in the specific reach of the Action Area.

Table 4.5-3. Clean Water Act Section 303(d) list for the lower Tuolumne River

Water Body	Pollutant	Final Listing Decision
Lower Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	List on 303(d) list (TMDL required list)
	Diazinon	Do Not Delist from 303(d) list (TMDL required list)
	Escherichia coli	List on 303(d) list (TMDL required list)
	Mercury	List on 303(d) list (TMDL required list)
	Temperature	List on 303(d) list (TMDL required list)
	Unknown Toxicity	List on 303(d) list (TMDL required list)

Source: California Environmental Protection Agency, State Water Resources Control Board (2016)

4.6 Status of the *O. mykiss* Population in the Lower Tuolumne River

4.6.1 Anadromy Versus Residency

The tendency for anadromy or residency in sympatric populations of resident *O. mykiss* in the Tuolumne River is poorly understood (TID/MID 2017h). In comments provided to the Districts on the Draft License Application (DLA) for the Project, CDFW (2017b) confirmed the following statement to be true: “there is no empirical evidence of a self-sustaining 'run' or population of steelhead in the lower river (TID/MID 2013d).” As discussed in Section 3.1.2, Zimmerman et al. (2008) examined the otolith chemistry of 147 *O. mykiss* from the lower Tuolumne River. Results indicated that only one of these fish was a steelhead (had displayed anadromy) and eight were spawned by a steelhead (i.e., of anadromous maternal origin). Of the eight *O. mykiss* with an anadromous parent, the variable range of age classes indicated that not all were spawned at the same time (i.e., not all of them originated from the same parent). Parental origin of these fish was unknown due to historical planting operations and straying of steelhead, including hatchery-origin steelhead that are not currently part of the listed CCV steelhead DPS.

Most steelhead and resident rainbow trout in the Central Valley are genetically similar (Pearse et al. 2009) and of common hatchery origin (Garza and Pearse 2008). Nielsen et al. (2005) examined the relatedness and origins of Central Valley *O. mykiss* using genetic techniques and determined that *O. mykiss* populations downstream of dams in Central Valley rivers, including the Tuolumne River, are not genetically distinct from one another.

The results of recent investigations suggest that flow and temperature management of tailwater fisheries downstream of many dams in the Central Valley may be preferentially selecting for resident rainbow trout over anadromous steelhead (TID/MID 2013d). In their final recovery plan for the Central Valley Steelhead DPS, NMFS (2014) notes that large resident rainbow trout populations have developed in parts of the Central Valley as a result of actions undertaken for the management of coldwater species.

The probability of *O. mykiss* smolting has also been observed to vary with water temperature, with fish held in cold thermal regimes more likely to mature in freshwater than fish held in warm thermal regimes (Sloat 2013). These findings relate to both fish size (larger fish tend to survive at higher rates in the ocean than do smaller fish) as well as fat stores (fish with higher lipid content have higher energy reserves required for sexual maturation). Fish held in warm thermal regimes may have higher rates of smolting because they may be able to grow to larger total sizes but have lower body lipid stores than fish held in cold thermal regimes (Sloat 2013). McMillan et al. (2012) found that higher body lipid stores were significantly correlated with an increased probability of maturation in freshwater. In other words, if a juvenile *O. mykiss* has sufficient lipid reserves to allow maturation in freshwater, there may be no need for it to undergo smoltification and migrate to the ocean to gain sufficient lipid stores to mature (TID/MID 2017h). In some instances, decreased survival associated with downstream migration to and through the Delta and ocean rearing may not be offset by increased size (fecundity) of steelhead relative to resident *O. mykiss*.

It appears that increased summer flows since 1996 have resulted in large increases in the abundance of resident rainbow trout in the lower Tuolumne River (TID/MID 2017h). The low numbers of anadromous *O. mykiss* adults entering the Tuolumne River (Zimmerman et al. 2008) suggest that increased cold water releases from the La Grange powerhouse during summer reduce the probability of smoltification (TID/MID 2017h). However, as discussed by Yoshiyama and Moyle (2012), poor migration survival along the migratory pathway (e.g., lower San Joaquin River and south Delta) of any juveniles that do smolt would result in a low probability of their returning to spawn. Narum et al. (2008) and Satterthwaite et al. (2010) suggested that reduced smolt survival through the Delta was the greatest management concern, if the goal was to preserve or enhance expression of anadromy among Central Valley *O. mykiss* populations.

4.6.2 Presence of Anadromous *O. mykiss* in the Lower Tuolumne River

Anadromous *O. mykiss* (i.e., steelhead) are rare in the Tuolumne River. Data collected at the Tuolumne River weir at RM 24.5 during escapement monitoring from 2009 through 2016 (FISHBIO 2017) included only six detections of *O. mykiss* longer than 16 inches (i.e., steelhead per the CDFW size classification [*O. mykiss* >16 inches]). It should be noted that four of the six detections occurred during 2011, and, based on observed body length and depth, these four detections were likely two fish counted twice. In addition, as discussed in Section 3.1.2, a review of otolith data from Tuolumne River *O. mykiss* by Zimmerman et al. (2008) demonstrates that size alone is not a reliable indicator of anadromous life history. Over 97 percent (37 out of 38) of sampled Tuolumne River *O. mykiss* greater than or equal to 400 mm (i.e., ≥16 inches) were classified as having a resident life history (see Appendix 1, Zimmerman et al. 2008). Only one individual (fork length of 455 mm, or 17.9 inches) was determined to have a migratory, or anadromous, life history out of 147 *O. mykiss* sampled in the Tuolumne River.

In addition to the detections discussed above, 12 individual *O. mykiss* that were less than 16 inches long were observed passing upstream or downstream of the weir (at RM 24.5) during the 2009-2016 monitoring period. Although these fish were less than 16 inches in length, they lacked adipose fins (ad-clipped). A lacking adipose fin indicates that these fish were hatchery-origin steelhead because 100 percent of hatchery steelhead production in the Sacramento and San Joaquin basins is ad-clipped. The likelihood that these hatchery steelhead are part of the ESA-listed CCV steelhead DPS is low. As presented in Section 3.1, steelhead produced at the Coleman National Fish Hatchery, located on Battle Creek in Shasta County, and the Feather River Hatchery, located on the Feather River in Butte County, are included as part of the listed DPS. These hatchery programs are located along tributaries of the Sacramento River, on average about 200 miles north of LGDD. Therefore, although straying is a possibility, it is unlikely that detected ad-clipped steelhead at the Tuolumne River weir are part of the listed DPS. Rather, based on proximity, these individuals were likely from hatchery programs in the Mokelumne and American rivers. To date, however, there has not been an assessment of hatchery-origin for the few ad-clipped *O. mykiss* observed at the Tuolumne River weir.

As part of on-going juvenile fall-run Chinook Salmon monitoring at rotary screw traps, the Districts have conducted evaluation of the physical stage of *O. mykiss* juveniles collected at two locations in the lower Tuolumne River: the Grayson River Ranch (RM 5.2), and a site downstream of the City of Waterford (RM 29.8). Sampling at the Grayson and Waterford sites has taken place annually from 1999-2017 and 2006-2017, respectively. Based on physical condition, a total of 12 individual *O. mykiss* were considered smolts based on appearance (J. Guignard, FISHBIO, pers comm, 8/1/2017). Two smolts were captured at Grayson since 2005 (and both captured in 2008), and 10 smolts were captured at Waterford (2006-2008) (J. Guignard, FISHBIO, pers comm, 8/1/2017; FISHBIO 2016c).

4.6.3 *O. mykiss* Spawning in the Lower Tuolumne River

O. mykiss spawn in the lower Tuolumne River from mid-December through April, with peak activity in February and March. The Districts conducted redd mapping surveys between October and April in the 2012/2013 and 2014/2015 spawning seasons (TID/MID 2013e, 2015). River conditions were similar between the two study years, with a relatively consistent flow of about 165 cfs. During the 2012/2013 study period, 38 *O. mykiss* redds were observed from October 1, 2012 through April 19, 2013. The first *O. mykiss* redds were observed on January 7, 2013, and peak observations occurred during the week of April 1, when 10 new redds were identified (Table 4.6-1). The majority (63 percent) of *O. mykiss* redds were observed in the reach between RM 47.4 and RM 52.0 and 97 percent were observed above RM 42.0.

During the 2012/2013 survey season, the total redd areas for *O. mykiss* were significantly smaller than fall-run Chinook Salmon redds, ranging from 0.8 ft^2 to 26.6 ft^2 for *O. mykiss* and from 2.3

ft^2 to 405.6 ft^2 for Chinook. Based on this range in *O. mykiss* redd size it is likely that all spawning was by resident rather than anadromous *O. mykiss*, as average redd sizes for anadromous *O. mykiss* range from 57 ft^2 to 74.3 ft^2 (Shapovalov and Taft 1954; Wilson and Collins 1992). This is supported by weir monitoring on the Tuolumne River, which only detected four *O. mykiss* passing upstream during the 2012/2013 monitoring season (FISHBIO 2017).

Table 4.6-1. New *O. mykiss* redds identified by reach and date during the 2012-2013 survey period.

Week[1]	Survey Dates	Reach (RM)				Grand Total	Percent
		1 (52.0-47.4)	2 (47.4-42.0)	3 (42.0-31.6)	4 (31.6-22.0)		
1	10/1–10/4/12	0	0	0	0	0	0.0%
3	10/15–10/18/12	0	0	0	0	0	0.0%
5	10/29–11/2/12	0	0	0	0	0	0.0%
6	11/5–11/9/12	0	0	0	0	0	0.0%
7	11/12–11/15/12	0	0	0	0	0	0.0%
8	11/18–11/21/12	0	0	0	0	0	0.0%
9	11/26–11/29/12	0	0	0	0	0	0.0%
11	12/10–12/13/12	0	0	0	0	0	0.0%
14	1/2–1/5/13	0	0	0	0	0	0.0%
15	1/7–1/10/13	5	0	0	0	5	13.2%
17	1/21–1/24/13	3	2	0	0	5	13.2%
19	2/5–2/8/13	5	2	1	0	8	21.1%
21	2/18–2/21/13	0	1	0	0	1	2.6%
23	3/4–3/7/13	5	2	0	0	7	18.4%
25	3/18–3/21/13	0	2	0	0	2	5.3%
27	4/1–4/4/13	6	4	0	0	10	26.3%
29	4/17–4/19/13	0	0	0	0	0	0.0%
Grand Total		24	13	1	0	38	--
Percent		63.2%	34.2%	2.6%	0.0%	--	100%

[1] Week refers to the number of weeks after the week of 10/1/12.

During the 2014/2015 survey season, 41 redds were identified (TID/MID 2015) (Table 4.6-2). The first *O. mykiss* redds were observed on December 29, 2014, and peak observations occurred during the week of February 22, 2015, when 11 new redds were identified. *O. mykiss* spawning activity declined rapidly after mid-March, and the last redd was documented on March 26, 2015. *O. mykiss* spawning activity at recent gravel augmentation sites (near RMs 50 and 51) accounted for 19.5 percent (8 of 41) of the redds observed during the 2014-2015 spawning season and 75 percent of observations occurred above RM 42.0.

Table 4.6-2. New *O. mykiss* redds identified by reach and date during the 2014-2015 survey period.

Week[1]	Survey Dates	Reach (RM)				Grand Total	Percent
		1 (52.0-47.4)	2 (47.4-42.0)	3 (42.0-31.6)	4 (31.6-22.0)		
1	10/7	0	--	--	--	0	0.0%
3	10/22–10/23	0	0	--	--	0	0.0%
5	11/3–11/6	0	0	0	--	0	0.0%
7	11/18–11/21	0	0	0	0	0	0.0%
9	12/1–12/5	0	0	0	0	0	0.0%

Week[1]	Survey Dates	Reach (RM)				Grand Total	Percent
		1 (52.0-47.4)	2 (47.4-42.0)	3 (42.0-31.6)	4 (31.6-22.0)		
11	12/15–12/18	0	0	0	0	0	0.0%
13	12/28–12/30	0	3	0	0	3	7.3%
15	1/13–1/15	4	3	2	--	9	22.0%
17	1/26–1/28	0	1	1	--	2	4.9%
19	2/9–2/11	0	5	3	--	8	19.5%
21	2/24–2/26	2	8	1	--	11	26.8%
23	3/10–3/13	2	3	0	--	5	12.2%
25	3/24–3/26	0	0	3	--	3	7.3%
28	4/14–4/16	0	0	0	--	0	0.0%
Grand Total		8	23	10	--	41	--
Percent		19.5%	56.1%	24.4%	--	--	100%

1 Week refers to the number of weeks after the week of 10/5/14.

The relative number and timing of *O. mykiss* redd development was similar between the 2012/1013 and 2014/2015 spawning seasons, with 38 and 41 redds identified, respectively. In both periods, the initial onset of spawning was detected in late-December to early-January. Cumulatively, 50 percent of *O. mykiss* redds were detected by mid-February, and no redds were documented after the first week of April. Based on relative *O. mykiss* redd size and no detections of large individuals passing the Tuolumne River weir (RM 24.5), it is likely that all spawning was by resident rather than anadromous *O. mykiss* during both years of monitoring.

4.6.4 *O. mykiss* Rearing in the Lower Tuolumne River

During intensive summer snorkel surveys conducted from 2008–2011 in the lower Tuolumne River, young of the year *O. mykiss* (<150 mm) were found primarily in riffle habitats, whereas Age 1+-sized fish (>150 mm) were found primarily in run and pool heads at riffle tailouts (Stillwater Sciences 2008, 2009b; TID/MID 2011; TID/MID 2012). Where these age classes co-occurred, young of the year fish were typically found at 2–10 times greater densities than Age 1+-sized fish. Similar relationships of Age 0+ and Age 1+ fish densities have been found in other studies (Grant and Kramer 1990). Age 0+ fish can generally use riffle habitats from which Age 1+ fish may be excluded (Stillwater Sciences 2012a). As discussed further in the current *O. mykiss* Habitat Survey Study (W&AR-12), other than riffle/pool transitions, few structural elements such as instream wood or boulders are available for adult *O. mykiss*.

Estimated young of the year (<150 mm) and Age 1+ (>150 mm) *O. mykiss* population sizes (Stillwater Sciences 2012b) in the lower Tuolumne River from July 2008 to September 2011 are shown in Table 4.6-3. Results of instream flow studies (Stillwater Sciences 2013) show that fry *O. mykiss* weighted usable area (WUA) is maximized at 50 cfs and is 90 percent of maximum at 75 cfs, declining as flow increases. Adult WUA is maximized at 500 cfs and is 90 percent of maximum at 275 cfs, declining as flow decreases. Stillwater Sciences (2012b) reported that *O. mykiss* in the lower Tuolumne River were observed primarily in habitats with cobble-dominated substrates. Adult fish were concentrated upstream of RM 45.0 and occurred primarily in transitional run-head and pool-head habitats. Juvenile fish had a similar longitudinal distribution and occurred primarily in riffles and transitional run-head and pool-head habitats.

Table 4.6-3. Population estimates of *O. mykiss* for the lower Tuolumne River (RM 31.5-51.6), from 2008 to 2011.

Survey Date	*O. mykiss* <150 mm				*O. mykiss* ≥150 mm			
	No. Obs.[1]	Est.	St. Dev.	95% CI[2]	No. Obs.[1]	Est.	St. Dev.	95% CI[2]
July 2008	128	2,472	616.9	1,263–3,681	41	643	217.7	217–1,070
March 2009	5	63	--	--	7	170	86.3	7–339
July 2009	641	3,475	1,290.5	945–6,004	105	963	254.4	464–1,461
March 2010	1	1	0.3	1–2	13	109	30	50–168
August 2010	313	2,405	908.1	625–4,185	324	2,139	720.6	727–3,552
September 2011	4,913	47,432	5,662.2	36,334–58,530	813	9,541	1,200.9	7,188–11,895

Source: Adapted from Stillwater Sciences (2012b).
[1] Largest numbers seen in any single dive pass for each unit, summed over units.
[2] Nominal confidence intervals (CI) calculated as ± 1.96 standard deviations (SD).

Following emergence in winter and spring, *O. mykiss* fry generally occupy shallow, low-velocity areas near the stream margin and may use interstitial spaces among cobble substrates for resting and cover habitat (Bustard and Narver 1975). Distribution of *O. mykiss* in the Tuolumne River has been documented during winter and spring seine surveys conducted from RM 31.5 to 51.6, as well as during summer snorkel surveys first conducted in the early 1980s (Ford and Kirihara 2010; Stillwater Sciences 2012b). Low numbers of *O. mykiss* fry were found from February through May in bi-weekly seining in the Tuolumne River (TID/MID 2012). Observations of both Age 0+ and older age classes were documented in snorkel surveys at one or more sites upstream of Roberts Ferry Bridge (RM 39.5) in summer (July-September) since 2001. Juvenile *O. mykiss* (<150-mm) as well as Age 1+ and older adult fish (>150 mm) have been routinely documented in summer snorkel surveys since the 1980s (Ford and Kirihara 2010) and during intensive surveys (Stillwater Sciences 2008, 2009b; TID/MID 2011, 2012) from 2008–2011. Almost no *O. mykiss* were observed in summer snorkel surveys from 1983–1996 but have been observed in greater numbers since increased summer flows were implemented under the FERC (1996) Order (TID/MID 2005; Ford and Kirihara 2010). *O. mykiss* populations have increased in the years since implementation of increased summer flows under FERC (1996) order.

Low levels of instream cover might increase predation risk for juvenile *O. mykiss* in the lower Tuolumne River. As noted previously, because of its generally small size, location in the channel, and lack of complexity, most wood in the lower Tuolumne River is unlikely to provide significant cover and habitat for *O. mykiss* (TID/MID 2017g). In addition, the amount of shelter in the form of boulders, aquatic vegetation, overhanging banks, and terrestrial vegetation is relatively low. During a 2012 survey, riffles, flat water, main channel pools, and scour pools had shelter ratings (on a scale of 0–300) of 10, 31, 49, and 40, respectively (TID/MID 2017g).

4.6.5 Adult *O. mykiss* Upstream Migration

Information reviewed as part of the Salmonid Population Information Integration Study (TID/MID 2013d) suggests very low rates of *O. mykiss* immigration into the Tuolumne River, either as resident or anadromous life-history types. Since weir operations at RM 24.5 were initiated in 2009, upstream passage of a single *O. mykiss* was documented in the first year of weir operation, no observations occurred in Fall 2010, 16 individuals were detected between September 2011 and June 2012, four were detected between September 2012 and May 2013, and six were detected in 2016 (TID/MID 2014a; *unpublished data*, FISHBIO 2017). Because the counting weir operations are limited to flows below approximately 1,400 cfs, immigration of anadromous *O. mykiss* as well as residents from nearby river locations might occur during flood control releases such as those that occurred during winter/spring 2011.

Based on *O. mykiss* redd surveys conducted during the 2012/2013 and 2014/2015 spawning seasons (TID/MID 2013e, 2015), spawning of *O. mykiss* in the Tuolumne River occurs from mid-December through April. Based on this timing, the majority of any adult upstream migrants that enter the Tuolumne River likely do so when water temperatures are relatively low. No occurrences of pre-spawn mortality due to elevated water temperatures have been identified for *O. mykiss* in the Tuolumne River.

4.6.6 Existing Water Temperatures in the Lower Tuolumne River

Water temperature is an important factor affecting egg incubation rates as well as juvenile and adult *O. mykiss* growth rates. Water temperatures in the vicinity of the LGDD are a function of the temperature of releases occurring from the Don Pedro Reservoir, located approximately two miles upstream of LGDD. The temperature of water discharged from Don Pedro Reservoir is cold, ranging from about 9°C to 12°C annually. Water temperatures in the vicinity of LGDD generally reflect Don Pedro release temperatures, with summer temperatures at LGDD being 1° to 2°C warmer in the summer (TID/MID 2017f). Farther downstream of LGDD, over-summering *O. mykiss* are exposed to warmer temperatures (Table 4.6-4). The approximate temperature ranges for each of these locations during the June through September period are listed below. Adult and juvenile *O. mykiss* in the lower Tuolumne River are typically found upstream of RM 40 and therefore experience temperature ranges that are cooler than downstream reaches.

Table 4.6-4. Instream summer temperatures in lower Tuolumne River.

River Mile	Temperature (°C)
54	10.0–12.5
46	17.5–20.0
40	18.5–22.0
34	19.5–24.0
24	22.0–27.0
10	23.5–27.0
1	22.5–27.0

As part of a river temperature modeling study to simulate current and potential future water temperature conditions in the lower Tuolumne River from below Don Pedro Dam (RM 54.8) to the confluence with the San Joaquin River (RM 0), the Districts computed water temperatures in the lower Tuolumne River during 2011 and 2012 (Figure 4.6-1). Note that 2011 was a wet year.

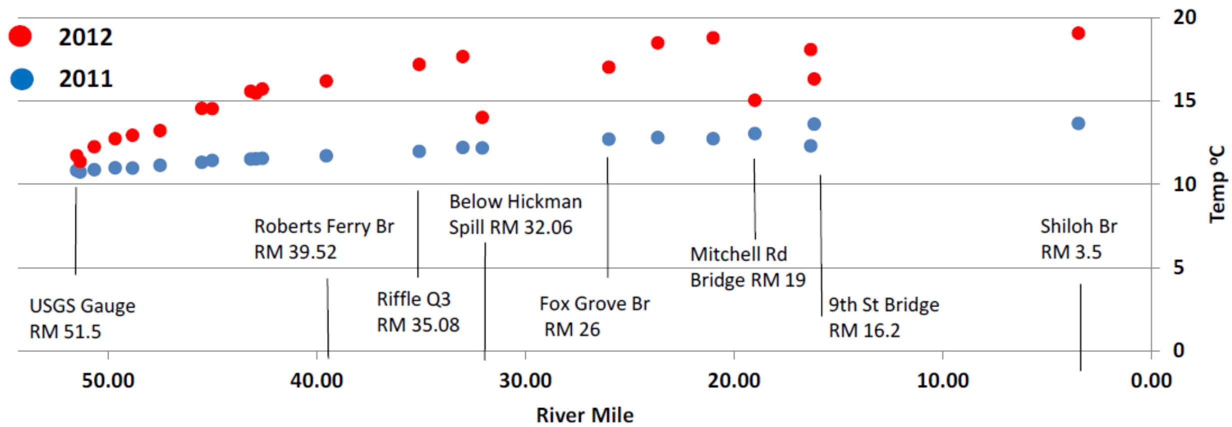

Figure 4.6-1. Observed and computed annual average temperature in lower Tuolumne River 2011-2012.

Tuolumne River *O. mykiss* model results suggest that under existing conditions summer water temperatures may limit juvenile *O. mykiss* productivity and adult replacement in “dry” water years, based on generalized temperature criteria. The territoriality of *O. mykiss* adults (Grant and Kramer 1990) suggests that fish excluded from rearing habitats due to exceedance of maximum rearing densities, high spring flows, or exceedances of presumed water temperature preference limits may be unable to locate undefended territories in other portions of the river with cool temperatures. These results are consistent with summaries of historical monitoring data provided in the Synthesis Study (TID/MID 2013d).

The investigation of thermal performance (TID/MID 2015) showed that wild *O. mykiss* from the lower Tuolumne River can maintain 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C, and all fish tested could maintain sufficient aerobic capacity to properly digest a meal at temperatures up to 23°C. Video analysis of *O. mykiss* swimming activity in the Tuolumne River indicates that fish at ambient water temperatures have an excess aerobic capacity well beyond that needed to swim and maintain station against the river current in their usual habitat (FISHBIO 2016b). These thermal performance results are consistent with those derived for *O. mykiss* populations known to be tolerant of high temperatures, such as the redband strain of rainbow trout that occurs in the high deserts of Idaho and eastern Oregon.

Results of the thermal performance study (TID/MID 2015) support the hypothesis that the thermal performance of wild *O. mykiss* from the Tuolumne River represents an exception to that expected based on the 18°C 7DADM guidance set out by EPA (2003) for Pacific Northwest *O. mykiss*. Given that lower Tuolumne River *O. mykiss* can maintain 95 percent of peak aerobic capacity at temperatures up to 24.6°C, a more reasonable upper performance limit is likely to be 22°C, rather than the established 18°C.

4.7 Presence of *O. mykiss* in the Action Area

The following sections present the findings of several studies investigating suitable salmonid habitat and *O. mykiss* occurrence in the Action Area (i.e., LGDD dam and impoundment, Tuolumne River from LGDD to the confluence with the tailrace, the Project tailrace channel, and the sluice gate channel).

4.7.1 Presence of Anadromous *O. mykiss* Upstream of LGDD

As part of the FERC-defined Project Boundary, the LGDD and its impoundment are part of the Action Area for the La Grange Hydroelectric Project. The CCV steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and human-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, except for steelhead from San Francisco Bay and San Pablo Bay and their tributaries (63 FR 13347; 71 FR 860). Based upon this DPS delineation, *O. mykiss* upstream of impassable barriers (i.e., LGDD) are not part of the listed DPS.

4.7.2 Presence of Anadromous *O. mykiss* in Action Area downstream of LGDD

Anadromous *O. mykiss* are rare in the Tuolumne River, and therefore rare in the Action Area. In comments provided to the Districts on the DLA for the Project, CDFW stated that the following statement was true "there is no empirical evidence of a self-sustaining 'run' or population of steelhead in the lower river (TID/MID 2013f)." For the purposes of this Draft BA, however, the Districts conservatively assume the very low likelihood that anadromous *O. mykiss* could occur in the Action Area at some point during the requested 50-year FERC license for the Project. However, the Districts disagree that size alone (i.e., *O. mykiss* greater than 16 inches are steelhead per CDFW 2017a) is a reliable indicator of anadromy. As discussed in Sections 3.1.2 and 4.6.1, a review of *O. mykiss* otolith data (Zimmerman et al. 2008) showed that 38 of 147 fish sampled were ≥400 mm (≥16 inches). Only one of the 38 sampled individuals ≥400 mm (≥16 inches) showed evidence of a migratory life history (i.e., steelhead).

As presented in Section 4.6.2, only six detections of *O. mykiss* greater than 16 inches have been counted during escapement monitoring at the Tuolumne River weir (RM 24.5) from 2009-2016 (FISHBIO 2017). Although the weir is well downstream of the Action Area, it cannot be ruled out that these fish could occur in the Action Area because there is no passage barrier between the Action Area and the counting weir at RM 24.5. In addition to the few detections of *O. mykiss* greater than 16 inches in length, 12 individual *O. mykiss* less than 16 inches long, but ad-clipped, were observed passing upstream or downstream of the weir. All hatchery steelhead produced in the Sacramento and San Joaquin basins are ad-clipped. Therefore, ad-clipped *O. mykiss* observed at the weir were presumably hatchery-origin steelhead. Given the location of the weir, these individuals were most likely propagated at hatcheries on the Mokelumne or American rivers. As of this writing, hatchery steelhead released from these facilities are not part of the ESA-listed CCV steelhead DPS. To date, however, there has not been an assessment of hatchery of origin of the few *O. mykiss* observed at the Tuolumne River weir.

As discussed in Section 4.1.1, two temporary fish counting weirs were installed in the Tuolumne River in the Action Area during the 2015/2016 and 2016/2017 *O. mykiss* spawning period as part of the Fish Barrier Assessment study (TID/MID 2017e). One weir was placed downstream of the large pool below LGDD in the Tuolumne River main channel, and the second was placed just below the La Grange powerhouse in the tailrace channel (see Figure 4.7-1). A total of 272 *O.*

mykiss passage events (141 upstream, 131 downstream) were detected at the tailrace weir during the 2015/2016 monitoring period[13]. No *O. mykiss* were detected at the main channel weir. Estimated lengths of observed *O. mykiss* ranged from 100 mm to 600 mm (Figure 4.7-1); several fish were estimated with high probability to be greater than 400 mm (or roughly 16 inches). By CDFW sizing definition (see Section 3.1.2), these *O. mykiss* would be classified as anadromous *O. mykiss*. However, size alone is not a reliable indicator of anadromy, and as discussed in the first paragraph (also Sections 3.1.2, 4.6.1, and 4.7.1), the likelihood that these fish actually expressed an anadromous life history is exceedingly low.

O. mykiss individuals greater than 16 inches (406 mm) in length accounted for 96 passage events (55 upstream, 41 downstream), but it is important to note that these do not represent individual fish. During this study, one ad-clipped *O. mykiss* (500 mm) was detected between February 19 and February 24, 2015 and previously detected at the lower Tuolumne weir (RM 24.5) on January 29 (discussed below). This is the only fish that can be assumed with high probability to be a steelhead (hatchery-origin).

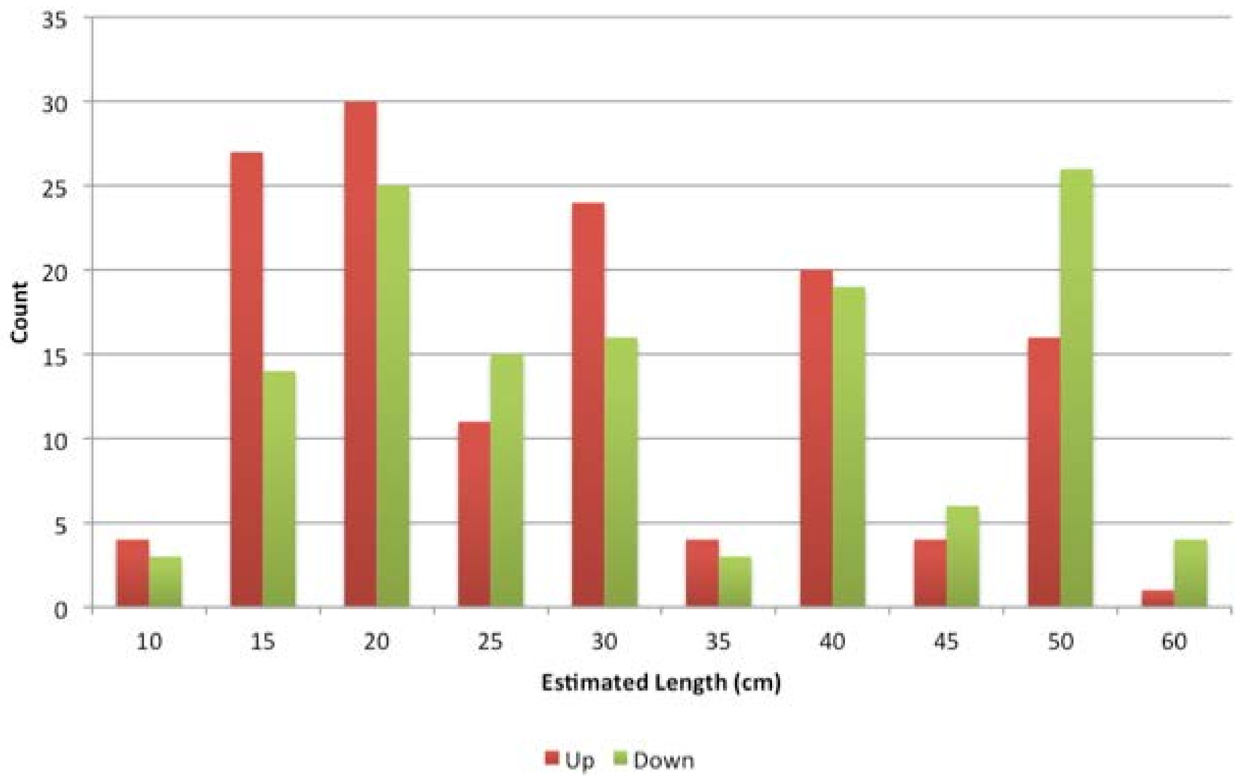

Figure 4.7-1. 2015/2016 *O. mykiss* tailrace length frequency histogram (all passages).

Adult-sized *O. mykiss* (>30 cm; 11.8 inches) were first observed on October 6, 2015, and last observed on March 29, 2016 (Figure 4.7-2). The majority of adult *O. mykiss* detections occurred during the November through January period, accounting for 83.5 percent of the passage events.

[13] It is unknown how many individual fish were involved in this count of passages due to the difficulty of distinguishing juvenile or small adult *O. mykiss*. Difference in passages likely associated with fish passing undetected or not positively identified as *O. mykiss* during periods of low light, high turbidity, or video outage periods.

Although it was not possible to identify individual *O. mykiss* passing the La Grange weirs, 83.5 percent (n=90) of the adult *O. mykiss* passage events occurred prior to the first *O. mykiss* detection at the lower weir site. Additionally, snorkel surveys (Stillwater Sciences 2011, 2012a, 2012b) have regularly identified adult *O. mykiss* (30-50 cm; 11.8 – 19.7 inches) in the upper reaches of the lower Tuolumne River.

As mentioned above, during monitoring of the tailrace channel weir, a total of two observations of ad-clipped *O. mykiss* were made, one on February 19 and one on February 24. Based on estimated length (~500 mm [19.7 inches]) and general morphological characteristics, these two observations were likely of a single fish. Because the length of the observed fish exceeded 16 inches (it was 500 mm, or 19.7 inches), CDFW's sizing criterion (per annual fishing regulations) would classify this individual was a steelhead. In this case, the absence of an adipose fin indicates that the individual was likely a hatchery-origin steelhead. As discussed in the preceding paragraph, based on proximity, it is likely that this fish originated from the Mokelumne Fish Hatchery or American River Fish Hatchery. As of this writing (September 2017), neither hatchery program is part of the listed CCV steelhead DPS. Regardless, no genetic testing was conducted and the hatchery of origin of this ad-clipped fish is unknown.

Despite the observation of a few *O. mykiss* individuals exceeding 16 inches in length in the tailrace, based on the lack of correlated upstream passages at the downstream weir at RM 24.5, it is likely that these individuals are resident *O. mykiss*. During the 2015/2016 monitoring season, three upstream migrating adult *O. mykiss*, were detected at the Tuolumne River weir (RM 24.5). Due to the low number of upstream migrating *O. mykiss* observed at that weir, the 103 adult (>300 mm) *O. mykiss* passages detected at the temporary tailrace weir during the 2015/2016 monitoring period are believed to be resident *O. mykiss* that occupy habitat in and around the Project tailrace channel. Although it was not possible to identify individual *O. mykiss* passing the La Grange weirs, 83.5 percent (n=90) of the adult *O. mykiss* passage events occurred prior to the first *O. mykiss* detection at the lower weir site (at RM 24.5). This primary resident life history assumption is supported by data collected during snorkel surveys (Stillwater Sciences 2011, 2012a, 2012b) during which adult *O. mykiss* (30-50 cm) were regularly observed in the upper reaches of the lower Tuolumne River.

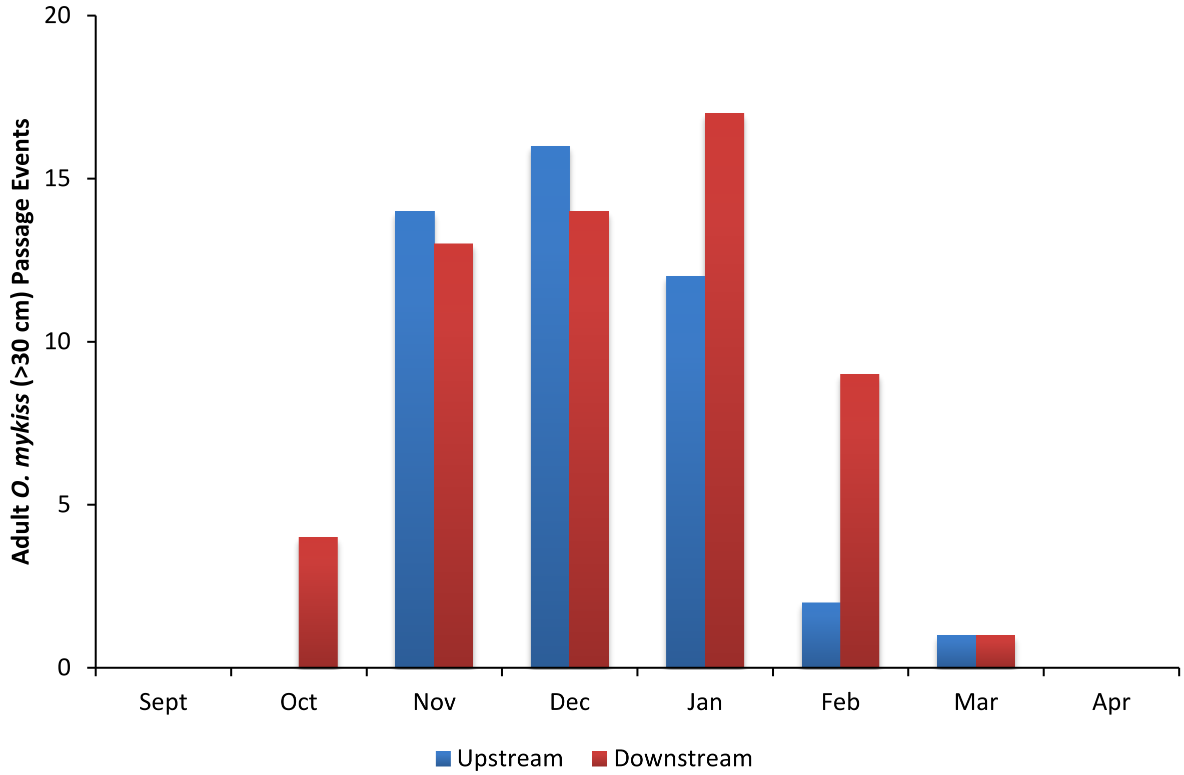

Figure 4.7-2. Adult *O. mykiss* (>30 cm) passage events at the tailrace channel weir.

4.7.3 *O. mykiss* Spawning in Action Area downstream of LGDD

Although TID/MID (2015) documented *O. mykiss* spawning activity in Reach 1 of the Tuolumne River (RM 52.0-47.4), all of the redds in Reach 1 were observed at the CDFW gravel augmentation sites near RMs 50 and 51. No *O. mykiss* redds were observed in the Project Action Area during the 2012/13, 2014/15, or 2015/16 spawning seasons (J. Guignard, FISHBIO, pers comm, 8/1/17).

As part of the Salmonid Habitat Mapping study conducted in the Action Area (see Section 4.1.8), TID/MID (2016b) determined that suitable salmonid spawning gravel is lacking in the mainstem Tuolumne River from LGDD to the confluence with the tailrace channel. Two salmonid spawning gravel patches were mapped in the tailrace channel. However, neither of the tailrace spawning gravel patches contained suitable substrate for *O. mykiss* spawning, based on pebble diameters that exceed the suitable range for *O. mykiss* (10–46 mm). In addition to falling outside the suitable substrate range, run habitat and pool habitat located in the La Grange powerhouse tailrace exceeds *O. mykiss* spawning depth criteria across the center of the channel with velocity measurements below the minimum criteria along the margins. Further, riffle habitat and glide habitat exceeds velocity criteria across the channel, with depths along the margin below the minimum criteria. Based on the information presented above, the likelihood that *O. mykiss* adults spawn in the Action Area is low and therefore discountable.

4.7.4 *O. mykiss* Rearing and Migration in Action Area downstream of LGDD

As presented in Section 4.6.4, from 2001-2013, both Age 0+ *O. mykiss* and older age classes were documented in snorkel surveys conducted at one or more sites from RM 39.5 – 51.6 (TID/MID 2013b). Only five juvenile *O. mykiss* were observed at the most upstream snorkel site (RM 51.6), in August 2004.

Recent studies completed for the Project have documented both juvenile (i.e., <150 mm) and adult *O. mykiss* (i.e., >300 mm) in the Action Area downstream of LGDD. All observations occurred in the tailrace channel. As discussed in Section 4.1.1, two fish counting weirs were installed in the Tuolumne River in the Action Area during the 2015/2016 spawning seasons as part of the Fish Barrier Assessment study (FISHBIO 2017). With the exception of two high-debris flow events on October 17 and 28 and eight brief inactive periods, these weirs operated continuously from September 23, 2015 through April 14, 2016. One weir was placed downstream of the large pool below LGDD in the Tuolumne River main channel, and the second was placed just below the La Grange powerhouse in the tailrace channel (see Figure 4.7-1). During this study, a total of 272 *O. mykiss* passage events (141 upstream, 131 downstream[14]) were detected at the tailrace weir during the 2015/16 monitoring period. No *O. mykiss* were detected at the main channel weir. Estimated lengths of observed *O. mykiss* ranged from 10 mm to 600 mm (0.4 to 23.6 inches), including one ad-clipped *O. mykiss* that was approximately 500 mm (19.7 inches) in length. As stated in Section 4.7.2, anadromous *O. mykiss* are conservatively assumed to have the potential, albeit low, to occur in the Action Area in very low numbers over the course of the requested 50-year FERC license.

Adult *O. mykiss* (>300 mm; 11.8 inches) accounted for 103 of observed passages (45 upstream, 58 downstream) during the 2015/2016 season. Adult *O. mykiss* were first observed on October 6, 2015, and last observed on March 29, 2016. The majority of adult *O. mykiss* detections occurred during the November through January period, accounting for 83.5 percent of the passage events. No *O. mykiss* were observed in the sluice gate channel during survey periods in 2015/2016 and 2016/2017 when the sluice gate was opened following a powerhouse outage, and no *O. mykiss* were observed attempting to enter into the La Grange powerhouse or the TID sluice gate channel (TID/MID 2017e). Further, the Draft Tube Study (TID/MID 2017l) documented that adult salmonids often occupy the area in front of the powerhouse but do not approach the draft tube during both operation and non-operational periods.

These study findings confirm the presence of rearing juvenile and adult *O. mykiss* in portions of the Action Area downstream of LGDD, as well as the rare occurrence of *O. mykiss* that are longer than 16-inches, including one ad-clipped individual (hatchery-origin steelhead).

[14] Difference in passages likely associated with fish passing undetected or not positively identified as *O. mykiss* during periods of low light, high turbidity, or video outage periods (J. Guignard, FISHBIO, pers comm, 8/1/2017).

4.8 Designated Critical Habitat in the Action Area

As discussed in Section 3.1.4, designated Critical Habitat for Central Valley Steelhead in the Tuolumne River includes the Tuolumne River (Lat 37.6401, Long –120.6526 [confluence with the San Joaquin River) upstream to endpoint(s) in: Tuolumne River (37.6721, –120.4445 [LGDD]) (70FR 52605). Designated critical habitat terminates at the LGDD; the headpond is not designated as critical habitat. NMFS (70FR 52522) defines the lateral extent of designated critical habitat as the width of the stream channel defined by the ordinary high water line, or by a channel's bankfull elevation in areas for which ordinary high water has not been defined pursuant to 33 CFR 329.11. Based on this definition, the tailrace channel and the mainstem Tuolumne River downstream of the LGDD are designated as critical habitat. The sluicegate channel, including that portion of the channel proposed for installation of the fish barrier, is above the OHWM and therefore not designated as critical habitat. As discussed above, the Action Area does not contain gravel patches that are suitable for *O. mykiss* spawning. No anadromous *O. mykiss* have been observed spawning in the mainstem Tuolumne River downstream of the LGDD to the confluence with the tailrace, or in the tailrace channel. Therefore, PBF #1, freshwater spawning sites for *O. mykiss*, is not currently supported in the Action Area.

PBF #2, freshwater rearing sites, is present in the Action Area. Pockets of suitable rearing habitat for all age classes is present in both the mainstem Tuolumne River downstream of LGDD to the confluence with the tailrace channel, and within the tailrace channel proper. During weir monitoring discussed in Section 4.7.4, young of the year (<150 mm), Age 1+ fish (150-300 mm), and adults (>300 mm) were observed in the tailrace channel; however, no *O. mykiss* were observed passing through the weir at the base of the mainstem plunge pool.

PBF #3, freshwater migration corridors free of obstruction, is present in that portion of the Action Area downstream of the LGDD. As demonstrated during the weir study conducted in the Action Area (TID/MID 2017e), both juvenile and adult *O. mykiss* were observed passing upstream and downstream through the tailrace channel.

5.0 EFFECTS OF PROPOSED ACTION

As discussed in Sections 3.1.2, 4.6.2, and 4.7.2, anadromous *O. mykiss* adults are extremely rare in the Tuolumne River. CDFW (2017b) confirmed there is no empirical evidence of a self-sustaining 'run' or population of steelhead in the lower river (TID/MID 2013d). Zimmerman et al. (2008) demonstrated that size alone is not a reliable indicator of anadromy in the Tuolumne River, and that the vast majority (37 out of 38) of sampled *O. mykiss* greater than or equal to 400 mm (≥16 inches) expressed a resident life history. These findings contradict CDFW's definition of "steelhead" per annual fishing regulations (i.e., steelhead include any rainbow trout greater than 16 inches found in anadromous waters; CDFW 2017a)[15]. However, because Zimmerman et al. (2008) did find evidence of a single anadromous steelhead in their study, for the purposes of this Draft BA, the Districts conservatively assume that a very low number individual steelhead adults could be present in the Action Area during the 50-year term of the FERC license. The potential for Project-related effects on adult steelhead, in the highly unlikely event they are present in the Action Area, is discountable, as discussed in detail in the following sections.

The CCV steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations below natural and human-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, except for steelhead from San Francisco Bay and San Pablo Bay and their tributaries (63 FR 13347; 71 FR 860). Juvenile *O. mykiss* downstream of impassable barriers (i.e., LGDD) are considered putative steelhead and therefore part of the listed DPS. Juvenile *O. mykiss* occur in the Action Area, and may therefore be subject to Project-related impacts, as described in this section. Despite the inclusion of juvenile *O. mykiss* downstream of LGDD as part of the listed DPS, there is no evidence to suggest that these juveniles smoltify and become or attempt to become steelhead. Further, a lack of steelhead adult returns to the lower Tuolumne River suggests juvenile *O. mykiss* in the Action Area do not express a migratory life history.

As presented in Section 3.1, the CCV steelhead hatchery program at Mokelumne River Hatchery is not currently included in the listed DPS. However, NMFS (2016) recommended that the Mokelumne River Hatchery steelhead be added to the CCV DPS based on the genetic similarities with fish produced at the Feather River Hatchery (Pearse and Garza 2015). As of this writing, Mokelumne River Hatchery steelhead are not part of the listed DPS; however, it is reasonably foreseeable that, during the term of the FERC license to be issued for the operation of the Project, NMFS may change the boundary delineation for the CCV steelhead DPS to include steelhead from the Mokelumne River Hatchery. Based on this and the lack of genetic testing on ad-clipped *O. mykiss* observed at the tailrace channel weir, it is presumed that these hatchery-origin steelhead may rarely occur, in low numbers, in the Action Area.

5.1 Effects of Continued Hydroelectric Power Generation on *O. mykiss*

Because *O. mykiss* juveniles and adults greater than 16 inches (406 mm) rarely occur in the Action Area downstream of LGDD, continued hydroelectric power generation at the Project may

[15] Based on the findings of Zimmerman et al. (2008), the Districts do not agree that size alone (i.e., individuals > 16 inches) is indicative of anadromy in *O. mykiss*.

affect *O. mykiss*, including CCV steelhead. Direct effects, if any, would include hydraulic impacts from the passing of flows through the units and into the powerhouse tailrace. Such flows, however, will occur whether or not the generation of electricity occurs at the TID powerhouse. This is because, if FERC does not issue a hydropower license for the Project, the powerhouse would likely be retrofit to continue passing flows through the installation of pressure reduction valves (PRVs) in the powerhouse unit bays. Although the Project may affect CCV steelhead in the Action Area downstream of the LGDD, for the reasons described below, Project hydropower operation would have no adverse effect on flows, temperature, water quality, or any other environmental conditions in the Action Area.

When the powerhouse is off-line and not generating power (either a planned or unplanned unit or station trip), remote operators immediately open the sluice gates to ensure flows continue to be passed downstream without interruption, as is usual and customary for a run-of-river facility. Coordinated and rapid opening of the sluice gates during powerhouse outages minimizes the likelihood that unscheduled outages adversely affect any CCV steelhead in the Action Area downstream of the LGDD.

5.1.1 Power Generating Operations: Powerhouse On-line

Electric power is generated at TID's La Grange powerhouse using all or a portion of flows at LGDD that are not diverted for water supply purposes. For example, releases occurring from Don Pedro Reservoir to meet the instream flow requirements of the Districts' FERC license may be passed through the TID powerhouse units for the purpose of generating electricity.

The turbines and draft tubes remove energy from water passing through the powerhouse and convert it to electricity. This minimizes the remaining energy in the discharge from the powerhouse and, given the stable substrate, does not create turbidity at the discharge. Aside from localized hydraulic effects (e.g., turbulence) occurring at the immediate powerhouse exit, hydroelectric generation at the Project does not impact *O. mykiss* in the Action Area downstream of the LGDD. Further, based on the studies conducted as part of the La Grange FERC licensing process, including temporary weir monitoring (TID/MID 2017e), there is no evidence that such localized turbulence has any adverse effects on *O. mykiss*. Absent power production at the TID powerhouse, the most likely future condition would be for flows not needed for water supply, to continue to be diverted through the penstocks and powerhouse via PRVs installed in the powerhouse.

Turbulent waters at the immediate exit from the powerhouse are generally stable and of low energy, and are unlikely to create conditions that are adverse for juvenile *O. mykiss* rearing. Further, the observed presence of adult *O. mykiss* and juveniles near the powerhouse exit (TID/MID 2017e) indicates that powerhouse flows do not have an adverse effect.

Because Project operations do not include hydropeaking, there exists little likelihood of stranding due to rapid changes in generation. Finally, the Draft Tube Study (TID/MID 2017c) (also corroborated by daily field observations from the Fish Presence and Stranding Assessment [TID/MID 2017a]) indicates that the risk of fish entering unit draft tubes while in operation and being injured by the turbine runners is extremely low.

Water quality parameters downstream of the powerhouse are unlikely to be affected by Project operations. The physics of the passage through the powerhouse do not facilitate changes in dissolved oxygen or other gases. No new dissolved oxygen or other gasses are introduced at the powerhouse, and no stripping of gasses occurs at the powerhouse. At the Project powerhouse, there exists no plunging flow over spillways, and thus no entrained air is captured in the spill or forced under high pressure to become supersaturated and then taken in by fish. Dissolved oxygen monitoring proposed in the Action Area will further inform this issue.

Based on the information presented above, continued hydropower generation at the Project is *not likely to adversely affect* juvenile *O. mykiss* in the Action Area downstream of the LGDD. Considering the high likelihood that adult *O. mykiss* greater than or equal to 400 mm (≥16 inches) in the Action Area are residents and not anadromous (see Sections 3.1.2, 4.6.2, and 4.7.2), the likelihood of direct effects on adult CCV steelhead is exceedingly low and therefore discountable. There is little evidence to suggest that on-going power generation at the Project affects adult CCV steelhead.

5.1.2 Non-Power-Generating Operations: Powerhouse Off-Line

When there is a unit or station trip (planned or unplanned), the powerhouse is off-line and not generating power. During the Fish Presence and Salmon Stranding Assessment (TID/MID 2017a), the La Grange powerhouse tripped offline, and the TID sluice gate opened, 18 times during the 2015/2016 monitoring season (September 23, 2015 through April 15, 2016) and 11 times during the 2016/2017 monitoring season (September 15, 2016 through January 1, 2017). During all off-line periods, the operator stationed in the TID Control Center (remote from the Project) immediately opens the sluice gates. This remote gate opening provides flow to the tailrace channel in less than one minute (J. Guignard, FISHBIO, pers comm, 8/1/2017) and makes certain flows continue downstream without interruption. The coordinated and rapid opening of the sluice gates during powerhouse outages minimizes the likelihood for adverse effects on CCV steelhead in the Action Area during off-line operations.

Despite this coordinated response protocol, over the 50-year term of the Project license, it is possible that a remote operator could fail to respond immediately, resulting in a delay in sluice gate opening. Such a delay could result in temporary dewatering of the tailrace channel, or a temporary reduction in the wetted width or depth of the tailrace. Although highly unlikely, if this occurs, *O. mykiss* that are present in the tailrace channel could be adversely affected via temporary displacement from occupied habitats, or stranding in the tailrace channel. Depending on the duration of the delay, stranding could lead to mortality. For the purposes of this assessment, the Districts assume such an operator delay could occur twice over the course of the 50 year license term. It should be noted that no such delay has occurred in the last 30 years of sluice gate operation.

5.1.3 Stage Changes during Generating and Non-Generating Periods

At the request of NMFS and FERC as part of the Don Pedro Project relicensing, the Districts evaluated changes in river stage at the La Grange gauge located just downstream of LGDD during both generating and non-generating periods This evaluation demonstrated that changes in stage were less were less than two inches (0.17 feet) up or down 99.4 percent of the time, less than four inches (0.33 feet) 99.9 percent of the time, and less than eight inches (0.67 feet) 99.99 percent of the time. One hour stage changes were less than two inches up or down 96.6 percent of the time, less than four inches 99.0 percent of the time, and less than eight inches 99.8 percent of the time (TID/MID 2014b). Relative to use by CCV steelhead, these changes in downstream hydrologic conditions are likely to be insignificant and would not lead to stranding or redd dewatering (in the unlikely event that *O. mykiss* spawn in the Action Area downstream of the LGDD).

Water level data collected in the tailrace channel during the Fish Presence and Stranding Assessment conducted from 2015-2017 (TID/MID 2017a) has shown that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline, resulting in a relatively stable flow in the tailrace channel. Based on water level data recorded at 15-minute intervals, the maximum elevation change between readings was 0.57 feet during the 2015/2016 monitoring season. Due to the extended high flow period beginning January 2, 2017, the levelogger in the tailrace channel was inaccessible for data download during the 2016/2017 monitoring season. However, it is expected that only minimal elevation changes occurred during this season. Given that the sluice gates open immediately when the La Grange powerhouse trips offline, there is little risk in redd dewatering or stranding in the tailrace channel during these operational changes.

In addition, under the Proposed Action, the addition of a fish barrier at the sluice gate channel (PM&E measure, discussed below in Section 5.2.1) would prevent the entry of fish into the channel during periods when the powerhouse is offline. This measure would therefore eliminate the potential for stranding of individual *O. mykiss* in the sluice gate channel.

5.2 Effects of Proposed Aquatic PM&E Measures on *O. mykiss*

As discussed in Section 2.1.2, the Districts are proposing to implement three PM&E measures for the benefit of aquatic resources, including *O. mykiss*, in the Action Area. Implementation of these measures may affect CCV steelhead in the Action Area downstream of the LGDD. Effects are discussed in the following subsections.

5.2.1 Sluice Gate Channel Fish Barrier Construction and Operation

As discussed in Section 2.1.2.1, the Districts would construct a fish barrier near the downstream end of the existing sluice gate channel (see Attachment B for conceptual plan) and close the existing 18-inch pipe that continuously releases a flow of 5 to 10 cfs to the channel. The barrier would be designed to NMFS salmonid passage and screening criteria (NMFS 2011) to prevent impingement or entrainment. Closure of the 18-inch pipe would prevent fish from being attracted into the sluice gate channel by the continuous flow released from the pipe, and the fish barrier would prevent fish from entering the sluice gate channel at all times. Based on the periodicity of salmonids in the lower Tuolumne River, and allowable windows established for in-water work in the Central Valley (USACE et al. 2006), the fish barrier would be installed over a period of 8 weeks during a July 15 – mid-September in-water work window.

5.2.1.1 Construction

As discussed in Section 2.1.2.1, the fish barrier would be constructed in the dry. Prior to in-water construction, flow would be shut off to the sluice gate channel and sandbags would be installed to isolate the work area. Fish would be herded from work area prior to gate closure, and remaining fish would be salvaged from the work area prior to isolation. Salvaged fish would be removed via dip netting, seining or electrofishing, and relocated to the tailrace downstream. Following sluice gate closure, about 75 cfs would be routed to river right, through the MID canal and the MID Hillside Discharge. A channel will be excavated between the plunge pool below LGDD and the tailrace to connect these two waterbodies, allowing the 75 cfs routed through the MID Hillside Discharge to water the tailrace channel continuously. These activities, including dewatering of the in-water work area and fish salvage and relocation, have the potential to affect CCV steelhead, including juvenile *O. mykiss* that are part of the DPS, as described below.

Adults

On two occasions in January/February 2016, one ad-clipped *O. mykiss* adult (~500 mm, 19.7 inches) was observed in the Action Area downstream of the LGDD. This individual was presumably a hatchery-origin steelhead from one of the hatchery programs in the Mokelumne and American rivers. As discussed in Section 4.7.2, *O. mykiss* greater than 16 inches (406 mm) in length with an intact adipose fin have rarely been observed, in the Action Area. During 2015/2016 monitoring conducted in the tailrace channel, a few observations of individuals exceeding 16 inches (406 mm) in length were recorded at the tailrace channel weir. No observations of individuals greater than 16 inches were recorded at the mainstem Tuolumne River weir. Despite the recorded observations of individuals exceeding 16 inches in length in the tailrace channel, based on the lack of correlated upstream passages at the downstream mainstem weir (RM 24.5), it is likely that the majority of these fish were residents. Further, *O. mykiss* otolith analysis by Zimmerman et al. (2008) supports the position that anadromous steelhead are rare visitors to the lower Tuolumne River, and that size alone is not a reliable indicator of *O. mykiss* anadromy (see Sections 4.6.1 and 4.6.2).

In the highly unlikely event that adult steelhead listed under the CCV DPS enter the Action Area, in-water work to construct the fish barrier has little, if any, potential to affect them. Adult steelhead typically immigrate into Tuolumne River from November through March and spawn from mid-December through April (TID/MID 2017l). Based on the information presented above and in Section 4.7.2, there is an exceedingly low likelihood that listed CCV steelhead adults would be present in the Action Area (downstream of the LGDD) during the July 15 through mid-September in-water work window. Anadromous *O. mykiss* do not spawn in the Action Area; the in-water work period does not coincide with spawning periods, and work would overlap with only the earliest migrational period. Therefore, the likelihood that adult CCV steelhead would be affected by in-water construction associated with fish barrier installation at the sluice gate channel is so remote as to be discountable.

Redds/Eggs/Emergent Fry

Although anadromous steelhead do not spawn in the Action Area, the progeny of resident *O. mykiss* (i.e., juvenile *O. mykiss*) are considered part of the listed CCV DPS. Resident *O. mykiss* spawn from late-December through April in the lower Tuolumne, and although redds have been observed downstream of the Action Area, none have been observed in the Action Area (see Section 4.7.3). Further, suitable spawning gravel for *O. mykiss* is not present in any portion of the Action Area (i.e., LGDD headpond, mainstem Tuolumne downstream of the LGDD to the confluence with the tailrace and the tailrace channel). Based on the proposed timing of in-water work and the lack of suitable spawning habitat in the Action Area, in-water work from July 15 – mid-September would have no effect on *O. mykiss* redds, eggs, or emergent fry. Turbidity associated with placement of a temporary cofferdam and excavation of the connecting channel would not extend beyond the downstream limits of the Action Area.

Juveniles

Temporary Habitat Alteration

As presented in Section 4.7.4, juvenile *O. mykiss* have been observed passing upstream and downstream through the tailrace channel weir and therefore may be exposed to temporary habitat alteration during in-water work associated with fish barrier construction. Increased underwater noise and vibrations caused by machinery operating in the channel may cause juvenile *O. mykiss* to avoid the area during periods of construction activity. If present near the sluice gate channel work area or connecting channel location, individuals could be adversely affected via temporary displacement from occupied habitats. Such displacement could alter foraging behaviors or force individuals into habitats that are less suitable, or already occupied by other fish, including those that may prey on juvenile *O. mykiss*.

With the exception of the isolated work area, the quantity of rearing habitat in the tailrace channel would not be affected during construction. As presented above, approximately 75 cfs would be routed into the tailrace channel during construction. This quantity of flow is consistent with the June 1 through September 30 schedule of flow releases from the Don Pedro Project to the lower Tuolumne River at LGDD, as mandated by FERC's 1996 order. This flow would make certain that the tailrace remains watered and continues to provide habitat for rearing juvenile *O. mykiss* during in-water work.

Fish Salvage and In-Water Work Isolation

Dewatering, fish salvage, and relocation activities associated with in-water construction are likely to adversely affect juvenile *O. mykiss* that are present in the work area. Individuals could be displaced from occupied habitats in the sluice gate and tailrace channels and could be subject to harm or harassment. The potential for harm and potentially lethal effects during salvage would be minimized by conducting fish salvage in accordance with NMFS (2000) guidelines (if electrofishing is required), and using fish biologists with experience in fish salvage and relocation. Juvenile *O. mykiss* should recover quickly from electroshocking and relocation.

Following initial in-water work isolation activities, including connecting channel excavation and installation of a sandbag cofferdam, there is a low likelihood for adverse effects on juvenile *O. mykiss* that may be present in the tailrace channel.

Sediment

Disturbance and short-term increases in suspended sediment levels can reduce light penetration, inhibit primary production, abrade and clog fish gills, prevent feeding by sight feeders, stop migration, and cause any fish in the area to avoid the disturbed reaches of the creek. Exposure to increased turbidity from sedimentation can disrupt normal behavior, causing individuals to avoid available habitat, become vulnerable to predation, lose foraging opportunities near the project area, and delay or prevent movement into suitable habitat.

Sediment releases caused by machinery operating in the sluice gate and tailrace channels (e.g., during connecting channel excavation) may cause juvenile steelhead to avoid the construction area. Potential negative effects would be minimized by the relatively short duration of in-water work, and conducting instream work in the dry during the summer work window. To further minimize potential adverse effects from sedimentation, a turbidity curtain would be installed at the downstream exit to the tailrace channel prior to the final downstream cut for the temporary connecting channel connecting the plunge pool with the tailrace. The temporary connecting channel bypass would be opened incrementally to reduce the downstream sediment pulse into the tailrace channel. Despite this sediment reduction measure, initial opening of the temporary bypass, as well as fill during closure of the connecting channel, has the potential to adversely affect juvenile *O. mykiss* through increased turbidity, which could temporary displace them from optimal foraging and rearing habitats in the tailrace channel. Depending on the nature of the sediment pulse, juvenile *O. mykiss* could experience gill abrasion and clogging, which could lead to harm or mortality. The likelihood of such adverse effects would be minimized with the use of the turbidity curtain and incremental opening of the connecting channel to connect the waterbodies. The sediment pulse would last for a matter of hours over the eight-week construction period, further reducing the likelihood of adverse effects.

Potential sediment introduction and transport would be a temporary rather than a chronic concern. Once construction is complete and the area is stabilized, the risk of sediment introduction would be removed.

Long-Term Habitat Alteration

Construction of the fish barrier would permanently block access to 11,490 square feet (383 linear feet by an average width of 30 feet; see Section 4.3.1) of step-pool habitat in the sluice gate channel that is dominated by bedrock. This habitat is not optimal for juvenile *O. mykiss* rearing. Therefore, the loss of habitat in the channel upstream of the barrier is insignificant and not likely to adversely affect rearing potential in the Action Area downstream of the LGDD.

Petroleum and Concrete

Petroleum products and wet concrete are two elements that may negatively impact juvenile *O. mykiss*. Sources of fuel and oil spills or leakage into the sluice gate and tailrace channels include heavy equipment, portable water pumps, or products stored on site throughout the duration of the project. Specific minimization measures have been established regarding fuel storage, fueling of equipment and spill containment (Section 2.1.2.1). These measures should reduce or eliminate the potential for spill events, and thereby reduce or eliminate any effects to CCV steelhead, including juvenile *O. mykiss*. Wet concrete, if placed directly in contact with live stream water can increase pH and release carbonate, both of which are toxic to fish under certain conditions. Therefore, all concrete or grout required for the fish barrier would be placed "in the dry" behind the sandbag cofferdam, and allowed to cure for a minimum of seven days prior to rewatering.

NMFS (2003) states, "salmon and steelhead are generally able to avoid the adverse conditions created by (in-water) construction if those conditions are limited to areas that are small or local compared to the total habitat area, and if the system can recover before the next disturbance. This means juvenile and adult salmon and steelhead would, to the maximum extent possible, readily move out of a construction area to obtain a more favorable position within their range of tolerance along a complex gradient of temperature, turbidity, flow, noise, contaminants, and other environmental features. The degree and effectiveness of the avoidance response varies with life stage, season and the frequency and duration of exposure to the unfavorable condition, and the ability of the individual to balance other behavioral needs for feeding, growth, migration, and territory." NMFS (2003) concludes that, with due diligence and implementation of a full range of mitigation measures, "the threat is negligible that the environmental changes caused by events at any single construction site associated with a proposed activity, or even any likely combination of such construction sites in proximity, could cause chronic or unavoidable exposure over a large habitat area sufficient to cause more than transitory direct affects to individual salmon or steelhead…small to intermediate reductions in juvenile population density in action areas caused by individuals moving out of the construction area to avoid short-term physical and chemical effects of the proposed construction are expected to be transitory and are not expected alter juvenile survival rates."

5.2.1.2 Sluice Gate Operations During High Flows

As described in Section 2.1.2.1, during high flow events, LGDD spillway flows greater than 7,000 cfs would result in some flow entering the sluice gate channel, allowing fish to access the channel upstream of the fish barrier. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Opening of the 18-inch pipeline would prevent dewatering of the sluice channel, but any fish that accessed the sluice channel during high flows would be isolated from the tailrace channel. Therefore, fish salvage operations would be conducted in a manner similar to that described for initial construction of the fish barrier.

Unlike the fish barrier construction, which would occur in the summer when anadromous adult *O. mykiss* would not be present, high flow events could occur in the spring, near the end of the spawning and migration season. As such, if present, anadromous adult *O. mykiss* could be exposed to harassment or harm during salvage and relocation activities. Effects on individuals, including anadromous adults *O. mykiss* and juvenile *O. mykiss*, would be similar to those described under Section 5.2.1.1, *Fish Salvage and In-Water Work Isolation*. However, electrofishing would not be used if adults are present. Based on gauge data from the Tuolumne River just below LGDD (water years 1971-2012, USGS gauge 11289650), and anticipated flow management strategies, spillway flows greater than 7,000 cfs are anticipated to occur approximately once every 5 years.

5.2.2 Continuous Surface Water Release to LGDD Plunge Pool

As detailed in Section 2.1.2.2, the Districts would formalize an operation that they currently implement voluntarily. The Districts would continuously release 5 to 10 cfs of surface water into the LGDD plunge pool to maintain dissolved oxygen and reduce instream temperatures in the reach of the mainstem Tuolumne River within the Action Area downstream of the LGDD. This 5 to 10 cfs of surface water is typically routed to the plunge pool through Portal No. 1 in the dam, over the spillway, or via the river-right MID Hillside Discharge (see Figure 2.2-1). The releases would occur 24-hours a day, every day of the year. Similar to existing conditions, surface water would be released into the plunge pool at the MID Hillside Discharge, Portal No. 1 in the dam, or via the LGDD spillway.

This measure would cause localized, short-duration increases in turbulence at the discharge location; however, juvenile *O. mykiss* are highly unlikely to occupy plunge pool habitat near the three potential discharge locations. As presented in Section 4.7.4, no *O. mykiss* were observed passing through the mainstem weir during monitoring of the Action Area (TID/MID 2017e). Therefore, impacts on juvenile *O. mykiss* that are part of the listed CCV DPS of steelhead are considered discountable. In the unlikely scenario that juvenile *O. mykiss* or steelhead adults are present immediately downstream of the discharge site(s), they may experience a minor increase in turbidity. However, given the depths of the plunge pool and the predominately cobble nature of the substrate (see Section 4.3.2), little, if any, turbidity is expected, and the effect on listed *O. mykiss* would be insignificant.

The overall effect of this PM&E measure is expected to be positive. *O. mykiss* would benefit from the introduction of cooling waters, and maintenance of dissolved oxygen in downstream rearing, habitats in the mainstem Tuolumne River portion of the Action Area.

5.2.3 Dissolved Oxygen Monitoring

As presented in Section 2.1.2.3, the Districts propose to monitor dissolved oxygen from September 1 to November 30 each year for the first 2 years of a new operating license. Monitoring equipment would collect dissolved oxygen information at 15 minute intervals at three locations; the Project forebay, immediately below the powerhouse, and at the lower end of the tailrace channel. The Districts would install monitoring equipment at the end of August, and remove equipment in early December. The installation of such equipment would require the temporary presence of staff at the three monitoring locations for less than one day. Although the presence of staff may temporarily displace fish from two of the proposed monitoring locations (i.e., locations in the tailrace channel), the researchers would not touch, capture, or intentionally harass them. Effects are anticipated to be insignificant. Therefore, implementation of this PM&E measure is not likely to adversely affect juvenile *O. mykiss* that may be present in the tailrace channel.

5.3 Effects of Proposed Action on Designated Critical Habitat

As discussed in Section 4.8, the headpond is not designated as critical habitat. The sluicegate channel, including that portion of the channel proposed for installation of the fish barrier, is above the OHWM and therefore not designated as critical habitat. However, construction activities associated with fish barrier installation may impact designated critical habitat in the tailrace channel. The tailrace channel and the mainstem Tuolumne River downstream of the LGDD are designated as critical habitat. Potential effects of the Proposed Action on CCV steelhead critical habitat PBFs are described below.

5.3.1 PBF #1, Freshwater Spawning Sites

As discussed is Sections 4.7.3 and 4.8, PBF #1, *O. mykiss* freshwater spawning habitat is not currently supported in the Action Area. Hydraulic effects as related to on-going operation of the Project (i.e., release of non-Project Don Pedro flows from the powerhouse) would not extend beyond the Action Area and would therefore have No Effect on PBF #1 (i.e., spawning habitats) downstream of the Action Area. In the event that anadromous *O. mykiss* spawn in the tailrace channel or mainstem Tuolumne River downstream of the LGDD over the term of the 50-year license, Project-related effects on PBF #1 are described below.

Under power generating operations, water released from the Project powerhouse maintains a stable flow into the tailrace channel at all time of the year. Therefore, if the Action Area is used by spawning CCV *O. mykiss* in the future, continued hydropower operations are not likely to adversely affect PBF #1. During non-power generating operations when the powerhouse trips offline, a TID remote operator stationed in the Control Center opens the sluice gates. This remote gate opening provides flow to the tailrace channel in less than one minute (J. Guignard, FISHBIO, pers comm, 8/1/17) and makes certain flows continue downstream without interruption. As described in Section 5.1.2, downstream flow fluctuations during power outages are insignificant with regard to spawning habitat and availability, and redds, if present, would not be dewatered. Therefore, during non-generating project operations, the Project is not likely to adversely affect PBF #1. The likelihood that an operator would fail to open the sluice gates in a timely fashion is exceedingly low and therefore the effect on PBF #1 is discountable.

Steelhead spawn in the lower Tuolumne River from mid-December through April. Therefore, in the unlikely event that CCV steelhead spawn in the Action Area, in-water construction of the sluice gate fish barrier, proposed to occur from July 15 through mid-September, would not affect PBF #1. All construction-related materials would be removed from the tailrace channel by mid-September, approximately three months prior to the earliest spawning period. Affected portions of the tailrace channel near the connection channel excavation site would be returned to pre-construction conditions (e.g., contours and substrates). Therefore, fish barrier construction would have no effect on suitable spawning habitat (i.e., PBF #1).

As described in Section 2.1.2.1, when spillway flows exceed 7,000 cfs at LGDD, surface water would overtop the sluice gate channel. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Fish trapped behind the sluice gate barrier would be salvaged in a manner similar to that described for pre-construction activities associated with fish barrier installation. During these periods, opening of the 18-inch pipeline would prevent dewatering of the tailrace channel. Therefore, if any redds remain in the tailrace channel after the high flow event, they would not be dewatered. This action is estimated to be required once every 5 years for the term of the 50-year license, and is not likely to adversely affect PBF #1.

5.3.2 PBF #2, Freshwater Rearing Sites

PBF #2, freshwater rearing sites, is present in the tailrace channel and Tuolumne River downstream of the LGDD. On-going Project operations downstream of the LGDD would occur in critical habitat and therefore may affect PBF #2. However, measurable impacts on water quality do not occur as a result of hydropower generation at the powerhouse. Further, the Project does not include peaking operations, and therefore does not create rapid fluctuations in the amount of water discharged into the tailrace. Therefore, continued hydropower operation, using surface water that would be passed downstream of LGDD regardless of the Proposed Action, may affect, but is not likely to adversely affect PBF #2. The Proposed Action would not result in measurable changes in water quality, water quantity, or floodplain connectivity in rearing habitats because the same quantity of water would be routed downstream regardless of the Project.

Freshwater rearing sites (i.e., PBF #2) may be affected when the powerhouse trips offline and flows are released through the sluice gates and into the tailrace channel. Although remote operators immediately open the sluice gates to make certain flows continue downstream without interruption during a unit or station trip, small but measurable changes in surface water elevations and wetted widths have been documented. At the request of NMFS and FERC as part of the Don Pedro Project relicensing, the Districts monitored changes in downstream flow during these powerhouse outages, as measured at the downstream La Grange gauge. Monitoring indicated that flow fluctuations were less than two inches (0.17 feet) up or down 99.4 percent of the time, less than four inches (0.33 feet) 99.9 percent of the time, and less than eight inches (0.67 feet) 99.99 percent of the time. One hour stage change was reported as less than two inches up or down 96.6 percent of the time, less than four inches 99.0 percent of the time, and less than eight inches 99.8 percent of the time (TID/MID 2014b). In addition to this monitoring data, water level data recorded at 15-minute intervals in the tailrace channel during the Fish Presence and Stranding Study (MID/MID 2017a) indicated that the maximum elevation change between readings was 0.57 feet during the 2015/2016 monitoring season. Although these changes are small, such fluctuations could result in temporary, measurable effects on the availability of rearing habitat in the downstream tailrace channel. These changes could reduce the wetted width or depth along the shallow stream margins occupied by rearing juvenile *O. mykiss*, and therefore temporarily reduce the quantity of rearing habitat in the tailrace channel. Therefore, these small, but measurable changes in the tailrace channel are likely to adversely affect critical habitat PBF #2.

Under the Proposed Action, three PM&E aquatic resource measures would be conducted in designated critical habitat for CCV steelhead. The continuous release of surface water downstream of LGDD into the plunge pool would improve water quality downstream of the release location. This measure is intended to reduce instream temperatures and maintain levels of dissolved oxygen within the Action Area. Although the release of water into the plunge pool may cause minor turbidity, given the lack of fine substrates and predominance of larger cobble and bedrock, turbidity-related effects would be insignificant. Therefore, this action would be beneficial to rearing habitat for *O. mykiss*, and is not likely to adversely affect PBF #2. Installation of dissolved oxygen monitoring devices would have no effect on PBF #2.

Under the Proposed Action, installation of a fish barrier at the downstream end of the sluice gate channel would require in-water work for a period of up to eight weeks during the July 15 to mid-September in-water work window. Although the sluice gate channel is above the ordinary high water line and therefore not part of designated critical habitat, in-water work required for instream isolation of the fish barrier area (i.e., connecting channel excavation) would occur in critical habitat. As discussed in Section 2.1.2.1, flow would be shut off to the sluice gate channel. About 75 cfs would be routed to river right, through the MID canal and into the MID Hillside Discharge. A connecting channel would be excavated between the plunge pool below LGDD and the tailrace to connect these two waterbodies, allowing approximately 75 cfs routed through the MID Hillside Discharge to water the tailrace channel continuously. Block nets would be placed along the entrance and exits to the channel to prevent fish entry. These activities, including dewatering of the sluice gate channel work area, have the potential to introduce sediment into downstream rearing habitat in the tailrace channel. During in-water work, short-term effects on water quality via sediment mobilization and potential chemical contamination from operation of instream equipment are likely to adversely affect critical habitat PBF #2 for CCV steelhead. A minor reduction in the amount of available rearing habitat would occur for the duration of in-water construction due to the presence of a sandbag cofferdam.

As described in Section 2.1.2.1, when spillway flows are greater than 7,000 cfs at LGDD, flow would enter the sluice gate channel. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Fish trapped behind the sluice gate barrier would be salvaged in a manner similar to that described for pre-construction activities associated with fish barrier installation. During these periods, opening of the 18-inch pipeline would prevent dewatering of the tailrace channel. Therefore, if rearing juvenile *O. mykiss* are present in the tailrace channel, they would not be stranded during these infrequent salvage operations, which are estimated to be required once every 5 years for the term of the 50-year license. This action is not likely to adversely affect PBF #2.

5.3.3 PBF #3, Freshwater Migration Corridors

PBF #3, freshwater migration corridors free of obstruction, is present in the tailrace channel and Tuolumne River downstream of the LGDD. As demonstrated during the weir study conducted in the Action Area (TID/MID 2017e), both juvenile and adult *O. mykiss* were observed passing upstream and downstream through the tailrace channel. Under the Proposed Action, the sandbags used to isolate the in-water work area would result in a temporary impediment to *O. mykiss* upstream migration. However, little usable upstream habitat is available in the sluice gate channel (which is not designated as critical habitat). The quantity of migratory habitat affected by the two-month placement of a sandbag cofferdam is insignificant, and therefore construction of the fish barrier is not likely to adversely affect PBF #3.

As described in Section 2.1.2.1, when spillway flows are greater than 7,000 cfs at LGDD, flow would enter the sluice gate channel. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Opening of the 18-inch pipeline would prevent dewatering of the tailrace channel and allow for continued movement in the tailrace channel. However, the sandbag cofferdam required for fish salvage would temporarily block a small amount of habitat in the upper portion of the tailrace channel. Similar to the initial fish barrier construction, the amount of migration habitat that would be temporarily unavailable during sandbag isolation in the tailrace channel is insignificant. Further, because fish salvage would take place over a matter of days, and given the anticipated frequency of this action (i.e., approximately once every 5 years), it is not likely to adversely affect PBF #3.

5.4 Interrelated and Interdependent Actions

As noted in Section 2.1, the Proposed Action is FERC issuance of an original license to allow for the continued generation of hydroelectric power at existing facilities downstream of LGDD. Upstream surface water diversions for irrigation and M&I uses and the discharge of Don Pedro settlement flows downstream of LGDD are in no way dependent on the issuance of a FERC license for the La Grange Hydroelectric Project, and would occur with or without the licensing of the Proposed Action. As such, these uses are *not* interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. As discussed in Section 2.1, if FERC does not issue the Districts a license to continue hydroelectric generation at LGDD (i.e., No Action alternative), Don Pedro settlement flows will still be released downstream. The location of the release would be determined in the future, but it is anticipated that flows could still be routed through the powerhouse because it could be retrofitted to allow required flows to pass through the facility without generation.

Because the Districts are consulting with NMFS on the Proposed Action, and power would be generated as it has historically (i.e., the effects of generation would be equivalent to those occurring under existing conditions, so there would be no incremental effects on resources in the Action Area), the effects of the aforementioned non-hydropower water uses are addressed as independent actions in the cumulative effects analysis of this BA (see Section 5.5). Other than the proposed PM&E measures, which are part of the Proposed Action, the Districts are aware of no other actions that have the potential to affect *O. mykiss*, including and CCV steelhead, in the Action Area that could be considered related to or interdependent with the Proposed Action to continue hydroelectric power generation at the Project.

5.5 Cumulative Effects of the Proposed Action

Under the ESA, cumulative effects are the effects of future state or private activities not involving federal activities that are reasonably certain to occur within the Action Area of the federal action subject to consultation (i.e., FERC issuance of a license for the Project) [50 CFR §402.02]. This definition applies only to ESA Section 7 analyses and should not be confused with the broader use of the term in NEPA or other environmental laws. Federal actions that are unrelated to the Project are not considered because they require separate consultation pursuant to Section 7 of the ESA.

This section presents those non-federal actions that have impacted or are reasonably certain to impact CCV steelhead in the Action Area. Although the spatial scope for assessment of cumulative effects in this BA is the Action Area, non-federal actions that occur upstream of the Action Area have the potential to affect aquatic habitat in the Action Area, primarily through flow alteration. Relative to aquatic resources, the Action Area includes the lower Tuolumne River from La Grange Diversion Dam (RM 52.2) to the confluence with the tailrace channel, the tailrace channel proper, and the sluice gate channel. Upstream activities that have the potential to affect water quantity and quality in the Action Area include irrigation-related operations at LGDD as well as Don Pedro Dam. These activities are included herein for context. In addition to these actions, several additional non-federal dams are operated in the upper Tuolumne River. These projects cumulatively affect flow, and ultimately, the Action Area. However, non-Project irrigation diversions at LGDD and flow management at Don Pedro Dam are the primary drivers of cumulative effects in the Action Area. A comprehensive analysis of cumulative effects from all upstream activities is presented in Attachment C.

5.5.1 Past, Present, and Future Actions Affecting the Action Area

The Tuolumne River basin has been affected by substantial resource use and land and water management activities over the past 150 years. Eight dams and reservoirs are located on the Tuolumne River and its tributaries, with a combined storage capacity of about 2,777,000 ac-ft. Seven of these dams are located upstream of the Project. The lower Tuolumne River below LGDD is directly affected by the operations of LGDD, the primary purpose of which is to divert water into the Districts' two irrigation canals.

Attachment C presents robust chronology and comprehensive analysis of actions in the Tuolumne River basin, including the Action Area. This section, however, focuses on non-federal activities that directly affect instream habitat in the Action Area, specifically, flow-management at the upstream Don Pedro Dam, the LGDD, and irrigation diversions at the LGDD.

5.5.1.1 Flows Released Downstream of Don Pedro Dam

Don Pedro Dam is a 1,900-feet-long and 580-feet-high, zoned earth and rockfill structure. The top of the dam is at an elevation of 855 feet (National Geodetic Vertical Datum of 1929). Don Pedro Reservoir extends upstream for approximately 24 miles at its normal maximum water surface elevation of 830 feet. In a typical year, water surface elevation in Don Pedro Reservoir peaks in late June/early July at the end of the snowmelt runoff, and is then steadily drawn down over the summer and fall to serve water supply and lower Tuolumne River fish protection needs. Rainfall and snowmelt runoff resumes in December.

Water is released downstream of Don Pedro Dam for only three reasons: (1) to provide water needed to meet the Districts' irrigation and M&I demands at LGDD, (2) for flood management purposes, and (3) to meet the license requirements for fish protection flows in the lower

Tuolumne River. In general, flow release operations follow a relatively consistent annual cycle of water management for flood control; capturing runoff from snowmelt and seasonal rainfall; delivery of water to meet irrigation, municipal, and industrial needs; and providing scheduled releases for the protection of anadromous and resident salmonids in the lower Tuolumne River.

FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of the lower Tuolumne River minimum flow provisions contained in the 1995 settlement agreement between the Districts, the City and County of San Francisco, resource agencies, and environmental groups. The revised minimum flows in the lower Tuolumne River vary from 50 to 300 cfs, depending on water year hydrology and time of year. The water year classifications are recalculated each year to maintain an approximately consistent frequency distribution of water year types over time. The settlement agreement and license order also specified certain pulse flows for the benefit of upstream migrating adult salmonids and downstream migrating juveniles, the amount of which also varies with water-year type. The downstream flow schedule provided for by the settlement agreement and subsequent FERC Order is part of the environmental baseline and was presented in Table 4.4-2. These required release flows contribute positively to cumulative effects on CCV steelhead in the Action Area, and would continue regardless of whether or not the Project is licensed.

5.5.1.2 La Grange Diversion Dam and Irrigation Diversions

As presented in Section 1.2, the Districts constructed LGDD from 1891 to 1893. The LGDD replaced Wheaton Dam, which was built by other parties in the early 1870s. LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID.

The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. LGDD provides no flood control benefits, and no recreation facilities are associated with the Project or the La Grange headpond. From 1971 to 2012, the average annual water diversion at LGDD to the Districts canals was approximately 900,000 ac-ft. Diversions for irrigation can occur year round, but generally occur from late February to early November. This non-Project water management contributes to cumulative effects on *O. mykiss* in the Action Area by diverting water upstream of the Action Area, thereby reducing flow and available habitat downstream of the LGDD.

The maintenance and operation of LGDD for irrigation diversion has directly affected flows in the Action Area since 1893, thereby influencing water resources and, as a result, habitat potentially occupied by CCV steelhead in the Action Area. The direct effects resulting from these non-Project irrigation operations at LGDD occur whenever all flows, except FERC-required minimum flows for the Don Pedro Project, are diverted to meet the needs of the Districts' water users. During flood management periods at Don Pedro Dam that coincide with water diversions, non-Project LGDD irrigation operations contribute to cumulative effects in the Action Area. However, during flood management periods when there are no irrigation diversions, cumulative effects in the Action Area are due to flood management requirements alone.

The presence of the LGDD has affected channel morphology immediately downstream of the LGDD, including the Action Area. The channel downstream of LGDD is characterized by down-cutting, widening, armoring, a lack of large woody debris, and depletion of sediment storage features (e.g., lateral bars and riffles) due to the cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses (California Department of Water Resources [CDWR] 1994; McBain and Trush 2004).

5.5.2 Assessment of Cumulative Effects of the Project on CCV Steelhead

The Proposed Action would not contribute to cumulative effects on CCV steelhead in the Action Area. The non-Project LGDD irrigation diversions, and flow releases from Don Pedro Dam, will occur regardless of the Proposed Action. Therefore, hydropower operations at the La Grange powerhouse using surface water that would be passed downstream of the LGDD regardless of the Project do not contribute to cumulative effects on CCV steelhead and their habitat within the Action Area. Any CCV steelhead occurring in the Action Area are affected by a large number of past, present, and potential future anthropogenic actions and background environmental conditions. Factors that influence CCV steelhead in the Action Area include water management activities, past and present in-river and floodplain mining, a variety of historical and current land-use practices, non-native species, ongoing fisheries management, and habitat restoration activities (see Attachment C).

5.6 Effects of Climate Change

According to the California Environmental Protection Agency (CEPA) (2006), there is no clear trend in precipitation projections for California over the next 100 years, but the consensus based on recent Intergovernmental Panel on Climate Change (IPCC) model projections is for small changes in total precipitation, with slightly greater winter and lower spring precipitation. Despite the modest projected change in precipitation, warmer temperatures may reduce snow accumulation in the Sierra Nevada. A greater proportion of precipitation may be in the form of rain, and snowmelt may occur earlier.

Reductions in snowpack and earlier runoff would have impacts on natural ecosystems and water supply. Climate simulations predict that losses in snowpack may become progressively larger during the 21st century, and by the 2035–2064 period, snowpack in the Sierra Nevada could decline by 10–40 percent (CEPA 2006). By 2100, snowpack could decrease by as much as 90 percent if temperatures rise at the high end of the range of predicted increases (see preceding paragraph).

Declining snowpack would exacerbate the already substantial competition for water resources in California (CEPA 2006). The snowpack in the Sierra Nevada provides water storage equivalent to about half the capacity of California's major reservoirs. This loss in storage in the form of snow could lead to greater and longer duration future water shortages. Under most scenarios, stream flows are projected to decline slightly by about 2050, with more dramatic changes possibly occurring near the end of the century (CEPA 2006).

Managing California's reservoirs efficiently will be critical to avoiding or minimizing the effects of any such shortages. Flows into the major Sierra Nevada reservoirs could decline from 25–30 percent, even under moderate warming levels (CEPA 2006), i.e., nearly twice the decrease projected if temperatures increase within the lower range of possible warming. After about 2050, alteration of the volume and timing of snowmelt runoff may limit the ability of the major water storage projects to deliver irrigation water to users south of the Delta (CEPA 2006). The reductions in the availability of water would be exacerbated by any increases in demand, and by 2100, increasing temperatures would increase the crop demand for water from 2 to 13 percent in the low to medium warming ranges, respectively (CEPA 2006).

As the Central Valley warms, CCV steelhead, which in California are at the southern end of the species' distribution, will be at greater risk than under current conditions (NMFS 2010). If temperatures rise and flows decline in California as predicted, it will become more difficult to manage cold-water fisheries. Effects of climate change are expected to be particularly acute in the southern Sierra Nevada mountains (NMFS 2014), i.e., the headwaters to the major eastside tributaries to the San Joaquin River, including the Tuolumne River.

Projected temperatures for the next three decades under a higher emissions scenario would reduce habitat quality and quantity for salmon and steelhead dramatically (Mote et al. 2008; Salathé 2005; Keleher and Rahel 1996; McCullough et al. 2001, as cited in NMFS 2014). Warmer water and lower baseflows will alter salmonid metabolism, potentially affecting fish growth. Warmer water also causes salmonid eggs to hatch earlier, resulting in young that can be smaller and emerge from the gravel at a time when their invertebrate prey species are less abundant (Thomas et al. 2009). Also, diseases and parasites that infect steelhead are more prevalent in warmer water. Earlier peaks in snowmelt runoff could also prematurely flush juvenile steelhead downstream within river systems and from rivers into estuaries, thereby increasing their susceptibility to predation and other adverse effects (NMFS 2014). Ocean temperatures will also be impacted by a warming climate. Warm ocean temperatures along the west coast of the United States have been correlated with low salmon abundance (Janetos et al. 2008; Crozier et al. 2008, as cited in NMFS 2014).

In its CCV steelhead recovery plan, NMFS (2014) identifies resiliency and refugia as the large-scale phenomena necessary to help buffer a salmonid population against the adverse effects of climate change. Resiliency, i.e., the amount of disturbance a system can absorb, can only occur if enough individual rivers are available with the appropriate habitat and connectivity so that a disturbance to one portion of the system has little impact on a given aquatic species, because other parts of the system are able to support populations through recovery and recolonization following abatement of the disturbance (Bakke 2009). The degree to which resiliency will shield steelhead against the adverse effects of climate change is unknown, given that climate-related alterations are likely to persist over the long term, so recolonization of impacted river reaches might not be possible.

Refugia are locations where organisms can go to escape threatening conditions (Bakke 2009). Refugia are usually considered relevant in the context of short-duration threats such as floods or seasonally high water temperatures. However, in the context of climate change, NMFS (2014) characterizes refugia as places where a population can persist through decades or even centuries of unfavorable conditions. However, if worst-case climate change scenarios play out, favorable conditions at a regional scale might not return for a very long period of time, i.e., potentially way past the point of any reasonable management planning. NMFS (2014) states, "Because…steelhead…exhibit juvenile over-summer rearing as part of their life history strategies, long-term climate change considerations are discouraging for [the] species, unless coldwater refugia at local and larger scales exist or can be provided…" For steelhead, refugia may exist where groundwater emergence influences water temperature and volume. NMFS (2014) identifies three scales at which refugia could occur: (1) local areas of cold water emergence within a reach that is otherwise too warm, (2) rivers downstream of reservoirs with large amounts of coldwater storage, and (3) entire reaches or even streams in which groundwater hydrology is dominant or snowmelt hydrology is preserved at high elevations.

Lindley et al. (2007) (i.e., Appendix C to the NMFS 2014) state, "Recovering Central Valley ESUs may require re-establishing populations where historical populations have been extirpated (e.g., upstream of major dams). Such major efforts should be focused on those watersheds that offer the best possibility of providing suitable habitat in a warmer future." Lindley et al. (2007) note that "By the end of the century, it may be difficult to achieve current operations targets for fish conservation even with substantial decreases in other demands for water." Lindley et al. (2007) state, "It would be a costly mistake to invest heavily in restoring habitat that will become too warm to support salmonids."

6.0 CONCLUSIONS

Table 6.0-1 summarizes potential effects of the Proposed Action (i.e., Project), including the Districts' proposed PM&E measures, on CCV steelhead and its critical habitat in the Action Area.

Table 6.0-1. Effect determinations associated with the Proposed Action, including the Districts' proposed PM&E measures, for the CCV steelhead DPS in the Action Area.

Action	Effect Determination (Species)	Effect Determination (Critical Habitat)	Impact Mechanism	Estimated Frequency of Action
Continued generation of hydroelectric power (4.6 MW) at Project using surface water that would be passed downstream of the LGDD regardless of power generation	NLAA[1]	NLAA	Continued generation of hydroelectric power would have no effect on flow quantity or water quality. However, release of non-Project flows from the Project powerhouse into the tailrace channel would contribute to turbidity and turbulence at and immediately downstream of the exit. This water would be passed downstream of LGDD, likely through an off-line powerhouse, regardless of the Project. Releases result in insignificant effect on CCV steelhead and their habitat in the tailrace channel.	Continuous with exception of short-term power outages
Non-generating operations (powerhouse is offline and sluice gates manually opened)	LAA[1]	LAA (small but measurable fluctuations in tailrace channel downstream of sluice gate channel, LAA rearing habitat – PBF #2; see Section 5.3.2)	Although the likelihood is low, there exists the potential for adverse effects on individuals and temporary effects on occupied critical habitat in the tailrace during the transitional period when the sluice gate is manually opened following a powerhouse outage. If there is a delay in sluice gate opening, the wetted width and depth of the tailrace could rapidly decrease, resulting in potential fish stranding until water is returned to the tailrace.	Powerhouse trips offline several times per month; estimated frequency of delay to manual gate opening result in LAA to species = 2 times in 50-year license.
Fish Barrier Installation on Sluice Gate Channel	LAA[1]	LAA	Discountable potential to affect adult CCV steelhead (NLAA). Adverse effects on juveniles are possible. During construction, likelihood of adverse impact on individual juvenile *O. mykiss* from fish salvage and relocation from in-	2 months during July 15 – mid-September work window

Action	Effect Determination (Species)	Effect Determination (Critical Habitat)	Impact Mechanism	Estimated Frequency of Action
			water work area. Also potential for juvenile displacement and potential injury from sediment released during connection of the plunge pool with the tailrace channel during excavation of a connecting channel to connect these waterbodies. Temporary, but adverse impact on critical habitat from instream construction activities. Following installation, the barrier would preclude entry of *O. mykiss* into the sluice gate channel and prevent fish from being stranded during potential power outages at the powerhouse when the sluice is not immediately opened to release flow downstream.	
Spillway flows greater than 7,000 cfs at LGDD resulting in flow entering sluice gate channel, allowing fish to access the channel upstream of the fish barrier and requiring fish salvage	LAA[1]	NLAA	Potential for harassment and harm from fish salvage and relocation activities. Juvenile *O. mykiss* have most likelihood to be affected. Discountable potential that adult CCV steelhead would be exposed to activity.	Salvage activities conducted over a matter of days approximately once every 5 years.
Continuous release of 8-10 cfs into LGDD plunge pool to improve instream temperatures and maintain dissolved oxygen.	NLAA[1]	NLAA	Insignificant turbidity at release location; benefit to CCV steelhead, their critical habitat, and potential prey resources from small increase in flows (including temperature reduction and dissolved oxygen maintenance) in Action Area downstream of LGDD.	Continuous
Dissolved oxygen monitoring	NLAA	NE	Temporary disturbance if fish are present near monitoring equipment sites during installation and removal. No effect during monitoring period.	Seasonal installation of equipment in late August, and removal in early December for two years.

[1] Considering the high likelihood that adult *O. mykiss* greater than 16 inches (~406 mm) in the Action Area are residents and not anadromous (see Sections 3.1.2, 4.6.2, and 4.7.2), the likelihood of direct effects on adult CCV steelhead is exceedingly low and therefore discountable.

7.0 REFERENCES

Anderson, J.H., G. R. Pess, R. W. Carmichael, M. J. Ford, T. Cooney, C. Baldwin, M. M. McClure. 2014. Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery. North American Journal of Fisheries Management, 34:1, 72-93.

Araki, H., B. Cooper, and M.S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318:100-103.

Bakke, P. 2009. Physical Science and Climate Change: A Guide for Biologists (and others). Stream Systems Technology Center. Rocky Mountain Research Station. April 2009.

Barnhart, R.A. 1991. Steelhead *Oncorhynchus mykiss*. Pages 324-336 in J. Stolz and J. Schnell, editors. Trout. Stackpole Books, Harrisburg, Pennsylvania.

Beakes, M.P., W.H. Satterthwaite, E.M. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard, and M. Mangel. 2010. Smolt transformation in two California steelhead populations: effects of temporal variability in growth. Transactions of the American Fisheries Society 139:1263-1275.

Behnke, R.J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, Maryland.

Berejikian, B.A. and M.J. Ford. 2004. Review of Relative Fitness of Hatchery and Natural Salmon. NOAA Technical Memorandum NMFS-NWFSC-61. December 2004. Seattle, Washington.

Bratovich, P. C. Addley, D. Simodynes, and H. Bowen. 2012. Water Temperature Considerations for Yuba River Basin Anadromous Salmonid Reintroduction Evaluations. Prepared for: Yuba Salmon Forum Technical Working Group.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead From Washington, Idaho, Oregon, and California. Report No. NMFS-NWFSC-27. NOAA Technical Memorandum. U.S. Department of Commerce. [Online] URL: http://www.nwfsc.noaa.gov/publications/techmemos/tm27/tm27.htm.

Bustard, D.R. and D.W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon (Oncorhynchus kisutch) and steelhead trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 32: 667-680. [Online] URL: http://www.for.gov.bc.ca/hfd/library/ffip/Bustard_DR1975JFishResBoardCan.pdf.

______. 1990. Central Valley Salmon and Steelhead Restoration and Enhancement Plan. Sacramento, California. April 1990. 115 pages.

______. 1993. Restoring Central Valley Streams: A Plan for Action. Sacramento, California. November 1993. 129 pages.

______. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, California.

California Department of Fish and Game (CDFG). 1988. California Advisory Committee on Salmon and Steelhead: Restoring the Balance.

California Department of Fish and Wildlife (CDFW). 1991. Steelhead Restoration Plan for the American River. Prepared by D. McEwan and J. Nelson.

______. 2000. Lower American River Pilot Salmon and Steelhead Spawning Habitat Improvement Project. Quarterly Status Report July 1999-March 2000. U.S. Fish and Wildlife Service.

______. 2017a. 2017-2018 California Freshwater Sport Fishing Regulations. Effective March 1, 2017 through February 28, 2018.

______. 2017b. California Department of Fish and Wildlife, Central Region's Comments on the Draft License Application for the La Grange Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-14581, Tuolumne River, California. August 2017.

California Department of Water Resources (CDWR). 1994. California Water Plan Update 1993. Bulletin 160-93. October. [Online] URL: http://www.waterplan.water.ca.gov/previous/b160-93/TOC.cfm.

California Energy Commission (CEC). 2011. Updated California Energy Demand Forecast 2011-2022. May 2011. CEC-200-2011-006-SD.

California Environmental Protection Agency (CEPA). 2006. Climate Action Team Report to Governor Schwarzenegger and the Legislature, March 2006, 107 pages.

California Environmental Protection Agency, State Water Resources Control Board. 2016. Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report). [Online] URL: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml (Accessed June 2016).

Central Valley Regional Water Quality Control Board (CVRWQCB). 1998. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and the San Joaquin River Basin. 4th ed. California Regional Water Quality Control Board, Central Valley Region. Revised in September 2009 with the Approved Amendments. [Online] URL: http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/.

———. 2010. San Joaquin River Basin Rotational Subbasin Monitoring: East Side Basin: January 2003-April 2004.

Chapman, D.W. 1958. Studies on the life history of Alsea River steelhead. Journal of Wildlife Management 22: 123-134.

Crozier, L.G., A.P. Hendry, P.W. Lawson, T.P. Quinn, N.J. Mantua, J. Battin, R.G. Shaw, and R.B. Huey. 2008. Potential Responses to Climate Change in Organisms with Complex Life Histories: Evolution and Plasticity in Pacific Salmon. Evolutionary Applications, 1(2), 252-270.

Everest, F.H. and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout in two Idaho streams. Journal of the Fisheries Research Board of Canada 29: 91-100.

Everest, F.H., G.H. Reeves, J.R. Sedell, J. Wolfe, D. Hohler, and D.A. Heller. 1986. Abundance, behavior, and habitat utilization by coho salmon and steelhead trout in Fish Creek, Oregon, as influenced by habitat enhancement. Annual Report 1985 Project No. 84-11. Prepared by U.S. Forest Service for Bonneville Power Administration, Portland, Oregon.

Farrell, A.P., N.A. Fangue, C.E. Verhille, D.E. Cocherell, and K.K. English. 2017. Thermal performance of wild juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: a case for local adjustment to high river temperature. Final Report. (W&AR-14). Prepared by the Department of Wildlife, Fish, and Conservation Biology, University of California, Davis for Turlock Irrigation District and Modesto Irrigation District. February 2017.

Federal Energy Regulatory Commission (FERC). 1996. Reservoir release requirements for fish at the New Don Pedro Project, California. FERC Project No. 2299-024, FERC, Office of Hydropower Licensing, Washington, D.C.

FISHBIO. 2011. Fall/Winter Migration Monitoring at the Tuolumne River Weir. 2011 Annual Report.

_____. 2012. 2012 Lower Tuolumne River Annual Report, Report 2012-6. Fall Migration Monitoring at the Tuolumne River Weir. 2012 Annual Report.

_____. 2013. 2013 Lower Tuolumne River Annual Report, Report 2013-6, Fall Migration Monitoring at the Tuolumne River Weir. 2013 Annual Report.

_____. 2014. 2014 Lower Tuolumne River Annual Report, Report 2014-6, Fall Migration Monitoring at the Tuolumne River Weir. 2015 Annual Report.

_____. 2015. 2015 Lower Tuolumne River Annual Report. Report 2015-6, Fall Migration Monitoring at the Tuolumne River Weir. 2015 Annual Report.

_____. 2016a. 2016 Lower Tuolumne River Annual Report, Report 2016-6, Fall Migration Monitoring at the Tuolumne River Weir. 2016 Annual Report.

_____. 2016b. In -River Assessment of Metabolic State and Feeding Behavior of Juvenile Oncorhynchus mykiss in the Lower Tuolumne River. Prepared for TID/MID.

_____. 2016c. Outmigrant Trapping of Juvenile Chinook Salmon in the Lower Tuolumne River, 2015.

_____. 2017. Unpublished *O. mykiss* fish passage data at Tuolumne River weir (RM 24.5). Emailed to HDR Engineering from Jason Guignard, June 26, 2017.

Ford, T. and S. Kirihara. 2010. Tuolumne River *Oncorhynchus mykiss* monitoring report. Prepared by Turlock Irrigation District/Modesto Irrigation District, California and Stillwater Sciences, Berkeley, California for Federal Energy Regulatory Commission, Washington, D.C.

Garza, J.C. and D.E. Pearse. 2008. Population genetic structure of *Oncorhynchus mykiss* in the California Central Valley. Report to California Department of Fish and Game. Contract No. PO485303. University of California, Santa Cruz, and NOAA Southwest Fisheries Science Center, Santa Cruz, California.

Grant, J., and D. Kramer. 1990. Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams: Canadian Journal Fisheries Aquatic Science, V. 47, No. 9, p. 1724–1737.

Hallock, R.J., W.F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatcheryreared steelhead rainbow trout (*Salmo gairdnerii gairdnerii*) in the Sacramento River system. Fish Bulletin 114. California Department offish and Game.

Janetos, A., L. Hansen, D. Inouye, B.P. Kelly, L. Meyerson, B. Peterson, and R. Shaw. 2008. Biodiversity. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States [Backlund, P., A. Janetos, D. Schimel, J. Hatfield, K. Boote, P. Fay, L. Hahn, C. Izaurralde, B.A. Kimball, T. Mader, J. Morgan, D. Ort, W. Polley, A. Thomson, D. Wolfe, M.G. Ryan, S.R. Archer, R. Birdsey, C. Dahm, L. Heath, J. Hicke, D. Hollinger, T. Huxman, G. Okin, R. Oren, J. Randerson, W. Schlesinger, D. Lettenmaier, D. Major, L. Poff, S. Running, L. Hansen, D. Inouye, B.P. Kelly, L. Meyerson, B. Peterson, and R. Shaw (eds.)]. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 151-181.

Jayasundara, N.C., M.L. Deas, E. Sogutlugil, E. Miao, E. Limanto, A. Bale, and S.K. Tanaka. 2014. Tuolumne River flow and temperature model: without project assessment. Prepared by Watercourse Engineering, Inc., Davis, CA.

Julien, P. Y. 2002. River mechanics. Cambridge University Press, United Kingdom.

Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). 2009. Global Climate Change Impacts in the United States. Cambridge University Press. 2009. [Online] URL: http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

Keleher, C.J. and F.J. Rahel. 1996. Thermal Limits to Salmonid Distributions in the Rocky Mountain Region and Potential Habitat Loss Due to Global Warming: A Geographic Information System (GIS) Approach. Transactions of the American Fisheries Society. 125(1), p.p. 1-13.

Leopold, L.B., 1992. Sediment Size that Determines Channel Morphology. In: Dynamics of Gravel-Bed Rivers, P. Billi, R.D. Hey, C.R. Thorne, and P. Taconi (Editors). John Wiley and Sons, Chichester, United Kingdom, pp. 297-310, ISBN-13: 978- 0471929765.

Leopold, L.B., 1994. A View of the River. Harvard University Press, Cambridge, Massachusetts, 312 pp., ISBN-13: 978-0674018457.

Lindley, S.T., R. Schick, A. Agrawal, M. Goslin, T. Pearson, E. Mora, J.J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2006. Historical population structure of Central Valley steelhead and its alteration by dams. San Francisco Estuary and Watershed Science 4(1) (3):1-19. [Online] URL: http://repositories.cdlib.org/jmie/sfews/vol4/iss1/art3.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered salmon and steelhead in the Sacramento- San Joaquin Basin. San Francisco Estuary and Watershed Science Volume 5, Issue 1 [February 2007], article 4.

Martyniuk C., G. Perry, H. Moghadam, M. Ferguson, and R. Danzmann. 2003. The genetic architecture of correlations among growth-related traits and male age at maturation in rainbow trout (*Oncorhynchus mykiss*). J Fish Biol 63: 746−764.

McBain and Trush. 2004. Coarse sediment management plan for the lower Tuolumne River. Revised Final Report. Prepared by McBain and Trush, Arcata, California for Tuolumne River Technical Advisory Committee, Turlock and Modesto Irrigation Districts, USFWS Anadromous Fish Restoration Program, and California Bay-Delta Authority.

McCullough, D.A., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids - Issue Paper 5. Report No. EPA-910-D-01-005. United States Environmental Protection Agency.

McEwan, D. 2001. Central Valley steelhead. In R. Brown, editor. Contributions to the biology of Central Valley salmonids, Volume 1. California Department of Fish and Game, Fish Bulletin 179. 43 pages.

McEwan, D. and T.A. Jackson. 1996. Steelhead restoration and management plan for California. Management Report. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

McKinnell, S., J.J. Pella, and M.L. Dahlberg. 1996. Population-specific aggregations of steelhead trout (*Oncorhynchus mykiss*) in the North Pacific Ocean (NPAFC Doc. No. 197, Rev. 1). 22 p. Dept. of Fisheries and Oceans, Ocean Science and Productivity Division, Pacific Biological Station, Nanaimo, BC, Canada V9R 5K6.

McMillan, J.R., J.B. Dunham, G.H. Reeves, J.S. Mills, and 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.

Mote, P., E. Salathé, V. Dulière, and E. Jump. 2008. Scenarios of Future Climate for the Pacific Northwest. Climate Impacts Group. University of Washington. Seattle. 12 pp. [Online] URL: http://cses.washington.edu/db/pubs/abstract628.shtml.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles, California.

Myrick, C.A. and J.J. Cech. 2001. Temperature Effects on Chinook Salmon and Steelhead: A Review Focusing on California's Central Valley Populations. Bay-Delta Modeling Forum Technical Publication 01-1.

Narum, S.R., J.S. Zendt, D. Graves, and W.R. Sharp. 2008. Influence of landscape on resident and anadromous life history types of *Oncorhynchus mykiss*. Can. J. Fish. Aquat. Sci. 65(6): 1013–1023. doi:10.1139/F08-025.

National Marine Fisheries Service (NMFS). 1996. Steelhead Conservation Efforts A Supplement to the Notice of Determination for West Coast Steelhead Under the Endangered Species Act. [Online] URL: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/stlhd-cons.pdf.

_____. 1998. Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors for Decline Report. National Marine Fisheries Service Protected Resourced Division. June 1998.

_____. 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. June 2000.

_____. 2003. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Bonneville Power Administration Habitat Improvement Program (HIP) in the Columbia River Basin.

_____. 2004. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead. February 2003.

_____. 2010. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of Central Valley Steelhead DPS.

_____. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

_____. 2014. Recovery Plan for the Evolutionarily 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.

_____. 2016. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment. Prepared by D. Swank and A. Cranford. 1 Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, CA 95814-4706.

Nielson, J.L., S.A. Pavey., T. Wiacek, and I. Williams. 2005. Genetics of Central Valley *O. mykiss* populations: drainage and watershed scale analysis. San Francisco Estuary and Watershed Science [online serial] 3.

Nielsen, J.L., T.E. Lisle, and V. Ozaki. 1994. Thermally Stratified Pools and Their Use by Steelhead in Northern California Streams. Transactions of the American Fisheries Society Volume 123: 613-626.

Pearse, D.E. and J.C. Garza. 2015. Unscrambling an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Snp Data. San Francisco Estuary and Watershed Sciences 13(4).

Pearse, D.E., S.A. Hayes, M.H. Bond, C.V. Hanson, E.C. Anderson, et al. 2009. Over the falls? Rapid evolution of ecotypic differentiation in steelhead/rainbow trout (*Oncorhynchus mykiss*). J. Hered. 100: 515–525.

Peven, C.M., R.R. Whitney, and K.R. Williams. 1994. Age and length of steelhead smolts from the mid-Columbia River basin, Washington. North American Journal Fisheries Management 14: 77-86. [Online] URL: http://www.ykfp.org/steelheadworkshop/literature/ Pevenetal1994.pdf.

Prince, D.J., S.M. O'Rourke, T.Q. Thompson, O.A. Ali, H.S. Lyman, I.K. Saglam. T.J. Hotaling, A.P. Spidle, and M.R. Miller. 2017. The evolutionary basis of premature migration in Pacific salmon highlights the utility of genomics for informing conservation. Evolutionary Genetics. Sci Adv., 2017, 3: e1603198.

Provencher, M. 2012. Coleman National Fish Hatchery Reconditioning Program Increases Survival of Steelhead Kelt. US Fish & Wildlife Service Field Notes. [Online] URL: http://www.fws.gov/fieldnotes/print/print_report.cfm?arskey=31884.

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. University of Washington Press, Seattle.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams; A Plan for Action. Sacramento (CA): California Department of Fish and Game. 129 pp. [Online] URL: http://www.dfg.ca.gov/fish/documents/Resources/RestoringCentralValleyStreams.pdf. (Accessed July 27, 2010.)

Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO, Wildland Hydrology.

Salathé, E.P. 2005. Downscaling Simulations of Future Global Climate with Application to Hydrologic Modeling. International Journal of Climatology, 25(4), 419-436.

Satterthwaite, W.H., M.P. Beakes, E. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard et al. 2009. Steelhead life history on California's central coast: insights from a state dependent model. Transactions of the American Fisheries Society 138:532–548.

Satterthwaite, W.H., M.P. Beakes, E.M. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard, and M. Mangel. 2010. State-dependent life history models in a changing (and regulated) environment: steelhead in the California Central Valley. Evolutionary Applications 3:221-243.

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. Calif. Dep. Fish Game Fish Bull. 98, 375 pp. [Online] URL: http://content.cdlib.org/ark:/13030/kt9x0nb3v6/.

Sloat, M. 2013. Born to Run? Integrating Individual Behavior, Physiology, and Life Histories in Partially Migratory Steelhead and Rainbow trout (*Oncorhynchus mykiss*). PhD dissertation, Oregon State Univerity, Corvalis, OR. March. 148 pp.

Snyder, J.B. 1993 Memorandum to Park Superintendent Mike Finley. Did salmon reach Yosemite Valley or Hetch Hetchy? 9 May 1993 manuscript. P.O. Box 577, Yosemite National Park. 8 p.

Stillwater Sciences. 2008. July 2008 population size estimate of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, California. October.

_____. 2009a. Don Pedro Reservoir Fish Mercury Study. Final Report for Turlock Irrigation District and Modesto Irrigation District.

_____. 2009b. March and July 2009 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, California. November.

_____. 2011. March and August 2010 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, CA. March.

_____. 2012a. Lower Tuolumne River Instream Flow Studies: Pulse Flow Study Report. Final. Prepared by Stillwater Sciences, Berkeley, California for Turlock Irrigation District and Modesto Irrigation District, California.

_____. 2012b. Tuolumne River 2011 *Oncorhynchus mykiss* monitoring summary report. Prepared by Stillwater Sciences, Berkeley, California for the Turlock Irrigation District and Modesto Irrigation District.

_____. 2013. Lower Tuolumne River Instream Flow Study. Final Report. Prepared by Stillwater Sciences, Davis, California for Turlock and Irrigation District and Modesto Irrigation District, California. April 2013.

STORET. 2010. STOrage and RETrieval/Water Quality Exchange. data from Old La Grange Bridge (1952-1988). https://www.epa.gov/waterdata/water-quality-data-wqx

Thomas R. Karl, J.M. Melillo, and T.C. Peterson (eds.). 2009. Global Climate Change Impacts in the United States. Cambridge University Press. 2009. URL = http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

Thrower, F.P., J.J. Hard, and J.E. Joyce. 2004. Genetic architecture of growth and early life-history transitions in anadromous and derived freshwater populations of steelhead. J. Fish Biol. 65: 286–307.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 1992. Lower Tuolumne River spawning gravel availability and superimposition report. Appendix 6 in Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299 Vol. VIII. Prepared by EA Engineering, Science, and Technology, Lafayette, California.

_____. 2005. 2005 Ten Year Summary Report. Pursuant to Paragraph (G) of the 1996 FERC Order issued July 31, 1996. Don Pedro Project, No. 2299. April.

_____. 2007. 2006 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. March.

_____. 2011. Fall/Winter Migration Monitoring at the Tuolumne River Weir – 2010 Annual Report. Prepared by FISHBIO, Oakdale, California.

_____. 2012. Fall/winter Migration Monitoring at the Tuolumne River Weir – 2011 Annual Report. Prepared by FISHBIO, Oakdale, California.

_____. 2013a. Fish Assemblage and Population between Don Pedro Dam and La Grange Dam Study Report (W&AR-13). Prepared by HDR Engineering, Inc. January 2013.

_____. 2013b. Lower Tuolumne River Riparian Information and Synthesis Study Report (W&AR-19). Prepared by Stillwater Sciences. December 2013.

_____. 2013c. *Oncorhynchus mykiss* Scale Collection and Age Determination Study Report (W&AR-20). Prepared by Stillwater Sciences. December 2013.

_____. 2013d. Salmonid Population Information Integration Study Report (W&AR-05). Prepared by Stillwater Sciences. January 2013.

_____. 2013e. Spawning Gravel in the Lower Tuolumne River Study Report (W&AR-04). Prepared by Stillwater Sciences. January 2013.

_____. 2014a. Don Pedro Hydroelectric Project Final License Application, FERC No. 2299. April 2014.

_____. 2014b. Final License Application for the La Grange Hydroelectric Project. FERC No. 14581. Districts' Response to NMFS-4, Element 1 through 6 attached to this Final License Application. January 2014.

_____. 2015. Salmonid Redd Mapping Study Report (W&AR-08). Don Pedro Project. FERC NO. 2299. Prepared by FISHBIO.

_____. 2016a. Fish Passage Facilities Alternatives Assessment Progress Report. Prepared by HDR, Inc. February 2016.

_____. 2016b. Salmonid Habitat Mapping Technical Memorandum. Prepared by Stillwater Sciences. February 2016.

_____. 2017a. Fish Presence and Stranding Assessment Technical Memorandum. Prepared by FISHBIO. September 2017.

_____. 2017b. Flow Records for Five Discharge Structures at the La Grange Project Technical Memorandum. Prepared by HDR, Inc. September 2017.

_____. 2017c. Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes Study Report. Prepared by FISHBIO and LGL Alaska Research Associates. September 2017.

_____. 2017d. La Grange Hydroelectric Project Final License Application, FERC No. 14581. September 2017.

_____. 2017e. La Grange Project Fish Barrier Assessment Study Report. Prepared by FISHBIO. September 2017.

_____. 2017f. Lower Tuolumne River Temperature Model Study Report. Don Pedro Project. FERC No. 2299 (W&AR-16). Prepared by HDR Engineering, Inc. September 2017.

_____. 2017g. *Oncorhynchus mykiss* Habitat Survey Study Report (W&AR-12). Prepared by Stillwater Sciences. September 2017.

_____. 2017h. *Oncorhynchus mykiss* Population Study Report (W&AR-10. Prepared by Stillwater Sciences. September 2017.

_____ 2017i. Project Operations/Water Balance Model Study Report (W&AR-02). Prepared by Dan Steiner. September 2017.

_____. 2017j. Reservoir Temperature Model Study Report (W&AR-03), Attachment C: Water Temperature Dataset. Prepared by HDR Engineering, Inc. September 2017.

_____. 2017k. Topographic Survey Technical Memorandum. Prepared by HDR, Inc. February 2017.

_____. 2017l. Upper Tuolumne River Reintroduction Assessment Framework. Water Temperature Subcommittee. Lifestage-Specific Water Temperature Biological Effects and Index Temperature Values. Literature Review Summary.

United States Army Corps of Engineers, United States Fish and Wildlife Service, and National Marine Fisheries Service (USACE, USFWS, and NMFS). 2006. Proposed Procedures for Permitting Projects that will Not Adversely Affect Selected Species in California. Enclosure A of NMFS Programmatic ESA and EFH Consultation for eight actions permitted by the USACE. NMFS Ref: 2007/07475:KAS.

United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Endangered Species Consultation Handbook, Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.

United States Geological Survey (USGS). 2017. Daily water temperature data for USFS 11289650 Tuolumne River Below La Grange Dam near La Grange, CA. Accessed July 6, 2017.

Verhille C.E., K.K. English, D.E. Cocherell, A.P. Farrell, N.A. Fangue. 2016. High thermal tolerance of a rainbow trout population near its southern range limit suggests local thermal adjustment. Conserv Physiol 4(1): cow057; doi:10.1093/conphys/cow057.

Ward, B.R. and P.A. Slaney. 1988. Life history and smolt-to-adult survival of Keogh River steelhead trout (*Salmo gairdneri*) and the relation to smolt size. Canadian Journal of Fisheries and Aquatic Sciences 45: 1110-1122.

Wilson, C.E. and B.W. Collins. 1992. Life history, distribution, run-size and angler harvest of steelhead in the South Fork Trinity River basin. Chapter III Job III p. 51-90. In: Kevin Urquhart and Ralph Carpenter (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. December 1992. 186 p.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress. In: University of California, Center for Water and Wildlife Resources, Davis. Assessments, commissioned reports, and background information. p 309-362. [Online] URL: https://www.sierraforestlegacy.org/FC_SierraNevadaWildlifeRisk/Chinook.php. (Accessed August 10, 2010.)

Yoshiyama, R. and P. Moyle. 2012. Factors that influence the expression of anadromy in steelhead-rainbow trout (*Oncorhynchus mykiss*) and other salmonids. Memorandum submitted to FERC August 17, 2012 under accession 20120817-5082. July. [Online] URL: http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20120817-5082.

Zimmerman, C.E. and G.H. Reeves. 2000. Population structure of sympatric anadromous and non-anadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57: 2152–2162.

Zimmerman, C.E., G.W. Edwards, and K. Perry. 2008. Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured on rivers of the Central Valley, California. California Department of Fish and Game.

APPLICANT-PREPARED BIOLOGICAL ASSESSMENT
CALIFORNIA CENTRAL VALLEY STEELHEAD
(ONCORHYNCHUS MYKISS)
DISTINCT POPULATION SEGMENT

ATTACHMENT A

PACIFIC COAST SALMON
ESSENTIAL FISH HABITAT ASSESSMENT

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List of Acronyms and Abbreviations

ac-ft	acre-feet
AFLA	amendment to the Final License Application
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CEC	California Energy Commission
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FMP	Fishery Management Plan
ft	foot
ft^2	square foot
HSC	habitat suitability criteria
LGDD	La Grange Diversion Dam
M&I	municipal and industrial
mg/L	milligrams per liter
MID	Modesto Irrigation District
m^2	square meter
mm	millimeter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity unit
PFMC	Pacific Fisheries Management Council
PM&E	Protection, Mitigation, and Enhancement
RM	river mile
SPD	Study Plan Determination
TID	Turlock Irrigation District

USACE ......................U.S. Army Corps of Engineers

USFWS ......................U.S. Fish and Wildlife Service

USGS .........................U.S. Geological Survey

USR............................Updated Study Report

WUA..........................weighted usable area

1.0 INTRODUCTION

This Essential Fish Habitat (EFH) Assessment is part of the La Grange Hydroelectric Project (Project) Final License Application submitted to the Federal Energy Regulatory Commission (FERC) in accordance with an application for an original license for hydropower generation at the La Grange Diversion Dam (LGDD). Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are filing the final application for an original license with FERC (or Commission) for the existing Project, located on the Tuolumne River in the Central Valley of California. FERC is the federal agency authorized to issue licenses for the construction, operation, and maintenance of the nation's non-federal hydroelectric facilities. The issuance of an original license to generate hydropower is a federal action that requires FERC to consult with the National Marine Fisheries Service (NMFS) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The MSA requires an assessment of effects to designated EFH in the project area (in this case, for Pacific Coast Salmon, specifically, for fall-run Chinook Salmon [*Oncorhynchus tshawytscha*]). This document is intended to fulfill the requirements of the MSA.

It should be noted that non-Project facilities are those operated by the Districts to achieve the primary purposes of the "La Grange Project", which is diverting water from the Tuolumne River for irrigation and municipal and industrial (M&I) uses. Hydroelectric generation is a secondary purpose of the La Grange Project. Water diversions at the La Grange Project are not dependent on the issuance of a FERC license and will occur with or without the licensing of the hydroelectric facilities. The distinction between La Grange Project (i.e., surface water diversion for M&I) and the "La Grange Hydroelectric Project", or "Project", is important because the "Project" is the Proposed Action requested for consultation in this EFH assessment.

1.1 Essential Fish Habitat Regulatory Framework

In accordance with the Federal Power Act, FERC is able to issue such licenses for a period not less than 30 years, but no more than 50 years. Under the Federal Power Act FERC issues licenses that are best adapted to a comprehensive plan for improving or developing a waterway. As the federal "action agency," FERC must also comply with the requirements of the National Environmental Policy Act, under which FERC must clearly define the specific action it is considering and the purpose and need for the Proposed Action. In the case of the La Grange Hydroelectric Project (La Grange Project or Project; FERC No. 14581), the Proposed Action under review by FERC is the issuance of an original license to the Districts to authorize the continued generation of renewable hydroelectric power at a powerhouse just downstream of the LGDD. Also included under the Proposed Action is the implementation of three Protection, Mitigation, and Enhancement (PM&E) measures proposed by the Districts for the purpose of protecting anadromous salmonids in the Project vicinity.

During National Environmental Policy Act scoping conducted by FERC for the issuance of an original license for hydropower generation at the Project, issues were raised regarding the effects of the Proposed Action on fall-run Chinook Salmon (*Oncorhynchus tshawytscha*), a species of anadromous salmonid that is managed in accordance with the MSA.

The MSA establishes jurisdiction over marine fisheries within the exclusive economic zone of the United States. These fisheries are managed by Regional Fisheries Management Councils, which are required to develop Fishery Management Plans (FMPs) to administer fisheries management and conservation. Among other things, the FMPs establish EFH to conserve and enhance fish species managed under the FMPs. The Pacific Fisheries Management Council (PFMC) manages all species of Pacific Coast salmon pursuant to the Pacific Coast Salmon FMP (PFMC 2014), which includes fall-run Chinook Salmon in the State of California. In California, the Pacific Coast Salmon FMP does not distinguish between the EFH of winter, spring, and fall/late fall Chinook Salmon run types.

Pursuant to section 305(b)(2) of the MSA, a federal agency (in this case FERC) must consult with the NMFS regarding any of its actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect EFH. The Districts, under the direction of FERC, have prepared this EFH assessment is intended to serve as the basis for consultation between FERC and NMFS. This EFH assessment describes the potential effects of the Proposed Action, including the Districts' proposed PM&E measures (see Section 2.2), on Pacific Coast Salmon EFH in the La Grange Hydroelectric Project Action Area (see Section 2.4).

1.2 Purpose of Assessment

The purpose of this EFH assessment is to determine whether or not the Proposed Action "may adversely affect" designated EFH for relevant commercial, federally managed fisheries species (i.e., fall-run Chinook Salmon) within the Action Area. An adverse effect is any impact that reduces quality and/or quantity of EFH and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 Code of Federal Regulations [CFR] 600.810(a)).

This assessment includes a general overview of the occurrence of species for which EFH is designated in the Action Area (i.e., fall-run Chinook Salmon in the Tuolumne River), and considers measures proposed to avoid, minimize, or otherwise offset effects on EFH resulting from the Proposed Action.

1.3 Project Background

The Districts own the LGDD located on the Tuolumne River in Stanislaus County, California (Figure 1.3-1). LGDD is 131 feet (ft) high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the headpond formed by the diversion dam. Under normal river flows, the headpond formed by the diversion dam extends for approximately two miles upstream. When not in spill mode, the water level upstream of the diversion dam is between elevation 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the headpond storage is estimated to be approximately 100 acre-feet (ac-ft) of water. During non-spill conditions, the headpond has a surface area of approximately 29.2 acres.

The Districts constructed LGDD from 1891 to 1893, and replaced Wheaton Dam, which was built by other parties in the early 1870s. LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. LGDD provides no flood control benefits, and no recreation facilities are currently associated with the Project or the La Grange headpond.

The La Grange powerhouse, originally constructed in 1924 and located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River, is owned and operated by TID. The powerhouse has a current capacity of approximately 4.7 megawatts and was put into service in 1924, thirty years after construction of the LGDD. The La Grange powerhouse operates in a run-of-river mode. The electricity produced by the powerhouse is used as part of TID's portfolio of electric power generation to serve its retail customers. Under non-spill conditions, water not diverted by TID and/or MID for water supply purposes is passed downstream. Waters passed downstream benefit aquatic resources in the lower Tuolumne River. Water introduced into the lower Tuolumne River downstream of the Project is passed through one or both of the turbine-generator units located in the powerhouse and/or one or more of three separate flow conduits located at the Project. If the powerhouse units are not able to be used, water not diverted for water supply purposes would be passed downstream via one or more of the available flow conduits at the Project. In the event that the La Grange powerhouse trips offline (i.e., unexpectedly stops generating) and water stops flowing through the powerhouse, the TID sluice gate(s) open immediately to maintain flows to the river. In addition, TID currently maintains in an open position an 18-inch pipe that continuously delivers flow to the sluice gate channel. The exact flow quantity is not measured, but is roughly estimated to be 5 to 10 cubic feet per second (cfs) (TID/MID 2017f).

Don Pedro Dam, owned jointly by the Districts, is located approximately two miles upstream of LGDD. Water released from Don Pedro Reservoir is either diverted by TID or MID at LGDD for the purposes of irrigation or M&I water supply or passes to the lower Tuolumne River through one of the flow conduits available at the Project. MID's diversion tunnel intake is located at the west (looking downstream, river right) end of the dam, and TID's irrigation diversion tunnel intake is located at the east (river left) end of the dam. TID's diversion tunnel and intake are non-Project facilities as their primary purpose is to divert Tuolumne River flows to the TID irrigation system. Project facilities are discussed in detail in the following sections.

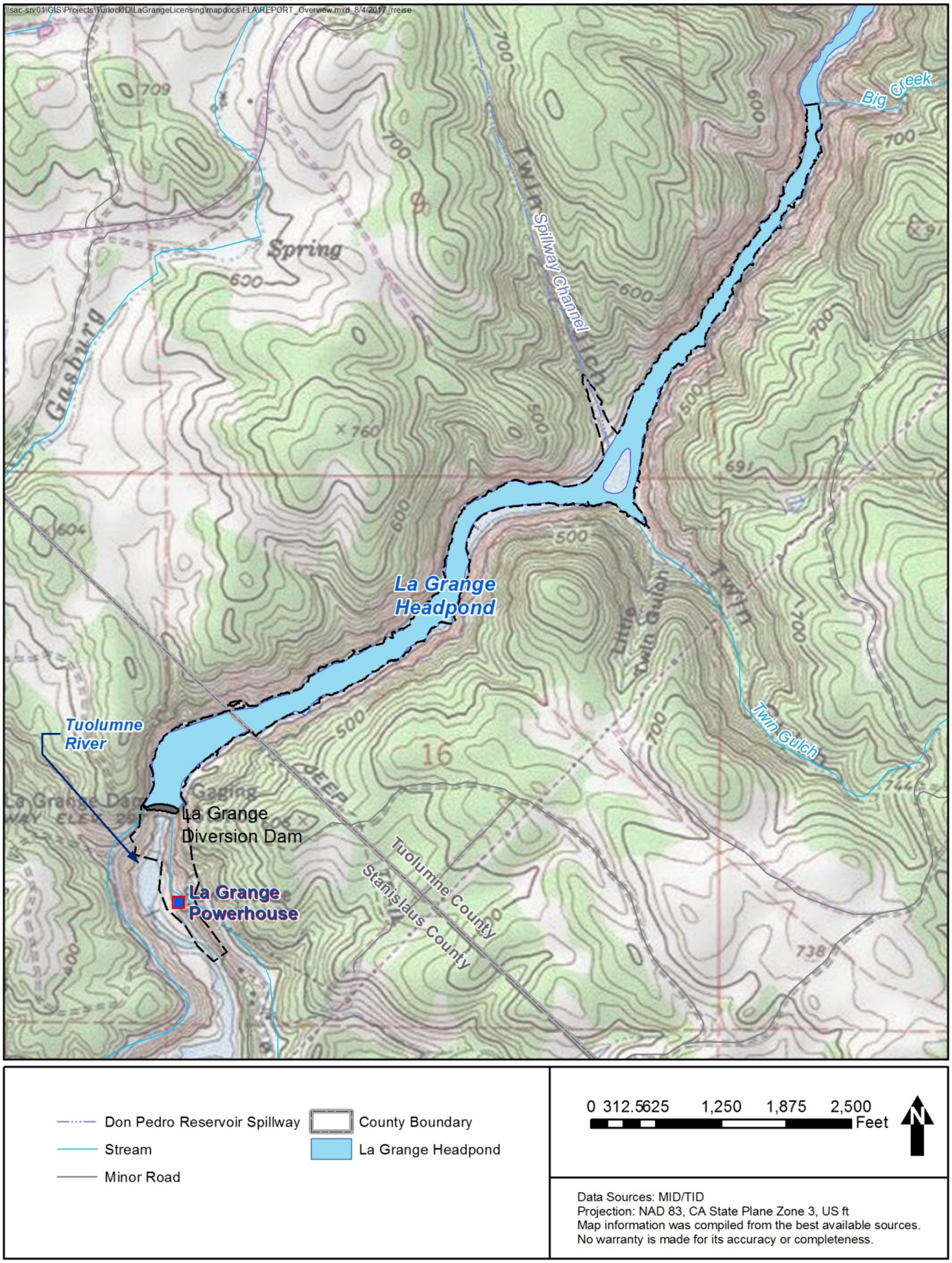

Figure 1.3-1. La Grange Hydroelectric Project location map.

1.3.1 Project Facilities and Project Boundary

The Project includes the LGDD, its impoundment, and certain facilities and structures dedicated to the support hydroelectric power generation. Project facilities serving hydropower generation include a penstock intake structure with trashracks, two penstocks, a powerhouse, an excavated tailrace channel, and a substation. The penstock intakes for the TID powerhouse are located just upstream of TID's non-Project Upper Main Canal headworks. Under current powerhouse operations, other structures necessary for the safe and effective operation of power generation are the sluice gate structure located just upstream of and conjoined with the penstock intake structure, two sluice gates contained in the sluice gate structure, and an 18-inch pipeline at the base of the structure. No FERC-jurisdictional transmission lines are associated with the Project (see Section 1.3.1.6). The location of the Project and its primary facilities are shown in Figure 1.3-2. The Proposed Action considered in this EFH assessment includes three PM&E measures discussed in Section 2.2.

The Project Boundary includes a number of Project facilities and structures that occupy upland and/or riverine habitats. Upland habitats are either steep-sided rock hillsides or made land containing project structures (e.g., intakes, penstocks, powerhouse, and substation). Riverine habitat within the boundary includes the sluice gate channel and the tailrace channel, which flows for a distance of approximately 640 feet from the powerhouse to its confluence with the mainstem Tuolumne River. The boundary also includes a 475-foot reach of the mainstem Tuolumne River from LGDD downstream to the MID Hillside Discharge. Land within the Project Boundary is jointly owned by the Districts. In addition, the Bureau of Land Management administers land within the Project Boundary, and a privately held parcel within the Project Boundary is owned by the Coleman Ranch. Although the Project Boundary includes the LGDD and associated headpond, the dam's primary purpose is to divert water for irrigation and M&I use. Absent power generation, LGDD will continue to be operated for water supply purposes just as it is currently.

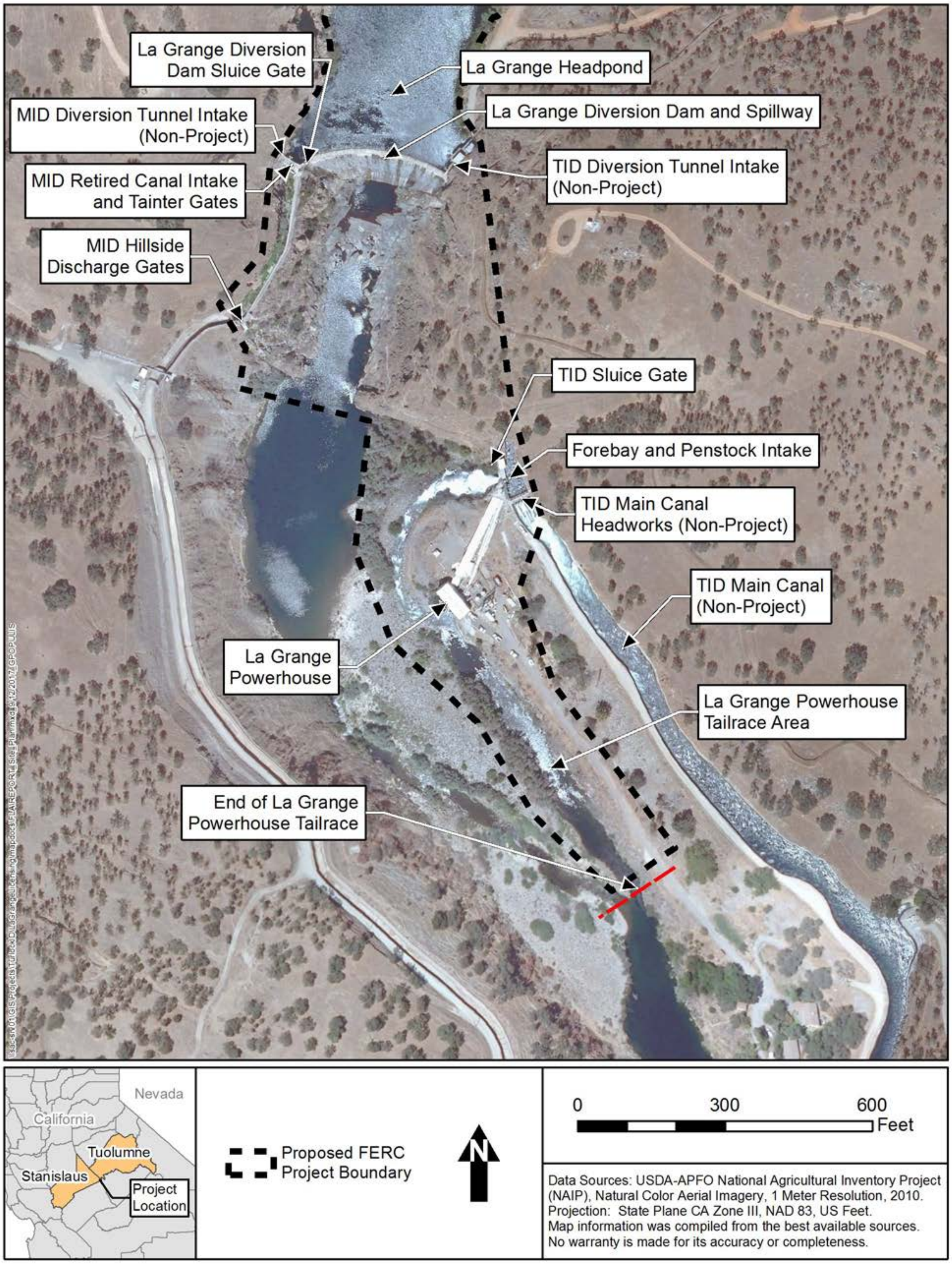

Figure 1.3-2. La Grange Project site plan, showing project and non-project facilities.

1.3.1.1 Diversion Dam and Spillway

The original 127.5 feet high, arched dam placed in service in 1893 was constructed of boulders set in concrete and faced with roughly dressed stones from a nearby quarry. In 1923, an 18-inch-high concrete cap was added, and in 1930 an additional 24-inch-high concrete cap was added, resulting in the final and current height of 131 feet. The crest elevation was raised to increase the flows that could be diverted to each of the Districts' irrigation canals. There have been no significant modifications to LGDD and spillway since 1930, except for routine maintenance and repairs.

The dam was constructed such that the top of the dam is almost entirely an uncontrolled overflow spillway. The spillway crest is at elevation 296.5 feet (all elevations are referenced to 1929 National Geodetic Vertical Datum) and has a length of 310 feet.

1.3.1.2 Headpond

The diversion dam was constructed for the purpose of raising the level of the Tuolumne River to a height that enabled gravity flow of diverted water into the Districts' irrigation systems. When not in spill mode, the water level above the diversion dam is between 294 feet and 296 feet approximately 90 percent of the time.

Based on hydraulic modeling performed by the Districts[1], the upper end of the headpond formed by LGDD under non-spill conditions terminates approximately two miles above the diversion dam. This creates a shoreline length of approximately two miles and a surface area of approximately 29.2 acres. The headpond has a maximum depth of 35 feet, a mean depth of approximately 11 feet, a gross storage capacity of approximately 340 ac-ft, and a usable storage capacity of less than 100 ac-ft.
of less than 100 ac-ft.

1.3.1.3 Penstock and Sluice Gates

Flows entering TID's non-Project irrigation intake and tunnel discharge nearly 600 feet downstream into a concrete forebay structure (Figure 1.3-3) that contains the sluice gate and penstock intake as well as the headworks structure for delivering water to the TID Upper Main Canal The penstock intake structure contains a trashrack and three 7.5 feet wide by 14 feet high concrete intake bays that deliver water to the two penstocks. The penstock for Unit 1 is a 235-foot-long, 5-foot-diameter steel pipe. The penstock for Unit 2 is a 212-foot-long, 7-foot-diameter steel pipe. Manually operated steel gates are used to shut off flows to the penstocks. Immediately adjacent to the penstock intakes are two automated 5 feet high by 4 feet wide sluice gates that discharge water over a steep rock outcrop at the head of the sluice gate channel (Figure 1.3-2) which feeds water to the tailrace channel.

[1] The backwater study was submitted to the Commission under Docket UL11-1 (TID 2011) as part of the Commission's deliberations related to the jurisdictional status of the La Grange powerhouse.

Figure 1.3-3. Sluice gate channel and penstock intake. In the photo, flow is being discharged from the sluice gates to the sluice gate channel.

1.3.1.4 Powerhouse

The TID-owned and operated powerhouse was built in 1924 and is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River (Figure 1.3-4). Water diverted through the TID intake and tunnel to the forebay can enter the two penstocks that deliver flow to the powerhouse. The powerhouse is a 72-foot by 29-foot structure with a reinforced concrete substructure and steel superstructure. The powerhouse contains two turbine-generator units. Unit 1 is a Francis turbine rated at 1,650 horsepower at 140 cfs and 115 feet of net head. Unit 2 is a Francis turbine rated at 4,950 horsepower at 440 cfs and 115 feet of net head. Both turbines are fitted with straight-drop vertical draft tubes. The combined generator rated output is approximately 4,700 kilowatts.

1.3.1.5 Tailrace Channel

Turbine discharges at the La Grange powerhouse flow into a tailrace that joins the lower Tuolumne River about 0.5 miles below LGDD. The two sluice gates in the TID forebay can also discharge flows into the tailrace.

1.3.1.6 Substation and Transmission Line

The transmission line connecting the La Grange powerhouse to the grid originates at the 4.16/69 kilovolt transformer in the substation located on the east side of the powerhouse. The transmission line connects to both TID's Tuolumne Line No. 1 and its Hawkins Line. In the event that the Project powerhouse is decommissioned in the future, this transmission line would need to be retained to provide power needed to operate the Main Canal Headworks associated with the irrigation canal systems and the sluice gates. Therefore, under FERC's transmission line jurisdictional criteria, the transmission line currently serves as part of the existing distribution/transmission grid and would not fall within FERC jurisdiction. As such, it is a non-Project element and operation of the transmission line is not part of the Proposed Action.

Figure 1.3-4. Aerial view of penstock and sluice gate intake structure, penstocks, sluice gate channel, powerhouse, tailrace, and substation.

1.3.2 Powerhouse Operations

The Project powerhouse generates electricity using a portion of the flows released by the upstream Don Pedro Project. Flows used for power generation are discharged from the turbines and enter the tailrace. Absent a FERC license to continue operating TID's two turbine-generator units, these flows would continue to be passed downstream at LGDD to the tailrace. A portion of the flows that are passed at LGDD to the river are releases made at the Don Pedro Project over and above flow amounts needed to be diverted by LGDD for water supply purposes, including flows released at Don Pedro to meet its FERC license requirements. These flows are normally passed downstream at LGDD via the TID intake and tunnel, penstocks and powerhouse units. Turbine discharges at the La Grange powerhouse flow into a tailrace channel that joins the lower Tuolumne River about 0.5 miles below LGDD. The two sluice gates adjacent to the penstock intake can also discharge flows into the tailrace via the sluice gate channel.

Operation of TID's La Grange powerhouse is monitored around-the-clock from TID's Control Center. Although remote start-up is possible, for safety reasons, operators are generally dispatched to the Project to check conditions following a station trip and to start the unit(s). If a unit or the station trips, Control Center operators immediately open the two sluice gates to make certain flows continue downstream without disruption. The impact of a station trip on downstream flow as measured at the USGS La Grange gauge was examined by the Districts at the request of NMFS and FERC as part of the Don Pedro Project relicensing. Recorded stage changes in 15 minutes were less than 2 inches (0.17 foot) up or down 99.4 percent of the time, less than 4 inches (0.33 foot) 99.9 percent of the time, and less than 8 inches (0.67 foot) 99.99 percent of the time. One hour stage change is less than 2 inches up or down 96.6 percent of the time, less than 4 inches 99.0 percent of the time, and less than 8 inches 99.8 percent of the time (TID/MID 2017i).

1.3.3 Other Project Operations

All flows released at the Don Pedro Dam are either diverted at LGDD by TID and/or MID, spilled over the LGDD spillway, and/or pass through one of the LGDD's outlet structures. Diverted water is delivered to each District's water supply delivery systems through non-Project facilities. On the MID side of the river, in addition to water diversions for water supply purposes, slide gates (Hillside Gates) located about 300 feet downstream of the LGDD can safely discharge water from the retired MID open channel irrigation canal down a rock hillside to the plunge pool below the LGDD. Currently, MID releases a flow of approximately 5 to 10 cfs from the Hillside Gates to the river, this being sufficient to maintain dissolved oxygen and cold water in the plunge pool. The Portal No. 1 gate located in the LGDD also can be used to discharge flows to the plunge pool area. On the TID side of the river, water can flow to the tailrace, and thence to the river, either through the powerhouse units or through the 5-foot-wide by 4-foot-high sluice gates located adjacent to the penstock intakes.

1.4 Licensing Process and Studies to Date

In 2014, the Districts commenced the pre-filing process for the licensing of the Project by filing a Pre-Application Document with FERC[2]. On September 5, 2014, the Districts filed their Proposed Study Plan to assess Project effects on fish and aquatic resources, recreation, and cultural resources in support of their intent to license the Project. On January 5, 2015, in response to comments from licensing participants, the Districts filed their Revised Study Plan (RSP) containing three study plans: (1) Cultural Resources Study Plan; (2) Recreation Access and Safety Assessment Study Plan; and (3) Fish Passage Assessment Study Plan[3].

[2] On December 19, 2012, Commission staff issued an order finding that the La Grange Hydroelectric Project is required to be licensed under Section 23(b)(1) of the Federal Power Act. Turlock Irrigation District and Modesto Irrigation District, 141 FERC ¶ 62,211 (2012), aff'd Turlock Irrigation District and Modesto Irrigation District, 144 FERC ¶ 61,051 (2013). On May 15, 2015, the U.S. Court of Appeals for the District of Columbia Circuit denied the Districts' appeal and affirmed the Commission's finding that the La Grange Hydroelectric Project requires licensing. Turlock Irrigation District, et al., v. FERC, et al., No. 13-1250 (D.C. Cir. May 15, 2015).

[3] The Fish Passage Assessment Study Plan contained a number of individual, but related, study elements.

On February 2, 2015, FERC issued the Study Plan Determination (SPD), approving or approving with modifications six studies (Table 1.4-1). Of those six studies, five had been proposed by the Districts in the RSP. The Districts note that although FERC's SPD identified the Fish Passage Barrier Assessment, Fish Passage Facilities Alternatives Assessment, and Fish Habitat and Stranding Assessment below La Grange Diversion Dam as three separate studies, all three assessments are elements of the larger Fish Passage Assessment as described in the RSP. The sixth study approved by FERC, Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River, was requested by the NMFS in its July 22, 2014 comment letter.

Table 1.4-1. Studies approved or approved with modifications in FERC's Study Plan Determination.

No.	Study	Approved by FERC in SPD without Modifications	Approved by FERC in SPD with Modifications
1	Recreation Access and Safety Assessment		X
2	Cultural Resources Study		X
3	Fish Passage Barrier Assessment		X[1]
4	Fish Passage Facilities Alternatives Assessment		X
5	Fish Habitat and Stranding Assessment below La Grange Dam		X
6	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River	X[2]	

[1] Page A-1 of Appendix A of FERC's SPD states that FERC approved with modifications the Fish Passage Barrier Assessment. However, the Districts found no modifications to this study plan in the SPD and page B-7 of the SPD states "no modifications to the study plan are recommended."

[2] FERC directed the Districts to conduct the study plan as proposed by NMFS.

In the SPD, FERC recommended that, as part of the Fish Passage Facilities Alternatives Assessment, the Districts evaluate the technical and biological feasibility of the movement of anadromous salmonids through La Grange and Don Pedro project reservoirs if the results from Phase 1 of that study indicate that the most feasible concept for fish passage would involve fish passage through Don Pedro Reservoir or La Grange headpond. On September 16, 2016, the Districts filed the final study plan with FERC. On November 17, 2016, the Districts filed a letter with FERC after consulting with fish management agencies (i.e., NMFS and the California Department of Fish and Wildlife [CDFW]) regarding the availability of test fish and a determination that no fish would be available to support conducting this study in 2017. On January 12, 2017, the Districts filed a letter with FERC stating that with FERC's approval, they intend to conduct the study in 2018 if the results from the Fish Passage Facilities Alternatives Assessment indicate that upstream or downstream fish passage at La Grange and Don Pedro projects would require anadromous fish transit through one or both reservoirs.

In addition to the six studies noted in Table 1.4-1, the SPD required the Districts to develop a plan to monitor anadromous fish movement in the vicinity of the Project's powerhouse draft tubes to determine the potential for injury or mortality from contact with the turbine runners. The Districts filed the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes study plan with FERC on June 11, 2015, and on August 12, 2015; FERC approved the study plan as filed.

On February 2, 2016, the Districts filed the Initial Study Report for the La Grange Hydroelectric Project. The Districts held an Initial Study Report meeting on February 25, 2016, and on March 3, 2016, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 4, 2016. One new study request was submitted; NMFS requested a new study entitled Effects of La Grange Hydroelectric Project Under Changing Climate (Climate Change Study). On May 2, 2016, the Districts filed with FERC a response to comments received from licensing participants and proposed modifications to the Fish Passage Facilities Alternatives Assessment and the La Grange Project Fish Barrier Assessment, and a revised pre-filing schedule. On May 27, 2016, FERC filed a determination on requests for study modifications and new study. The May 27, 2016 determination approved the Districts' proposed modifications and did not approve the NMFS Climate Change Study, and accepted the Districts' revised pre-filing schedule.

On February 1, 2017, the Districts filed the Updated Study Report (USR) for the La Grange Hydroelectric Project. The Districts held a USR meeting on February 16, 2017, and on March 3, 2017, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 3, 2017. Comments on the USR were received from the Central Sierra Environmental Resource Center on February 27, 2017, from NMFS on April 3, 2017, and from CDFW on April 13, 2017. On May 2, 2017, the Districts filed with FERC a response to comments received from licensing participants.

On April 24, 2017, the Districts filed the Draft License Application for the La Grange Hydroelectric Project. Comments on the Draft License Application were received from NMFS on May 12, 2017, from FERC on July 18, 2017, and from CDFW on August 18, 2017. The Districts' response to these comments is included in the La Grange Hydroelectric Project Final License Application (FLA). The FLA was filed with FERC on October 11, 2017, in accordance with the Districts' Request for Extension of Time granted by FERC on September 1, 2017.

2.0 PROPOSED ACTION

As presented in Section 2.0, the Proposed Action under review by FERC is the issuance of an original license to the Districts to authorize the continued generation of hydroelectric power at the Project, and the implementation of three water resource PM&E measures. As generally described in FERC's Scoping Document 2 issued on September 5, 2014, any actions proposed to mitigate the Project's effects (i.e., PM&E measures) must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydropower generation at the Project.

It should be noted that this EFH assessment addresses the Proposed Action, which is FERC's issuance of an original license to continue operation of the existing Project. If FERC does not issue an original license, power generation facilities would cease to operate at the Project. Exhibit E of the FLA (TID/MID 2017e) provides a description of the "No Action" alternative (i.e., FERC does not issue a license and power generation ceases). Under the No Action alternative, flows released from the upstream Don Pedro Project that are not needed to be diverted for water supply purposes will continue to be passed downstream at the LGDD as they currently are; however, power would no longer be generated. Under the No Action alternative, the powerhouse would be retrofitted to allow flows to pass through the facility without generation.

2.1 Hydropower Generation

Tuolumne River flows being passed downstream at LGDD may flow through TID's two-unit powerhouse up to the plant's hydraulic capacity of 580 cfs (at 115 feet of net head). Powerhouse flows are discharged through the turbine runners to vertical draft tubes and then into the Project tailrace. The tailrace extends for approximately 650 feet where it joins the mainstem Tuolumne River. The rated capacity of the two-unit powerhouse is 4.7 MW. The minimum hydraulic capacity of Unit 1 is approximately 75 cfs and that of Unit 2 approximately 150 cfs.

Under typical Project operations, the MID Hillside Gates and the TID powerhouse are the preferred conduits used to pass flows at LGDD not needed for water supply purposes. If the powerhouse is out of service for maintenance or repairs, then typically the TID sluice gates are put in use, followed by the Portal No.1 gate. When there is a unit or station trip, the on-duty Control Center operator opens the sluice gates. This remote gate opening provides flow to the tailrace channel in less than one minute (J. Guignard, FISHBIO, pers comm, 8/1/2017) and makes certain flows continue downstream without interruption. Studies conducted during the Don Pedro Project relicensing and reported in the Don Pedro Updated Study Report and the amendment to the Don Pedro Final License Application (AFLA) show that under conditions of a station trip, fluctuations in stage as recorded at the nearby USGS gage are less than 2 inches (0.17 foot) up or down 99.4 percent of the time, less than 4 inches (0.33 foot) 99.9 percent of the time, and less than 8 inches (0.67 foot) 99.99 percent of the time. One hour stage change is less than 2 inches up or down 96.6 percent of the time, less than 4 inches 99.0 percent of the time, and less than 8 inches 99.8 percent of the time.

2.2 Proposed Aquatic PM&E Measures

As noted above, the Districts propose three PM&E measures under the Proposed Action. These measures would be implemented below LGDD, within the Action Area. One measure is intended to monitor dissolved oxygen in the Action Area and the remaining two are designed to benefit aquatic habitat downstream of the LGDD, including habitat for fall-run Chinook Salmon (*O. tshawytscha*). The environmental benefit of these measures is discussed in Section 7.2.

2.2.1 Sluice Gate Fish Barrier Installation

Under the Proposed Action, the Districts would construct a fish barrier near the downstream end of the existing sluice gate channel and close (but not remove) the 18-inch pipe that continuously releases a flow of 5 to 10 cfs to the channel. These actions would prevent fish from being attracted into or entering the sluice gate channel at all times except extreme high flow events. Although there is no evidence of stranding of salmonid juveniles in the channel under current conditions (TID/MID 2017f), this PM&E measure would prevent access to the channel under Project operations. Over the last two decades, two fall-run Chinook Salmon have been found dead in the sluice gate channel; one potentially due to dewatering (prior to the open pipe flow being provided) and one due to predation (TID/MID 2017f). The sluice gate channel is a constructed, non-natural, channel built to carry water from the TID forebay to the constructed tailrace. The upper part is a waterfall, and the lower part is a steep rock, boulder, and cobble channel.

Once installed, the barrier, designed to NMFS (2011) salmonid passage and screening criteria, would also allow the Districts to conduct inspections of its water supply tunnel and forebay (non-Project elements) without the need for fish salvage. Following barrier installation, except during powerhouse outages, the Districts would no longer discharge surface water into the sluice gate channel. The 18-inch pipe would no longer release a constant flow of 5 to 10 cfs of surface water into the sluice channel.

The proposed fish barrier would consist of a concrete weir with a maximum height of 8 feet above foundation level abutting the steep bank on channel-left and tying into a rock-filled dike on channel-right that is used to prevent flows during spill periods less than 7,000 cfs from entering the sluice gate channel. Based on gauge data from the Tuolumne River just below LGDD (water years 1971-2012, USGS gauge 11289650), and anticipated flow management strategies to maintain spills below 7,000 cfs, spillway flows greater than 7,000 cfs are anticipated to occur approximately once every 5 years. During these periods, salvage efforts would occur as described herein following any such high-flow events. Attachment B of the LaGrange Hydroelectric Project Biological Assessment shows the preliminary functional design of the barrier.

2.2.1.1 Construction

Approach

The fish barrier would be constructed in the dry, and a temporary sandbag cofferdam would be placed between the barrier location and the tailrace channel to prevent powerhouse flows or minor spills from entering the construction area. The construction would take approximately two months to complete, starting in mid-July and completed before the beginning of October, following issuance of the FERC license.

Prior to construction activities, a team of biologists would observe initial dewatering and relocate any fish from the sluice gate channel areas. The Districts would conduct fish salvage in the sluice gate channel by herding fish in the downstream direction from the channel into the tailrace using dip nets and a series of block nets once a reach has been sufficiently inspected. A barrier block net would be installed at the downstream terminus of the in-channel construction area upon completion of salvage, the sluice gate then closed, and the temporary sand bag cofferdam installed. If salvage were to involve e-fishing, an electrofisher would be used in accordance with NMFS (2000) electrofishing guidelines. All salvaged fish would be relocated to the tailrace channel.

At the beginning of construction, a channel connecting the LGDD plunge pool area with the tailrace would be constructed to maintain flow into the tailrace throughout construction. Following the completion of the connection, the powerhouse would be turned off to avoid the occurrence of station trips. A sandbag dike would be placed in the mainstem at the downstream end of the plunge pool with a pipe through it to maintain control of the elevation of the plunge pool while also maintaining flow to the mainstem. The connecting channel would be sized to approximately 75 cfs. Prior to opening the connecting channel connecting the plunge pool with the tailrace, a turbidity curtain would be installed upstream of where the channel connects to the tailrace. The temporary bypass would be opened incrementally to reduce the downstream sediment pulse into the tailrace channel. During fish barrier construction, the MID Hillside gate would be placed into operation at the appropriate flow rate, depending on the required instream flow (based on water year type), and water would be released into the LGDD plunge pool. The MID Hillside gate has the flow capacity to release up to 350 cfs (TID/MID 2017c). Following construction, the sandbag cofferdams would be removed. Once the fish barrier is in place, the sluice gate channel would typically be dry except during periods when the powerhouse trips and the sluice gate is manually opened. During these periods, as soon as the powerhouse comes back on line, the sluice gate would be closed, and the channel would again be dewatered.

As discussed above, when flows exceed 7,000 cfs and fish salvage operations are required in the sluice channel, salvage operations would follow the same procedure as defined for initial fish barrier construction. This is because the powerhouse must be shut down to avoid the sluice gates having to be opened upon a station trip. Therefore, a temporary channel connecting the plunge pool below LGDD to the tailrace would serve to keep the tailrace wetted and flowing during these salvage operations. Excavation of the connection channel would require temporary sandbagging of the main channel at the exit from the plunge pool to raise and control the elevation of the pool. A pipe would be inserted in the sandbags to continue flow to the mainstem.

The fish barrier would allow the sluice gate to operate without concern for any fish making their way into the sluice channel and then being dewatered or stranded. There would be no need to keep the 18-inch pipe open, but it would be opened any time salvage operations are necessary following high (i.e., >7,000 cfs) flow events.

Construction Timing

Construction of the fish barrier, including fish salvage and in-water work isolation would occur over approximately eight weeks from mid-July 15 to mid-September. This window is consistent with in-water work periods established by NMFS, U.S. Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers (USACE) for instream work in the Central Valley (USACE et al. 2006) and is supported by spawning studies conducted near the Action Area. Researchers conducting redd surveys in the reach of the Tuolumne River immediately downstream of the Action Area (RM 52.0 – 47.4) during the 2014-2015 spawning season observed fall-run Chinook Salmon redds from late October through December, with peak spawning in mid-November. During this study, *O. mykiss* redds were observed between January and April, with peak observations in late February (TID/MID 2016a). There were no redds observed in the sluice gate channel. Given these observations, the July 15 through mid-September in-water work window would avoid sensitive salmonid life histories including spawning adults, eggs, and alevins in the Action Area.

Impact Minimization Measures

The following impact minimization measures are considered part of the Proposed Action and will be implemented during construction of the fish barrier:

- The proposed sluice gate channel fish barrier would be designed to meet NMFS screening and approach velocity and leaping criteria (NMFS 2011) to prevent the upstream movement of fish into the sluice gate channel.
- In-water work to install the fish barrier at the base of the sluice gate channel will occur from July 15 – mid September.
- To the extent practicable, machinery used for in-water elements will be operated atop bedrock to limit substrate compaction and downstream sedimentation. During sandbag installation, equipment may be driven in flowing water.
- Following placement of the sandbag cofferdam, equipment will not operate in active flow as the sluice gate will be shut, and the cofferdam will prevent water from the tailrace channel to enter the construction area.
- The sandbag cofferdam will be removed from the sluice gate channel and mainstem by the end of September. All instream spoils will be removed from the isolated work area prior to sandbag removal.

- Prior to opening the connecting channel connecting the plunge pool with the tailrace, a turbidity curtain will be installed at the downstream exit to the tailrace. The temporary bypass will be opened incrementally to reduce any potential downstream sediment pulse.
- Temporary spoils from connecting channel excavation will be stored adjacent and upslope of the connecting channel and covered with plastic sheeting. Existing riparian vegetation will be protected to the extent possible. Vegetated areas disturbed along the connecting channel area will be restored with native species.
- During initial connecting channel backfill, a turbidity curtain will again be placed at the downstream exit of the connecting channel to the tailrace channel.
- Following connecting channel backfill, adjacent reaches of the mainstem pool and tailrace channel will be returned to pre-construction contours.
- To prevent spread of invasive species/disease the appropriate field gear disinfection protocol will be adhered to for instream equipment use (e.g., nets, hip boots, equipment, etc.).
- Because the construction area will be small and dry, no significant seepage is anticipated. If needed, diesel or electric sump pumps will be used to capture seepage flow from the cofferdam area.
- A pollution and erosion control plan will be prepared and carried out by the Contractor to prevent pollution related to construction activities. The pollution and erosion control plan will also contain specific information regarding emergency spill and preventative measures. The pollution and erosion control plan will address equipment and materials storage sites, fueling operations, staging areas, hazardous materials, spill containment and notification, and debris management.
- Immediately prior to initiating construction activities, qualified fisheries biologists will remove all fish species present from the immediate area in accordance with the procedures outlined above.

2.2.1.2 Sluice Gate Operations During High Flows

During high flow events, spillway flows greater than 7,000 cfs at LGDD will cause some flow to enter the sluice gate channel. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. During these periods, estimated to occur at a frequency of approximately once every five years, the pipeline flows would remain in the sluice channel, and fish salvage operations would proceed to relocate fish that are in the sluice channel to the tailrace channel. Salvage operations would be similar to those proposed for installation of the fish barrier. When salvage is complete, the Districts would close the 18-inch pipeline and cease the discharge of flow to the sluice channel.

2.2.2 Continuous Surface Water Release to LGDD Plunge Pool

Under the Proposed Action, the Districts would formalize an operation that currently is maintained voluntarily. Currently, with the exception of spring spill events when water flows over LGDD, water not diverted for water supply purposes is routed through the Project powerhouse (river left). The powerhouse tailrace receives approximately 95 percent of flows redirected to the river outside of spring spill season. Because resident fish occupy the plunge pool downstream of the LGDD, the Districts have been voluntarily releasing 5 to 10 cfs of surface water to the plunge pool to maintain dissolved oxygen and cool water temperatures. As discussed in Section 1.3.3, this 5 to 10 cfs is typically routed to the plunge pool via the river-right MID Hillside gate(s) (Figure 1.3-2), via Portal No. 1 in the dam, or over the spillway.

Under the Proposed Action, the Districts would formalize this voluntary action as a standard operating condition and continuously release 5 to 10 cfs to the mainstem Tuolumne River plunge pool downstream of the LGDD. The release would occur 24-hours a day, every day of the year. Similar to existing conditions, surface water would be released into the plunge pool below the MID Hillside, Portal No. 1 in the dam, or the LGDD spillway.

2.2.3 Dissolved Oxygen Monitoring

The Districts have collected temperature, turbidity, and dissolved oxygen data in the tailrace channel as part of the Fish Barrier Assessment, all of which indicate satisfactory conditions for aquatic life (TID/MID 2017e). During the first year of the assessment (2015), there was a brief period from late September through October during which daily instantaneous measurements of dissolved oxygen below 8.0 mg/L were recorded at the tailrace channel weir location. The low instantaneous dissolved oxygen levels appeared to be a localized event as dissolved oxygen levels at the main channel weir remained above 8.0 mg/L during the same period of time. To further evaluate the potential cause of this spatially and temporally isolated event, the Districts propose to monitor dissolved oxygen from September 1 to November 30 each year for the first 2 years of a new operating license. Monitoring equipment will collect dissolved oxygen information at 15 minute intervals at three locations; the Project forebay, immediately below the powerhouse, and at the lower end of the tailrace channel. At the end of the monitoring period each year, these data will be compiled, analyzed, and submitted as an annual report to FERC. If results indicate a specific cause for low dissolved oxygen exists, the Districts will develop and submit an action plan to FERC in year 3 of the license.

2.3 Interrelated and Interdependent Actions

Interrelated actions are actions that are part of a larger action and depend on the larger action for their justification (50 CFR § 402.02), whereas interdependent actions are actions with no independent utility apart from a Proposed Action (50 CFR § 402.02). If a private activity would not occur in the absence of a proposed federal action, the effects of that private activity are interdependent and/or interrelated with the Proposed Action, and the effects of the private activity are considered attributable to the proposed federal action for consultation purposes.

In contrast, actions that would occur with or without the occurrence of the Proposed Action are not interdependent or interrelated with the Proposed Action. The USFWS and NMFS (1998) state that if a project would exist independent of a Proposed Action, it cannot be considered “interrelated” or “interdependent” and included in the effects of the Proposed Action.

As noted above, the Proposed Action is the issuance of an original FERC license for the continuation of the hydroelectric generation at the Project. Water diversion for the Districts’ water supply purposes is the Project's primary purpose (i.e., the diversion of water for irrigation and M&I uses for the Districts are not dependent on the issuance of a FERC license for the Project) and will occur with or without the licensing of the Proposed Action. In addition, as with every diversion dam, waters not being diverted must be passed safely downstream. Any of the flow conduits associated with LGDD may be used to safely pass flows downstream, including the powerhouse whether or not use of the turbine-generator units are authorized by FERC.[4] As such, these primary purposes are *not* interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are consulting with NMFS on the Proposed Action, analysis of the potential effects associated with the aforementioned non-hydropower uses are addressed only in the context of cumulative effects in the Action Area (i.e., there are no direct or indirect effects). This EFH assessment includes an analysis of the direct effects on Pacific Salmon EFH associated with the Districts' proposed PM&E measures, which are specifically designed to benefit aquatic resources in the Action Area.

2.4 Action Area

The Action Area is defined as the geographic area likely to be affected by the direct[5] and indirect[6] effects of the Proposed Action (50 CFR § 402.02; USFWS and NMFS 1998), and considers the effects of interrelated and interdependent actions. The action considered in this EFH assessment is FERC's issuance of an original license for hydropower generation at the Project. FERC licenses a "complete unit of development" that consists of all dams, reservoirs, and other engineered structures necessary for operation and maintenance of a project (i.e., Project Boundary). Therefore, for this EFH assessment, the aquatic portion of the Action Area includes: (1) the upstream extent of the Project Boundary, including the LGDD and its impoundment; (2), the main channel of the Tuolumne River from the LGDD downstream to its confluence with the powerhouse tailrace channel near RM 51.8; (3) the tailrace channel from the powerhouse exit to the confluence with the mainstem Tuolumne River; and, (4) and the TID sluice gate channel. The terrestrial portion of the Action Area includes the Project powerhouse, the forebay, penstocks, and substation on river-left, and the MID Hillside Discharge on river-right (Figure 2.4-1). All surface water passing through the Project powerhouse would be routed downstream of the LGDD regardless of the Proposed Action. Therefore, the downstream extent of the Action Area is defined based on the extent of hydraulic and water quality impacts attributed to release of surface water from the powerhouse to the tailrace. When compared to the environmental baseline, the effects of hydroelectric power generation on the environment are not measurable downstream of the confluence of the mainstem Tuolumne River with the tailrace.

Although the forebay, LGDD and the impoundment are part of Project Boundary, and therefore part of the Action Area, each structure has independent utility, and their primary purpose is to convey water diverted for irrigation. Hydropower generation at the Project is a secondary purpose the LGDD. Non-Project irrigation and M&I surface water diversion is the primary purpose of the LGDD, which would exist regardless of the Proposed Action.

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[4] If continuation of power generation is not authorized by FERC, the Districts would be able to replace the turbines with pressure relief valves in the powerhouse to continue to pass water through the powerhouse.

[5] Direct effects: the direct or immediate effects of the project on the species or its habitat (Final ESA § 7 Handbook at 4-25).

[6] Indirect effects: those effects that are caused by or will result from the Proposed Action and are later in time, but are still reasonably certain to occur [50 CFR § 402.02].

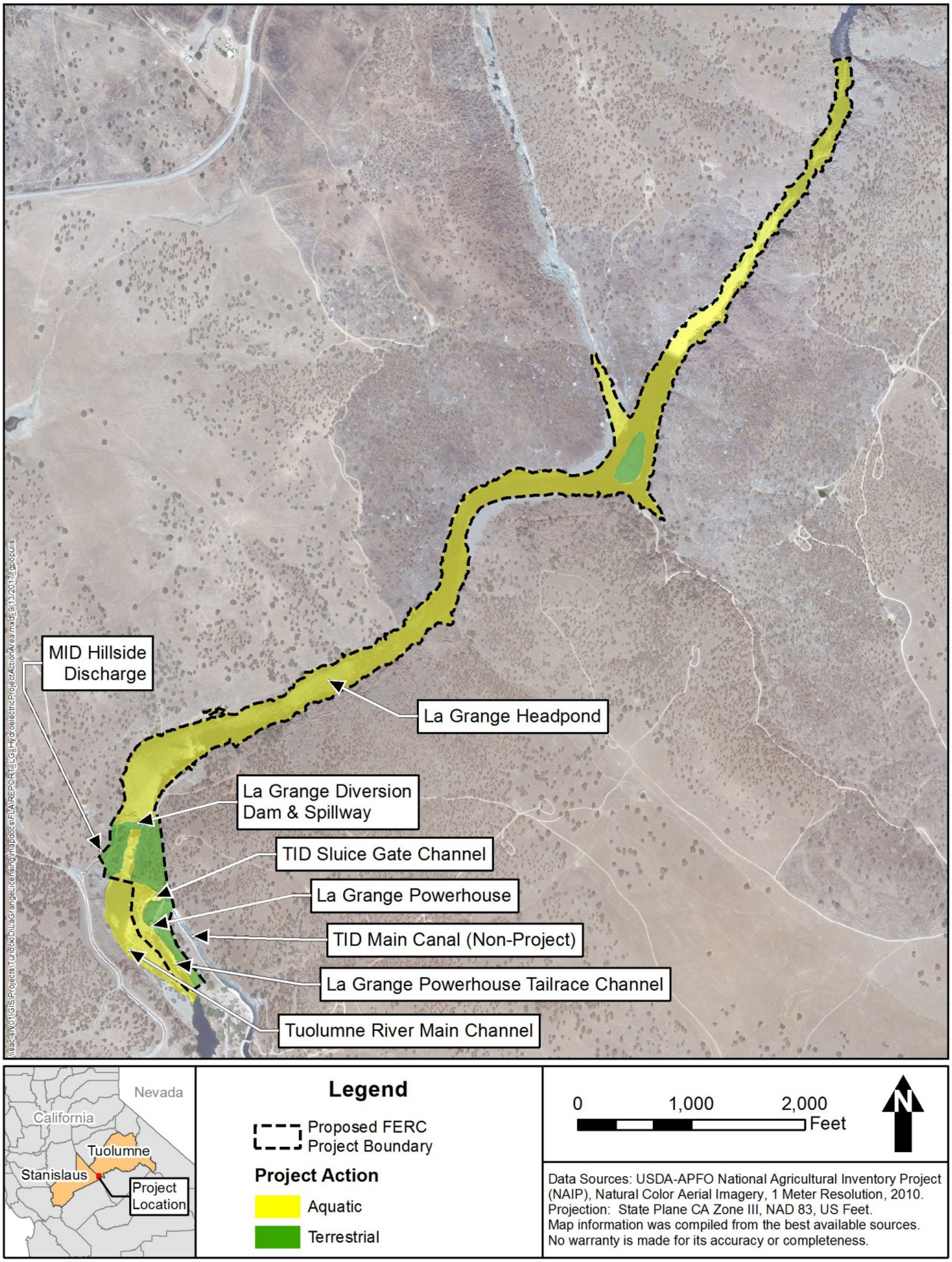

Figure 2.4-1. **La Grange Hydroelectric Project Action Area (aquatic and terrestrial portions).**

3.0 EFH IN ACTION AREA

EFH is defined by the Magnuson-Stevens Act in 50 CFR 600.905-930 as "those *waters* and *substrate necessary* to fish for spawning, breeding, feeding, or growth to maturity," where:

- *Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate (50 CFR 600.10).
- *Substrate* includes sediment, hard bottom, structures underlying the waters, and associated biological communities (50 CFR 600.10).
- *Necessary* means habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem (50 CFR 600.10).

In freshwater, EFH for Pacific Coast Salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassible barriers identified by PFMC (1999). The La Grange Diversion Dam is currently considered an impassable man-made barrier (73 FR 609994). According to the PFMC (2014, Appendix A) freshwater EFH for Pacific Coast Salmon consists of (1) spawning and incubation, juvenile rearing, juvenile migration corridors, and adult migration corridors and holding habitat. Freshwater EFH depends on floodplain, riparian, hyporheic, and longitudinal connectivity to create suitable conditions. Variables of importance for spawning, rearing, and migration include (1) water quality, (2) water quantity, depth, and velocity, (3) riparian-stream-marine energy exchanges, (4) channel gradient and stability, (5) prey availability, (6) cover and habitat complexity, (7) space, (8) habitat connectivity from headwaters to the ocean; (9) groundwater-stream interactions; and (10) substrate composition.

The USGS's 4th field hydrologic units (HUs) designated as EFH for fall-run Chinook Salmon in California are shown in Figure 3.1-1. In the Tuolumne River, Pacific Coast Salmon EFH extends from LaGrange Diversion Dam (RM 52.2) to the confluence with the San Joaquin River. Both the tailrace channel and sluice gate channel are currently accessible to fall-run Chinook Salmon. Therefore, the Action Area includes EFH for all life-history stages of fall-run Chinook Salmon (Table 3.0-1). Only fall-run Chinook Salmon occur in the Action Area.

Table 3.0-1. Fall-run Chinook Salmon life-history stages with designated EFH in the action area.

Species	Adult	Spawning/Mating	Juvenile	Eggs/Parturition
Chinook Salmon (fall-run)	X	X	X	X

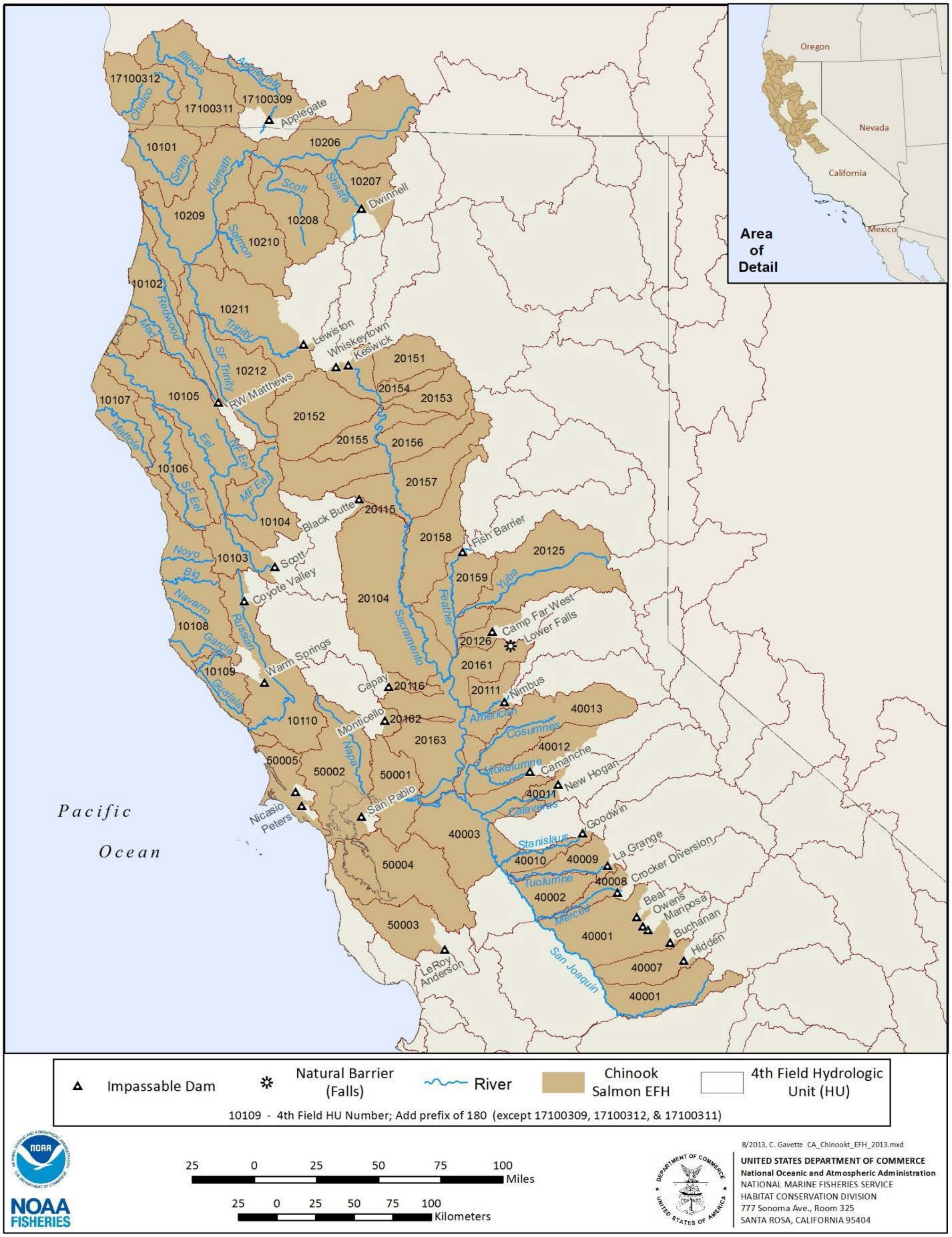

Figure 3.1-1. **Fall-run Chinook Salmon EFH in California. EFH designations are based on the USGS 4th field hydrologic units. (Source: PFMC 2014, Appendix A to the Pacific Coast Salmon FMP).**

4.0 MANAGED FISH SPECIES: CENTRAL VALLEY FALL-RUN CHINOOK SALMON

There are four distinct Chinook Salmon runs in the Sacramento and San Joaquin River basins. The Tuolumne River supports Chinook Salmon belonging to the fall-/late fall-run Evolutionarily Significant Unit (ESU), which migrate upstream from September-December (peak in November) and spawn primarily in November and December. Fall-run Chinook Salmon, which are currently the most abundant of the Central Valley races, contribute significantly to large commercial and recreational fisheries. Because of concerns over population size and hatchery influence, the Central Valley fall/late fall-run Chinook Salmon ESU is considered a Species of Concern under the federal Endangered Species Act (ESA); it is not listed as threatened or endangered.

4.1 Life History in Lower Tuolumne River

4.1.1 Adult Immigration

Adult fall-run Chinook Salmon return to the lower Tuolumne River (i.e., downstream of LGDD) from September through December, with peak migration in October and November (TID/MID 2013b). Fall-run Chinook Salmon escapement to the Tuolumne River has historically varied. Since fall 2009, escapement monitoring has been conducted at a counting weir established at RM 24.5. Cumulative adult fall-run Chinook Salmon counts at the weir from 2009–2013 generally indicate a positive escapement trend over the study years (Figure 4.1-1).

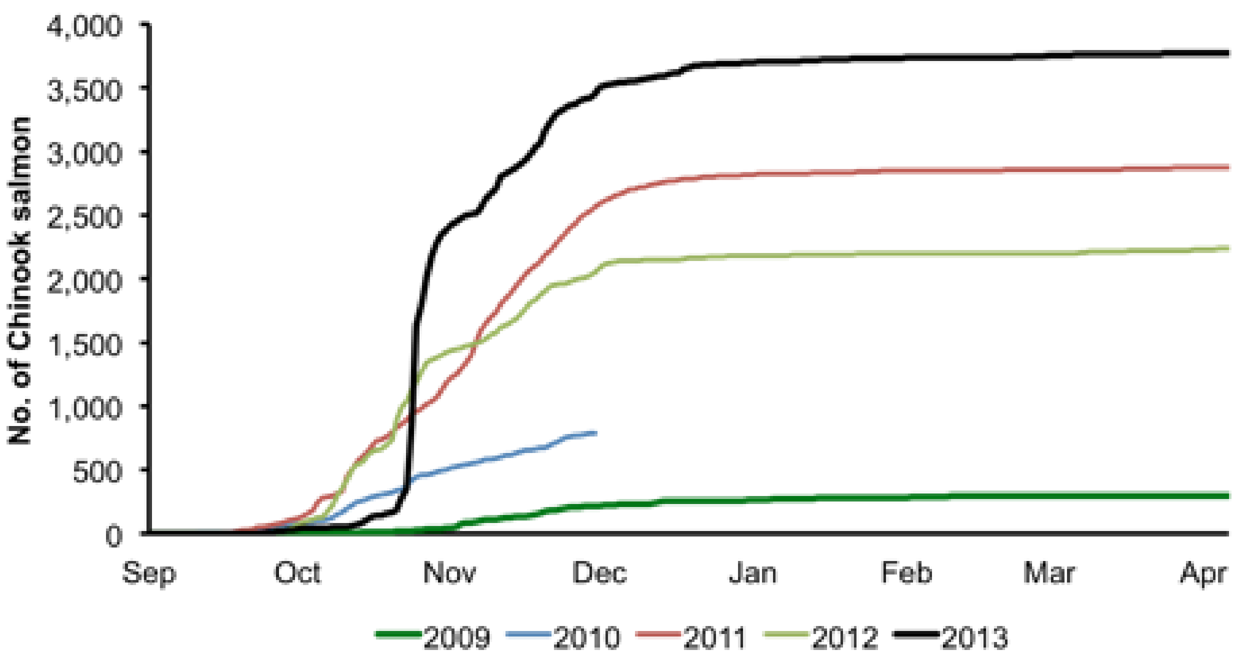

Figure 4.1-1. Cumulative adult fall-run Chinook Salmon counts at the Tuolumne River weir (RM 24.5) 2009–2013.

Variations in ocean productivity and commercial harvest directly affect the number of fall-run Chinook Salmon escaping the ocean troll fishery to spawn in the lower Tuolumne River (TID/MID 2013b). The Central Valley Harvest Rate Index (i.e., catch/[catch + escapement]) has been in excess of 70 percent in many years (TID/MID 2005), suggesting that year-to-year variations in ocean survival and harvest may affect Tuolumne River escapement and subsequent population levels (TID/MID 2013b). Commercial harvest in the Valley District[7], which includes rivers in San Joaquin, Stanislaus, and Tuolumne counties, is currently closed to the take of salmon (TID/MID 2013b).

Fall-run Chinook Salmon in the Tuolumne River have been heavily influenced by hatchery operations in the State of California. Straying of hatchery-origin fish has been documented in the Tuolumne River and has likely affected the numbers of salmon in annual spawning runs. Although the proportions of adipose-fin-clipped fall-run Chinook Salmon identified as hatchery-origin fish have been historically low in Tuolumne River spawning surveys, this proportion has increased dramatically from the 1990s to the present (TID/MID 2005; Mesick 2009). Based on the results of the District's Chinook Salmon Otolith Study (TID/MID 2016a), the estimated average hatchery contribution of adult fall-run Chinook Salmon in the lower Tuolumne River during the years studied (i.e., 1998, 1999, 2000, 2003, and 2009) was 67 percent, and hatchery contribution generally increased in later years. Recognizing that some years in the otolith sample inventory over- or under-represent the typical age class structure in the escapement record, the overall proportion was estimated using only three-year old fish, which are expected to make up the bulk of the annual escapement. For these fish, hatchery contribution in the aforementioned years ranged from 36 to 90 percent, with a mean of 58 percent.

Straying of hatchery fall-run Chinook Salmon can be linked to reduced fish size-at-return (Flagg et al. 2000) and as a result can reduce subsequent fry productivity per spawner. However, despite the high proportion of hatchery fish contributing to fall-run Chinook Salmon escapement into the Tuolumne River, fall-run Chinook Salmon size-at-return does not appear to be declining in response to hatchery introgression (TID/MID 2013b).

4.1.2 Spawning and Incubation

Fall-run Chinook Salmon spawning in the lower Tuolumne River occurs primarily from October through December (with peak activity in November) in the gravel-bedded reach (RM 24 to 52), where water temperatures are suitably cool and spawning riffles are present (TID/MID 2013b). Egg incubation and fry emergence occur from October through January.

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[7] Per the 2013-2014 California Freshwater Sport Fishing Regulations (http://www.dfg.ca.gov/regulations/), the Valley District consists of all of Butte, Colusa, Glenn, Kern, Kings, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, Yolo and Yuba counties; Tulare County west of the west boundaries of Sequoia National Forest and Sequoia National Park; Fresno County west of the west boundaries of Sierra and Sequoia National Forests (including all of Pine Flat Lake); Madera County west of the west boundary of the Sierra National Forest; Amador, Calaveras, El Dorado, Mariposa, Nevada, Placer and Tuolumne counties west of Highway 49 (including all of Don Pedro, McClure and New Melones lakes); that portion of Alameda County which is both east of Interstate 680 and north of Interstate 580; and all of Contra Costa County east of Interstate 680 and that portion of Contra Costa County which is both north of Highway 4 and east of Interstate 80; and all of Black Butte Lake.

The Districts conducted redd mapping surveys from RM 52.0 to 22.0 during the 2012–2013 and 2014–2015 spawning seasons to evaluate peak fall-run Chinook Salmon spawning periods (TID/MID 2013c). In 2012–2013, 653 completed fall-run Chinook Salmon redds were identified during the surveys, which were conducted between October 1 and April 19 (Table 4.1-1). Of the total 653 redds, 622 (95 percent) completed redds were observed between October 29 and November 29 (TID/MID 2013c). An additional 233 fall-run Chinook Salmon redds were classified as incomplete. Peak spawning in all survey reaches occurred during the week of November 12, when 186 new redds were identified.

Table 4.1-1. New fall-run Chinook Salmon redds identified by reach and date during the 2012–2013 survey period.

Week[1]	Survey Dates	Reach (RM)				Grand Total	Percent
		1 (52.0–47.4)	2 (47.4–42.0)	3 (42.0–31.6)	4 (31.6–22.0)		
1	10/1–10/4/12	7	1	1	0	9	1.4%
3	10/15–10/18/12	1	0	0	0	1	0.2%
5	10/29–11/2/12	28	13	30	5	76	11.6%
6	11/5–11/9/12	86	48	36	11	181	27.7%
7	11/12–11/15/12	87	48	37	14	186	28.5%
8	11/18–11/21/12	84	15	37	8	144	22.1%
9	11/26–11/29/12	14	9	4	8	35	5.4%
11	12/10–12/13/12	3	4	5	0	12	1.8%
14	1/2–1/5/13	0	1	2	0	3	0.5%
15	1/7–1/10/13	2	0	0	0	2	0.3%
17	1/21–1/24/13	0	0	1	0	1	0.2%
19	2/5–2/8/13	2	0	0	0	2	0.3%
21	2/18–2/21/13	0	0	0	0	0	0.0%
23	3/4–3/7/13	0	0	0	0	0	0.0%
25	3/18–3/21/13	1	0	0	0	1	0.2%
27	4/1–4/4/13	0	0	0	0	0	0.0%
29	4/17–4/19/13	0	0	0	0	0	0.0%
Grand Total		315	139	153	46	653	100%
Percent		48.2%	21.3%	23.4%	7.0%	100%	--

1 Week refers to the number of weeks after the week of 10/1/12.

In 2014–2015, 337 completed fall-run Chinook Salmon redds were documented between October 7 and April 16, of which 307 (91 percent) were observed between November 3 and December 30; 5 redds (1.5 percent) were observed prior to November 3 (Table 4.1-2) (TID/MID 2013c). An additional 70 fall-run Chinook Salmon redds were classified as incomplete. Peak spawning in all survey reaches occurred during the week of November 18, when 142 new fall-run Chinook Salmon redds were identified. Twenty-five new fall-run Chinook Salmon redds were identified from January through April.

Table 4.1-2. New fall-run Chinook Salmon redds identified by reach and date during the 2014–2015 survey period.

Week[1]	Survey Dates	Reach 1 (52.0-47.4)	Reach 2 (47.4-42.0)	Reach 3 (42.0-31.6)	Reach 4 (31.6-22.0)	Grand Total	Percent
1	10/7	2	--	--	--	2	0.6%
3	10/22–10/23	3	0	--	--	3	0.9%
5	11/3–11/6	13	6	7	--	26	7.7%
7	11/18–11/21	57	40	43	2	142	42.1%
9	12/1–12/5	15	19	34	10	78	23.1%
11	12/15–12/18	19	6	20	7	52	15.4%
13	12/28–12/30	7	1	0	1	9	2.7%
15	1/13–1/15	2	1	6	--	9	2.7%
17	1/26–1/28	0	1	5	--	6	1.8%
19	2/9–2/11	2	0	0	--	2	0.6%
21	2/24–2/26	1	0	0	--	1	0.3%
23	3/10–3/13	2	0	0	--	2	0.6%
25	3/24–3/26	0	0	2	--	2	1.6%
28	4/14–4/16	2	0	1	--	3	0.9%
Grand Total		125	74	118	20	337	--
Percent		37.1%	22.0%	35.0%	5.9%	--	--

[1] Week refers to the number of weeks after the week of 10/5/14.

During the 2012-2013 and 2014-2015 spawning seasons, fall-run Chinook Salmon spawning activity (by absolute number of redds and densities) tended to increase as RM increased, with the highest abundance (48.2 percent and 37.1 percent) of observed redds occurring in Reach 1 (RM 52.0 to RM 47.4) (TID/MID 2013c, 2016a). Spawning activity at recent gravel augmentation sites (from RM 50.6 to 51.0) accounted for 21.6 percent (141 of 653) of the fall-run Chinook Salmon redds observed during the 2012–2013 spawning season. In 2014–2015, spawning activity at recent gravel augmentation sites accounted for 16.3 percent (55 of 337 total) of fall-run Chinook Salmon redds observed.

4.1.3 Juvenile Rearing, Smoltification, and Outmigration

Fall-run Chinook Salmon typically rear in the Tuolumne River from January to May (TID/MID 2013b). However, low numbers of over-summering juveniles have been found downstream of the USGS La Grange gauge (RM 51.7) during snorkel surveys in most years (TID/MID 2013d). Based on seine and rotary screw trap monitoring, juvenile fall-run Chinook Salmon fry (<50 millimeters [mm]) outmigrate from the lower Tuolumne River into the lower San Joaquin River and Delta as early as February in years with high flows, and smolts (>70 millimeters [mm]) emigrate during April and May in most years (TID/MID 2013b).

The Tuolumne River Chinook Salmon Otolith Study (TID/MID 2016a) indicates that the total number of days from formation of the otolith core to ocean entry for Tuolumne River juvenile fall-run Chinook Salmon was relatively constant at 99 (±20) days for each of the five outmigration years studied (1998, 1999, 2000, 2003, and 2009). The study also indicated that the vast majority of adult fall-run Chinook Salmon returning to the Tuolumne River had emigrated as parr or smolts, suggesting that there is a survival advantage for fish emigrating at larger sizes.

Surveys to assess the impact of flow fluctuations on salmonids in the lower Tuolumne River were conducted from 1986 to 2002. Rapid flow reductions can cause stranding and entrapment of fry and juvenile salmon on gravel bars and floodplains and in off-channel habitats that may become cut off from the main channel when flows are reduced. A comprehensive evaluation of stranding was conducted in the lower Tuolumne River (TID/MID 2001) and is summarized in the 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs (i.e., the range of flows under which the floodplain is inundated in several areas of the spawning reach). However, under current flow management scenarios in the Tuolumne River (i.e., Don Pedro Project operations), the risk of salmonid stranding is considered to be low. The Districts curtailed large hydropower-related flow fluctuations in the river well before the 1995 Settlement Agreement, which established ramping rates developed to minimize the potential for stranding. As such, since 2002 there have been no requirements to monitor salmonid stranding, and all current floodplain restoration projects include design requirements for minimizing stranding potential.

4.2 Habitat in the Lower Tuolumne River

4.2.1 Spawning and Incubation

Results from a recent physical habitat simulation study in the lower Tuolumne River (Stillwater Sciences 2013) corroborate results of previous modeling efforts that indicate fall-run Chinook Salmon spawning habitat is maximized at flows between 175 and 400 cfs (Table 4.2-1).

Table 4.2-1. Comparison of flows providing maximum weighted usable area in the lower Tuolumne River based on instream flow studies conducted in 1981, 1995, and 2013.

Species/Life Stage	Stillwater Sciences 2013 (cfs)	Stillwater 2013 (USFWS 1995 HSC)[1] (cfs)	USFWS 1995 (cfs)	CDFG 1981[2] (cfs)
Fall-run Chinook Salmon fry	≤100	≤100	<75 cfs	40–280
Fall-run Chinook Salmon juvenile	50–300	50–400	75–225	80–340
Fall-run Chinook Salmon spawn	200–400	200–400	175–325	180–360

1 These results reflect the current PHABSIM model run with the habitat suitability criteria (HSC) used in the USFWS 1995 study.
2 The CDFG 1981 study (reported in TID/MID 1992) simulated results to 600 cfs. The study showed contrasting results for fall-run Chinook Salmon fry and juveniles between the two study reaches, with a 1991 reanalysis (TID/MID 1992) documenting that the lower reach (Reach 2) results were disproportionately due to the influence of a single transect. As a consequence, only the results from Reach 1 are included above to maximize comparability of the data.

The availability, distribution, and quality of gravel for fall-run Chinook Salmon spawning in the lower river was assessed through a series of studies conducted by the Districts from 1986 to 1992. Results showed that riffle areas extended downstream from just below the LGDD to approximately RM 23.0, although the actual area available for spawning was less extensive due to site-specific flow characteristics and gravel quality (TID/MID 1992).

Gravel quality was poor in riffles, with an associated estimated survival-to-emergence of 16 percent (TID/MID 1992). Gravel quality in redd locations was greater, but still considered poor, with an associated average estimated survival-to-emergence of 34 percent. Following the 1997 flood, which introduced large volumes of fine sediment to the lower Tuolumne River, an in-situ egg-survival-to-emergence study was conducted to assess the effects of various fine sediment levels within spawning gravels (TID/MID 2007). Study results included an estimated survival-to-emergence rate ranging from near zero to approximately 40 percent, depending on fine sediment levels and intra-gravel flows. Beginning in 2001, gravel augmentation projects were undertaken to improve the quality of spawning gravel in the lower Tuolumne River.

In June 2001, discrete fine sediment deposits in the lower Tuolumne River channel were mapped from RM 52.2 to RM 39.6 (Stillwater Sciences 2003). Results of the survey indicated that fine sediment constituted a large fraction of the channel bed surface, and the largest volumes of fine sediment were observed from RM 45.5 to RM 39.5. Subsequent field observations during the spring and summer of 2012 indicated that pool tails and riffle crests, where fall-run Chinook Salmon spawning preferentially occurs, contained little fine (<2 mm) bed material (TID/MID 2013d). Fine bed material was distributed nearly equally among pool margins, other channel margins, and alcoves and backwaters.

4.2.2 Juvenile Rearing, Smoltification, and Outmigration

A recent habitat simulation study (Stillwater Sciences 2013) corroborated the results of previous studies, indicating that the weighted-usable-area (WUA) for rearing fall-run Chinook Salmon fry and juveniles is maximized at lower flows, with juveniles maintaining high habitat values up to around 300 cfs (see Table 4.2-1). Fall-run Chinook Salmon juvenile and fry WUA exhibits a similar pattern of annual fluctuation across all water year types, except for reductions in WUA that occur during high flows in wet years.

A Pulse Flow Study (Stillwater Sciences 2012) indicates that flows above bankfull discharge at the locations studied were associated with increases in potential overbank habitat area. However, results of the Lower Tuolumne River Floodplain Hydraulic Assessment (TID/MID 2017i) confirm that only a portion of the inundated floodplain area provides suitable habitat for fall-run Chinook Salmon fry and juveniles. In addition, although some floodplain areas are present over the length of the lower Tuolumne River, not all sections of the floodplain are inundated at the same flows. In the uppermost reach (i.e., RM 51.7–40.0), the largest increase in inundated floodplain area occurs at low to moderate flows. However, the majority of available floodplain habitat in this reach is limited to several disturbed areas formerly overlain by dredger tailings (McBain and Trush 2000). These areas were also associated with the highest frequency of stranding and entrapment of juvenile fall-run Chinook Salmon during historical stranding surveys at flows between 1,100–3,100 cfs (TID/MID 2001).

Estimates of usable floodplain habitat for fall-run Chinook Salmon fry and juvenile life stages were developed as part of the floodplain modeling study (TID/MID 2017i) based on suitability indices from Stillwater Sciences (2013). Estimates of total usable habitat including both in-channel and floodplain areas steadily increased with increasing discharge from RM 52.2 to RM 40, but total habitat area became limited at intermediate discharges in the reaches downstream of

RM 40. This occurred because reductions in suitable main channel habitat (primarily as the result of unsuitable water velocities) were not offset by increases in floodplain habitat. In the lower reach (i.e., RM 21.5–0.9), suitable habitat for fall-run Chinook Salmon fry ranged from 37 percent of the total inundated floodplain area at 7,000 and 9,000 cfs to 58 percent of the inundated area at 1,000 cfs. For juvenile fall-run Chinook Salmon in this reach, suitable habitat ranged from approximately 45 percent of the total inundated floodplain area at 7,000 cfs to 53 percent at 2,000 and 3,000 cfs.

5.0 ENVIRONMENTAL BASELINE

5.1 General Physical, Hydrologic, Water Quality Conditions

The Action Area has been affected by a wide range of human actions conducted over many decades. Anthropogenic changes that have occurred in the lower Tuolumne River corridor since the mid-1800s include gold mining, aggregate mining, grazing, agriculture, water management, and urban encroachment. A detailed account of baseline conditions for physical, hydrologic, and water quality habitat parameters in the Action Area is provided in Sections 4.2 through 4.4 of the La Grange Hydroelectric Project Biological Assessment (TID/MID 2017h), and summarized below.

Habitat mapping studies in the Action Area (TID/MID 2016b) have determined that the mainstem Tuolumne River channel in the Action Area is dominated by pool habitat, including a plunge pool immediately downstream of the LGDD, a large mid-channel pool adjacent to the MID Hillside Discharge, and two smaller pools in the lower portion of the channel. The thalweg of the Tuolumne River main channel is also predominately composed of cobble-sized sediments, with varying proportions of gravel- and boulder-size substrates, and some bedrock outcrops (TID/MID 2016b).

The tailrace channel includes two riffles, one of which includes salmonid spawnable substrate, along with one run habitat in the lower portion of the channel. The upper portion of the tailrace channel includes a single pool with turbulent flow from the La Grange powerhouse discharge along with a glide associated with the tailout of this pool. Estimated average width of habitats in the tailrace channel is approximately 50 feet. The TID sluice gate channel is a high-gradient step-pool that originates at the TID canal (a non-Project feature) and empties into the pool at the upstream portion of the tailrace channel. The sluice gate and tailrace channels are predominately cobble-bedded with varying proportions of gravel- and boulder-size substrates, along with some bedrock outcrops in the sluice gate channel (TID/MID 2016b).

Discrete water quality parameters were recorded during fish weir monitoring in the Tuolumne River main channel, and in the tailrace channel just below the La Grange powerhouse. During the September 23, 2015 through April 14, 2016 monitoring period, instantaneous turbidity ranged from 0.69 nephelometric turbidity units (NTU) to 14.06 NTU (mean 2.82 NTU) in the tailrace channel and from 0.54 NTU to 11.96 NTU (mean 2.44 NTU) in the main channel. Instantaneous dissolved oxygen ranged from 4.03 milligrams per liter (mg/L) to 13.93 mg/L (mean 9.34 mg/L) in the tailrace channel and from 8.96 mg/L to 14.24 mg/L (mean 10.97 mg/L) in the main channel (TID/MID 2017b).

The low instantaneous dissolved oxygen levels reported during the 2015/2016 monitoring season appeared to be a localized event associated with high levels of aquatic vegetation in the La Grange powerhouse forebay and penstock intake. Instantaneous readings below 8.0 mg/L were recorded 35 times between 9/23 and 11/3. These low levels were only in the tailrace channel, as levels in the main channel during the same period ranged from 9.1-11.1 mg/L. Daily instantaneous dissolved oxygen readings downstream at RM 24.5 during the same time period ranged from 7.1 to 9.8 mg/L (mean 8.5 mg/L), supporting the hypothesis that low dissolved oxygen levels in the tailrace channel were a localized issue. No low dissolved oxygen levels were observed during the 2016 monitoring season as instantaneous readings ranged from 7.06 to 10.88 mg/L (J. Guignard, FISHBIO, pers comm, 8/1/2017).

As presented in the Project Biological Assessment (TID/MID 2017h), FERC’s 1996 order (FERC 1996) amending the Don Pedro Project license requires the release of minimum flows in the lower Tuolumne River range from 50 to 300 cfs, depending on water year hydrology and time of year. The downstream flow schedule provided for by the settlement agreement and subsequent FERC Order is shown below (Table 5.1-1). Don Pedro settlement flows are routed through the Project powerhouse on right-left, and released into the powerhouse tailrace channel.

Table 5.1-1. Schedule of flow releases to the lower Tuolumne River by water year type contained in FERC's 1996 order.

Schedule	Units	# of Days	Critical and Below	Median Critical[1]	Interm. CD[1]	Median Dry	Interm. D-BN	Median Below Normal	Interm. BN-AN[2]	Median Above Normal	Interm. AN-W	Median Wet/Max
Occurrence	%		6.4%	8.0%	6.1%	10.8%	9.1%	10.3%	15.5%	5.1%	15.4%	13.3%
October 1–15	cfs	15	100	100	150	150	180	200	300	300	300	300
	ac-ft		2,975	2,975	4,463	4,463	5,355	5,950	8,926	8,926	8,926	8,926
Attraction Pulse	ac-ft		none	none	None	none	1,676	1,736	5,950	5,950	5,950	5,950
October 16–May 31	cfs	228	150	150	150	150	180	175	300	300	300	300
	ac-ft		67,835	67,835	67,835	67,835	81,402	79,140	135,669	135,669	135,669	135,669
Outmigration Pulse Flow	ac-ft		11,091	20,091	32,619	37,060	35,920	60,027	89,882	89,882	89,882	89,882
June 1–September 30	cfs	122	50	50	50	75	75	75	250	250	250	250
	ac-ft		12,099	12,099	12,099	18,149	18,149	18,149	60,496	60,496	60,496	60,496
Volume (total)	ac-ft	365	94,000	103,000	117,016	127,507	142,502	165,003	300,923	300,923	300,923	300,923

Source: FERC 1996.

[1] Critically dry.

[2] Between a Median Critical Water Year and an Intermediate Below Normal-Above Normal Water Year, the precise volume of flow to be released by the Districts each fish flow year is to be determined using accepted methods of interpolation between index values.

5.2 Salmonid Studies in the Lower Tuolumne River

The Tuolumne River downstream of the LGDD (including the Action Area) has been the subject of continuous study and evaluation related to the District-owned Don Pedro Project and its environmental effects. The Districts, in cooperation with state and federal resource agencies and environmental groups, have conducted over 200 individual resource investigations since the Don Pedro Project began commercial operation in 1971. The first 20 years of study led in 1995 to the development of a FERC-mediated settlement agreement with resource agencies and NGOs, whereby the Districts agreed to modify their operations to increase the flows released to the lower Tuolumne River for the benefit of salmonids (see Section 5.1).

On an annual basis, the Districts file with FERC, and share with the Technical Advisory Committee, results of ongoing monitoring of aquatic resources downstream of the LGDD. The up-to-date record created by the continuous process of environmental investigation and resource monitoring has produced detailed baseline information. Studies pertaining to directly or indirect to salmonid use and habitat fall into the following general categories: (1) salmon population models, (2) salmon spawning surveys, (3) seine, snorkel, and fyke net reports and various juvenile salmon studies, (4) screw trap monitoring, (5) flow fluctuation assessments, (6) smolt monitoring and survival evaluations, (7) fish community assessments (8) invertebrate reports, (9) Delta salmon salvage reports, (10) gravel, incubation, and redd distribution studies, (11) water temperature and water quality assessments, (12) instream flow incremental methodology assessments, (13) flow and Delta water export reports, (14) restoration, monitoring, and mapping, and (15) general monitoring. A complete list of studies is available upon request.

5.3 Fish Species in the Action Area

5.3.1 LGDD Headpond

In October 2012, the Districts collected baseline information on the fish community in the reach of the Tuolumne River between La Grange Diversion Dam (52.2) and Don Pedro Dam (RM 54.8) (TID/MID 2013a). This study characterized the fish assemblage in this reach of the river and supplemented what limited information was previously available from a single sampling event that occurred in 2008 (Stillwater Sciences 2009). The study area included the LGDD headpond portion of the Action Area.

In total, 133 fish consisting of 86 rainbow trout (*O. mykiss*) and 47 prickly sculpin (*Cottus asper*) were collected during the boat electrofishing sampling effort conducted in the study area. Rainbow trout made up 64.7 percent of the overall catch in the study area and lengths ranged from 85 mm to 344 mm with a mean length of 153.5 mm. Results indicated that rainbow trout were proportionally more abundant in the lower reaches of the study area.

5.3.2 Action Area Downstream of LGDD

Fall-run Chinook Salmon and *O. mykiss* were observed during 2015–2016 weir monitoring of the tailrace channel, but only fall-run Chinook Salmon were observed in the mainstem Tuolumne River portion of the Action Area. Other fish species observed near the La Grange facilities during 2015–2016 monitoring included bluegill (*Lepomis macrochirus*), carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), largemouth bass (*Micropterus salmoides*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and striped bass (*Morone saxatilis*) (TID/MID 2017b) (Table 5.3-1).

Table 5.3-1. Non-target fish species observed passing the tailrace and main channel weirs during the 2015–2016 monitoring season.

Species	Location	Estimated Length Range (cm)	First Passage Date	Last Passage Date	Passage Events	
					# Up	# Down
Striped bass	Tailrace	45-90	9/18/15	4/7/16	701	682
Carp/goldfish	Tailrace	20-90	12/24/15	4/11/16	645	407
Sacramento pikeminnow	Tailrace	15-90	9/23/15	4/15/16	277	267
	Main channel	20-40	9/27/15	2/25/16	9	5
Bluegill/sunfish	Tailrace	5-20	9/21/15	2/21/16	67	13
	Main channel	10-20	9/27/15	10/28/15	12	1
Sacramento sucker	Tailrace	45-60	10/2/15	1/24/16	3	4
Largemouth bass	Tailrace	25-60	11/2/15	2/26/16	3	1
Unidentified adult	Tailrace	30-90	10/2/15	4/13/16	212	102
	Main channel	30-50	10/21/15	10/31/15	7	5
Unidentified juvenile	Tailrace	10-25	9/22/15	3/25/16	57	36
	Main channel	10-25	9/23/15	4/13/16	52	110

Previous monitoring on the Tuolumne River documented non-native centrachids (bluegill and largemouth bass) below RM 48.0, with striped bass observed upstream to RM 51.8 (Stillwater Sciences 2012). The 2015–2016 monitoring study (TID/MID 2017b) provided the first formal documentation of these three species directly below La Grange powerhouse. On multiple occasions during the monitoring season, attempted predation events by striped bass were observed within the tailrace weir passing chute. Striped bass were observed holding in the tailrace passing chute and video monitoring shows these fish making multiple predation attempts (quick, darting actions) at juvenile fish (likely *O. mykiss* and/or pikeminnow).

6.0 FALL-RUN CHINOOK SALMON IN THE ACTION AREA

The following sections present the findings of several studies investigating the occurrence of fall-run Chinook Salmon and suitable spawning and rearing habitat in the Action Area (i.e., Tuolumne River from LGDD to the confluence with the tailrace, the Project tailrace channel, and the sluice gate channel).

6.1 Salmonid Spawning Habitat

As part of the Salmonid Habitat Mapping study conducted in the Action Area (TID/MID 2016b), the Districts determined that suitable salmonid spawning gravel is lacking in the mainstem Tuolumne River from LGDD to the confluence with the tailrace channel. Two salmonid spawning gravel patches were mapped in the tailrace channel. Only one of the two spawning gravel patches (riffle habitat unit 16; Figure 6.1-1) mapped in the La Grange powerhouse tailrace channel was determined suitable for fall-run Chinook Salmon spawning based on a pebble count D_{50} of 70 mm. The D_{50} of 112 mm, based on a pebble count within the other spawning gravel patch (riffle habitat unit 14), exceeded the suitable range for fall-run Chinook Salmon (16–78 mm).

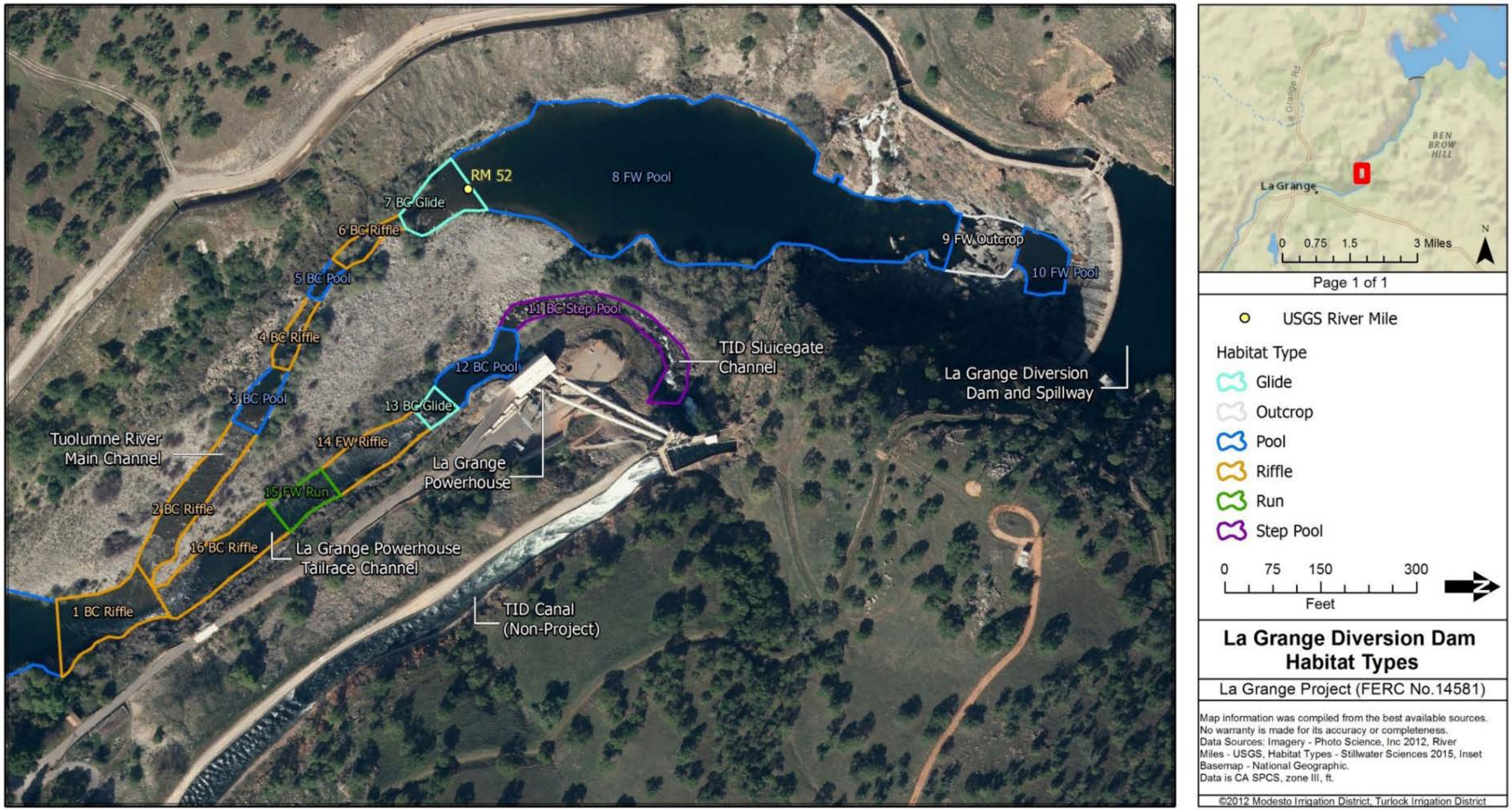

Figure 6.1-1. **Habitat types downstream of La Grange Diversion Dam (Source: TID/MID 2016b).**

For fall-run Chinook Salmon, the total area of suitable spawning gravel within the tailrace channel was estimated to be 13,610 square feet (ft^2). Of that area, a total of 9,014 ft^2 was estimated to meet the spawning depth and velocity criteria at approximately 175 cfs (Table 6.1-1). The suitable spawning habitat area for fall-run Chinook Salmon was extrapolated to current spawning flow requirements (settlement flows for October 16 – May 31) of the Don Pedro Project (FERC 1996) to estimate the maximum potential fall-run Chinook Salmon spawning population sizes. Maximum population sizes for fall-run Chinook Salmon would range from approximately 328 to 422 individuals, dependent on redd size estimates (Table 6.1-1). These maximum potential spawning population size estimates are based on the average redd size estimates from the Tuolumne River (TID/MID 2016b) and do not take into account factors related to actual spawning site selection (i.e., non-uniform habitat selection at the site-scale) or superimposition of redds constructed by later arriving spawners upon previously constructed redds.

Table 6.1-1. Estimated suitable spawning area and maximum fall-run Chinook Salmon population size in the tailrace channel.

FERC (1996) Spawning Flow Requirement (cfs)	FERC (1996) Water Year Type(s)	Suitable Spawning Area (ft^2)	Estimated Maximum Potential Fall-Run Chinook Salmon Spawning Population Size[3]	
			1988-1989 Redd Size Data[1]	2012 Redd Size Data[2]
150	Critical and below through Median Dry	8,540	328	396
175	Median Below Normal	9,014	346	418
180	Intermediate Dry-Below Normal	9,086	350	422
300	Intermediate Below Normal-Above Normal through Median Wet/Maximum	8,839	340	410

1 Based on average Tuolumne River fall-run Chinook Salmon disturbed redd area of 52 ft^2 (4.8 square meters [m^2]) (TID/MID 1992, Appendix 6).
2 Based on average Tuolumne River fall-run Chinook Salmon disturbed redd area of 43.1 ft^2 (4.0 m^2) from the *Redd Mapping Study* (TID/MID 2013c).
3 Population size is a theoretical maximum based solely on spawning area divided by redd size.

6.2 Adult Fall-Run Chinook Salmon

6.2.1 Occurrence

6.2.1.1 2015–2016 Monitoring Season

In 2015, the Districts installed two fish monitoring weirs in the Action Area as part of the Fish Barrier Assessment study (TID/MID 2017g). One weir was placed downstream of the large pool below LGDD in the Tuolumne River main channel, and a second weir was placed just below the La Grange powerhouse in the tailrace channel. Between September 23, 2015 and April 14, 2016, a total of 3,264 fall-run Chinook Salmon passage events (1,617 upstream, 1,647 downstream) were detected at the tailrace and main channel weirs. The first fall-run Chinook Salmon upstream passage was observed September 23, 2015, and the last fall-run Chinook Salmon was observed February 15, 2016. The majority of passage events (89.7 percent) occurred in

November and December, accounting for 48.0 percent and 41.7 percent of fall-run Chinook Salmon passages, respectively.

Individual fish were identified based on estimated fish length, sex, and general morphological characteristics. Though subjective in nature, the researchers were confident in this approach. Further identification of individual using other methods (e.g., trapping, tagging) would require extensive handling and stress, neither of which is recommended at spawning sites. This classification resulted in a total of 105 individual fall-run Chinook Salmon accounting for the 2,329 passages at the tailrace channel weir, and a total of 12 fall-run Chinook Salmon accounting for the 935 passages at the main channel weir. Sex was determined for nearly all passages and consisted of 82 males and 35 females, with 28.2 percent (number=33) of the fish having a clipped adipose fin (ad-clipped). Based on morphological characteristics, it is likely that some individuals may have been detected at both weirs.

Økland et al (2001), as cited in Reischel and Bjornn (2003), identified three migration phases of Atlantic salmon migrating in a free-flowing river. The first was migratory, the second and most common phase was search (moving upstream or back downstream), and finally a holding phase near the spawning area. During the Project weir study, individual fall-run Chinook Salmon often made multiple, consecutive upstream and downstream passages. These passages were likely of the “search” variety. The mean number of upstream/downstream passage events for individual salmon at the tailrace weir was 10.8 (range: 1 to 54 passages), and at the main channel weir was 38.8 (range: 1 to 111 passages). The mean time from initial passage through final passage was 119 hours (4.98 days), and ranged from 0.37 hours to 823.89 hours (34.33 days) at the tailrace weir. The mean time from initial passage through final passage was 183.87 hours (7.66 days), and ranged from 4.83 hours to 491.28 hours (20.47 days) at the main channel weir.

Of the individual salmon observed during the 2015–2016 monitoring season, most (85.5 percent) spent less than 10 days near the La Grange facilities, with 21.4 percent (number=25) spending less than 24 hours near the La Grange facilities (TID/MID 2017g). This is consistent with typical observations of a lag of 1-2 weeks between arrival on the spawning grounds and spawning as documented by comparison of weir counts and redd mapping conducted by the Districts (Becker et al. 2016; FISHBIO unpublished, cited in TID/MID 2017g) and by live counts and redd counts reported by CDFW (O’Brien 2008).

6.2.1.2 2016–2017 Monitoring Season

During monitoring of the Action Area from September 15, 2016 through January 1, 2017, fall-run Chinook Salmon were observed in the tailrace channel between October 20, 2016 and December 31, 2016; daily counts ranged from 0 to 50. Adult fall-run Chinook Salmon were regularly observed in the sluice gate channel between October 20, 2016 and December 2, 2016; daily counts ranged from 0 to 30. Adult fall-run Chinook Salmon were also observed in the main channel between November 4, 2016 and December 29, 2016; daily counts ranged from 0 to 7.

6.2.2 Spawning

The Districts conducted bi-weekly redd surveys in the Action Area during the 2015–2016 and 2016–2017 fall-run Chinook Salmon spawning seasons. During surveys from October 14, 2015 through April 6, 2016 a single fall-run Chinook Salmon redd was identified in the tailrace channel on November 30, 2015 (Figure 6.2-1). Based on levelogger data, this redd was not dewatered during the monitoring season (Figure 6.2-2). During redd surveys conducted during the 2016–2017 spawning season, a total of 11 fall-run Chinook Salmon redds were identified from mid- to late-November in the tailrace channel. Although the Salmonid Mapping Study (TID/MID 2016b) identified no suitable spawning gravel in the main channel portion of the Action Area (see Section 6.1), two fall-run Chinook Salmon redds were identified in the main channel in mid-November, just upstream of the temporary weir location (Figure 6.2-1). Although flood control releases made the levelogger inaccessible for data download from December 2016 through January 1, 2017, high flows (3,000- 9,000 cfs) were measured during this period in the tailrace. Considering these flows, it is unlikely that redds were dewatered during the monitoring season.

6.2.3 Stranding

During the Fish Presence and Salmon Stranding Assessment (TID/MID 2017b), the La Grange powerhouse tripped offline, and the TID sluice gate opened, 18 times during the 2015–2016 monitoring season (September 23, 2015 through April 15, 2016). The powerhouse tripped offline and the sluice gate opened 11 times during the 2016–2017 monitoring season (September 15, 2016 through January 1, 2017). The duration of flow events in the sluice gate channel (above the minimum flow maintained at all times) ranged from 0.25 to 505.5 hours (median 40.5 hours) in 2015–2016, and 1.0 to 29.75 hours (median 10.0 hours) in 2016–2017.

During both survey seasons, TID operators and a qualified biologist were on-site and surveyed the channel for stranded fish each time the sluice gate was closed and flow was reduced to the minimum flow of approximately 5 to 10 cfs through the existing 18-inch pipe. On three occasions during the 2015–2016 monitoring season, fish were documented in the sluice gate channel during stranding surveys, with five adult fall-run Chinook Salmon observed. Three fish were relocated to the tailrace channel, one fish swam into the tailrace channel volitionally, and a single, unspawned female salmon carcass was recovered on December 25, 2015. This salmon mortality likely occurred after sluice gate event #10 on December 23, 2015. No fish were observed in the sluice gate channel during the December 24 stranding survey; however, it is possible that this fish was near the channel margin under heavy vegetation. Although this fish was not observed during the December 24 stranding survey, it likely entered the sluice gate channel on December 23 during a powerhouse outage event when approximately 155 cfs flowed down the channel for 1.25 hrs. When the carcass was found on December 25, it showed signs of fresh predation, and had likely been moved into the center of the channel where it was discovered. The recovered salmon carcass was frozen and turned over to CDFW (La Grange field office).

Fish were documented in the sluice gate channel on four occasions during the 2016–2017 monitoring season, with counts ranging from 2-20 adult fall-run Chinook Salmon. On all occasions it was determined that fish were in good condition with low risk of becoming stranded due to sufficient egress to the tailrace channel; therefore, relocation was not attempted.

In summary, adult fall-run Chinook Salmon were documented to enter the sluice gate channel during periods when the sluice gates were opened and at minimum flow conditions during both monitoring seasons. Given that a minimum flow of 5 to 10 cfs is currently maintained in the sluice gate channel, stranding of fish in this channel is believed to be rare. During the two-year monitoring season, stranding was limited to a single event during the 2015–2016 monitoring season.

Figure 6.2-1. Location of fall-run Chinook Salmon redds identified in the Project tailrace and main channels during the 2015–2016 and 2016–2017 monitoring season.

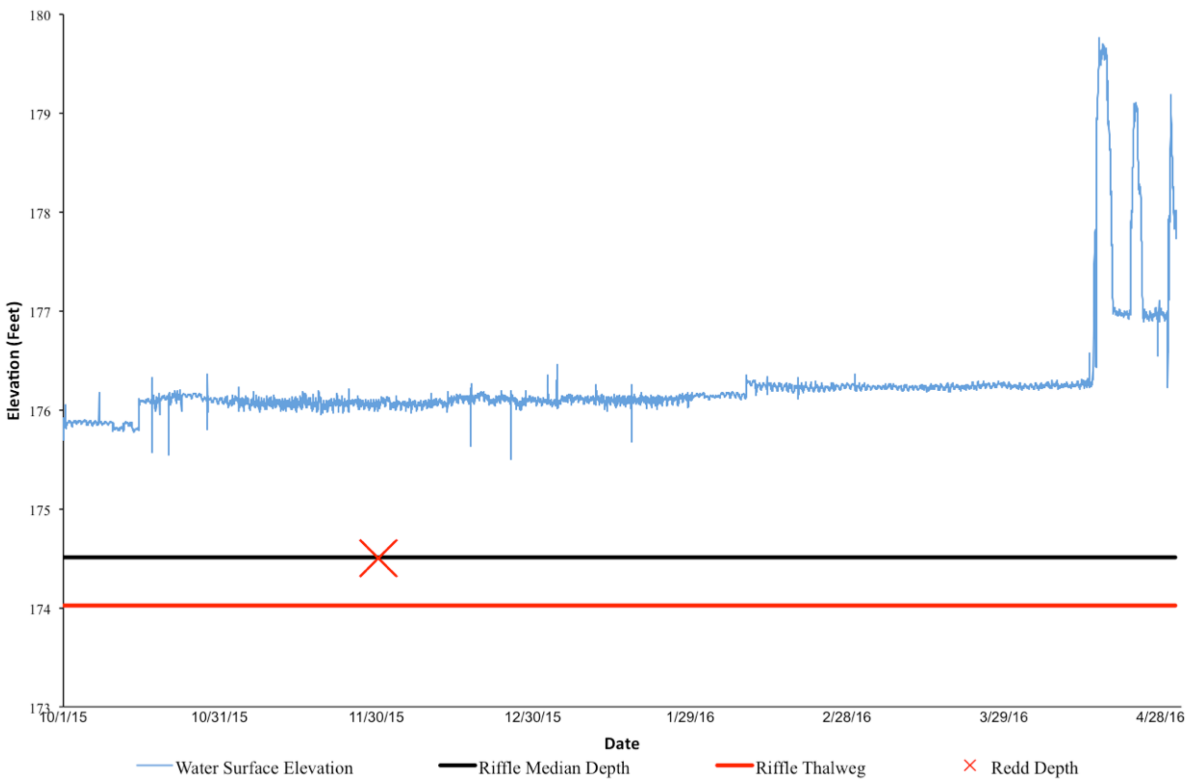

Figure 6.2-2. Tailrace channel water surface elevation levelogger data for the 2015–2016 monitoring season.

6.3 Juvenile Rearing Habitat

Juvenile fall-run Chinook Salmon were not observed passing through temporary monitoring weirs in the tailrace and mainstem channels of the Action Area during the Fish Barrier Assessment (TID/MID 2017g) conducted from September 23, 2015 through April 14, 2016. However, only one fall-run Chinook Salmon redd was observed during the 2015–2016 monitoring season (TID/MID 2017b). Similarly, only adult fall-run Chinook Salmon were observed during the Fish Presence and Stranding Assessment (TID/MID 2017b) conducted from September 15 through January 1, 2017. During the 2016–2017 monitoring season, a total of 13 fall-run Chinook Salmon redds were observed in the Action Area (see Section 6.2.2). Therefore, had monitoring continued into the spring of 2017, it is reasonable to presume that juveniles would have been observed following emergence from redds in the tailrace channel.

As presented in Section 4.2.2, Stillwater Sciences (2013) determined that juvenile rearing habitat is optimized between 50 and 300 cfs in the lower Tuolumne River. As stated in Section 5.1 and presented in Table 5.1-1, the flow release schedule for Don Pedro settlement flows mandates the release of 50 to 300 cfs downstream of LGDD through the Project powerhouse. Therefore, released flows meet fall-run Chinook Salmon n rearing requirements in the tailrace channel. Based on this, and the observed spawning of fall-run Chinook Salmon in the tailrace channel and lower portions of the mainstem in the Action Area, rearing habitat for juvenile fall-run Chinook Salmon is supported in the Action Area downstream of LGDD.

7.0 DIRECT AND INDIRECT EFFECTS OF PROPOSED ACTION ON PACIFIC COAST SALMON EFH

7.1 Effects of Continued Hydroelectric Power Generation on EFH

The Tuolumne River and all accessible waters downstream of the LGDD are designated as EFH for Pacific Coast Salmon (i.e., fall-run Chinook Salmon). Therefore, continued hydroelectric power generation has the potential to affect EFH. Direct effects are primarily related to hydraulic and water quality impacts from the passing of flows through the units and into the powerhouse tailrace. Such flows, however, will occur whether or not the generation of electricity occurs at the TID powerhouse because the powerhouse would likely be retrofit to continue passing flows through the installation of pressure reduction valves in the powerhouse unit bays. Although the Project may affect EFH in the Action Area downstream of the LGDD, for the reasons described below, typical Project hydropower operation will not adversely affect EFH. Typical Project operations will not adversely affect flows, instream temperature, water quality, or substrates used for Chinook Salmon spawning, feeding, or growth to maturity in the Action Area.

When the powerhouse is off-line and not generating power (either a planned or unplanned unit or station trip), remote operators immediately open the sluice gates to ensure flows continue to be passed downstream without interruption, as usual and customary for a run-of-river facility. Coordinated and rapid opening of the sluice gates during powerhouse outages minimizes the likelihood that unscheduled outages will adversely affect EFH for Pacific Coast Salmon in the Action Area.

7.1.1 Power Generating Operations: Powerhouse On-Line

Electric power is generated at TID's La Grange powerhouse using all or a portion of flows at LGDD that are not diverted for water supply purposes at LGDD. For example, releases occurring from Don Pedro Reservoir to meet the instream flow requirements of the Districts' FERC license may be passed through the TID powerhouse units for the purpose of generating electricity.

The turbines and draft tubes remove energy from water passing through the powerhouse and convert it to electricity. This minimizes the remaining energy in the discharge from the powerhouse and, given the predominately cobble nature of substrates in the tailrace channel, does not create turbidity at the discharge. Aside from localized hydraulic effects (e.g., turbulence) occurring at the immediate powerhouse exit, hydroelectric generation at the Project does not impact water quality in the Action Area downstream of the LGDD. Further, based on the studies conducted as part of the La Grange FERC licensing process, including temporary weir monitoring (TID/MID 2017b), there is no evidence that such localized turbulence has any adverse effect on fall-run Chinook Salmon use or occurrence in the Action Area. Absent a FERC license to continue operating TID's two turbine-generator units, , the most likely future condition would be for flows not diverted for water supply to continue to be diverted through the penstocks and powerhouse via PRVs installed in the powerhouse.

Turbulent waters at the immediate exit from the powerhouse are generally stable and of low energy, and are unlikely to create conditions that are adverse for juvenile fall-run Chinook Salmon rearing. Further, the observed presence of spawning adults and redds near the powerhouse exit (TID/MID 2017b) indicates that powerhouse flows do not adversely affect spawning in the tailrace channel.

Because Project operations do not include hydropeaking, there exists little likelihood of stranding due to rapid changes in generation. Finally, the Draft Tube Study (TID/MID 2017d) (also corroborated by daily field observations from the Fish Presence and Stranding Assessment [TID/MID 2017b]) indicates that the risk of fish entering unit draft tubes while in operation and being injured by the turbine runners is extremely low.

Water quality downstream of the powerhouse would not be affected by hydropower generation at the La Grange powerhouse. The physics of the passage through the powerhouse do not facilitate changes in dissolved oxygen or other gases. No new dissolved oxygen or other gasses are introduced at the powerhouse, and no stripping of gasses occurs at the powerhouse. At the La Grange powerhouse, there exists no plunging flow over spillways, and thus no entrained air is captured in the spill or forced under high pressure to become supersaturated and then taken in by fish. Dissolved oxygen monitoring proposed in the Action Area will further inform this issue.

7.1.2 Non-Power-Generating Operations: Powerhouse Off-Line

If there is a unit or station trip at the TID powerhouse (planned or unplanned), the powerhouse is off-line and not generating power. During the Fish Presence and Salmon Stranding Assessment (TID/MID 2017b), the La Grange powerhouse tripped offline, and the TID sluice gate opened, 18 times during the 2015–2016 monitoring season (September 23, 2015 through April 15, 2016) and 11 times during the 2016–2017 monitoring season (September 15, 2016 through January 1, 2017). During these off-line periods, a TID Control Center operator immediately opens the sluice gates. This remote gate opening provides flow to the tailrace channel in less than one minute (Guignard, pers comm, 8/1/2017) and makes certain flows continue downstream with minimal interruption. The coordinated and rapid opening of the sluice gates during powerhouse outages minimizes the likelihood for adverse effects on EFH in the tailrace channel during off-line operations.

Despite this coordinated response protocol, over the 50-year term of the Project license, it is possible that a remote operator could fail to respond immediately, resulting in a delay in sluice gate opening. Such a delay could result in temporary dewatering of the tailrace channel or a temporary reduction in the wetted width or depth of the tailrace. Although highly unlikely, if this occurs, Pacific Salmon EFH in the tailrace channel could be adversely affected for a brief period of time. Adverse effects on EFH could include a reduction or loss of available spawning or rearing habitat for fall-run Chinook Salmon, if the tailrace channel is occupied by individuals during the power outage. Depending on the duration of the delay, stranding could occur. For the purposes of this assessment, the Districts assume such an operator delay could occur twice over the course of the 50 year license term. It should be noted that no such delay has occurred in the last 30 years of sluice gate operation.

At the request of NMFS and FERC as part of the Don Pedro Project relicensing, the Districts evaluated changes river stage at the La Grange gauge located just downstream of LGDD during both generating and non-generating periods. This evaluation demonstrated that changes in stage were less were less than 2 inches (0.17 foot) up or down 99.4 percent of the time, less than 4 inches (0.33 foot) 99.9 percent of the time, and less than 8 inches (0.67 foot) 99.99 percent of the time. One hour stage change is less than 2 inches up or down 96.6 percent of the time, less than 4 inches 99.0 percent of the time, and less than 8 inches 99.8 percent of the time (TID/MID 2017b). Relative to use of EFH in the tailrace channel, these changes in downstream hydrologic conditions would not lead to stranding or redd dewatering.

Water level data collected in the tailrace channel during the Fish Presence and Stranding Assessment conducted from 2015-2017 (TID/MID 2017b) has shown that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline, resulting in a relatively stable flow in the tailrace channel. Based on water level data recorded at 15-minute intervals, the maximum elevation change between readings was 0.57 foot during the 2015–2016 monitoring season. Due to the extended high flow period beginning January 2, 2017, the levelogger in the tailrace channel has been inaccessible for data download during the 2016–2017 monitoring season. However, it is expected that only minimal elevation changes occurred during this season. Given that the sluice gates open immediately when the La Grange powerhouse trips offline, there is minimal risk for redd dewatering or stranding in the tailrace channel during these periods.

An additional consideration is that, under the Proposed Action, the addition of a fish barrier at the sluice gate channel (PM&E measure, discussed below) would prevent the entry of fall-run Chinook Salmon into the channel during periods when the powerhouse is offline. This measure would therefore eliminate the potential for stranding of individual fall-run Chinook Salmon in the sluice gate channel. Based on the information presented above, during periods when the powerhouse is offline and not generating power, the Project may result in minimal but adverse effects on EFH (i.e., will adversely affect) in the tailrace channel.

7.2 Effects of Proposed Aquatic PM&E Measures on EFH

As detailed in Section 2.2, the Districts are proposing to implement three PM&E measures for the benefit of aquatic resources and their habitat, including EFH for Pacific Coast Salmon, in the Action Area. Implementation of these measures may affect EFH in the Action Area. Effects are discussed in the following subsections.

7.2.1 Sluice Gate Channel Fish Barrier Construction and Operation

7.2.1.1 Construction Effects on EFH

As discussed in Section 2.2.1, the Districts would construct a fish barrier near the downstream end of the existing sluice gate channel (see Attachment B of the LaGrange Hydroelectric Project Biological Assessment for a conceptual plan) and close the existing 18-inch pipe that continuously releases a flow of 5 to 10 cfs to the channel. The barrier would be designed to NMFS (2011) salmonid passage and screening criteria to prevent impingement or entrainment.

Closure of the 18-inch pipe would prevent fish from being attracted into the sluice gate channel by the continuous flow released from the pipe, and the fish barrier would prevent fish from entering the sluice gate channel at all times. Based on the periodicity of salmonids in the lower Tuolumne River, and allowable windows established for in-water work in the Central Valley (USACE et al. 2006), the fish barrier would be installed over a period of 8 weeks during a July 15 – mid-September in-water work window.

As discussed in Section 2.2.1.1, the fish barrier would be constructed in the dry. Prior to in-water construction, flow would be shut off to the sluice gate channel and sandbags would be installed to isolate the work area. Fish would be herded from work area prior to gate closure, and remaining fish would be salvaged from the work area prior to cofferdam closure. Following sluice gate closure, about 75 cfs would be routed to river right, through the MID canal and the MID Hillside Discharge. A connecting channel would be excavated between the plunge pool below LGDD and the tailrace to connect these two waterbodies, allowing the 75 cfs routed through the MID Hillside Discharge to continuously water the tailrace channel (see Attachment B of the LaGrange Hydroelectric Project Biological Assessment). These activities, including dewatering of the in-water work area, would temporarily reduce the availability of EFH for fall-run Chinook Salmon in the in-water work area.

Effects on EFH: Waters and Substrate Necessary for Spawning and Breeding

As discussed in Section 6.2.2, fall-run Chinook Salmon are documented to spawn in the tailrace channel downstream of the fish barrier construction area. Although adult fall-run Chinook Salmon may begin upstream migrations into the Tuolumne River as early as August, recent monitoring of the tailrace channel indicates that they do not enter the Action Area until late October (see Section 6.2). Further, spawning in the tailrace typically occurs from mid-November through December. Based on this timing, there is an exceedingly low likelihood that migrating adult fall-run Chinook Salmon would be present in the Action Area during the July 15 through mid-September in-water work window.

All construction-related materials would be removed from the tailrace channel by mid-September, approximately two months prior to the first spawning of fall-run Chinook Salmon in the tailrace channel based on recent observations in the Action Area (Section 6.2.2). Based on this timing, no effects are anticipated on adult fall-run Chinook Salmon, including migratory and spawning fish. Affected portions of the tailrace channel near the trench excavation site would be returned to pre-construction conditions (e.g., contours and substrates). Therefore, no construction-related impacts on suitable spawning habitat (i.e., EFH) would occur. The placement of a turbidity curtain at the downstream exit of the tailrace channel during trench excavation and backfill would limit the introduction of fine sediments to downstream habitats. Any potential fines resulting from trench backfill would be flushed from the channel by flows released from the powerhouse for a period of two months prior to observed spawning periods in the tailrace channel. Therefore, construction of the fish barrier at the sluice gate channel will not adversely affect EFH used for migration or spawning fall-run Chinook Salmon.

Effects on EFH: Waters and Substrate Necessary for Feeding or Growth to Maturity (i.e., juvenile rearing)

As presented in Section 4.1.3, fall-run Chinook Salmon typically rear in the Tuolumne River from January to May (TID/MID 2013b). No juveniles were observed during recent monitoring at weirs in the tailrace channel and mainstem Tuolumne River in the Action Area (Section 6.3; TID/MID 2017g). However, low numbers of over-summering juveniles have been observed downstream of the La Grange gauge (RM 51.7) during snorkel surveys in most years (TID/MID 2013d). Based on the observation of over-summering juveniles near the Action Area, and documented spawning in the Action Area, it is reasonable to assume that fall-run Chinook Salmon may utilize EFH in the Action Area for feeding and growth. Therefore, construction of the proposed fish barrier at the sluice gate channel has the potential to affect occupied EFH that is used by rearing fall-run Chinook Salmon. Potential effects are described by topic, below.

Temporary Habitat Alteration

Approximately 11,409 square feet of instream habitat would be isolated and therefore inaccessible for rearing during in-water construction of the fish barrier. With the exception of the isolated work area, the quantity of rearing habitat in the tailrace channel would not be affected during construction. As presented above, approximately 75 cfs would be routed into the tailrace channel during construction. This quantity of flow is consistent with the June 1 through September 30 schedule of flow releases from the Don Pedro Project to the lower Tuolumne River at LGDD, as mandated by FERC's 1996 order. This flow would make certain that the tailrace channel remains watered and continues to support EFH for Pacific salmonid rearing during in-water work.

Sediment

Sediment releases caused by machinery operating in the sluice gate and tailrace channels during fish barrier isolation and connecting channel excavation may degrade EFH rearing habitat downstream of the in-water work areas. Potential negative effects would be minimized by the relatively short duration of in-water work, and by conducting instream work behind sandbags (i.e., "in the dry") during the summer work window. To further minimize potential adverse effects from sedimentation, a turbidity curtain would be installed at the downstream exit to the tailrace prior to the final downstream cut for the temporary trench connecting the plunge pool with the tailrace. The temporary connecting channel would be opened incrementally to reduce the downstream sediment pulse into the tailrace channel. Following construction of the fish barrier, a similar curtain would be placed at the downstream exit prior to backfill of the connecting channel.

Potential sediment introduction and transport would be a temporary rather than chronic concern. Once construction is complete and the channel is returned to pre-construction conditions (e.g., contours and substrates), the risk of sediment introduction would be removed. As such, construction of the fish barrier will not adversely affect EFH used by fall-run Chinook Salmon for feeding and growth to maturity.

Petroleum and Concrete

The use of instream machinery has the potential to introduce fuel or oil into the Action Area. The risk of such inadvertent introduction is risk is greatly minimized with the implementation of the spill prevention, containment, and control plan included in Section 2.2.1.1. With implementation of this plan, no adverse effects on EFH would occur.

7.2.1.2 Long-Term Effects of Fish Barrier on EFH

Construction of the fish barrier would permanently block access to 11,490 square feet (383 linear feet by an average width of 30 feet) of step-pool habitat in the sluice gate channel dominated by bedrock. This habitat is not suitable spawning habitat for fall-run Chinook Salmon and not ideal for juvenile rearing. This terminal habitat is unlikely to provide measurable function to EFH in the Action Area. Therefore, the loss of habitat in the channel upstream of the barrier will not adversely affect rearing potential in the Action Area.

7.2.1.3 Sluice Gate Operations During High Flows

As described in Section 2.2.1.1, during high flow events, spillway flows greater than 7,000 cfs at LGDD would overflow into the sluice gate channel, allowing fish to access the channel upstream of the fish barrier. As these flows recede to less than 7,000 cfs, the 18-inch pipeline would be opened, and spill flows would exit the sluice channel. Opening of the 18-inch pipeline would prevent dewatering of the sluice channel, but any fish that accessed the sluice channel during high flows would be isolated from the tailrace channel. Therefore, fish salvage operations would be necessary to relocate fish to the tailrace channel. Salvage operations conducted in a manner similar to that described for initial construction of the fish barrier.

Unlike initial fish barrier construction, which would occur in the summer when anadromous adult fall-run Chinook Salmon are not present, high flow events could occur in the spring when rearing juvenile fall-run Chinook Salmon could be present. Under these circumstances, EFH that is occupied by juvenile fall-run Chinook Salmon could be affected during fish salvage and relocation activities required to remove fish upstream of the fish barrier. Effects on EFH supporting feeding and growth of fall-run Chinook Salmon would be similar to those described under Section 7.2.1.1. Based on historic hydrographs (water years 1971-2012, USGS gauge 11289650), flow events exceeding 7,000 cfs are estimated to occur at a frequency of about once every five years.

7.2.2 Continuous Surface Water Release to LGDD Plunge Pool

As detailed in Section 2.2.2, the Districts would formalize an operation that they have voluntarily conducted in past years. The Districts would continuously release 5 to 10 cfs of surface water into the LGDD plunge pool to maintain dissolved oxygen and reduce instream temperatures in the reach of the mainstem Tuolumne River within the Action Area downstream of the LGDD. This 5 to 10 cfs of surface water is typically routed to the plunge pool through Portal No. 1 in the dam, over the spillway, or via the river-right MID Hillside Discharge. The releases would occur 24-hours a day, every day of the year. Similar to existing conditions, surface water would be released into plunge pools below the MID Hillside Discharge, Portal No. 1 in the dam, or the LGDD spillway.

This measure would cause localized, short-duration turbulence at the discharge location. Although this reach of the mainstem Tuolumne River is designated as EFH for Pacific salmonids, it is highly unlikely to provide spawning, breeding, feeding, or rearing habitat for fall-run Chinook Salmon. As presented in Section 4.1.2, although several fall-run Chinook Salmon redds have been observed in the reach of the mainstem immediately downstream of the LGDD plunge pool, potential sediment from this surface water release is highly unlikely to be measurable at the observed spawning sites. Further, given the depths of the plunge pool and the predominately cobble nature of the substrate (see Section 5.1), turbidity is expected to be minimal. Therefore, the release of water from MID Hillside Discharge, Portal No. 1 in the dam, or the LGDD spillway will not adversely affect occupied EFH in the Action Area.

The overall effect of this PM&E measure on EFH in the Action Area is expected to be positive. EFH would benefit from the introduction of cooling waters, and maintenance of dissolved oxygen in downstream rearing, spawning and migration habitats in the mainstem Tuolumne River portion of the Action Area. The introduction of these flows could also increase the amount of rearing and foraging habitat in the Action Area, although this increase is likely insignificant.

7.2.3 Dissolved Oxygen Monitoring

As presented in Section 2.2.3, the Districts propose to monitor dissolved oxygen from September 1 to November 30 each year for the first 2 years of a new operating license. Monitoring equipment would collect dissolved oxygen information at 15 minute intervals at three locations; the Project forebay, immediately below the powerhouse, and at the lower end of the tailrace channel. The Districts would install monitoring equipment at the end of August, and remove equipment in early December. The installation of such equipment would require the temporary presence of staff at the three monitoring locations for less than one day. This PM&E measure would not effect EFH in the Action Area.

8.0 INTERRELATED AND INTERDEPENDENT ACTIONS

The Proposed Action is FERC issuance of an original license to allow for the continued generation of hydroelectric power at existing facilities downstream of LGDD. Upstream surface water diversions for irrigation and M&I uses and the discharge of Don Pedro settlement flows downstream of LGDD are in no way dependent on the issuance of a FERC license for the Project, and would occur with or without the licensing of the Proposed Action. Therefore, these uses are *not* interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. As discussed in Section 2.0, if FERC does not issue the Districts a license to continue hydroelectric generation at LGDD (i.e., No Action alternative), Don Pedro settlement flows would still be released downstream. The location of the release would be determined in the future, but it is anticipated that flows could still be routed through the powerhouse because it could be retrofitted to allow required flows to pass through the facility without generation.

Because the Districts are consulting with NMFS on the Proposed Action, and power would be generated as it has historically (i.e., the effects of generation would be equivalent to those occurring under existing conditions, so there would be no incremental effects on EFH in the Action Area), the effects of the aforementioned non-hydropower water uses are addressed as independent actions in the cumulative effects analysis of this EFH assessment (see Section 9.0). Other than the proposed PM&E measures, which are part of the Proposed Action, the Districts are aware of no other actions that have the potential to affect EFH in the Action Area that could be considered related to or interdependent with the Proposed Action to continue hydroelectric power generation at the Project.

9.0 CUMULATIVE EFFECTS ON PACIFIC COAST SALMON EFH

A comprehensive analysis of cumulative effects in the Tuolumne River is provided in the La Grange Hydroelectric Project Biological Assessment (TID/MID 2017h). Attachment C of the Biological Assessment presents a robust chronology of actions that have cumulatively affected Pacific Coast Salmon EFH in the Tuolumne River basin, including the Action Area. This section focuses on non-federal activities that directly affect instream habitat in the Action Area, specifically, flow-management at the upstream Don Pedro Dam, the LGDD, and irrigation diversions at the LGDD.

9.1 Past, Present, and Future Actions Affecting the Action Area

The Tuolumne River basin has been affected by substantial resource use and land and water management activities over the past 150 years. Eight dams and reservoirs are located on the Tuolumne River and its tributaries, with a combined storage capacity of about 2,777,000 AF. Seven of these dams are located upstream of the Project. The lower Tuolumne River below LGDD is directly affected by the operations of LGDD, the primary purpose of which is to divert water into the Districts' two irrigation canals.

9.1.1 Flows Released Downstream of Don Pedro Dam

Don Pedro Dam is a 1,900-ft-long and 580-ft-high, zoned earth and rockfill structure. The top of the dam is at an elevation of 855 feet (National Geodetic Vertical Datum 29). Don Pedro Reservoir extends upstream for approximately 24 miles at its normal maximum water surface elevation of 830 feet. In a typical year, water surface elevation in Don Pedro Reservoir peaks in late June/early July at the end of the snowmelt runoff, and is then steadily drawn down over the summer and fall to serve water supply and lower Tuolumne River fish protection needs. Rainfall and snowmelt runoff resumes in December.

Water is released downstream of Don Pedro Dam for only three reasons: (1) to provide water needed to meet the Districts' irrigation and M&I demands at LGDD, (2) for flood management purposes, and (3) to meet the license requirements for fish protection flows in the lower Tuolumne River. In general, flow release operations follow a relatively consistent annual cycle of water management for flood control; capturing runoff from snowmelt and seasonal rainfall; delivery of water to meet irrigation, municipal, and industrial needs; and providing scheduled releases for the protection of anadromous and resident salmonids in the lower Tuolumne River.

FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of the lower Tuolumne River minimum flow provisions contained in the 1995 settlement agreement between the Districts, CCSF, resource agencies, and environmental groups. The revised minimum flows in the lower Tuolumne River vary from 50 to 300 cfs, depending on water year hydrology and time of year. The water year classifications are recalculated each year to maintain an approximately consistent frequency distribution of water year types over time. The settlement agreement and license order also specified certain pulse flows for the benefit of upstream migrating adult salmonids and downstream migrating juveniles, the amount of which also varies with water-year type. The downstream flow schedule provided for by the settlement agreement and subsequent FERC Order is part of the environmental baseline and was presented in table 4.2-1. These required release flows contribute positively to cumulative effects on EFH in the Action Area, and would continue regardless of whether or not the Project is licensed.

9.1.1.1 La Grange Diversion Dam and Irrigation Diversions

As presented in Section 1.3, the Districts constructed LGDD from 1891 to 1893. The LGDD replaced Wheaton Dam, which was built by other parties in the early 1870s. LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID.

The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. LGDD provides no flood control benefits, and no recreation facilities are associated with the Project or the La Grange headpond. From 1971 to 2012, the average annual water diversion at LGDD to the Districts canals was approximately 900,000 AF. Diversions for irrigation can occur year round, but generally occur from late February to early November. This non-Project water management contributes to cumulative effects on EFH in the Action Area by diverting water upstream of the Action Area, thereby reducing flow and the quantity of habitat downstream of the LGDD.

The maintenance and operation of LGDD for irrigation diversion has directly affected flows in the Action Area since 1893, thereby influencing water resources and, as a result, EFH for Pacific Coast Salmon in the Action Area. The direct effects resulting from these non-Project irrigation operations at LGDD occur whenever all flows, except FERC-required minimum flows for the Don Pedro Project, are diverted to meet the needs of the Districts' water users. During flood management periods at Don Pedro Dam that coincide with water diversions, non-Project LGDD irrigation operations contribute to cumulative effects in the Action Area. However, during flood management periods when there are no irrigation diversions, cumulative effects in the Action Area are due to flood management requirements alone.

The presence of the LGDD has affected channel morphology immediately downstream of the LGDD, including the Action Area. The channel downstream of LGDD is characterized by down-cutting, widening, armoring, a lack of large woody debris, and depletion of sediment storage features (e.g., lateral bars and riffles) due to the cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses (California Department of Water Resources [CDWR] 1994; McBain and Trush 2004).

9.2 Cumulative Effects Specific to Habitat for Fall-Run Chinook Salmon

Studies conducted in the Tuolumne River indicate that a lack of salmonid spawning gravel and curtailed sediment recruitment, due to in-river and floodplain mining, trapping by upstream dams, and other land uses, may result in density-dependent competition and exclusion from suitable spawning sites and may limit the number of female fall-run Chinook Salmon that successfully spawn in the lower Tuolumne River (TID/MID 1992, 2000, 2001). Fall-run Chinook Salmon appear to be limited by spawning habitat availability due to high spawning densities in wet years, and due to both low and high fish densities during dry years (TID/MID 2017a). Upstream reaches affected by gold dredger mining in the early part of the century (RM 50–47) were "reconfigured" following removal of dredger tailings for construction of the new Don Pedro Dam, and this reach currently supports the majority of fall-run Chinook Salmon spawning activity (TID/MID 2013b).

Although there is the potential for fall-run Chinook Salmon redd scouring to occur during flood events, minimum spawning flows required by FERC have reduced the risk of redd dewatering (TID/MID 2013b). The risk of mortality due to redd scour, redd dewatering, and entombment is considered to be low in the Tuolumne River due to current operations and reduced fine sediment supply in much of the spawning reach (TID/MID 2013b).

Floodplain access for rearing juvenile fall-run Chinook Salmon is limited in the lower Tuolumne River due to flows and habitat modification. During floodplain habitat modeling conducted by the Districts (TID/MID 2017i), total usable habitat, including both in-channel and floodplain areas, was demonstrated to steadily increase with increasing discharge in the upper reach of the study (RM 52.2–40), but total habitat area becomes limited at intermediate discharges in the reaches downstream of RM 40. This is because reductions in suitable main channel habitat (primarily as the result of unsuitable water velocities) are not offset by increases in floodplain habitat.

Because current Don Pedro Project operations do not include power peaking, potential risk of juvenile fall-run Chinook Salmon stranding and entrapment are low. Some stranding may occur during flow reductions following flood control releases; however, the low frequency of these flood events in combination with ramping rate restrictions required by the current FERC license likely result in a low risk of fish mortality due to stranding and entrapment (TID/MID 2013b). A comprehensive evaluation of stranding surveys was conducted on the lower Tuolumne River (TID/MID 2000) and is summarized in the 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs (i.e., the range of flows under which the floodplain is inundated in several areas of the fall-run Chinook Salmon spawning reach).

Special Run Pools, created by in-channel mining, can be up to 400 feet wide and 35 feet deep and occupy approximately 32 percent of the length of the channel in the gravel-bedded zone (RM 52–24). These habitat features harbor non-native fish, such as introduced largemouth and smallmouth bass that prey on juvenile salmonids. Introduced predators have been, and continue to be, most abundant in large, slow-moving areas prevalent in the middle section of the lower river, downstream of the major fall-run Chinook Salmon spawning areas (Orr 1997). It is likely that the present pattern and degree of predation mortality for fall-run Chinook Salmon juveniles in the Tuolumne River is to a large extent a result of past sand and gravel mining coupled with the introduction by CDFW of non-native piscivorous fish species (Orr 1997).

9.3 Assessment of Cumulative Effects of the Proposed Action on Pacific Coast Salmon EFH

The Proposed Action would not contribute to cumulative effects on Pacific Coast Salmon EFH in the Action Area. The LGDD, associated irrigation diversions, and flow releases from Don Pedro Dam would continue to affect the Action Area, and thereby EFH, regardless of the Proposed Action. Therefore, hydropower operations at the Project powerhouse using surface water that would be passed downstream of the LGDD regardless of the Project do not contribute to cumulative effects on Pacific Coast Salmon EFH in the Action Area.

10.0 CONCLUSIONS

The short-term, temporary effects on EFH from construction of the proposed fish barrier would not result in long-term measurable physical, biological, or chemical changes water quality or quantity, or substrates used by fall-run Chinook Salmon for spawning, breeding, feeding, or growth to maturity. The permanent loss of a minor amount of EFH upstream of the proposed fish barrier (in the sluice gate channel) is not an adverse effect on EFH because the habitat does not provide waters or substrates necessary for spawning, breeding, feeding or growth to maturity. Nor does the affected reach, primarily comprised of step-pool bedrock, support habitat for benthic organisms that may provide prey for EFH-managed species in the Action Area (i.e., fall-run Chinook Salmon).

With implementation of the proposed PM&E measures, continued hydropower generation at the La Grange powerhouse would not measurably reduce surface water quality or quantity in the Action Area. This is because hydropower is generated at the La Grange powerhouse using surface water that would be passed downstream of the LGDD regardless of the Project. Considering this, and based on the effects analysis presented in this EFH assessment, including implementation of impact minimization measures intended to reduce effects on EFH resources (see Section 2.2.1.1 and Table 10.1-1), continued hydropower generation will not adversely affect Pacific Coast Salmon EFH in the Action Area.

The Districts have determined that fish salvage operations upstream of the sluice gate fish barrier following flows exceeding 7,000 cfs (i.e., high flows that overspill into the sluice gate channel) will adversely affect EFH for Pacific Salmon. Depending on timing, these events, estimated to occur once every five years, could reduce the availability and quality of rearing habitat in the tailrace channel. Similarly, the Districts have determined that during periods when the powerhouse is offline and not generating power, the Project may result in minimal but adverse effects on EFH (i.e., will adversely affect) in the tailrace channel. The potential that EFH in the tailrace channel is adversely affected during offline operations is exceedingly low and greatly minimized via the demonstrated coordinated and rapid opening of the sluice gates during powerhouse outages.

Table 10.1-1. Project operations and PM&E implementation measures effects summary and impact minimization measures for Pacific salmon EFH.

Project Effect	EFH Determination	Impact Mechanism	Applicable Minimization Measures
Continued hydropower operations	Will not adversely affect	Minor turbulence at powerhouse exit from release of non-Project flows into the tailrace channel.	NA
Non-generating operations (power outages at powerhouse and sluice gate opening)	Will adversely affect	Potential reduction of quantity of EFH (i.e., wetted habitat for spawning, rearing, or migration) via dewatering in rare event that sluice gates are not opened in a timely fashion.	Rapid, coordinated opening of sluice gates via remote operations and installation of fish barrier to prevent fish entrance into the sluice gate channel

Project Effect	EFH Determination	Impact Mechanism	Applicable Minimization Measures
Fish barrier construction including in-water work isolation	Will not adversely affect	Potential for temporary turbidity and water quality degradation in tailrace channel due to installation of isolation cofferdams in the sluice gate channel.	Proposed timing of in-water work (July 15 through mid-September) avoids adult fall-run Chinook Salmon spawning and migration periods. Likelihood of over-summering juveniles is low based on snorkel surveys downstream of La Grange gauge. No juvenile observed in tailrace channel weirs. Use of turbidity curtain and implementation of impact minimization measures in Section 2.2.1.1 will reduce potential for sediment and contaminant introduction during fish barrier construction. Adverse impacts on EFH spawning, rearing, or migratory habitats are unlikely. Isolation sandbags will reduce water quality impacts and isolate in-water work from active channel flow.
Long –term Habitat Loss from Fish Barrier Installation	Will not adversely affect	Fish barrier would permanently block access to 11,490 square feet of EFH (step-pool habitat in the sluice gate channel dominated by bedrock). This EFH does not provide necessary substrates for spawning and is not optimal for juvenile rearing. Therefore, the loss of habitat in the channel upstream of the barrier is insignificant and will not adversely affect rearing potential in the Action Area.	The proposed fish barrier is an impact minimization measure intended to keep fish out of the sluice gate channel to avoid potential stranding during atypical operations. Because EFH upstream of the proposed barrier does not provide substrates or waters necessary for spawning, breeding, feeding, or growth to maturity, the loss of this habitat is not considered an adverse effect on EFH, and no other minimization measures are proposed.
Fish Salvage Operations in sluice gate following flows exceeding 7,000 cfs	Will adversely affect	Potential overlap of high spring flows and required fish salvage operations in EFH occupied by rearing fall-run Chinook Salmon.	With the exception of summer timing, similar measures as proposed for in-water work isolation for fish barrier. Estimated rarity of high flows exceeding 7,000 cfs (i.e., approximately once every 5 years) minimizes the frequency and duration of this action.

11.0 REFERENCES

California Department of Water Resources (CDWR). 1994. California Water Plan Update 1993. Bulletin 160-93. October. Available online at: http://www.waterplan.water.ca.gov/previous/b160-93/TOC.cfm.

California Energy Commission (CEC). 2011. Updated California Energy Demand Forecast 2011-2022. May 2011. CEC-200-2011-006-SD.

Federal Energy Regulatory Commission (FERC). 1996. Reservoir release requirements for fish at the New Don Pedro Project, California. FERC Project No. 2299-024, FERC, Office of Hydropower Licensing, Washington, D.C.

Flagg, T., B. Berejikian, J. Colt, W. Dickhoff, L.W. Harrell, D.J. Maynard, C.E. Nash, M.S. Strom, R.N. Iwamoto, and C.V.W. Mahnken. 2000. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmon populations. National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-41.

McBain and Trush. 2000. Habitat restoration plan for the Lower Tuolumne River corridor, Final Report. Prepared by McBain and Trush, Arcata, California for the Tuolumne River Technical Advisory Committee with assistance from U.S. Fish and Wildlife Service Anadromous Fish Restoration Program.

______. 2004. Coarse sediment management plan for the lower Tuolumne River. Revised Final Report. Prepared by McBain and Trush, Arcata, California for Tuolumne River Technical Advisory Committee, Turlock and Modesto Irrigation Districts, USFWS Anadromous Fish Restoration Program, and California Bay-Delta Authority.

Mesick, C. 2009. The high risk of extinction for the natural fall-run Chinook salmon population in the Lower Tuolumne River due to insufficient instream flow releases. U.S. Fish and Wildlife Service, Exhibit No. FWS-50, to Proceeding of the Presiding Administrative Law Judge on Interim Measures for the Don Pedro Project.

National Marine Fisheries Service (NMFS). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. June 2000.

_____. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

O'Brien, J. 2008. 2008 Tuolumne River Fall Chinook Salmon Escapement Survey (Draft). California Department of Fish and Game. La Grange, CA.

Økland, F., J. Erkinaro, K. Moen, E. Niemela, P. Fiske, R.S. McKinley, and E.B. Thorstad. 2001. Return migration of Atlantic salmon in the River Tana: phases of migratory behavior. Journal of Fish Biology 59:862–874

Orr, B.K. 1997. Ecosystem health and salmon restoration: a broader perspective. Pages 575-580 in S.S.Y. Wang, editor. Environmental and coastal hydraulics: protecting the aquatic habitat. Volume 1: Proceedings of Theme B. Water for a changing global community. The 27th Congress of the International Association for Hydraulic Research. American Society of Civil Engineers, New York. [Online] URL: http://www.stillwatersci.com/ resources/1997orrsalmon.pdf. (Accessed July 27, 2010.).

Pacific Fishery Management Council (PFMC). 1999. Appendix A: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan, Pacific Fishery Management Council, August 1999.

_____. 2014. Appendix A to the Pacific Coast Salmon Plan, as Modified by Amendment 18 to the Pacific Coast Salmon Plan: Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Pacific Fishery Management Council, September 2014.

Reischel, T.S. and T.C. Bjornn. 2003. Influence of Fishway Placement on Fallback of Adult Salmon at the Bonneville Dam on the Columbia River. North American Journal of Fisheries Management 23:1215–1224.

Stillwater Sciences. 2003. Preliminary assessment of physical habitat and temperature suitability for steelhead based on 1995 IFIM Study Results for the lower Tuolumne River. Technical Memorandum by Noah Hume and Peter Baker to Tim Ford, Turlock Irrigation District. Stillwater Sciences, Berkeley, CA. 23 September.

_____. 2009. March and July 2009 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, California. November 2009.

_____. 2012. Lower Tuolumne River Instream Flow Studies: Pulse Flow Study Report. Final. Prepared by Stillwater Sciences, Berkeley, California for Turlock Irrigation District and Modesto Irrigation District, California. June 2012.

_____. 2013. Lower Tuolumne River Instream Flow Study. Final Report. Prepared by Stillwater Sciences, Davis, California for Turlock and Irrigation District and Modesto Irrigation District, California. April 2013.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 1992. Lower Tuolumne River spawning gravel availability and superimposition report. Appendix 6 in Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299 Vol. VIII. Prepared by EA Engineering, Science, and Technology, Lafayette, California.

_____. 2000. 1999 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. 2 Volumes. March.

_____. 2001. 2000 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. 2 Volumes. March.

_____. 2005. 2005 Ten Year Summary Report. Pursuant to Paragraph (G) of the 1996 FERC Order issued July 31, 1996. Don Pedro Project, No. 2299. April.

_____. 2007. Tuolumne River La Grange gravel addition, Phase II annual report. Report 2006-10 *in* 2006 Lower Tuolumne River annual report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299. Prepared by D. Ridgeway, California Department of Fish and Game, Central Region (Region 4).

_____. 2012. Fall/winter Migration Monitoring at the Tuolumne River Weir – 2011 Annual Report. Prepared by FISHBIO, Oakdale, California.

_____. 2013a. Fish Assemblage and Population Between Don Pedro Dam and La Grange Dam Study Report (W&AR-13). Prepared by HDR Engineering, Inc. January 2013.

_____. 2013b. Salmonid Population Information Integration Study Report (W&AR-05). Prepared by Stillwater Sciences. January 2013.

_____. 2013c. Salmonid Redd Mapping Study Report (W&AR-08). Prepared by FISHBIO. December 2013 (W&AR-08). December 2013.

_____. 2013d. Spawning Gravel in the Lower Tuolumne River Study Report (W&AR-04). Prepared by Stillwater Sciences. December 2013.

_____. 2016a. Chinook Salmon Otolith Study (W&AR-11). Prepared by Stillwater Sciences. February 2016.

_____. 2016b. Salmonid Habitat Mapping Technical Memorandum. Prepared by Stillwater Sciences. February 2016.

_____. 2017a. Chinook Salmon Population Model Study Report (W&AR-06). Prepared by Stillwater Sciences. September 2017.

_____. 2017b. Fish Presence and Stranding Assessment Technical Memorandum. Prepared by FISHBIO. September 2017.

_____. 2017c. Flow Records for Five Discharge Structures at the La Grange Project Technical Memorandum. Prepared by HDR, Inc. September 2017.

_____. 2017d. Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes Study Report. Prepared by FISHBIO and LGL Alaska Research Associates. September 2017.

_____. 2017e. La Grange Hydroelectric Project Final License Application, FERC Project No. 14581. September 2017.

_____. 2017f. La Grange Hydroelectric Project Draft License Application, FERC Project No. 14581. April 2017.

_____. 2017g. La Grange Hydroelectric Project Fish Barrier Assessment Study Report. Prepared by FISHBIO. September 2017.

_____. 2017h. La Grange Hydroelectric Project Fish Biological Assessment for Central Coast Steelhead (*Oncorhynchus mykiss*) Distinct Population Segment. September 2017.

_____. 2017i. Lower Tuolumne River Floodplain Hydraulic Assessment Study Report (W&AR-21). Prepared by HDR Engineering, Inc. and Stillwater Sciences. February 2017.

_____ 2017j. Project Operations/Water Balance Model Study Report (W&AR-02). Prepared by Dan Steiner. September 2017.

United States Army Corps of Engineers, United States Fish and Wildlife Service, and National Marine Fisheries Service (USACE, USFWS, and NMFS). 2006. Proposed Procedures for Permitting Projects that will Not Adversely Affect Selected Species in California. Enclosure A of NMFS Programmatic ESA and EFH Consultation for eight actions permitted by the USACE. NMFS Ref: 2007/07475:KAS.

United States Fish and Wildlife Service (USFWS). 1995. The relationship between instream flow and physical habitat availability for Chinook salmon in the lower Tuolumne River, California. Prepared by USFWS, Ecological Services Division, Sacramento, California for Turlock Irrigation District and Modesto Irrigation District, California.

United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Endangered Species Consultation Handbook, Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.

APPLICANT-PREPARED BIOLOGICAL ASSESSMENT
CALIFORNIA CENTRAL VALLEY STEELHEAD
(ONCORHYNCHUS MYKISS)
DISTINCT POPULATION SEGMENT

ATTACHMENT B

CONCEPTUAL SLUICE GATE FISH BARRIER DESIGN

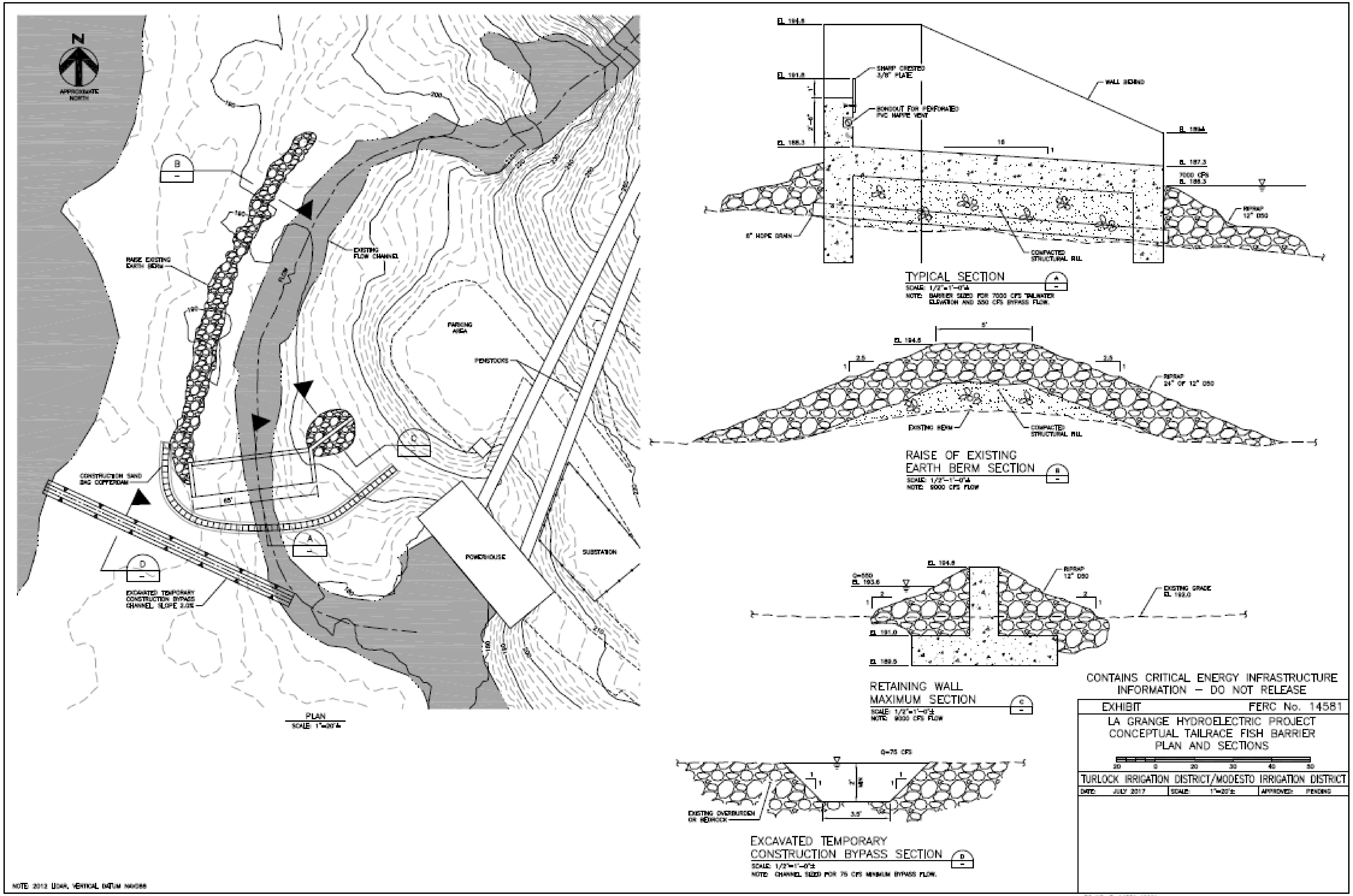

Figure B-1. Conceptual sluice gate fish barrier design.

APPLICANT-PREPARED BIOLOGICAL ASSESSMENT
CALIFORNIA CENTRAL VALLEY STEELHEAD
(*ONCORHYNCHUS MYKISS*)
DISTINCT POPULATION SEGMENT

ATTACHMENT C

CUMULATIVE EFFECTS SUPPLEMENT

1.0 CUMULATIVE EFFECTS OF THE PROPOSED ACTION

Under the ESA, cumulative effects are those effects of future state or private activities not involving federal activities that are reasonably certain to occur within the Action Area of the federal action subject to consultation (i.e., FERC issuance of a license for the Project) [50 CFR §402.02]. This definition applies only to ESA Section 7 analyses and should not be confused with the broader use of this term in the National Environmental Policy Act or other environmental laws. Federal actions that are unrelated to the Project are not considered because they require separate consultation pursuant to Section 7 of the ESA.

This section presents those non-federal actions that have impacted or are reasonably certain to impact habitat in the Action Area. Although the spatial scope for assessment of cumulative effects in the La Grange Project Biological Assessment (BA) is the Action Area, non-federal actions that occur upstream of the Action Area have the potential to affect aquatic habitat in the Action Area, primarily through flow alteration. Relative to aquatic resources, the Action Area includes the lower Tuolumne River from La Grange Diversion Dam (RM 52.2) to the confluence with the tailrace channel, the tailrace channel proper, and the sluice gate channel. Relative to upstream activities that have the potential to affect water quantity and quality in the Action Area, operations at Don Pedro Dam are included for context. Although numerous non-federal dams are operated in the upper Tuolumne that cumulatively affect flow in the Action Area, flow management at Don Pedro Dam is the primary driver of cumulative effects in the Action Area.

O. mykiss in the Action Area may be cumulatively affected by individually minor but collectively significant actions taking place over a period of time. Activities contributing to cumulative effects in the lower Tuolumne River include water storage and diversions for irrigation and M&I water supply, historical and ongoing gravel and gold mining activities, riparian diversions, urbanization, other land and water development activities, the introduction and persistence of non-native species, channel modification by levees, recreation, flood control operations, wastewater treatment plant discharges, climate change, and other potential activities.

Eight dams and reservoirs are located on the Tuolumne River and its tributaries, with a combined storage capacity of about 2,777,000 AF. Seven of these dams are located upstream of the La Grange Project. The lower Tuolumne River below LGDD is directly affected by the operations of LGDD, the primary purpose of which is to divert water into the Districts' two irrigation canals. Therefore, all flow-related effects of the Don Pedro Project downstream of the LGDD are, by definition, cumulative effects related to a variety of uses but not the result of hydropower generation associated with the Proposed Action.

1.1 Past, Present, and Future Actions Affecting the Action Area

1.1.1 Chronology of In-Basin Actions

The Tuolumne River basin has been affected by substantial resource use and land and water management activities over the past 150 years. Table 1.1-1 summarizes a chronology of major in-basin actions that are likely to contribute to cumulative effects on any CCV steelhead occupying the Action Area.

The information available on each of these potential contributors to cumulative effects varies greatly, ranging from very little (e.g., early to mid-1900s commercial and sport fish harvest) to large volumes of study (e.g., effects on flow-habitat relationships in the lower Tuolumne River over the past decade). This section includes operations and maintenance activities associated with the actions that are unrelated to the Proposed Action, e.g., providing water for irrigation or release of flood flows in the Action Area as required management of reservoir storage for flood control at the upstream Don Pedro Dam.

Table 1.1-1. Chronology of actions in the Tuolumne River Basin contributing to cumulative effects on *O. mykiss*, including any CCV steelhead, in the Action Area.

Action	Date
Dams, Diversions, Flow Regulation	
Wheaton Dam	1871
La Grange Mining Ditch (Indian Bar Diversion)	1871
Phoenix Dam	1880
La Grange Diversion Dam	1893
Irrigation diversion begins	1901
Modesto Reservoir Dam	1911
Turlock Lake Dam	1914
Eleanor Dam	1918
Old Don Pedro Dam	1923
O'Shaughnessy Dam (Hetch Hetchy) (206,000 AF)	1923
Priest Dam	1923
Early Intake	1924
Hetch Hetchy Aqueduct completed; exports to San Francisco begin	1934
O'Shaughnessy Dam raised (360,000 AF)	1938
Cherry Lake	1956
Pine Mountain Dam	1969
New Don Pedro Dam	1971
Riparian water diversions along the lower Tuolumne River	1870s to present
In-Channel and Floodplain Mining	
Placer mining	1848–1890
Hydraulic mining (La Grange)	1871–c.1900
Dredge mining of the lower Tuolumne River (gold)	1908-1942, 1945–1951
Gravel and aggregate mining of the lower Tuolumne River	1940s to present
Non-Native Fish Species	
18 fish species introduced in Tuolumne River basin by state/federal agencies	1874–1954
4 additional fish species introduced into the Tuolumne River basin	After 1954
Hatchery Practices	
CDFW begins stocking fish in the inland waters of California	Late 1800s
CDFW begins large-scale supplementation of anadromous fish stocks	1945
California's hatcheries at times use out-of-basin broodstocks/move fry to other basins	Before 1980s
Salmon from Central Valley hatcheries released in San Francisco Bay	Ongoing
Agriculture, Livestock, and Timber Harvest	
Significant timber harvest begins	Mid-1800s
Large-scale agriculture and livestock grazing begins in region	Mid-1800s

1.1.2 Don Pedro Project: Actions Independent of the Proposed Action

1.1.2.1 Project Dam and Reservoir

Don Pedro Dam is a 1,900-ft-long and 580-ft-high, zoned earth and rockfill structure. The top of the dam is at an elevation of 855 ft (NGVD 29). Don Pedro Reservoir extends upstream for approximately 24 miles at its normal maximum water surface elevation of 830 ft. In a typical year, water surface elevation in Don Pedro Reservoir peaks in late June/early July at the end of the snowmelt runoff, and is then steadily drawn down over the summer and fall to serve water supply and lower Tuolumne River fish protection needs. Rainfall and snowmelt runoff resumes in December.

Although operation of the hydroelectric facilities at the Don Pedro Dam is an important function, it is a secondary function of the Project. The primary purposes of the Project are to provide water storage to meet the needs of irrigation and M&I water users and facilitate flood management in accordance with the ACOE flood control manual.

Timing and Magnitude of Flow Releases

Water is released from Don Pedro Reservoir for only three reasons: (1) to provide water needed to meet the Districts' irrigation and M&I demands, (2) for flood management purposes, and (3) to meet the license requirements for fish protection flows in the lower Tuolumne River. In general, reservoir operations follow a relatively consistent annual cycle of water management for flood control; capturing runoff from snowmelt and seasonal rainfall; delivery of water to meet irrigation, municipal, and industrial needs; providing recreation opportunities; and providing scheduled releases for the protection of anadromous and resident salmonids in the lower Tuolumne River. The Districts possess senior water rights in the Tuolumne River, but Project operations must consider potential water availability over the course of multiple years, so that even in drier years the reservoir can retain a water supply to meet downstream needs.

Flows released at Don Pedro Dam to meet the Districts' irrigation and M&I water demands are all diverted from the Tuolumne River at La Grange Diversion Dam (the Districts' non-project Diversion Dam) to the TID and MID canal systems. From 1971 to 2012, the average annual water diversion at La Grange Diversion Dam to the Districts canals was approximately 900,000 AF. Diversions for irrigation can occur year round, but generally occur from late February to early November. This water management contributes to cumulative effects on *O. mykiss* in the lower Tuolumne River by storing water that is then scheduled for release into diversion canals. However, these effects due to diversion at La Grange Diversion Dam do not reflect outflow variability at the Don Pedro Project for the purpose of hydropower generation.

Flows released at Don Pedro Dam to comply with the ACOE flood management guidelines consist of both pre-releases to create storage in anticipation of high runoff and releases during periods of high runoff to moderate downstream effects. Both of these release scenarios occur to balance reservoir levels, forecasted runoff, and downstream flows. "High" river flows can be defined as any flows released at Don Pedro Dam that are greater than those needed for irrigation and M&I purposes and aquatic resource protection purposes. The ACOE guidelines call for making 340,000 AF of storage available for management of high-flow conditions. Flow releases for high-flow management purposes from March to July are affected by diversions at La Grange Diversion Dam for water supply purposes. High flows in the Tuolumne River are also affected by the operation of the upstream Hetch Hetchy system.

In addition to flood storage reservation within the reservoir, downstream flow restrictions also affect Project operations from a flood management perspective. The primary downstream flow guideline cited in the 1972 ACOE Flood Control Manual is that flow in the Tuolumne River at Modesto (as measured at the 9th Street Bridge) should generally not exceed 9,000 cfs. Flows in excess of 9,000 cfs have the potential to cause significant property damage in this area of the Tuolumne River basin, while also potentially contributing to flood flows in the San Joaquin River. If a large volume of water is forecasted that could result in flows higher than 9,000 cfs at Modesto, pre-flood releases may be made from Don Pedro Dam to create storage to prevent downstream flows from exceeding 9,000 cfs at a later time.

Rapid reductions in instream flows, particularly following flood flow conditions, may cause stranding and entrapment of fry and juvenile *O. mykiss* on gravel bars, floodplains, and in off-channel habitats; resulting in potential mortality. Although analysis of historical Chinook Salmon stranding data (TID/MID 2001) suggests a higher stranding risk for Age 0+ *O. mykiss* during rapid flow reductions following flood control releases, juvenile and larger size classes of *O. mykiss* are generally not found using floodplain habitats in the Tuolumne River or in floodplain studies in the Cosumnes River (Moyle et al. 2007). The cessation of hydropower peaking releases to the river by the Districts and inclusion of reduced ramping rates under the FERC (1996) Order reduces the risk stranding (TID/MID 2005). For these reason, although low levels of *O. mykiss* stranding may potentially occur during flood control operations as flows recede from the floodplain, high rates of mortality due to stranding are unlikely.

Between La Grange Diversion Dam and 9th Street in Modesto, the single largest contributor of local flow to the Tuolumne River is Dry Creek. The Dry Creek watershed has its headwaters in the foothills just northeast of the Project. It is a “flashy” watershed, and once its soil is saturated, any rainfall results in rapid runoff. High flows, on the order of 6,000 cfs or higher, can occur when significant rainfall occurs between Modesto and the upper end of the Dry Creek watershed. Because these flows from Dry Creek come in above the USGS’s Tuolumne River 9th Street river gage, they must be taken into account when making releases from Don Pedro Reservoir to the lower river to avoid exceeding 9,000 cfs.

CCSF participated financially in the construction of the new Don Pedro Dam. In return for its financial contribution, CCSF obtained up to 570,000 AF of water banking privileges in Don Pedro Reservoir, which allows CCSF to improve the reliability of its overall water supply management system for its Bay Area water users. CCSF pre-releases water from its upstream facilities into the water bank in the Don Pedro Reservoir so at other times it can hold back an equivalent amount of water that would otherwise have to be released to satisfy the Districts’ water rights. Once the water enters Don Pedro Reservoir, the water belongs to the Districts, and the Districts have unrestricted entitlement to its use.

Prior to its construction, it was recognized that the new Don Pedro Project was necessary for the protection of Tuolumne River fall-run Chinook Salmon because the original Don Pedro reservoir built in the early 1920s, which had no downstream release requirements, would spill less and less water as CCSF increased its exports to the Bay Area. The Federal Power Commission (FPC), the predecessor to FERC, recognized that fisheries releases to the lower Tuolumne River, when combined with rising CCSF diversions, could ultimately undermine the economic feasibility of the new Don Pedro Project. To balance those factors, FPC's 1964 decision set normal-year releases for fish of 123,210 AF for the first 20 years, and required the Districts to conduct studies that could be used to develop future fisheries requirements.

FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of the lower Tuolumne River minimum flow provisions contained in the 1995 settlement agreement between the Districts, CCSF, resource agencies, and environmental groups. The revised minimum flows in the lower Tuolumne River vary from 50 to 300 cfs, depending on water year hydrology and time of year. The water year classifications are recalculated each year to maintain an approximately consistent frequency distribution of water year types over time. The settlement agreement and license order also specified certain pulse flows for the benefit of upstream migrating adult salmonids and downstream migrating juveniles, the amount of which also varies with water-year type. The downstream flow schedule provided for by the settlement agreement and subsequent FERC Order was presented in Table 4.4-2 of the BA. These flows are a required element of the environmental baseline, and will continue regardless of whether or not the Proposed Action is licensed, i.e., the flow regime is not part of the Districts' Proposed Action.

Dam and Reservoir Operations Upstream of the Don Pedro Project

CCSF's Hetch Hetchy Water and Power Division maintains and operates several reservoirs in the middle-elevation band of the Tuolumne River watershed upstream of the Don Pedro Project, including CCSF's Cherry Lake (elevation 4,700 ft), Lake Eleanor (elevation 4,660 ft), and Hetch Hetchy Reservoir (elevation 3,800 ft) (CCSF 2006). The primary purposes of these projects are to provide water storage for purposes of water supply and hydropower generation. CCSF stores and diverts water from the upper Tuolumne River for use outside of the Tuolumne River basin. CCSF provides potable water to approximately 2.6 million Bay Area residents and serves much of the Bay Area's commercial, manufacturing, and industrial enterprises. The Hetch Hetchy system includes the San Joaquin Pipeline (SJPL), which transports about 85 percent of CCSF's total water supply. The Hetch Hetchy system is an indispensable component of the welfare and economy of the Bay Area. The Hetch Hetchy system also produces about 1,700,000 MWh of renewable hydroelectric energy in an average year. The maximum rate of diversion from of the upper Tuolumne River to the San Francisco Bay Area is about 465 cfs. The average annual use is about 230,000 AF, or about 12 percent of the average annual runoff.[1]

Another user of water in the upper Tuolumne River is CDFW, which operates the Moccasin Fish Hatchery below CCSF's Moccasin Reservoir, a 505-AF water supply reservoir. Water flow to the hatchery is estimated to be about 15 million gallons per day (23 cfs) or about 11,000 AF per

[1] For the period 1987 - 2012.

year. Water from the hatchery is discharged into Moccasin Creek. Water from Moccasin Reservoir also feeds CCSF's Foothill Tunnel.

Resource Extraction, Development, and Land Uses along the Tuolumne River

Decades of dredge mining in the main channel of the Tuolumne River resulted in the excavation of channel and floodplain sediments and a legacy of significant channel modifications and dredger tailings deposits between RM 50.5 and 38.0. Gravel and aggregate mining, with their attendant floodplain modifications, continue alongside the river corridor today, though these activities occur downstream of the Action Area. Similarly, the Gravel Mining Reach of the lower Tuolumne (RM 34.2 to 40.3), currently the focus of development by commercial aggregate producers, is outside the Action Area.

Much of the residual dredger tailings upstream of RM 45 were removed from the floodplain downstream of La Grange Diversion Dam as part of the construction of the new Don Pedro Dam in the 1960s. Reaches of the Tuolumne River between RM 47 and 50 that had been affected by gold dredger mining in the early 1900s were reconfigured following removal of the dredger tailings.

Agriculture, Livestock Grazing, and Timber Harvest

After the Gold Rush, there was a substantial increase in crop production and ranching in the Central Valley. During this period, woody vegetation along the Tuolumne River was cleared to allow for crop production in the rich alluvial soils of the bottomlands. Levees were constructed to protect the new farmlands from flooding in spring, and irrigation canals were constructed to provide water during the growing season (Thompson 1961; Katibah 1984). Of the estimated 4 million acres of wetland that occurred historically in the Central Valley, only about 300,000 ac remained in 1990. The conversion of wetlands to agricultural uses accounts for much of this reduction in wetland area.

Land in the lower Tuolumne River watershed is primarily privately owned, including that used for agriculture and livestock grazing (Stanislaus County 2006). Primary agricultural land uses along the gravel-bedded reach include orchards and row crops (RM 24.0-40) and livestock grazing (RM 40-51) (McBain and Trush 2000).

Timber operations have existed throughout the Sierra Nevada range since the mid-1800s. The Gold Rush of 1849 fueled a human migration into California that resulted in dramatic increases in the demand for timber. The indirect effects of gold mining included steamship transportation along the major rivers of the Central Valley, which was fueled by cordwood harvested from adjacent lands, which likely resulted in the first wave of riparian forest clearing in some areas of the Tuolumne River basin (McBain and Trush 2002).

Fish Hatchery Practices

Four hatcheries in the Central Valley produce steelhead. The production targets for these hatcheries are as follows (NMFS 2014):

- Coleman National Fish Hatchery - 600,000
- Feather River Fish Hatchery - 500,000
- Nimbus Hatchery - 430,000
- Mokelumne Fish Hatchery - 100,000

Significant transfer of genetic material has occurred among hatcheries in the Central Valley and from systems outside the Central Valley (NMFS 2014). The Eel River strain of steelhead was used as the founding broodstock for the Nimbus Hatchery, and eggs from the Nimbus Hatchery were transferred to the Feather River Fish Hatchery in the 1960s and 1970s. In the late 1970s, a strain of steelhead from Washington State was transferred to the Feather River Fish Hatchery. There have also been transfers of steelhead from the Feather River Fish Hatchery to the Mokelumne Hatchery.

CDFW manages the Don Pedro Reservoir fishery as a put-and-grow resource supported by substantial stocking. As part of its Inland Salmon Program, CDFW generally plants rainbow trout, kokanee (*O. nerka*), and land-locked Chinook Salmon in Don Pedro Reservoir annually. Don Pedro Reservoir is also managed by CDFW as a year-round fishery for black bass.

Freshwater Salmonid Harvest

In the Central Valley, recreational fishing for steelhead is a popular activity, but harvest is restricted to visibly marked hatchery-origin fish, which reduces the likelihood of anglers retaining naturally spawned fish (NMFS 2014). A combination of gear restrictions, closures, and size limits has been formulated to protect CCV steelhead smolts (NMFS 2014).

It is unclear to what degree historical commercial harvest took place in the Tuolumne River, but based on the scale of harvest within the San Joaquin River basin as a whole, past harvest, especially in the late 1800s and early 1900s, could have been significant.

Non-Native Fish Species Introduction

Of the 22 non-native fish species documented in the lower Tuolumne River, 18 were introduced by state or federal agencies (CDFW, NMFS, USFWS, and the State Board of Human Health) between 1874 and 1954, and one was introduced with permission from CDFW in1967 (Dill and Cordone 1997; Moyle 2002). The remaining three species were introduced by aquarists, catfish farms, or private individuals (Dill and Cordone 1997). Sixteen of the fish species released by state or federal agencies were introduced intentionally for sport or commercial fisheries, as a prey base for sport fish, or for mosquito control; two were introduced incidentally with shipments of sport fish (Dill and Cordone 1997). The most abundant and widespread non-native fish species in the lower Tuolumne River, bluegill, redear sunfish, and green sunfish, were first released in California between 1891 and 1954. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992). The other introduced fish species in the lower Tuolumne River include threadfin shad, black and brown bullhead, white and channel catfish, common carp, fathead minnow, red shiner, golden shiner, goldfish, striped bass, black and white crappie, warmouth, bigscale logperch, western mosquitofish, and inland silversides.

Management and Recovery Activities

Native Salmonid Management and Recovery Programs

Steelhead management has been addressed by a number of state initiatives. The Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990) was intended to outline CDFW's restoration and enhancement goals for salmon and steelhead in the Sacramento River and San Joaquin River systems and to provide direction for various CDFW programs and activities.

The Restoring Central Valley Streams (CDFG 1993) plan identifies the following goals to benefit anadromous fish: restore and protect California's aquatic ecosystems that support fish and wildlife, protect threatened and endangered species, and incorporate the state legislature's mandate and policy to double the size of populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

The Steelhead Restoration and Management Plan for California (CDFG 1996), which focuses on restoration of native and naturally produced fish stocks, has the following goals: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses.

To improve salmonid spawning and rearing conditions in the lower Tuolumne River, several coarse sediment augmentation and habitat restoration projects have been completed (TID/MID 2005, from TID/MID 2013c). CDFW placed approximately 27,000 yd^3 of gravel in the river near Old La Grange Bridge (RM 50.5) from 1999 to 2003 (TID/MID 2007).

1.2 Assessment of Cumulative Effects of the Project on CCV Steelhead

The Proposed Action would not contribute to cumulative effects on CCV steelhead in the Action Area. The non-Project LGDD irrigation diversions, and upstream flow management from Don Pedro Reservoir, will occur regardless of the Proposed Action. Therefore, hydropower operations at the La Grange powerhouse, which uses surface water that would be passed downstream of the LGDD regardless of the Project, do not contribute to cumulative effects on CCV steelhead and their habitat within the Action Area. Any CCV steelhead occurring in the Action Area are affected by a large number of past, present, and potential future anthropogenic actions and background environmental conditions. Factors that influence any steelhead in the Action Area include water management activities, past and present in-river and floodplain mining, a variety of historical and current land-use practices, non-native species, ongoing fisheries management, and habitat restoration activities.

Over the past 120 years, each increment of flow regulation (Wheaton, La Grange, O'Shaughnessy, old Don Pedro, and new Don Pedro dams along the mainstem and dams constructed along tributaries above O'Shaughnessy Dam, including Cherry and Eleanor Creeks) has modified the lower Tuolumne River hydrologic regime. Historically, Wheaton Dam and the present day La Grange Diversion Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain and Trush 2000). CCSF's Hetch Hetchy Project, the Districts' new Don Pedro Dam, and CCSF's Cherry Lake combined to reduce the magnitude and frequency of flood flows and snowmelt runoff to the Tuolumne River downstream of La Grange Diversion Dam.

Analyses of streamflow records from the USGS gaging station at La Grange (Station 11-289650) reveal the following alterations of hydrologic conditions: (1) the magnitude and variability of summer and winter baseflows, fall and winter storm flows, and spring snowmelt runoff have been reduced and (2) the magnitude, duration, and frequency of winter floods have been reduced (McBain and Trush 2000). Following completion of the New Don Pedro Dam in 1971, compliance with ACOE flood control and other flow requirements reduced the estimated average annual flood (based on annual maximum series) from 18,400 cfs to 6,400 cfs.

These changes in hydrology have both immediate impacts on habitat conditions (e.g., effects on depth, velocity, water temperature, etc.) for CCV steelhead and the non-native piscivores that may prey on any steelhead present in the Action Area. Hydrologic alterations have also had longer-term impacts on aquatic habitat characteristics due to changes in flow magnitude and timing, flood frequency, sediment supply and transport, and channel morphology.

The operation of La Grange Diversion Dam has directly affected flows in the lower Tuolumne River since 1893, thereby influencing water resources and, as a result, CCV steelhead habitat in the Action Area. The direct effects resulting from La Grange operations occur whenever all flows, except FERC-required minimum flows, are diverted to meet the needs of the Districts' water users. During flood management periods that coincide with water diversions, La Grange Diversion Dam operations contribute to cumulative effects in the Action Area, but during flood management periods when there are no such diversions, the La Grange Project does not contribute to either direct or cumulative effects on CCV steelhead habitat in the Action Area, and effects are due to flood management requirements alone.

Gravel and gold mining, as well as other land uses, adversely affected aquatic habitat prior to dam construction on the Tuolumne River (TID/MID 2005) (see Section 1.1 for a summary of the chronology of current and historic actions within the Tuolumne River basin). The presence of dams, aggregate extraction, agricultural and urban encroachment, and other land uses have resulted in sediment imbalances in the lower Tuolumne River channel (McBain and Trush 2000). Don Pedro Dam and La Grange Diversion Dam, combined with other dams upstream of the Project, trap all coarse sediment and woody debris that would otherwise pass downstream, and excavation of bed material for gold and aggregate to depths below the river thalweg has significantly reduced steelhead spawning habitat availability, eliminated active floodplains and terraces, and created large in- and off-channel pits that provide habitat suitable for non-native predator species. The channel downstream of La Grange Diversion Dam is characterized by downcutting, widening, armoring, and depletion of sediment storage features (e.g., lateral bars and riffles) due to the cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses (CDWR 1994; McBain and Trush 2004). Sequences of historical photos show that channel corridor width has been progressively reduced by land use (McBain and Trush 2000).

Sediment model simulations indicate that without gravel augmentation, the channel bed from RM 52 to 39.7 would undergo a slow degradation (as opposed to aggradation) and coarsening (armoring) in response to the reduction in sediment supply (TID/MID 2013d). Gravel augmentation, however, has helped to increase coarse sediment storage in this area (TID/MID 2013d). The current rate of gravel transport compared to the stores of gravel in most of the Action Area is low, and little change in overall gravel availability is expected to occur over the next several decades.

As noted above, the large pits formed where aggregate was extracted from the channel created SRPs. Historical deposits of dredger tailings (RM 50.5–38.0) confined the active river channel, preventing sediment recruitment that would otherwise have resulted from the normal process of channel migration (McBain and Trush 2000). Under current conditions, channel migration has been substantially curtailed.

More recent aggregate mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Roberts Ferry Bridge (RM 39.5). Floodplain and terrace pits in this reach are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. The January 1997 flood caused extensive damage to dikes separating deep gravel mining pits from the river, breaching or overtopping nearly every dike along a 6-mile-long reach in the lower river (TID/MID 2011).

Most woody debris captured in Don Pedro Reservoir is small, and it appears that the majority of it would pass through the lower Tuolumne River during high flows if it were not trapped in the reservoir (TID/MID 2017). The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 feet, and woody debris would have a limited effect on the morphology of such a channel (TID/MID 2017). It is unknown, however, to what extent smaller pieces of wood might add to existing wood accumulations or initiate small jams in the lower river, thereby increasing habitat complexity.

Historical clearing of riparian forests in the Tuolumne River basin modified vegetation and associated habitat, halting many attendant ecosystem processes (Katibah 1984; Naiman et al. 2005). Urban and agricultural encroachment and mining have resulted in the direct removal of large tracts of riparian vegetation. Livestock selectively graze younger riparian plants, which limits the establishment of vegetation adjacent to the channel (McBain and Trush 2000). The clearing of woody plant cover has also created openings in the riparian corridor where non-native plant species have become established and proliferated (McBain and Trush 2000). Land conversion and levee construction that constrain channel migration, including alteration of meander bends and cutoff/oxbow formations, have reduced riparian complexity (McBain and Trush 2000, Grant et al. 2003).

Mining has also substantially altered riparian conditions along the lower Tuolumne River. Aggregate mining leaves large pits in the floodplain, converting floodplain vegetation to open water. Levees built to isolate mining pits from the river constrain lateral movement of the river (TID/MID 2013b), which precludes regeneration of riparian vegetation by reducing the amount and diversity of riparian habitat surfaces (TID/MID 2013b). Dredger tailings of unconsolidated sediments on the floodplain have replaced rich soils with poor ones, resulting in changes to riparian plant species composition and reducing the extent and diversity of riparian vegetation. The reduced development of riparian vegetation on dredger spoil piles has also diminished riparian habitat connectivity (TID/MID 2013b).

Flow regulation and sediment trapping associated with upstream dams indirectly affected riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian vegetation. As noted above, each increment of flow regulation (La Grange Diversion Dam, Hetch Hetchy Dam, Old Don Pedro Dam, New Don Pedro Dam) successively reduced the magnitude, duration, and frequency of flood flows, and removed key mortality agents, including scour, channel migration, flood-induced toppling, and inundation (McBain and Trush 2000). Reduced flood scour allowed riparian vegetation to initiate along the low water channel, where historically vegetation would have been absent.

The lateral extent of riparian vegetation along the Tuolumne River remains greatly diminished from what it was prior to large-scale settlement along the river. Currently, less than 15 percent of the historical riparian forests remain along the Tuolumne River (McBain and Trush 2000). However, over the past 15 years the areal extent of lands dominated by native plants has slowly increased (TID/MID 2013b), with a 419-acre increase in the net extent of native vegetation between 1996 and 2012 (an average increase of about 8 acres/mile), brought about primarily through active vegetation restoration projects (TID/MID 2013b).

Anadromous fish abundance in the Tuolumne River has been reduced by habitat degradation and extensive instream and floodplain mining beginning in the mid-1800s (McBain and Trush 2000). Dams and water diversions associated with mining had affected fish migration as early as 1852 (Snyder 1993 unpublished memorandum, as cited in Yoshiyama et al.1996). Access to historical spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 near the site of the present-day La Grange Diversion Dam, was a barrier to anadromous fish migration. In 1884, the California Fish and Game Commission reported that the Tuolumne River was "dammed in such a way to prevent the fish from ascending" (California Fish and Game Commission 1884, as cited in Yoshiyama et al. 1996).

Because no impact of power peaking occurs downstream of La Grange Diversion Dam, the potential risk of juvenile steelhead stranding or entrapment is low. Some stranding may occur during flow reductions following flood control releases. However, the low frequency of these flood events, in combination with ramping rate restrictions required by the current FERC license, likely result in a low overall risk of fish mortality due to stranding and entrapment (TID/MID 2013c). A comprehensive evaluation of stranding surveys was conducted on the lower Tuolumne River (TID/MID 2000) and is summarized in the Districts' 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs, i.e., the range of flows under which the floodplain is inundated in several areas along the gravel-bedded reach.

Although increased structure has been shown to reduce territory size that must be defended (Imre et al. 2002) and to improve steelhead feeding opportunities (Fausch 1993), it is unlikely that the alluvial portions of the Tuolumne River downstream of La Grange Diversion Dam historically supported the large wood or boulder features more typically found in high-gradient streams of the Central Valley and along the coasts of California and Oregon (TID/MID 2013c). Therefore, it is unclear to what degree wood retention by upstream dams has contributed to adverse habitat effects in the lower river.

SRPs, which can be up to 400 ft wide and 35 ft deep and occupy approximately 32 percent of the length of the channel in the gravel-bedded reach (RM 52–24), harbor non-native fish, such as largemouth and smallmouth bass, which prey on juvenile salmonids. Introduced predators have been, and continue to be, most abundant in low-velocity areas prevalent in the middle section of the lower Tuolumne River (Orr 1997), making it likely that the present pattern and degree of predation mortality for any steelhead that occupy the Action Area is to a large extent a result of habitat alterations due to past sand and gravel mining coupled with the introduction of non-native piscivorous fish species (Orr 1997).

Measures have been undertaken to improve conditions for migratory and resident salmonids in the Tuolumne River relative to what they would otherwise be. Since implementation of increased summer flows under the 1996 FERC Order, the abundance of *O. mykiss* has increased, although stable flows in summer appear to select for a largely resident life-history type in the Action Area (TID/MID 2013c). Habitat protection, restoration, and enhancement projects (e.g., boulder placement and gravel augmentation) have improved instream habitat and riparian conditions, which may have benefitted *O. mykiss*. The measures proposed by the Districts for implementation under the new license term would result in a variety of direct and indirect effects on *O. mykiss*, as described in Section 2.1.2 of the BA.

1.2.1 Water Quality

Water quality conditions (primarily temperature and DO) with the potential to adversely affect any CCV steelhead in the Action Area are thought to be limited to late spring through early fall. Temperature modeling conducted to evaluate the reach of the Tuolumne River from La Grange Diversion Dam to the confluence with the San Joaquin River showed that water temperatures in this reach are typically affected more by meteorological conditions than they are by changes in flows.

Because adult resident *O. mykiss* are generally found in upstream habitats of the lower Tuolumne River throughout the year (Stillwater Sciences 2012), temperature related mortality is unlikely to occur in the lower Tuolumne River. It is unknown, however, whether adverse temperature effects occur during potential smolt emigration occurring late in the spring (TID/MID 2013c). As noted previously, increased summer baseflows and stable summer temperatures in the Tuolumne River since 1996 appear to have selected for a largely resident *O. mykiss* life history (TID/MID 2013c).

Water temperatures in the lower Tuolumne River are unlikely to cause mortality, either directly or as the result of increased susceptibility to pathogens, of any upstream migrating adult steelhead that may enter the Tuolumne River (TID/MID 2013c). NMFS (2014, Appendix B) states that because steelhead immigration into the Tuolumne River occurs mainly during winter, water temperatures downstream of La Grange Diversion Dam are probably suitable for adult immigration.

The CCV steelhead spawning period extends from December through April and peaks in February and March, so water temperature would be unlikely to adversely affect spawning success of any steelhead present in the lower Tuolumne River (TID/MID 2013c). NMFS (2014, Appendix B) states that water temperatures in the lower Tuolumne River during winter are probably suitable for steelhead spawning.

Available information suggests that juvenile *O. mykiss* rearing habitat may at times be limiting in the lower Tuolumne River during summer due to a combination of high water temperatures and potential territorial interactions with *O mykiss* of older age classes (TID/MID 2013c). Increased densities and downstream distribution of juvenile *O. mykiss* have been documented since implementation of increased summer baseflows under the 1996 FERC Order, and during years with extended flood control releases (TID/MID 2013c). NMFS (2014, Appendix B) states that high water temperatures during summer months are likely a limiting factor for steelhead rearing in the lower Tuolumne River, especially at low flows. NMFS (2014, Appendix B) states that current FERC-mandated flow schedules appear to provide suitable rearing habitat for the first 15 miles downstream of La Grange Diversion Dam during non-dry years (McBain and Trush 2000), but temperatures may not be low enough (i.e., < 14°C) to optimize smoltification and increase survival to the ocean. NMFS (2014, Appendix B) states that water quality, other than temperature, is not likely to adversely affect juvenile steelhead in the Tuolumne River.

A study recently conducted by the Districts, i.e., Thermal Performance of Wild Juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: a Case for Local Adjustment to High River Temperature (Farrell et al. 2017), calls into question some of the current assertions made about temperature suitability for *O. mykiss* in the lower Tuolumne River. The thermal performance study (i.e., the "swim tunnel" study) (Farrell et al. 2017) showed that wild *O. mykiss* from the lower Tuolumne River can maintain 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C, and all fish tested could maintain sufficient aerobic capacity to properly digest a meal at temperatures up to 23°C. Video analysis of *O. mykiss* swimming activity in the Tuolumne River indicates that fish at ambient water temperatures have an excess aerobic capacity well beyond that needed to swim and maintain station against the river's current in their usual habitat.

These thermal performance results are consistent with those derived for *O. mykiss* populations known to be high-temperature tolerant, such as the redband strain of rainbow trout (*O. mykiss gairdneri*) that occurs in the high deserts of eastern Oregon and Idaho.

Results of the study (Farrell et al. 2017; Verhille et al. 2016) support the hypothesis that the thermal tolerance of wild *O. mykiss* from the Tuolumne River represents an exception to that expected based on the 18°C 7DADM criterion set out by EPA (2003) for Pacific Northwest *O. mykiss*. Given that lower Tuolumne River *O. mykiss* can maintain 95 percent of peak aerobic capacity at temperatures up to 24.6°C, a more reasonable upper performance limit is likely to be 22°C, rather than the established 18°C.

Results from a CDFW (2014) drought stressor monitoring case study are consistent with the general findings of the thermal performance study (i.e., that *O. mykiss* in California tolerate temperatures greater than 18°C). From May through October 2014, 453 juvenile steelhead were caught in the lower American River (83 [18 percent] were of natural origin and 370 [82 percent] were of hatchery origin). A portion of these fish were PIT tagged (14 of natural origin and 59 of hatchery origin). Average monthly water temperature from July through September 2014 was 20°C (68°F), and the maximum observed temperature during this period was 22.8°C (73°F). Growth rates of recaptured fish were high (1.23-1.38 mm/day), but CDFW reports that "there were no visible signs of stress in the captured fish."

Shoreline protection measures at Don Pedro Reservoir, including prohibition of shoreline disturbances and off-road vehicle use on Project lands, benefit reservoir water quality, which could translate into limited downstream water quality benefits. There is no evidence that regulated herbicide and pesticide applications near recreation and operational facilities adjacent to Don Pedro Reservoir have adverse effects on water quality in the Tuolumne River.

The California Department of Pesticide Regulation (CDPR) has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of the Central Valley and Delta (Werner et al. 2008). Six pesticides were detected in runoff from agricultural and urban areas during a study conducted in the lower Tuolumne River, and chlorpyrifos, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998). Peak diazinon concentrations measured in the lower Tuolumne River have frequently exceeded levels that can be acutely toxic to some aquatic organisms (Dubrovsky et al. 1998).

Section 303(d) of the federal Clean Water Act (CWA) requires each state to submit to the EPA a list of rivers, lakes, and reservoirs for which pollution control and/or requirements have failed to provide adequate water quality. Based on a review of this list, the surface water bodies identified by the State Water Resources Control Board (SWRCB) as CWA § 303(d) State Impaired in and adjacent to the lower Tuolumne are listed in Table 1.2-1.

Table 1.2-1. Clean Water Act Section 303(d) list for the lower Tuolumne River and associated water bodies.

Water Body	Pollutant	Final Listing Decision
Lower Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	List on 303(d) list (TMDL required list)
	Diazinon	Do Not Delist from 303(d) list (TMDL required list)
	Escherichia coli	List on 303(d) list (TMDL required list)
	Mercury	List on 303(d) list (TMDL required list)
	Temperature	List on 303(d) list (TMDL required list)
	Unknown Toxicity	List on 303(d) list (TMDL required list)
Turlock Lake	Mercury	List on 303(d) list (TMDL required list)
Modesto Reservoir	Mercury	List on 303(d) list (TMDL required list)
Dry Creek (tributary to Tuolumne River at Modesto)	Chlorpyrifos	List on 303(d) list (TMDL required list)
	Diazinon	List on 303(d) list (TMDL required list)
	Escherichia coli	List on 303(d) list (TMDL required list)
	Unknown Toxicity	List on 303(d) list (TMDL required list)

Source: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml (accessed June 2016).

Discharge of nutrients such as nitrogen and phosphorus from non-point runoff of agricultural fertilizer and point sources, such as water treatment facilities, stimulates algae growth, with attendant increases in the magnitude of diurnal DO variation. This can cause changes in food webs (Durand 2008) and as a result food availability for fish populations (TID/MID 2013c).

The extent to which CCV steelhead may be affected by pollutants is not well understood, but a range of literature sources suggests that early life history exposure to trace metals, herbicides, and pesticides may impair olfactory capabilities required for homing sensitivity (Hansen et al. 1999, Scholz et al. 2000, Tierney et al. 2010), which could affect arrival of adult steelhead in their natal streams. However, there is no documentation of olfactory impairment of returning adult CCV steelhead in the Action Area (TID/MID 2013c). It is also unknown whether pesticide levels affect rearing or any out-migrating steelhead juveniles (TID/MID 2013c) in the lower Tuolumne River.

1.2.2 Connectivity and Entrainment

Dams throughout the San Joaquin River and its tributaries are barriers to upstream migration of anadromous salmonids and other migratory fish species. Dams and water diversions associated with mining adversely affected fish migration in the Tuolumne River as early as 1852 (Snyder 1993 unpublished memorandum, as cited in Yoshiyama et al.1996). Access to historic spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed on the Tuolumne River. Wheaton Dam, built in 1871 near the site of the present-day La Grange Diversion Dam (RM 52.2), was a barrier to salmonid migration. Under current conditions, La Grange Diversion Dam would act as a complete migration barrier if any CCV steelhead were to migrate upstream to its tailwater.

As noted, there are approximately 26 points of unscreened riparian water diversion along the lower Tuolumne River between La Grange Diversion Dam and the San Joaquin River. Diversions at these points typically occur during irrigation season. Juvenile CCV steelhead in the Action Area might be subject to entrainment in these diversion intakes along the river, although there are no available data that can be used to assess the extent to which these diversions affect *O mykiss*.

1.2.3 Hatchery Propagation and Stocking

Recent studies have increasingly indicated adverse effects of hatchery-reared fish on co-occurring wild stocks with which they may interact via interbreeding, competition, or predation. Hatchery management was identified as a cause for the ESA listing of CCV steelhead (61 FR 41541; 63 FR 13347). Over the past few decades, the genetic integrity of CCV steelhead has been reduced by increases in the abundance of hatchery fish relative to wild fish, the reliance on out-of-basin stocks for hatchery production, and the straying of hatchery-origin fish (CDFG and NMFS 2001; California Hatchery Scientific Review Group [HSRG] 2012). Genetic introgression of hatchery stocks with "natural" stocks can result in a decrease in the biological fitness of the natural stocks (e.g., ISAB 2003, Berejikian and Ford 2004, Kostow 2004, Araki et al. 2007, Lindley et al. 2007, CDFG and NMFS 2001). In its most recent five-year review for the CCV steelhead DPS, NMFS (2016) states, "It is unclear whether the impacts of hatchery programs have changed in severity since the last review, but new information clearly suggests a loss of genetic diversity and population structure over time. Overall, impacts from hatcheries continue to be an ongoing threat to this DPS."

Studies indicate that 63 to 92 percent of steelhead smolt production in the Central Valley is of hatchery origin (NMFS 2003), and hatchery fish account for the majority of the CCV steelhead DPS (Lindley et al. 2007). The California HSRG (2012) expressed concern related to the predominance of Eel River genetics in the Nimbus Hatchery steelhead program (NMFS 2014), and *O. mykiss* populations downstream of migration barriers are in fact most closely related to populations in far northern California, specifically genetic groups that include the Eel and Klamath rivers (NMFS 2014). Because Eel River broodstock were used for years at the Nimbus Hatchery, it is likely that Eel River genes not only persist there but have also spread to other basins via straying (NMFS 2014).

Although all naturally-spawned *O. mykiss* in Central Valley river basins are to some degree related, (NMFS 2014), lower genetic diversity in *O. mykiss* populations above migration barriers indicates a lack of substantial genetic input from outside (i.e., downstream) sources. The genetic clustering of *O. mykiss* that occur upstream of migration barriers and relationships in California-wide genetics comparisons indicate that the above-barrier fish better represent the ancestral genetic structure of CCV steelhead than fish currently occurring below barriers (Garza and Pearse 2008).

Facilities that produce steelhead whose life histories could overlap temporally or spatially with any steelhead in the Tuolumne River include the Coleman National Fish Hatchery, Feather River Fish Hatchery, Nimbus Hatchery, and the Mokelumne River Hatchery (ICF Jones & Stokes 2010). However, NMFS (2016) considers steelhead from the Coleman, Feather River, and Mokelumne River hatcheries to be part of the CCV DPS.

Although hatchery straying could affect any steelhead spawning in the lower Tuolumne River, the absence of basin-specific data on spawning or straying from out-of-basin hatcheries makes it difficult to determine to what extent hatchery-origin steelhead may attempt to spawn in the Action Area (TID/MID 2013c). However, based on the extremely low numbers of steelhead relative to resident *O. mykiss* documented in otolith analyses in the Tuolumne River (Zimmerman et al. 2009), and the rare observation of upmigrating *O. mykiss* at the counting weir, it is likely that effects of hatchery-origin fish would be primarily on resident *O. mykiss* (TID/MID 2013c).

No known fish stocking has occurred in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam (TID/MID 2013a), so rainbow trout in this reach appear to be displaced fish, likely of hatchery origin, from Don Pedro Reservoir.

Hatchery Genetic Management Plans (HGMPs) are being prepared pursuant to Section 7 of the ESA for hatcheries in California to guide the propagation of steelhead. The goal of the plans is to prevent adverse impacts on the genome of federally-listed fish and any potential effects of stocking on the size, abundance, run-timing, and distribution of wild fish.

In an attempt to encourage more harvest of hatchery-origin steelhead, regulations have been promulgated to incrementally increase the opportunity for harvest of hatchery-origin steelhead in the Central Valley (NMFS 2016). The rationale behind this is that increasing daily bag and possession limits for hatchery steelhead would minimize potential negative behavioral and genetic interactions with natural-origin steelhead.

The measures proposed by the Districts for implementation under the new license term would result in a variety of direct and indirect effects on *O. mykiss*, as described in Section 5.0 of the BA.

1.2.4 Introduced Species and Predation

Predation on native salmonids in the lower Tuolumne River is influenced by channel modifications that have created habitats that support non-native piscivores. Reductions in flood frequency resulting from the construction of large upriver reservoirs have increased predator habitat suitability within in-channel pits and SRPs created by mining (Orr 1997; McBain and Trush 2000; Ford and Brown 2001). Inter-annual variations in flows and water temperatures have been associated with variations in river-wide predator distribution (Ford and Brown 2001) and year-class strength in multi-year surveys for the SRP 9 predator isolation project at RM 25.7 (McBain and Trush 2004; Stillwater Sciences 2006).

No data exist to document the degree of piscine or avian predation on juvenile steelhead present in the lower Tuolumne River. Predation risk on resident *O. mykiss* in the lower river is likely low because their distribution during summer is generally restricted to cool water locations upstream of Roberts Ferry Bridge (RM 39.5), and predators are found mostly downstream of this reach (Brown and Ford 2002). In addition to this habitat segregation, the larger body size of adult *O mykiss* limits their risk to predation, so mortality is most likely limited to resident age 0+ fish during water-year types with low flows and warmer temperatures that allow predators to move upstream (TID/MID 2013c).

Predation on juvenile salmonids by piscivores is not the only adverse effect associated with introduced species. The presence of introduced zooplankton species and the overbite clam (*Corbula amurensis*) in the lower Tuolumne River (Brown et al. 2007) may have affected the availability of suitable prey for any rearing steelhead moving through this reach (see also, Benthic Invertebrates and Fish Food Availability, below).

The measures proposed by the Districts for implementation under the new license term, particularly the new counting weir and predator control program, would influence the degree of predation risk on *O. mykiss*, as described in Section 5.0 of the BA.

1.2.5 Benthic Invertebrates and Fish Food Availability

Analysis of long-term Hess sampling data gathered from 1988-2009 at Riffle 4A (RM 48.8) in the lower Tuolumne River indicates that increased summer flows since 1996 have resulted in beneficial shifts in the invertebrate food supply for fishes. Overall invertebrate abundances in Riffle 4A samples have declined slightly from 1996 to the present, but community composition has shifted away from pollution-tolerant invertebrate taxa toward those with higher food value for juvenile *O. mykiss* (TID/MID 2010).

1.2.6 Steelhead Harvest

There is no commercial steelhead fishery in the rivers of the Central Valley, and ocean harvest of steelhead is an insignificant source of mortality for the CCV steelhead DPS (NMFS 2016). Existing data are unavailable to directly estimate freshwater exploitation rates of CCV steelhead, but rates are considered to be low because it is illegal to keep natural-origin fish. Estimated angler effort based on self-report cards increased significantly over the period of 1993–2005, potentially as the result of regulations allowing anglers to keep hatchery-origin steelhead caught in the Central Valley. Despite the observed increase in angler effort, inadvertent injury resulting from targeting hatchery fish is extremely low in the Tuolumne River, given that steelhead, regardless of origin, are very rare.

To protect wild steelhead in California, all hatchery steelhead receive an adipose fin-clip, and CDFW works closely with NMFS to review and improve inland fishing regulations (NMFS 2014). These include zero bag limits for unmarked steelhead, gear restrictions, closures, and size limits designed to protect smolts. Notwithstanding the benefits of these regulations, McEwan and Jackson (1996) contend that legal harvest in the years prior to the listing of CCV steelhead was not the cause of recent population declines.

Because the Tuolumne River downstream of La Grange Diversion Dam supports a catch-and-release recreational trout fishery from January 1 through October 15, it is possible that *O. mykiss* redds in the Action Area are at times inadvertently disrupted by wading anglers (NMFS 2014). However, annual fishing report cards (Jackson 2007) do not provide data to quantitatively assess hooking mortality or other sport fishing impacts on *O. mykiss*. Illegal harvest of resident *O. mykiss* could occur year-round, but no data are available that address the extent to which *O. mykiss* poaching occurs in the Action Area (TID/MID 2013c).

2.0 REFERENCES

Araki, H., B. Cooper, and M.S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318:100-103.

Berejikian, B.A. and M.J. Ford. 2004. Review of Relative Fitness of Hatchery and Natural Salmon. NOAA Technical Memorandum NMFS-NWFSC-61. December 2004. Seattle, Washington.

Brown, L.R., J.K. Thompson, K. Higgins, and L.V. Lucas. 2007. Population density, biomass, and age-class structure of the invasive clam *Corbicula fluminea* in rivers of the lower San Joaquin River watershed, California. Western North American Naturalist 67: 572–586.

Brown, L.R. and T. Ford. 2002. Effects of flow on the fish communities of a regulated California river: implications for managing native fishes. River Research and Applications 18:331-342.

California Department of Fish and Game (CDFG). 1988. California Advisory Committee on Salmon and Steelhead: Restoring the Balance.

______. 1990. Central Valley Salmon and Steelhead Restoration and Enhancement Plan. Sacramento, California. April 1990. 115 pages.

______. 1993. Restoring Central Valley Streams: A Plan for Action. Sacramento, California. November 1993. 129 pages.

______. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, California.

California Department of Fish and Game (CDFG) and National Marine Fisheries Service (NMFS). 2001. Final report of anadromous salmonid fish hatcheries in California. December. [Online] URL: https://nrm.dfg.ca.gov/documents/ContextDocs.aspx?cat=Fisheries.

California Department of Fish and Wildlife (CDFW) 2014. Fishing for Black Bass. [Online] URL: http://www.dfg.ca.gov/fish/Resources/ (Accessed April 23, 2014).

California Department of Water Resources (CDWR). 1994. California Water Plan Update 1993. Bulletin 160-93. October. [Online] URL: http://www.waterplan.water.ca.gov/previous/b160-93/TOC.cfm.

California Environmental Protection Agency, State Water Resources Control Board. 2016. Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report). [Online] URL: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml (Accessed June 2016).

California Hatchery Scientific Review Group (California HSRG). 2012. California Hatchery Review Report. Prepared for the US Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. 100 pp.

City and County of San Francisco (CCSF). 2006. Tuolumne River System and HHWP Fact sheet. San Francisco, California.

Dill, W.A. and A.J. Cordone. 1997. History and status of introduced fishes in California, 1871-1996. California Department of Fish and Game Fish Bulletin 178. [Online] URL: http://www.escholarship.org/uc/item/5rm0h8qg#page-1. (Accessed August 2, 2010.)

Dubrovsky, N.M., C.R. Kratzer, L.R. Brown, J.M. Gronberg, and K.R. Burow. 1998. Water Quality in the San Joaquin-Tulare Basins, California, 1992-95. U.S. Geological Survey, Sacramento, California. [Online] URL: https://pubs.usgs.gov/circ/circ1159/circ1159.pdf.

Durand, J. 2008. Delta foodweb conceptual model. Delta Regional Ecosystem Restoration Implementation Plan. Sacramento, California. [Online] URL: http://www.science.calwater.ca.gov/pdf/drerip/DRERIP_food_web_conceptual_model_final_120208.pdf.

Farrell, A.P., N.A. Fangue, C.E. Verhille, D. E. Cocherell, and K.K. English. 2017. Thermal performance of wild juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: a case for local adjustment to high river temperature. Final Report. (W&AR-14). Prepared by the Department of Wildlife, Fish, and Conservation Biology, University of California, Davis for Turlock Irrigation District and Modesto Irrigation District. February 2017.

Fausch, K.D. 1993. Experimental analysis of microhabitat selection by juvenile steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) in a British Columbia stream. Can. J. Fish. Aquat. Sci. 50: 1198–1207.

Federal Energy Regulatory Commission (FERC). 1996. Reservoir release requirements for fish at the New Don Pedro Project, California. FERC Project No. 2299-024, FERC, Office of Hydropower Licensing, Washington, D.C.

Ford, T. and L.R. Brown. 2001. Distribution and Abundance of Chinook Salmon and Resident Fishes of the Lower Tuolumne River, California. Fish Bulletin.

Garza, J.C. and D.E. Pearse. 2008. Population genetic structure of Oncorhynchus mykiss in the California Central Valley. Report to California Department of Fish and Game. Contract No. PO485303. University of California, Santa Cruz, and NOAA Southwest Fisheries Science Center, Santa Cruz, California.

Grant, G.E., J.C. Schmidt, and S.L. Lewis. 2003. A geological framework for interpreting downstream effects of dams on rivers. Pages 209–225 *in* J. E. O'Connor and G. E. Grant, editors. A peculiar river: geology, geomorphology, and hydrology of the

Deschutes River, Oregon. Water Science and Application Series No. 7. American Geophysical Union, Washington, D.C.

Hansen, J.A., J.C.A. Marr, J. Lipton, D. Cacela, and H.L. Bergman. 1999. Differences in neurobehavioral responses of Chinook salmon (*Oncorhynchus tshawytscha*) and rainbow trout (Oncorhynchus mykiss) exposed to copper and cobalt: behavioral avoidance. Environmental Toxicology and Chemistry 18(9):1972-1978.

ICF Jones & Stokes. 2010. Hatchery and Stocking Program Environmental Impact Report/Environmental Impact Statement. Final. January.(ICF J&S 00264.08) (SCH #2008082025). Sacramento, CA. Prepared for the California Department of Fish and Game and U.S. Fish and Wildlife Service, Sacramento, CA.

Imre, I., J.W.A. Grant, and E.R. Keeley. 2002. The effect of visual isolation on territory size and population density of juvenile rainbow trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences 59:303-309.

Independent Scientific Advisory Board (ISAB). 2003. Review of salmon and steelhead supplementation. June 4, 2003. Independent Scientific Advisory Board for the Northwest Power Planning Council, the National Marine Fisheries Service, and the Columbia River Basin Indian Tribes, Portland, Oregon.

Jackson, T.A. 2007. California Steelhead Report-Restoration Card: A Report to the Legislature California Department of Fish and Game. 46 p. plus appendices

Katibah, E.F. 1984. A brief history of the riparian forests in the central valley of California. *in*: Warner, R.E.; Hendrix, K.M., editors. California riparian systems: ecology conservation and productive management. Berkeley, CA: University of California Press; 23-29.

Kostow, K.E. 2004. Differences in juvenile phenotypes and survival between hatchery stocks and a natural population provide evidence for modified selection due to captive breeding. Canadian Journal of Fisheries and Aquatic Sciences 61:577-589.

Lindley, S.,T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered salmon and steelhead in the Sacramento- San Joaquin Basin. San Francisco Estuary and Watershed Science Volume 5, Issue 1 [February 2007], article 4.

———. 2000. Habitat restoration plan for the Lower Tuolumne River corridor, Final Report. Prepared by McBain and Trush, Arcata, California for the Tuolumne River Technical Advisory Committee with assistance from U.S. Fish and Wildlife Service Anadromous Fish Restoration Program.

______. 2004. Coarse sediment management plan for the lower Tuolumne River. Revised Final Report. Prepared by McBain and Trush, Arcata, California for Tuolumne River Technical

Advisory Committee, Turlock and Modesto Irrigation Districts, USFWS Anadromous Fish Restoration Program, and California Bay-Delta Authority.

McEwan, D. and T.A. Jackson. 1996. Steelhead restoration and management plan for California. Management Report. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles, California.

Moyle, P. B., P. K. Crain, and K. Whitener. 2007. Patterns in the Use of a Restored California Floodplain by Native and Alien Fishes. San Francisco Estuary and Watershed Science, 5(3). Retrieved from: http://www.escholarship.org/uc/item/6fq2f838.

Naiman, R.J., H. Decamps, and M.E. McClain. 2005. Riparia: ecology, conservation, and management of streamside communities. Academic Press, New York, New York.

National Marine Fisheries Service (NMFS). 2003. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead. February 2003.

_____. 2014. Recovery Plan for the Evolutionarily 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.

_____. 2016. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment. Prepared by D. Swank and A. Cranford. 1 Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, CA 95814-4706.

Orr, B.K. 1997. Ecosystem health and salmon restoration: a broader perspective. Pages 575-580 in S.S.Y. Wang, editor. Environmental and coastal hydraulics: protecting the aquatic habitat. Volume 1: Proceedings of Theme B. Water for a changing global community. The 27th Congress of the International Association for Hydraulic Research. American Society of Civil Engineers, New York. [Online] URL: http://www.stillwatersci.com/%20resources/1997orrsalmon.pdf. (Accessed July 27, 2010.)

Scholz, N.L., N. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, and T.K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 57:1911-1918.

Stanislaus County. 2006. Stanislaus County General Plan. Stanislaus County Board of Supervisors, Modesto, California.

Stillwater Sciences. 2006. Lower Tuolumne River predation assessment final report. Prepared for the Tuolumne River Technical Advisory Committee, Turlock and Modesto Irrigation districts, USFWS Anadromous Fish Restoration Program and California Bay-Delta Authority.

_____. 2012. Tuolumne River 2011 *Oncorhynchus mykiss* monitoring summary report. Prepared by Stillwater Sciences, Berkeley, California for the Turlock Irrigation District and Modesto Irrigation District.

Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Annals of the Association of American Geographers 51: 294–315.

Tierney, K.B., D.H. Baldwin, T.J. Hara, P.S. Ross, N.L. Scholz, and C.J. Kennedy. 2010. Olfactory Toxicity In Fishes. Aquatic Toxicology, 96:2-26.

Turlock Irrigation District / Modesto Irrigation District (TID/MID). 1992. Lower Tuolumne River spawning gravel studies report. Appendix 8 in Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299. Vol. IV. Prepared by EA Engineering, Science, and Technology, Lafayette, California.

_____. 2000. 1999 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. 2 Volumes. March.

_____. 2001. 2000 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. 2 Volumes. March.

_____. 2005. 2005 Ten Year Summary Report. Pursuant to Paragraph (G) of the 1996 FERC Order issued July 31, 1996. Don Pedro Project, No. 2299. April.

_____. 2007. 2006 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. March.

_____. 2010. 2009 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299. March.

_____. 2011. Fall/Winter Migration Monitoring at the Tuolumne River Weir – 2010 Annual Report. Prepared by FISHBIO, Oakdale, CA.

_____. 2013a. Fish Assemblage and Population between Don Pedro Dam and La Grange Dam Study Report (W&AR-13). Prepared by HDR Engineering, Inc. January 2013.

_____. 2013b. Lower Tuolumne River Riparian Information and Synthesis Study Report (W&AR-19). Prepared by Stillwater Sciences. December 2013.

_____. 2013c. Salmonid Population Information Integration Study Report (W&AR-05). Prepared by Stillwater Sciences. January 2013.

_____. 2013d. Spawning Gravel in the Lower Tuolumne River Study Report (W&AR-04). Prepared by Stillwater Sciences. December 2013.

_____. 2017. *Oncorhynchus mykiss* Habitat Survey Study Report (W&AR-12). Prepared by Stillwater Sciences. September 2017.

United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

Verhille C.E., K.K. English, D.E. Cocherell, A.P. Farrell, N.A. Fangue. 2016. High thermal tolerance of a rainbow trout population near its southern range limit suggests local thermal adjustment. Conserv Physiol 4(1): cow057; doi:10.1093/conphys/cow057.

Werner, I., S. Anderson, K. Larsen, and J. Oram. 2008. Chemical stressors conceptual model. Delta Regional Ecosystem Restoration Implementation Plan, Sacramento, California. [Online] URL: http://www.science.calwater.ca.gov/pdf/drerip/DRERIP_chemical_stressors_conceptual_model_final_012808.pdf.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress. In: University of California, Center for Water and Wildlife Resources, Davis. Assessments, commissioned reports, and background information. p 309-362. [Online] URL: https://www.sierraforestlegacy.org/FC_SierraNevadaWildlifeRisk/Chinook.php. (Accessed August 10, 2010.)

Zimmerman, C.E., G.W. Edwards, and K. Perry. 2008. Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured on rivers of the Central Valley, California. California Department of Fish and Game.

———. 2009. Maternal origin and migratory history of steelhead and rainbow trout captured in rivers of the Central Valley, California. Transactions of the American Fisheries Society 138: 280–291.