LA GRANGE HYDROELECTRIC PROJECT

FERC NO. 14581

FINAL LICENSE APPLICATION

EXHIBIT A – PROJECT DESCRIPTION

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List of Acronyms and Abbreviations

CFR............................Code of Federal Regulations
cfs...............................cubic feet per second
Districts......................Turlock Irrigation District and Modesto Irrigation District
FERC..........................Federal Energy Regulatory Commission
FLA............................Final License Application
ft.................................feet
LGDD.........................La Grange Diversion Dam
M&I............................municipal and industrial
MID............................Modesto Irrigation District
MW............................megawatt
MWh..........................megawatt hour
Project........................La Grange Hydroelectric Project
RM.............................river mile
TID.............................Turlock Irrigation District
USGS.........................United States Geological Survey
WY.............................water year

EXHIBIT A – PROJECT DESCRIPTION

EXCERPT FROM CODE OF FEDERAL REGULATIONS (CFR) DESCRIBING CONTENTS OF THE EXHIBIT (18 CFR §4.61)

Subpart G—Application for License for Minor Water Power Projects and Major Water Power Projects 5 Megawatts or Less

(c) Exhibit A is a description of the project and the proposed mode of operation.
(1) The exhibit must include, in tabular form if possible, as appropriate:
(i) The number of generating units, including auxiliary units, the capacity of each unit, and provisions, if any, for future units;
(ii) The type of hydraulic turbine(s);
(iii) A description of how the plant is to be operated, manual or automatic, and whether the plant is to be used for peaking;
(iv) The estimated average annual generation in kilowatt-hours or mechanical energy equivalent;
(v) The estimated average head on the plant;
(vi) The reservoir surface area in acres and, if known, the net and gross storage capacity;
(vii) The estimated minimum and maximum hydraulic capacity of the plant (flow through the plant) in cubic feet per second and estimated average flow of the stream or water body at the plant or point of diversion; for projects with installed capacity of more than 1.5 megawatts, monthly flow duration curves and a description of the drainage area for the project site must be provided;
(viii) Sizes, capacities, and construction materials, as appropriate, of pipelines, ditches, flumes, canals, intake facilities, powerhouses, dams, transmission lines, and other appurtenances; and
(ix) The estimated cost of the project.
(x) The estimated capital costs and estimated annual operation and maintenance expense of each proposed environmental measure.
(2) State the purposes of project (for example, use of power output).
(3) An estimate of the cost to develop the license application; and
(4) The on-peak and off-peak values of project power, and the basis for estimating the values, for projects which are proposed to operate in a mode other than run-of-river.
(5) The estimated average annual increase or decrease in project generation, and the estimated average annual increase or decrease of the value of project power due to a change in project operations (i.e., minimum bypass flows, limiting reservoir fluctuations) for an application for a new license;
(6) The remaining undepreciated net investment, or book value of the project;
(7) The annual operation and maintenance expenses, including insurance, and administrative and general costs;
(8) A detailed single-line electrical diagram;
(9) A statement of measures taken or planned to ensure safe management, operation, and maintenance of the project.

PREFACE

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are filing this final application for an original license with the Federal Energy Regulatory Commission (Commission or FERC) for the existing La Grange Hydroelectric Project (Project) located on the Tuolumne River in the Central Valley of California. This Exhibit A, the Project Description of the Final License Application (FLA), is prepared in accordance with 18 CFR §4.61.

The following sections describe the La Grange Project facilities, including elements associated with hydropower generation (Project facilities) and non-Project features which 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.

1.0 PROJECT LOCATION

1.1 General Project Setting and Location

The La Grange Diversion Dam (LGDD) is located on the Tuolumne River near the border of Stanislaus and Tuolumne counties in central California at river mile (RM) 52.2. The diversion dam is owned jointly by TID and MID, with the diversion works on the west side (river right) of the river owned by MID and the facilities on the east owned by TID. The 4.7 megawatt (MW) hydropower project is located on the north side of the river, and owned by TID alone. The facilities associated with hydroelectric generation include the diversion dam, two-mile long impoundment, two penstock intakes, two sluice gates and sluice gate channel, a powerhouse, excavated tailrace, and substation. As proposed herein, the Project also includes the side-hill release gates, associated Tainter gates, and the channel leading from the Tainter gates to the side-hill release gates on the MID side of the river. The intakes for the TID powerhouse are located just upstream of TID's Upper Main Canal headworks. The general site arrangement is depicted in Figure 2.1-1. While certain facilities are necessary to support power generation (e.g., diversion dam), these project works are also necessary for the primary purpose of the La Grange Project, which is the diversion of water for water supply purposes, and the safe and effective passage downstream of waters not diverted.

1.2 Drainage Area

The 150-mile-long Tuolumne River begins at the confluence of the Dana Fork and the Lyell Fork in the Tuolumne Meadows area of Yosemite National Park. After traversing nearly 8,600 feet of elevation drop, the Tuolumne River flows into the San Joaquin River in the Central Valley region of California. The Tuolumne River initially passes through high mountain valleys and deeply incised canyons, then through the foothills of the Sierra Nevada Mountains, and then through the eastern side of the low-lying Central Valley. The 1,960-square-mile watershed can be subdivided into three river reaches—the upper Tuolumne River above roughly RM 80, the foothills reach between RM 54 and 80, and the valley reach from the mouth to RM 54. The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Flows reaching LGDD are regulated by four upstream reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake (also known as Lake Lloyd), and Don Pedro.

1.3 Purpose of La Grange Project

TID and MID (collectively, the Districts) are public agencies with headquarters located in Turlock and Modesto, California, respectively. Both Districts are organized under the laws of the State of California to provide water supplies and retail electric services. LGDD is jointly owned by the Districts. Originally constructed between 1891 and 1893, the purpose of the dam is to raise the level of the Tuolumne River to permit the diversion of water by means of gravity from the river for irrigation of Central Valley farmland and M&I water supply. TID alone owns and operates the La Grange powerhouse.

TID was established in June 1887 and was California's first publicly owned irrigation district. TID provides irrigation water to 150,000 acres of land and serves approximately 100,000 electric customers in a 662-square-mile electric service area (TID 2010). MID was established in July 1887. MID provides irrigation water to almost 60,000 acres of land and serves approximately 111,000 electric customers in a 560-square-mile electric service area (MID 2010). MID also supplies treated municipal water to the City of Modesto, and the Districts provide treated drinking water to the community of La Grange.

1.4 Purpose of and Need for TID's La Grange Hydroelectric Project

TID placed the La Grange powerhouse in service in 1924, thirty years after construction of LGDD. 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, river flows not needed to be diverted for water supply purposes may be passed downstream through one or both of the turbine-generator units located in the powerhouse. If the powerhouse is out of service, then river flows not needed to be diverted for water supply purposes may be passed downstream at the sluice gate structure located adjacent to the penstock intake, at MID's Hillside gates, and/or at Portal 1 gate in the diversion dam. For the period 2005 through 2016, the TID La Grange powerhouse produced an average of 17,746 megawatt hour (MWh) of renewable energy per year. Monthly generation through this period is shown below in Table 3.1-2.

2.0 PROJECT FACILITIES

The La Grange Project includes facilities associated with both water supply and hydroelectric power generation, including the diversion dam, impoundment, forebay, sluice gates and sluice channel, two penstocks and their intakes, a powerhouse, excavated tailrace, and substation. It also includes MID's Hillside gates, associated Tainter gates, and the channel leading from the Tainter gates to the Hillside gates. The intakes for the TID powerhouse are located just upstream of TID's Upper Main Canal headworks. Non-Project features are identified as such throughout this Exhibit A. No roads are used exclusively for the hydroelectric project and are therefore non-Project facilities. The general site arrangement is depicted in Figure 2.1-1.

2.1 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 (Figure 2.1-2 and Figure 2.1-3). 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. A rating table for the spillway is presented in Table 2.1-1. The maximum flow over the spillway occurred in 1997 and was approximately 59,462 cubic feet per second (cfs).

Table 2.1-1. Rating table for La Grange spillway.

Reservoir Elevation (ft)	Discharges in cfs			
	0.00 ft	**0.25 ft**	**0.50 ft**	**0.75 ft**
296	-	-	10	120
297	320	600	980	1,350
298	1,800	2,280	2,780	3,400
299	4,010	4,680	5,380	6,150
300	6,900	7,720	8,560	9,410
301	10,310	11,300	12,300	13,350
302	14,500	15,590	16,680	17,900
303	19,100	20,290	21,500	22,700
304	23,900	25,050	26,800	28,400

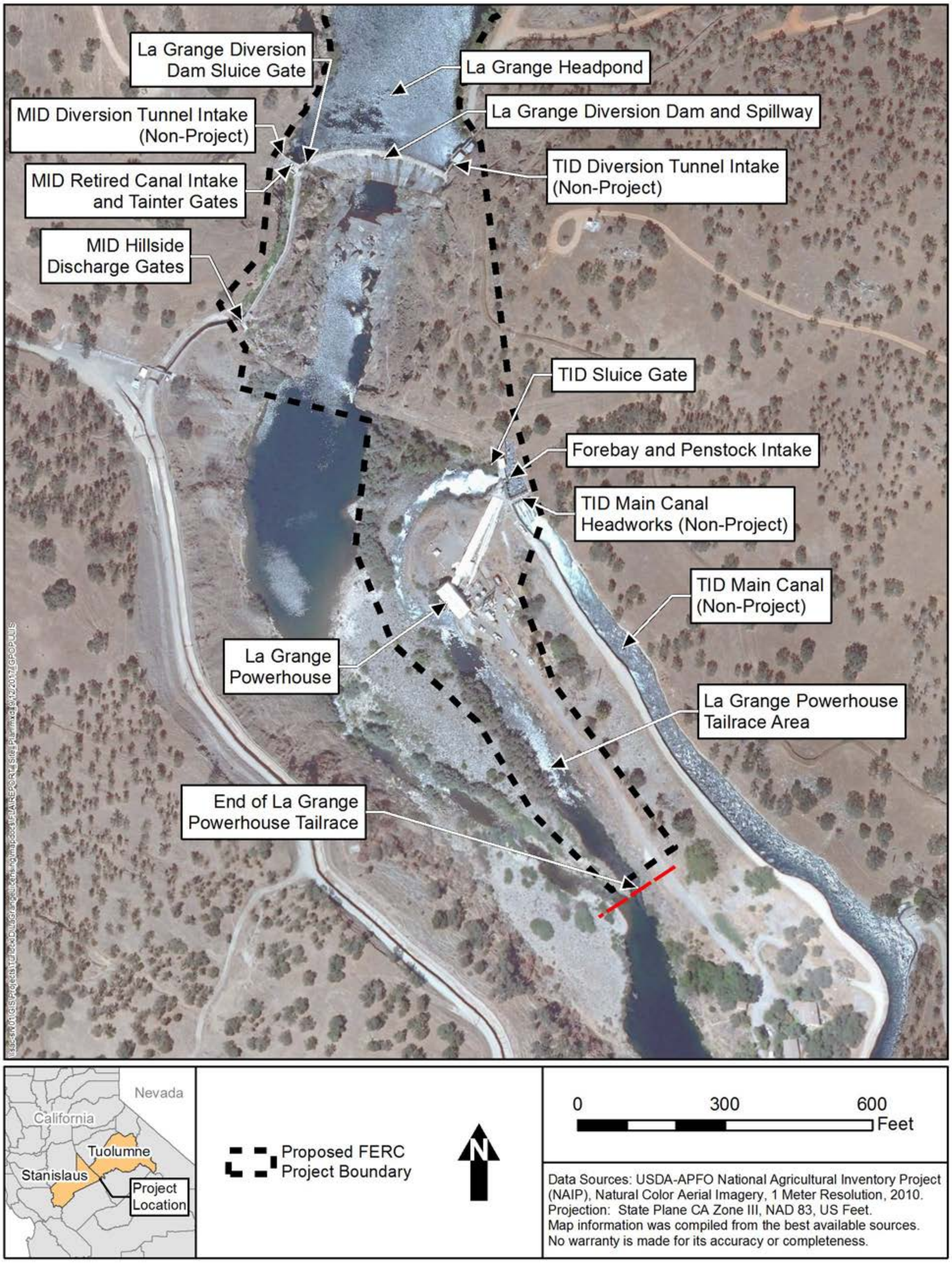

Figure 2.1-1. La Grange Project facilities.

Figure 2.1-2. La Grange Diversion Dam seen from retired MID irrigation canal on right bank.

Figure 2.1-3. La Grange Diversion Dam from TID intake on left bank. Note water flowing from MID Hillside outlet to river below.

2.2 Headpond

The diversion dam was constructed for the purpose of raising the level of the Tuolumne River to a height which 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. The headpond formed by LGDD is narrow and steep-sided and flow conditions along the headpond reflect a more riverine than lacustrine environment.

Based on FERC's assessment of 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 four miles and a surface area of approximately 35 acres. The headpond has a maximum depth of 35 feet, a mean depth of approximately 11 feet, a gross storage capacity of approximately 400 acre-feet, and a usable storage capacity of less than 100 acre-feet.

2.3 Intakes and Tunnels

The Don Pedro Dam and powerhouse, owned jointly by the Districts, are located approximately 2.2 miles upstream of LGDD. Water released from Don Pedro Reservoir is either diverted by TID or MID at LGDD for irrigation or M&I water supply purposes at LGDD or passes to the lower Tuolumne River through one of the flow passageways available at the diversion dam. MID's diversion tunnel intake is located on the west (looking downstream, river right) end of the diversion dam, and TID's diversion tunnel intake is located on the east (river left) end of the diversion dam. Consistent with each irrigation districts' acreage served, the irrigation canals were constructed such that approximately 68 percent of diverted flow is routed to the TID system and 32 percent to the MID system.

2.3.1 MID's Diversion Tunnel and Intake

MID's diversion tunnel and intake are non-Project facilities, as they are not used in conjunction with TID's hydropower facility. The description provided is for informational purposes only.

Due to maintenance and repair issues experienced along its Upper Main Canal, MID constructed in 1987/1988 the current diversion tunnel and tunnel intake to bypass this upper section of the Main Canal. The intake to the MID diversion tunnel is located in the face of a cliff on the west (river right) bank about 100 feet upstream of LGDD. The invert of the MID tunnel is at elevation 277.4 feet. Flow is conveyed through the 15-foot, 6-inch-diameter tunnel for 895 feet to a control structure. Flow is then conveyed through a 5,300-foot-long tunnel to an outlet structure which controls flow to the MID non-Project Main Canal, which provides water to MID's irrigation and M&I water systems. The design maximum flow rate for this tunnel is approximately 2,000 cfs. Water is delivered to MID's Hillside gates via the uppermost section of the retired Upper Main Canal (Figure 2.3-1 and Figure 2.1-3 above).

[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 2.3-1. Retired MID main canal on west (right) bank. Gate stems and hand-wheels controlling the openings of the Hillside gates that pass flow to the plunge pool below LGDD are seen in the far left of the photo.

2.3.2 TID's Intake and Diversion Tunnel

TID's diversion tunnel and intake are non-Project facilities, the primary purpose of which are to divert Tuolumne River flows to TID's main irrigation canal. The TID intake is located on the east (left) bank just upstream of the diversion dam and consists of two separate structures. The south intake structure contains two 8-foot wide by 11-foot, 10-inch-high control gates driven by electric motor hoists. The north intake structure contains a single 8-foot by 12-foot control gate (Figure 2.3-2).

Figure 2.3-2. TID diversion tunnel intake on east (left) bank.

The north intake structure was added in 1980 to increase the delivery capability to TID's irrigation canal system by reducing head losses through the single intake and lowering the tunnel invert. Flows from the intake are conveyed to a 600-foot-long tunnel to the 110-foot-long forebay for the TID non-Project Main Canal. The forebay was modified in the 1980s to reinforce the structure. Flows to TID's irrigation system are regulated at the non-Project Main Canal Headworks consisting of six slide gates, each of which being 5-feet-wide by 8-feet, 4-inches-high.

2.4 Powerhouse Intake and Main Canal Headworks

Flows from the TID tunnel discharge nearly 600 feet downstream from the intake into a concrete channel that contains the penstock intake structure and TID's non-Project Upper Main Canal Headworks (Figure 2.4-1). At the tunnel outlet portal, the channel invert is approximately 18 feet wide and gradually expands to 39 feet wide at the face of the Upper Main Canal Headworks. The channel runs 118 feet along the centerline of flow and is constructed with a gradual bend to the south as it enters the TID non-Project Upper Main Canal.

The original invert of the channel was constructed at an elevation of approximately 281.2 feet, but was excavated and rebuilt at a lower elevation of nearly 278 feet as a result of the new tunnel construction in 1980 undertaken to improve the irrigation flow delivery capacity to the TID Upper Main Canal. TID currently maintains in an open position an 18-inch pipe that continuously delivers flow to the sluice gate channel downstream of the sluice gates. This water flows into the tailrace just upstream of the powerhouse. The flow quantity is not measured but is estimated to be approximately 5 to 10 cfs.

Figure 2.4-1. TID penstock intake and sluice gates. In the photo, flow is being discharged from the sluice gates to the sluice gate channel.

Located at the west side of the concrete channel, the penstock intake structure contains a trashrack structure and three 7.5-foot-wide by 14-foot-tall concrete intake bays that deliver water to the penstocks. Manually-operated steel gates are used to shut off flows through these intakes. Immediately upstream and 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 and sluice gate channel to the tailrace just upstream of the powerhouse.

The non-Project TID irrigation canal headworks structure was originally constructed with five 5-foot-wide by 8-foot, 4-inch-tall outlets controlled by fabricated steel gates. In 1980, a sixth gate was added as part of the rehabilitation of the forebay. The sixth gate is the same dimensions of the original five gates. All the 1980 modifications were performed to improve the control of flows as part of improvements to the TID irrigation system.

2.5 Powerhouse

The La Grange powerhouse is located approximately 0.2 miles downstream of LGDD on the south (left) bank of the Tuolumne River (Figure 2.5-1). The power plant is owned and operated by TID. Water diverted through the TID intake and tunnel can enter the two penstocks that deliver flow to the powerhouse. The two-unit powerhouse was built in 1924. The powerhouse is a 72-foot by 29-foot structure with a reinforced concrete substructure and steel superstructure. The intakes for the two penstocks are located in the west (right) side of the forebay. 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.

There have been no modifications to the powerhouse since its original construction in 1924, except for routine maintenance and repairs.

Figure 2.5-1. View of TID's penstocks, powerhouse, tailrace, and substation looking downstream.

2.6 Turbines, Generators, and Accessory Equipment

The La Grange powerhouse contains two turbine-generator units originally installed circa 1924/1925 (Bechtel Civil 1987). The turbine of the smaller unit (Unit 1) contains a Voith runner rated, at its cavitation limit, at 1,650 horsepower at 140 cfs and 115 feet of net head. The larger unit (Unit 2) also contains a Voith runner rated, at its cavitation limit, at 4,950 horsepower at 440 cfs and 115 feet of net head. The actual net head at the plant varies with flow, which affects flow capacity and unit output. The runners of the original turbine-generator units were replaced with the current Voith runners in 1989.

Historically, the flow capacity of the original 1924 units exceeded 600 cfs (Bechtel Civil 1987). The units with the Voith replacement runners have a combined capacity of about 580 cfs at the guaranteed maximum capacity (i.e., their cavitation limit). The original Unit 1 design was an unconventional configuration, even for the 1910/1920s, consisting of a single horizontal Francis turbine coupled to two 500-kilowatt generators, one on each side of the turbine (Bechtel Civil 1987). The powerhouse has a minimum hydraulic capacity of roughly 100 cfs.

This two-generator configuration was replaced with an industry-standard single-generator configuration as part of the 1989/1990 rehabilitation work. The original Unit 2 design was a conventional configuration consisting of a single vertical Francis turbine coupled to a single 3,750-kilowatt generator (Bechtel Civil 1987). At the turbines' guaranteed maximum capacity, the combined generator output is approximately 4.7 megawatts.

2.7 Substation and Transmission Line

There are no FERC-jurisdictional transmission lines associated with the La Grange Hydroelectric Project. 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. This 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, therefore, would not fall under FERC jurisdiction. A single-line diagram of the grid connection is provided in Figure 2.7-1.

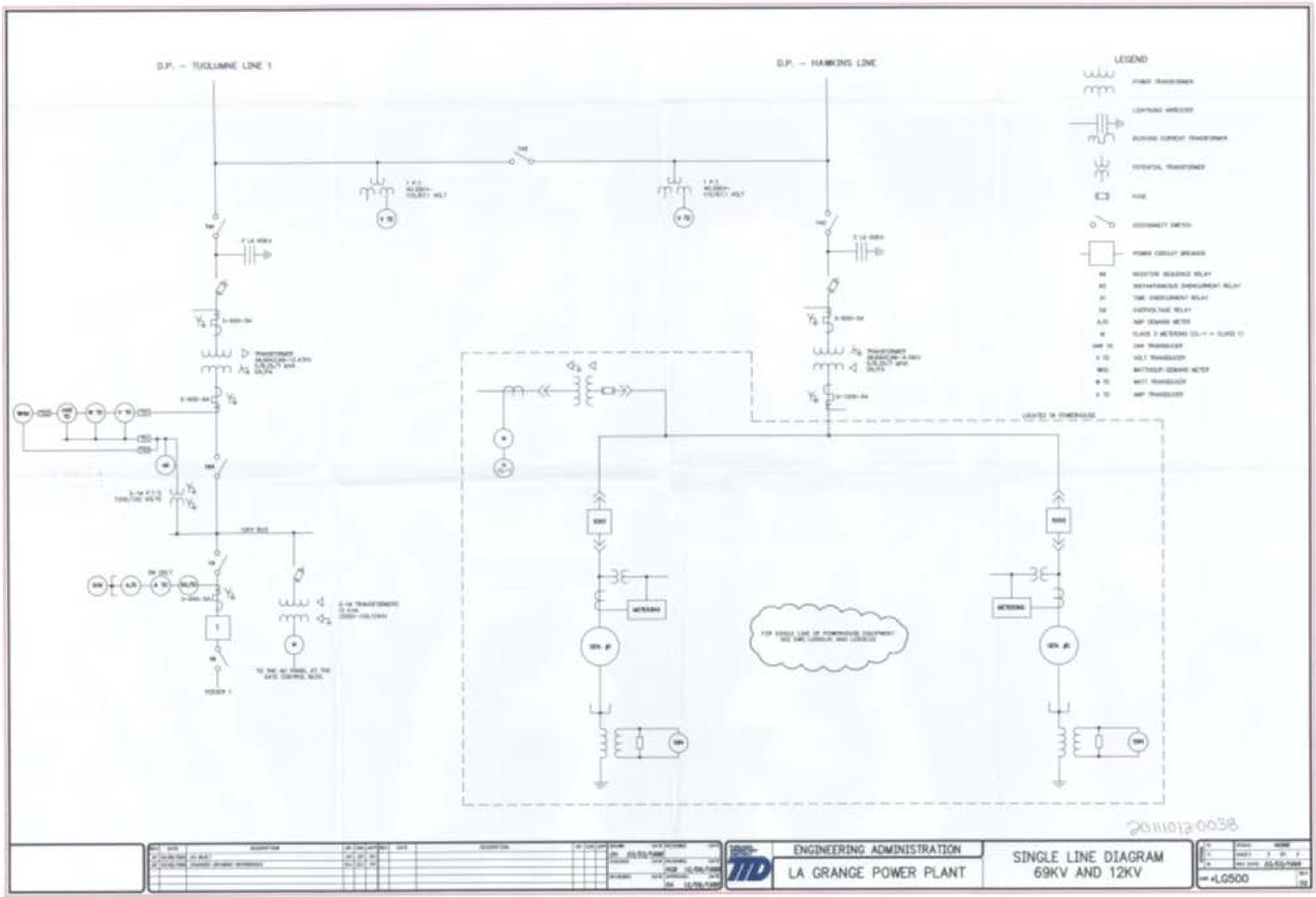

Figure 2.7-1. **Single line diagram showing grid interconnection.**

3.0 PROJECT OPERATIONS

3.1 Project Operations

The La Grange Diversion Dam is located at the exit of a narrow canyon and the impoundment formed by the diversion dam provides little to no active storage. LGDD allows for the diversion of water from the Tuolumne River to the TID and MID water supply canal systems. Combined, these canals provide water for over 200,000 acres of prime Central Valley farmland and a portion of the City of Modesto's M&I supply. Flows released from Don Pedro Reservoir that are not intended to be diverted into either of the TID or MID water supply systems are passed safely downstream to the Tuolumne River. Flows passing through the TID powerhouse are delivered to TID's 700-foot-long tailrace, which flows into the main stem of the Tuolumne River. TID's La Grange powerhouse operates in a run-of-river mode and has a hydraulic capacity of approximately 580 cfs. Flows are also passed downstream through either the MID Hillside gates or the Portal 1 gate to maintain favorable temperature and dissolved oxygen conditions in the LGDD plunge pool.

Powerhouse operations are monitored around-the-clock from the TID remote operations desk located at TID's Control Center. Although remote start-up is possible, for safety reasons, operators are generally dispatched to the powerhouse 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 with minimal disruption. The disruption to downstream flow as measured at the nearby U.S. Geological Survey (USGS) La Grange gage was examined by the Districts at the request of the National Marine Fisheries Service and FERC as part of the Don Pedro Hydroelectric Project relicensing. The results of this analysis showed that flow fluctuations at the La Grange gage were less than 2 inches in any 15-minute period 99.4 percent of the time and less than 4 inches 99.9 percent of the time. This study (Districts' Response to National Marine Fisheries Service-4, Element 1 through 6) is attached to this FLA. During the La Grange Fish Barrier Assessment, conducted as part of the FERC licensing process for the Project, a water level logger was placed in the powerhouse tailrace to monitor the change in stage in the tailrace as a result of a unit trip and the sluice gate opening (TID/MID 2017a; attached to this FLA). The stage change was measured to be 0.57 feet and lasted for 15 minutes until flows from the sluice gates arrived at the logger. This fluctuation did not adversely affect any salmonid redds existing in the tailrace (TID/MID 2017a).

Flows released from the Don Pedro Reservoir are diverted by TID and MID, spilled over the LGDD spillway, or pass through one of TID's or MID's outlet structures. Diverted water is delivered to the Districts' water supply delivery systems. On the MID side of the river, the Hillside release gates can pass water to the plunge pool below LGDD approximately 400 feet downstream of the diversion dam. Normally, a flow of approximately 5 to 10 cfs[2] is discharged from these gates to the river. The Portal 1 gate is also located in the spillway near the MID side of the river. On the TID side of the river, water can flow to the river through either two 5-foot-

[2] Flow from the Hillside gates to the plunge pool vary with LGDD water levels which normally fluctuate up to 2 feet.

wide by 4-foot-high sluice gates located adjacent to the penstock intakes or through the La Grange powerhouse.

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 that joins the lower Tuolumne River about 0.5 miles below LGDD. The two TID sluice gates can also discharge flows into the tailrace. A description of flow-related operations of LGDD can be found in the Districts' January 6, 2014, Updated Study Report filing done as part of the relicensing of the Don Pedro Project (TID/MID 2017b). Estimated flows at each of the diversion dam's outlet gates are presented in the Flow Records for Five Discharge Structures at the La Grange Project Technical Memorandum (TID/MID 2017c), which is provided as an attachment to this FLA.

From 1980 to 1996, the average annual generation of the La Grange powerhouse was 15,613 MWh, and ranged from a low of 514 MWh during the drought year of 1989 to a high of 38,150 MWh during the wet year of 1983 (Table 3.1-1). Subsequent to the 1996 implementation of the Settlement Agreement, between 1997 and 2016, the average annual generation at the La Grange powerhouse was 18,077 MWh, with a low of 7,765 MWh in 2014 (dry year) and a high of 35,953 MWh in 2011 (wet year). Monthly generation for the period 2005 through 2016 is shown below in Table 3.1-2. Since 1996, the capacity factor of the TID plant is approximately 44 percent.

Table 3.1-1. La Grange powerhouse annual generation from 1980 through 2016.

Year	Annual Generation (MWh)	Year	Annual Generation (MWh)
1980	14,631	1999	25,663
1981	13,606	2000	28,827
1982	36,538	2001	14,657
1983	38,150	2002	10,051
1984	20,223	2003	14,449
1985	15,008	2004	15,406
1986	24,782	2005	30,512
1987	12,620	2006	34,437
1988	2,864	2007	15,712
1989	514	2008	10,104
1990	4,388	2009	9,458
1991	4,705	2010	23,348
1992	5,509	2011	35,953
1993	19,913	2012	15,152
1994	9,976	2013	9,605
1995	31,314	2014	7,765
1996	10,687	2015	8,025
1997	9,840	2016	9,647
1998	32,923		

Table 3.1-2. La Grange powerhouse monthly generation from 2005 through 2016.

Year	Monthly Generation (MWh)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	938	2,895	3,294	3,236	3,328	3,224	3,243	2,625	717	2,496	1,814	2,703
2006	3,438	3,166	3,464	3,129	3,345	3,308	3,479	3,414	2,207	2,116	1,263	2,108
2007	2,175	2,043	2,184	2,542	2,272	626	713	713	529	566	502	846
2008	861	698	786	1,755	2,544	444	500	51	0	874	690	903
2009	907	831	919	917	9,34	743	621	587	571	885	636	907
2010	965	779	956	903	2,319	3,092	3,412	1,902	1,626	2,296	1,855	3,242
2011	3,439	3,109	3,518	3,306	3,343	3,390	3,477	3,523	2,297	2,282	2,046	2,223
2012	2068	1,960	1,887	1,536	2,884	639	417	346	344	1,371	849	852
2013	833	712	746	1,925	1,172	337	334	313	212	1,375	808	838
2014	843	746	813	1,457	823	327	417	429	423	687	724	77
2015	697	792	902	1,204	915	513	486	415	394	685	145	876
2016	927	830	824	1,218	944	475	469	441	297	1,445	945	832

3.1.1 Description of Safety Measures

There are no formal recreational facilities at or public recreation access to the La Grange headpond at the present time. A shoreline walking trail is proposed for installation and further detail about this proposed recreational facility is provided in Section 3.8 of Exhibit E of this FLA. Warning signs are placed in the headpond area to keep any potential users away from the tunnel intakes and spillway. A protective buoy system stretches across the river approximately 300 feet upstream of the spillway to prevent inadvertent access to the tunnels or spillway by potential users of the headpond. The Districts have standard safety procedures in place to protect personnel working on or near the diversion tunnels, spillway, and the powerhouse.

3.2 Project Costs

3.2.1 Current Project Costs

The estimated current cost for operation and maintenance of the hydroelectric facilities (including insurance, and administrative and general costs) is approximately $451,000/year, or $25.80/MWh. Costs associated with operation and maintenance of the water supply and non-Project uses of the LGDD and related facilities are not included in these costs.

3.2.2 Future Project Generation and Costs

No significant changes are planned by TID for operation and maintenance of the hydropower facilities at this time. However, there are four resource protection measures proposed as part of this FLA. Future generation at the TID powerhouse would increase under the Districts' preferred plan for the future operation of the Don Pedro Project.[3]

Under the Districts' preferred alternative for the La Grange Hydroelectric Project of continuing generation and implementing the proposed protection, mitigation, and enhancement measures,

[3] As contained in the October 2017 amendment to application for the Don Pedro Project, FERC No. 2299.

the annual cost of generation would be $490,000[4], including the annualized cost of the sluice channel fish barrier and the annual operation and maintenance cost of maintaining the foot trail and Hillside discharge gates. Therefore the future cost of project power under the preferred alternative would be $35.50/MWh.

[4] The estimated annual cost of Project O&M does not include the one-time cost of the investigation of the occurrence and causes of observed low dissolved oxygen levels in the Project tailrace. If the investigation leads to a PM&E measure, this could affect future Project costs.

4.0 PROJECT HYDROLOGY

Monthly and annual flow duration data are provided for the Tuolumne River below La Grange Diversion Dam in Figures 4.0-1 through 4.0-5. Curves are based on mean daily flows for the period of Water Year 1997 to 2012. Table 4.0-1 provides estimated mean, maximum, and minimum monthly flows from 1997 to 2012.

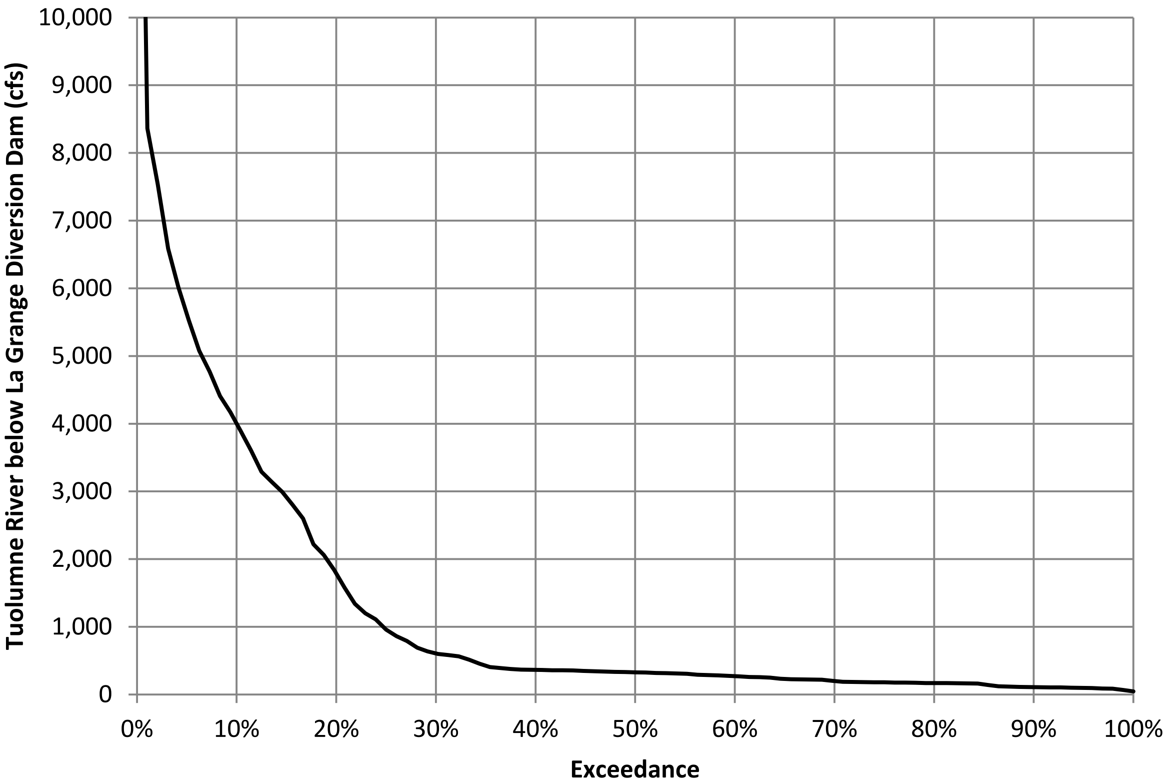

Figure 4.0-1. Annual flow duration curve for the Tuolumne River below La Grange Diversion Dam (USGS 11289650).

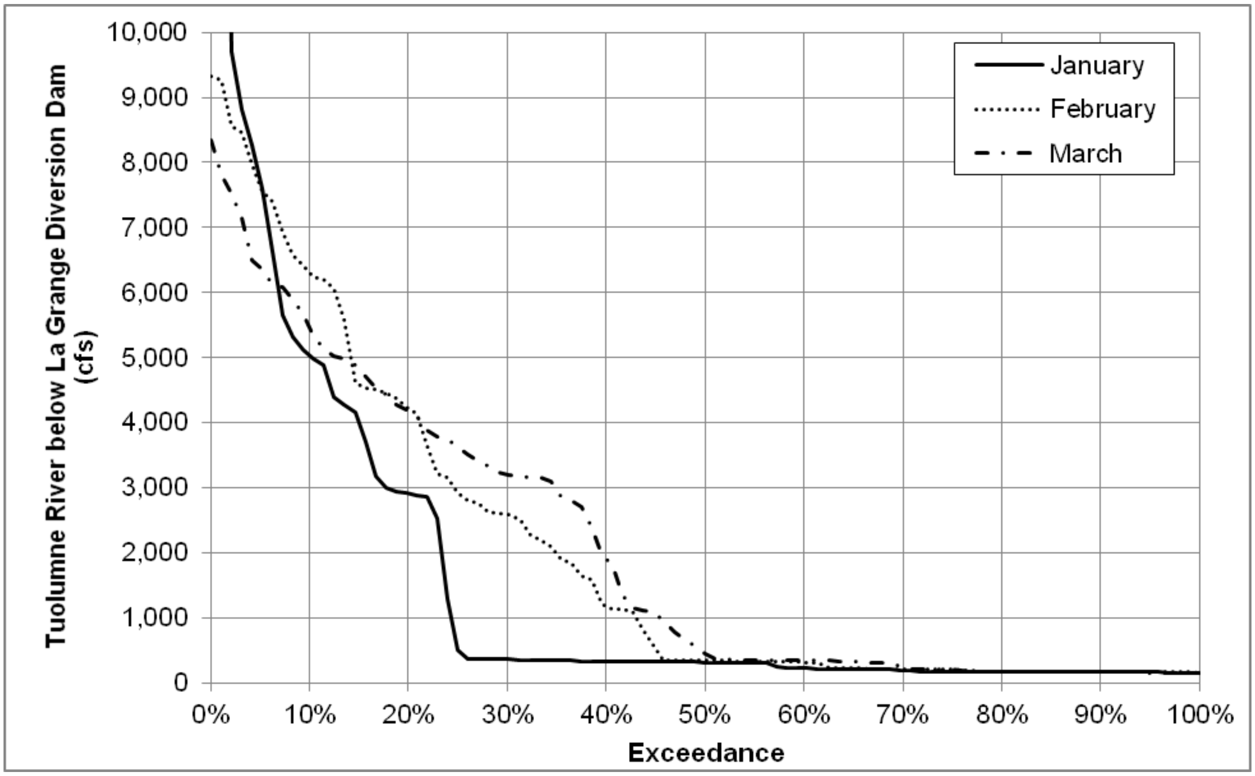

Figure 4.0-2. **January through March monthly flow duration curve for the Tuolumne River below La Grange Diversion Dam (USGS 11289650).**

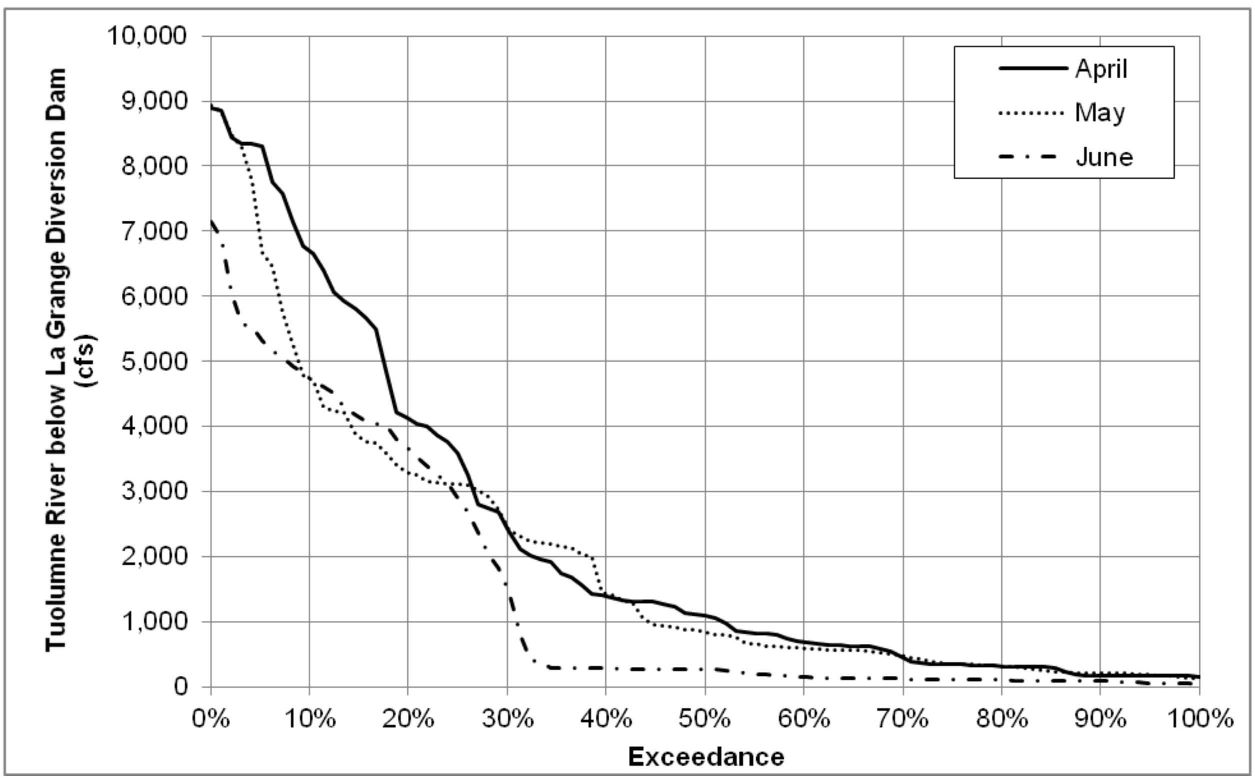

Figure 4.0-3. **April through June monthly flow duration curve for the Tuolumne River below La Grange Diversion Dam (USGS 11289650).**

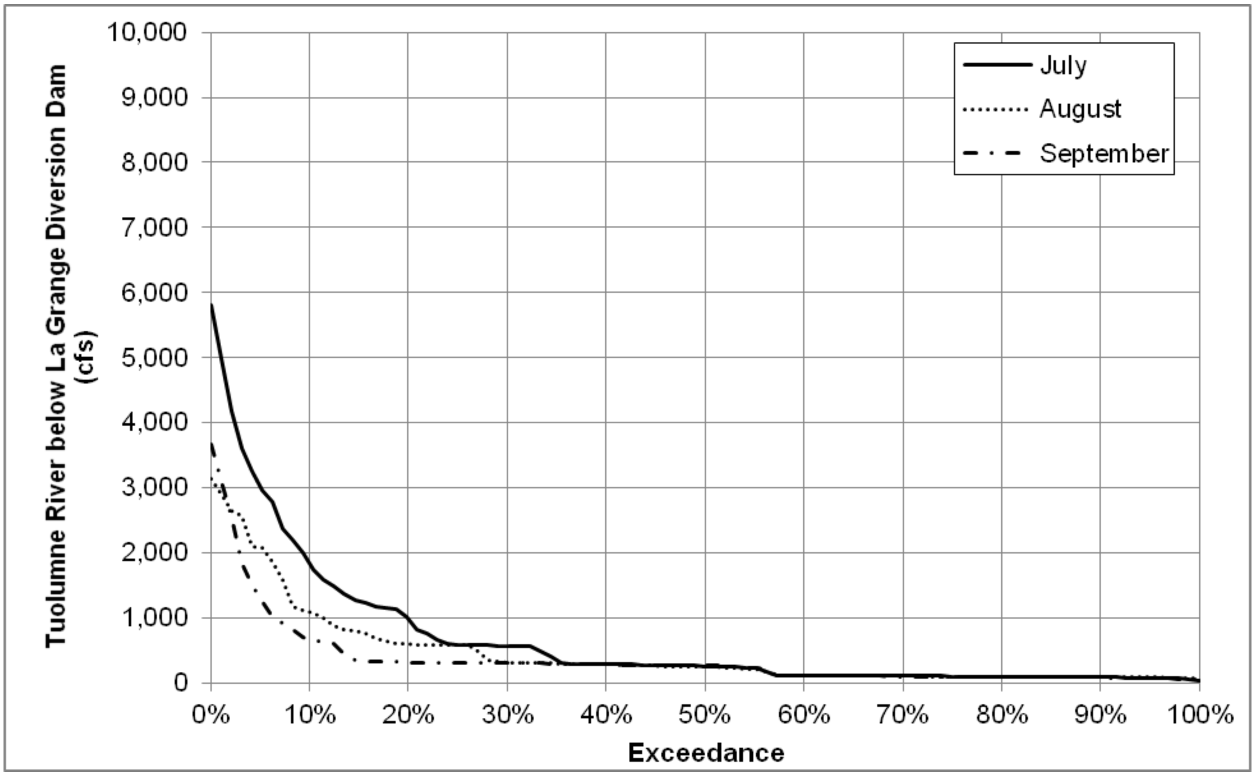

Figure 4.0-4. **July through September monthly flow duration curve for the Tuolumne River below La Grange Diversion Dam (USGS 11289650).**

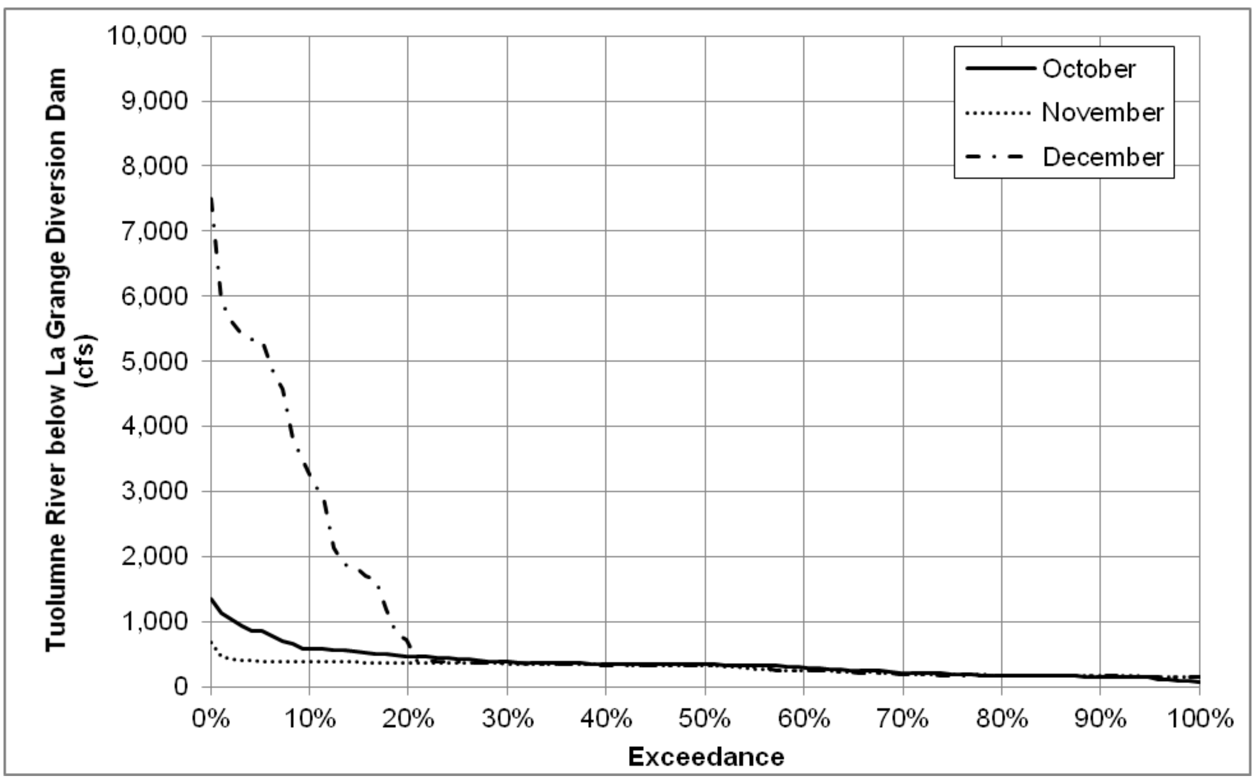

Figure 4.0-5. **October through December monthly flow duration curve for the Tuolumne River below La Grange Diversion Dam (USGS 11289650).**

Table 4.0-1. Flows downstream of La Grange Diversion Dam, water deliveries to TID and MID, and total Don Pedro Project outflows, 1997-2016.

Month	Monthly Mean Flow (cfs)[1]																				Mean monthly flow (cfs)	Highest mean monthly flow (cfs)	Lowest mean monthly flow (cfs)
	1997[2]	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016			
USGS 11289650 - Tuolumne River Below La Grange Diversion Dam Near La Grange, CA (cfs)																							
Jan	13,070	2,114	1,247	324	325	177	184	223	187	4,456	353	171	165	232	4,096	342	175	159	166	152	1,416	13,070	152
Feb	8,116	6,168	4,903	2,284	1,273	172	185	220	1,823	2,373	358	173	168	225	3,176	340	172	157	165	161	1,631	8,116	161
Mar	2,443	5,407	3,285	4,602	615	165	182	1,098	3,875	4,234	357	172	169	284	5,142	323	168	158	172	168	1,651	5,407	158
Apr	1,457	5,392	2,034	1,548	558	665	685	1,010	4,524	7,436	487	533	372	1,342	7,400	271	412	356	361	632	1,874	7,436	271
May	953	3,621	1,697	1,164	706	419	477	412	4,868	7,847	385	680	687	2,706	3,396	798	294	159	171	382	1,591	7,847	159
Jun	269	4,433	284	340	54	97	234	127	3,809	4,657	127	95	149	2,555	5,027	134	97	94	105	110	1,140	5,027	94
Jul	290	2,845	287	421	89	88	243	108	1,913	834	114	93	107	813	2,132	107	102	95	98	105	544	2,845	88
Aug	287	1,019	259	603	110	86	236	106	773	584	110	99	102	316	2,498	104	108	95	95	98	384	2,498	86
Sep	285	1,423	294	473	112	68	250	110	328	412	89	97	106	308	1,197	102	102	92	90	87	301	1,423	68
Oct	465	628	424	412	189	202	297	209	464	449	141	174	385	491	491	255	276	136	141	In WY 2017	328	628	136
Nov	380	316	338	347	184	191	231	186	369	379	174	161	255	399	366	176	164	168	162		260	399	161
Dec	330	1,321	336	334	177	187	226	178	1,285	352	169	164	256	4,152	366	174	158	167	155		552	4,625	155
USGS 11289000 - Modesto Canal Near La Grange, CA (cfs)																							
Jan	6	117	66	237	72	40	76	87	83	143	9	27	31	16	34	358	9	55	16	3	74	358	3
Feb	168	56	47	72	142	67	58	44	204	135	113	45	29	11	93	69	49	48	27	10	74	204	10
Mar	642	121	301	231	213	434	328	355	260	142	348	346	219	253	96	340	616	36	55	41	269	642	41
Apr	601	250	630	586	607	720	325	720	450	249	483	575	474	337	453	275	475	311	301	295	456	720	249
May	872	310	697	659	773	724	605	653	665	716	682	656	573	533	674	736	673	393	284	505	619	872	284
Jun	701	655	769	733	802	791	801	751	695	802	763	646	716	769	708	767	775	436	406	660	707	802	406
Jul	962	787	781	915	905	891	894	825	1,043	846	803	748	791	704	761	869	834	539	496	689	804	1,043	496
Aug	813	869	927	878	767	707	825	704	827	824	781	793	721	754	858	764	769	455	401	577	751	927	401
Sep	550	482	566	474	567	583	525	461	604	594	411	506	474	482	589	453	446	348	286	417	491	604	286
Oct	347	344	334	293	387	358	380	270	299	304	321	301	266	271	233	434	424	125	112	In WY 2017	305	434	112
Nov	78	73	195	44	36	105	172	84	141	173	162	100	112	184	169	53	109	135	85		116	195	36
Dec	26	86	72	75	72	58	13	43	126	8	9	18	2	0	0	3	26	0	0		34	126	0

Month	Monthly Mean Flow (cfs)[1]																				Mean monthly flow (cfs)	Highest mean monthly flow (cfs)	Lowest mean monthly flow (cfs)
	1997[2]	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016			
USGS 11289500 - Turlock Canal Near La Grange, CA (cfs)																							
Jan	387	69	506	0	91	27	6	25	316	299	164	4	82	108	301	581	93	17	0	1	154	581	0
Feb	599	326	313	0	8	6	323	302	339	529	257	101	151	180	190	202	265	0	0	0	205	599	0
Mar	1,457	454	623	603	595	1,023	637	1,035	872	644	1,113	1,132	601	601	581	477	963	86	44	153	685	1,457	44
Apr	1,222	699	1,304	1,135	1,110	1,249	771	1,272	1,184	529	1,082	866	1,013	712	1,070	623	792	659	833	759	944	1,304	529
May	1,710	800	1,321	1,246	1,455	1,121	1,073	1,336	1,256	1,339	1,166	1,136	1,021	1,171	1,145	1,248	1,074	760	595	848	1,141	1,710	595
Jun	1,445	1,243	1,525	1,725	1,664	1,483	1,639	1,552	1,504	1,624	1,599	1,310	1,525	1,569	1,398	1,425	1,467	1,077	1,016	1,364	1,458	1,725	1,016
Jul	2,081	1,817	1,938	1,898	1,805	1,817	1,883	1,840	1,917	2,000	1,816	1,572	1,899	1,846	1,845	1,788	1,637	1,335	1,130	1,545	1,770	2,081	1,130
Aug	1,587	1,681	1,796	1,784	1,526	1,489	1,516	1,510	1,706	1,674	1,494	1,314	1,482	1,656	1,718	1,510	1,312	1,050	825	1,375	1,550	1,796	825
Sep	812	977	952	1,063	825	736	714	617	991	936	631	571	793	1,097	1,069	953	566	532	506	786	806	1,097	506
Oct	505	613	566	527	445	358	742	577	259	379	305	129	180	430	533	139	390	274	283	In WY 2017	402	742	129
Nov	30	0	59	24	4	22	1	1	3	8	35	2	27	279	95	0	1	0	1		31	279	0
Dec	109	0	301	173	12	94	36	12	27	1	45	149	20	600	29	6	0	0	0		85	600	0
USGS 11289651 - Combined Flow Tuolumne River + Modesto Canal + Turlock Canal (~ total Don Pedro Project outflow)[3] (cfs)																							
Jan	13,630	2,301	1,818	561	489	244	266	335	585	4,897	525	203	278	355	4,430	1,282	276	230	182	155	1,652	13,630	155
Feb	8,885	6,551	5,262	2,355	1,424	245	565	566	2,365	3,038	728	320	348	415	3,458	611	486	205	191	171	1,909	8,885	171
Mar	4,544	5,983	4,210	5,435	1,423	1,622	1,146	2,487	5,005	5,020	1,818	1,651	989	1,139	5,818	1,142	1,748	279	270	361	2,605	5,983	270
Apr	3,280	6,341	3,968	3,269	2,276	2,634	1,781	3,001	6,158	8,211	2,052	1,973	1,860	2,392	8,922	1,168	1,680	1,326	1,494	1,686	3,274	8,922	1,168
May	3,535	4,732	3,714	3,067	2,935	2,263	2,155	2,402	6,790	9,902	2,234	2,472	2,280	4,408	5,216	2,783	2,039	1,313	1,050	1,735	3,351	9,902	1,050
Jun	2,415	6,332	2,579	2,796	2,519	2,371	2,672	2,430	6,009	7,083	2,488	2,049	2,391	4,894	7,134	2,328	2,337	1,606	1,527	2,135	3,305	7,134	1,527
Jul	3,333	5,448	3,006	3,234	2,798	2,795	3,021	2,772	4,872	3,678	2,732	2,414	2,798	3,363	4,738	2,766	2,571	1,971	1,724	2,340	3,119	5,448	1,724
Aug	2,687	3,569	2,982	3,264	2,403	2,281	2,578	2,319	3,305	3,082	2,385	2,205	2,304	2,725	5,074	2,377	2,189	1,598	1,320	2,049	2,635	5,074	1,320
Sep	1,647	2,882	1,812	2,009	1,504	1,386	1,489	1,188	1,922	1,942	1,130	1,175	1,371	1,888	2,855	1,509	1,115	971	882	Not repor-ted	1,615	2,882	882
Oct	1,318	1,584	1,324	1,231	1,021	917	1,419	1,055	1,021	1,133	766	604	832	1,193	1,258	827	1,089	535	537	In WY 2017	1,035	1,587	535
Nov	489	389	592	415	224	318	404	270	513	559	371	263	394	862	630	228	273	303	247		408	862	224
Dec	466	1,407	709	582	261	339	275	233	1,437	361	223	330	277	4,752	394	183	184	167	155		670	4,752	155

1 Values Calculated using USGS NWIS monthly statistics module: http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289650&agency_cd=USGS, http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289000&agency_cd=USGS, http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289500&agency_cd=USGS, and http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289651&agency_cd=USGS.

2 The flood of record occurred in January 1997, with high reservoir releases continuing into February 1997. These values skew the January and February mean monthly flow averages for the 1997 to 2012 period. Without 1997 values, the mean monthly flow in January is 973 cfs and February is 1,589, compared to 1,729 and 1,997 cfs, respectively.

3 Some values rounded by USGS - sum of individual gage monthly mean flows might not precisely equal combined gage monthly mean flows.

5.0 REFERENCES

Bechtel Civil. 1987. La Grange power plant rehabilitation proposal evaluation for turbine/generator equipment and auxiliaries including associated civil/structural work. Prepared for Turlock Irrigation District by Bechtel Civil, Inc. March 1987.

Modesto Irrigation District (MID). 2010. Irrigation district statistics and history. Modesto Irrigation District. [Online] URL: http://www.mid.org. (Accessed July 2010.)

Turlock Irrigation District (TID). 2010. Irrigation district statistics and history. Turlock Irrigation District. [Online] URL: http://www.tid.org. (Accessed August 2010.)

_______. 2011. La Grange Reservoir Backwater Analysis. Prepared by HDR Engineering, Inc. October 2011.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2017a. Fish Barrier Assessment Final Study Report. Prepared by FISHBIO. September 2017.

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

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