5.3 Tuolumne River System and Downstream Water Bodies

5.3 Tuolumne River System and Downstream Water Bodies

Section 5.3 Subsections

5.3.1 Stream Flow and Reservoir Water Levels

The following setting section describes the streams and reservoirs in the Tuolumne River watershed and downstream that could be affected by the WSIP. The impact section (Section 5.3.1.2) provides a description of the changes in stream flow and reservoir water levels that would result from implementation of the WSIP.

5.3.1.1 Setting

The Tuolumne River flows from the crest of the Sierra Nevada westward to its confluence with the San Joaquin River. The San Joaquin River flows north to the Sacramento–San Joaquin Delta. Water from the Delta discharges to the San Francisco Bay Estuary and the Pacific Ocean.

Surface water bodies in the Tuolumne River system that could be affected by the proposed program include the Tuolumne River, Cherry Creek, Eleanor Creek, and a quarter-mile reach of Moccasin Creek. Several reservoirs could be affected by the WSIP, including Hetch Hetchy Reservoir, Lake Lloyd, Lake Eleanor, and Don Pedro Reservoir. Because the Tuolumne River drains to the San Joaquin River and the Sacramento–San Joaquin Delta, these water bodies could also be affected by the WSIP. The proposed program could affect flow in the streams and water levels and water quality in the reservoirs.

Tuolumne River

General Description

The Tuolumne River rises in Yosemite National Park and flows approximately 130 miles to its confluence with the San Joaquin River about 10 miles west of the city of Modesto. Its headwaters are streams that descend the slopes of Mount Lyell and Mount Dana in the Sierra Nevada and join to form the river itself at Tuolumne Meadows. The Tuolumne River drains an area of 1,958 square miles. Its watershed is shown in **Figure 5.3.1-1**.

From Tuolumne Meadows (at an elevation of 8,600 feet above sea level), the river descends rapidly through a deep canyon in wilderness areas of Yosemite National Park to Hetch Hetchy Reservoir (at an elevation of about 3,500 feet). Six miles below O'Shaughnessy Dam, which impounds Hetch Hetchy Reservoir, the Tuolumne River leaves Yosemite National Park and enters the Stanislaus National Forest. Except for a short reach at Early Intake Reservoir, the river flows unimpeded through a deep canyon for approximately 40 miles, from O'Shaughnessy Dam to the upstream end of Don Pedro Reservoir.

Don Pedro Reservoir is at an elevation of about 500 feet. Several tributaries, including Cherry Creek, Jawbone Creek, the Clavey River, the North Fork of the Tuolumne River, and Turnback Creek, join the river from the north between Hetch Hetchy and Don Pedro Reservoirs. The South Fork of the Tuolumne joins the river from the south. Moccasin Creek and Woods Creek drain directly into Don Pedro Reservoir.

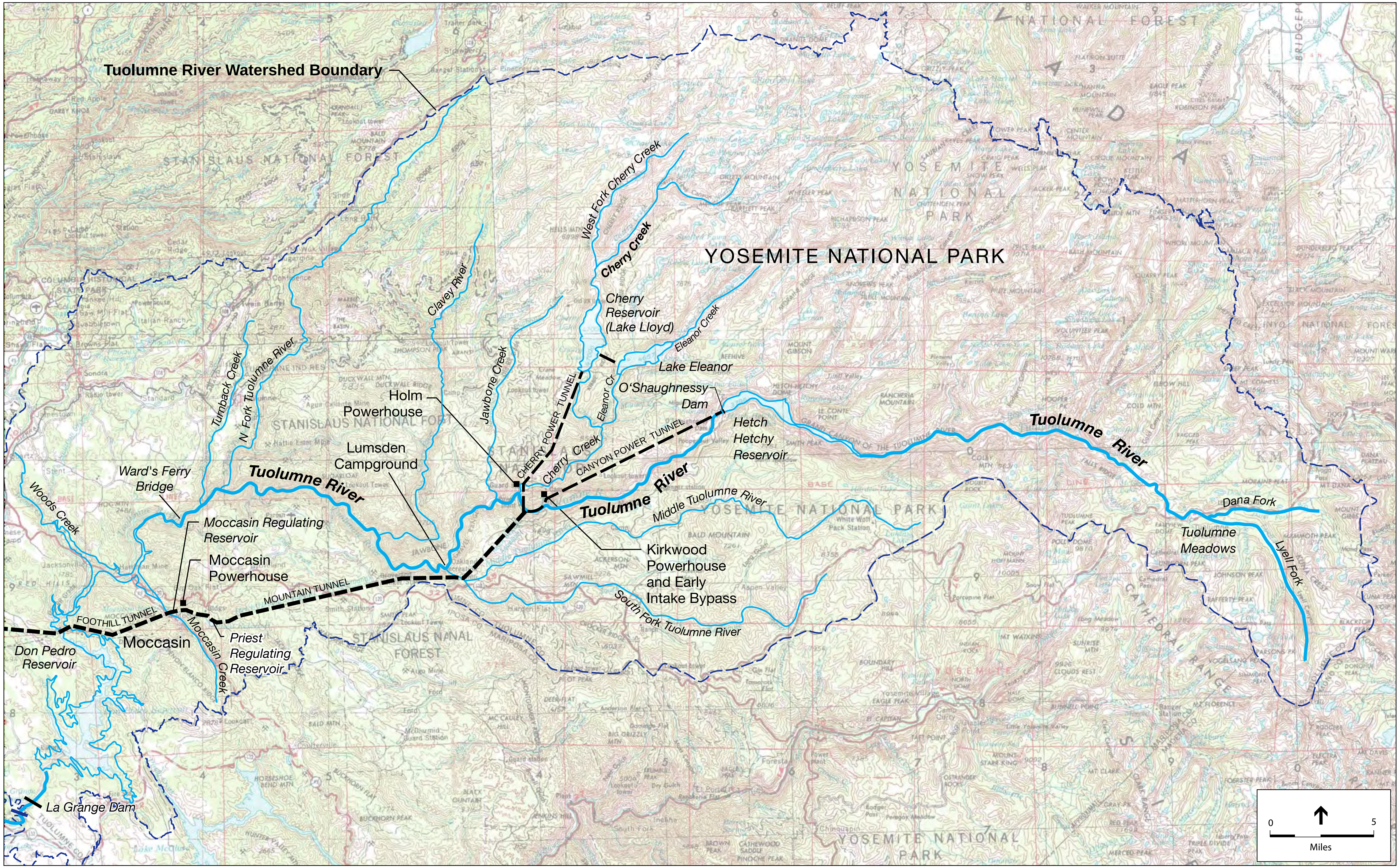
Below Don Pedro Reservoir, the Tuolumne River flows 2.3 miles to La Grange Dam, where water is diverted into two irrigation canals. Below La Grange Dam, the Tuolumne River descends through the Sierra Nevada foothills to the floor of the San Joaquin Valley and on to its confluence with the San Joaquin River, which is at an elevation of about 60 feet above sea level. This reach of the river flows through land used primarily for irrigated agriculture. A major tributary, Dry Creek, joins the river from the north in the city of Modesto.

Runoff in the Tuolumne River basin is produced by rainfall and snowmelt. Rainfall runoff occurs primarily in the Sierra foothills and the valley floor between December and March. Runoff from the upper basin is produced by snowmelt and occurs primarily between April and July. Annual runoff in the Tuolumne River basin is highly variable. Average annual "unimpaired" runoff[1] at Don Pedro Reservoir is estimated to be about 1.85 million acre-feet for the period from 1918 to 1991. The maximum estimated value is 3.84 million acre-feet in 1969, and the minimum is 0.39 million acre-feet in 1977 (Beck, 1992).

Stream Flow and Water System Operations

Flow in the Tuolumne River remained unaffected by humans until the 1860s, when water from the lower reaches of the river began to be diverted for agricultural irrigation. In 1871, a private company constructed Wheaton Dam near the site of present-day La Grange Dam. Wheaton Dam was used to divert water into irrigation canals. In 1887, the newly formed Turlock Irrigation District (TID) and Modesto Irrigation District (MID) constructed a new diversion dam, La Grange Dam, to replace Wheaton Dam (TID/MID, 2005).

[1] Unimpaired flow at a point on a river is the flow that would have occurred if there were no upstream water diversions or storage reservoirs. For the Tuolumne River, it is roughly equivalent to "natural flow"; that is, the flow that would have occurred prior to Euro-American settlement.



SOURCE: ESA+Orion, 2006; USGS 1970

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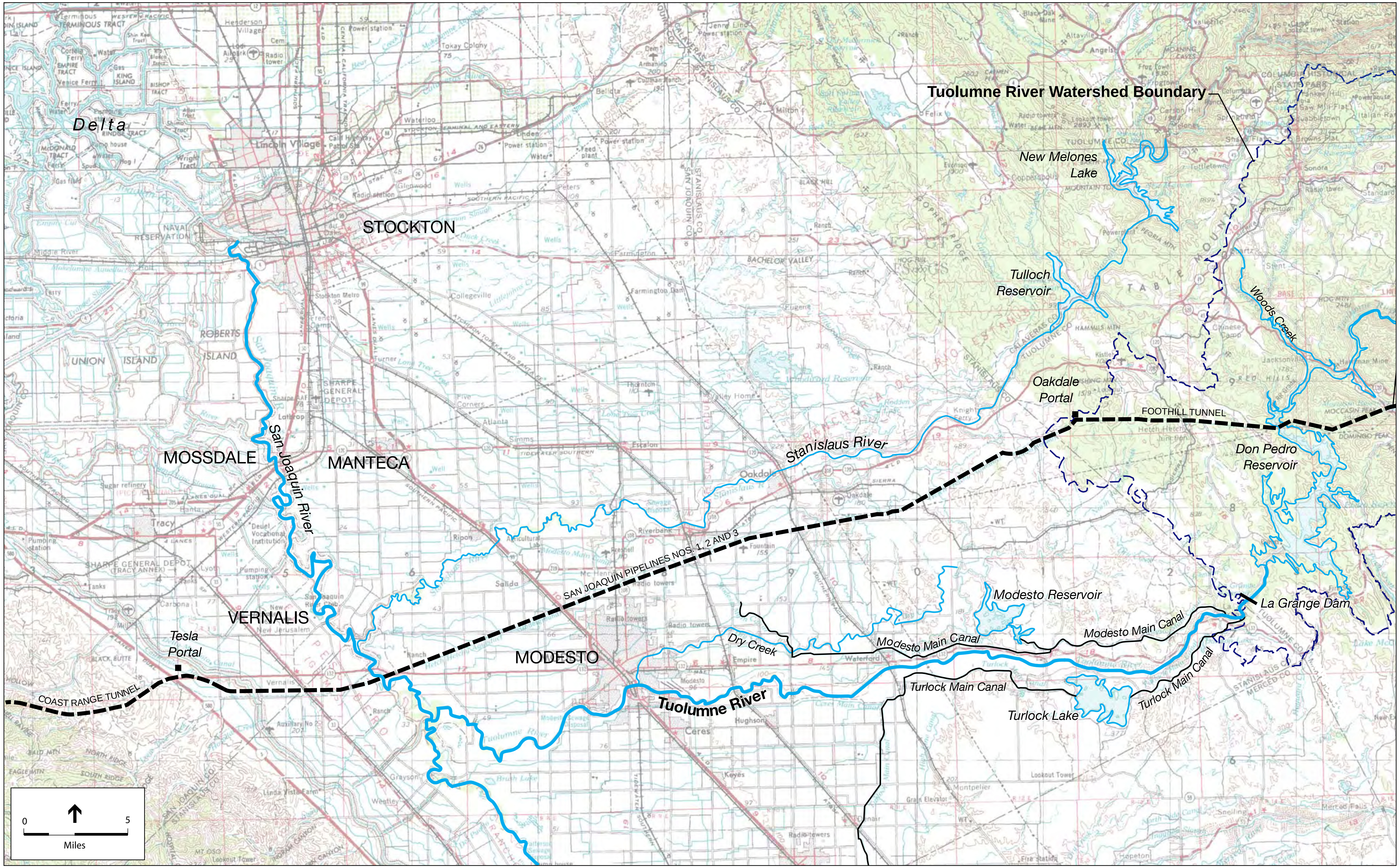
Figure 5.3.1-1a
Tuolumne River Watershed,
Headwaters to Don Pedro Reservoir



SOURCE: ESA+Orion, 2006; USGS 1970

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Figure 5.3.1-1b
Tuolumne River Watershed,
Don Pedro Reservoir to San Joaquin River

Early in the 20th century, development of the Tuolumne River accelerated. In 1918, the City and County of San Francisco (CCSF) completed Lake Eleanor, a reservoir on Eleanor Creek. Eleanor Creek is a tributary of Cherry Creek, which is itself a tributary of the Tuolumne River. Hetch Hetchy Reservoir and the original Don Pedro Reservoir, on the main stem of the river, were completed in 1923 (Hetch Hetchy by the CCSF and Don Pedro Reservoir by TID and MID). Hetch Hetchy Reservoir was expanded in 1938. In 1955, the CCSF completed Lake Lloyd on Cherry Creek. In 1971, TID and MID completed the new Don Pedro Reservoir, a much larger reservoir two miles downstream of the site of the original Don Pedro Reservoir (SFPUC, 2005).

Hetch Hetchy Reservoir, Lake Eleanor, and Lake Lloyd are owned by the CCSF and operated by the SFPUC, and Don Pedro Reservoir is owned and operated by TID and MID. The CCSF paid a portion of the construction costs of Don Pedro Reservoir and in return has indirect access to, and control of, a portion of the storage capacity of the reservoir by means of a water banking arrangement with the districts.[2]

Figure 5.3.1-2 is a diagrammatic representation of the natural features of the Tuolumne River showing the water and hydropower facilities that affect flow in the river. The figure also shows the approximate storage capacity of the reservoirs and the electrical generation capacity of the hydropower facilities.

The SFPUC diverts water from Hetch Hetchy Reservoir in the upper Tuolumne River basin and conveys it to the Bay Area in the Hetch Hetchy Aqueduct. The Hetch Hetchy Aqueduct consists of a series of facilities extending from Hetch Hetchy Reservoir to Crystal Springs Reservoir in San Mateo County (see Figure 2.1 in Chapter 2). Water leaves Hetch Hetchy Reservoir in the Canyon Power Tunnel, which delivers water to Kirkwood Powerhouse at Early Intake. Water leaving the powerhouse is either returned to the Tuolumne River or discharged into the Mountain Tunnel. The Mountain Tunnel conveys water to Priest Reservoir and Moccasin Powerhouse. Water discharged from Moccasin Powerhouse is either returned to the Tuolumne River via Moccasin Reservoir and Moccasin Creek or discharged to the Foothill Tunnel for conveyance to the Bay Area. Priest and Moccasin Reservoirs are small reservoirs used to control flow into Moccasin Powerhouse and regulate discharge of water to Moccasin Creek.

The SFPUC diverts an average of 244,000 acre-feet per year (afy) (218 million gallons per day [mgd]) from the Tuolumne River at Hetch Hetchy Reservoir and uses it for municipal water supply to about 2.4 million people in Tuolumne, Alameda, Santa Clara, San Mateo, and San Francisco Counties. Additional water is diverted at Hetch Hetchy Reservoir for hydropower generation at Kirkwood Powerhouse, but is returned to the Tuolumne River below Early Intake. The water diverted by the SFPUC for water supply represents about 32.5 percent of the average annual unimpaired runoff at Hetch Hetchy Reservoir, which is estimated to be 749,607 acre-feet. **Figure 5.3.1-3** shows the historical record of water storage in Hetch Hetchy Reservoir, as reflected in water levels, from 1989 to 2005.

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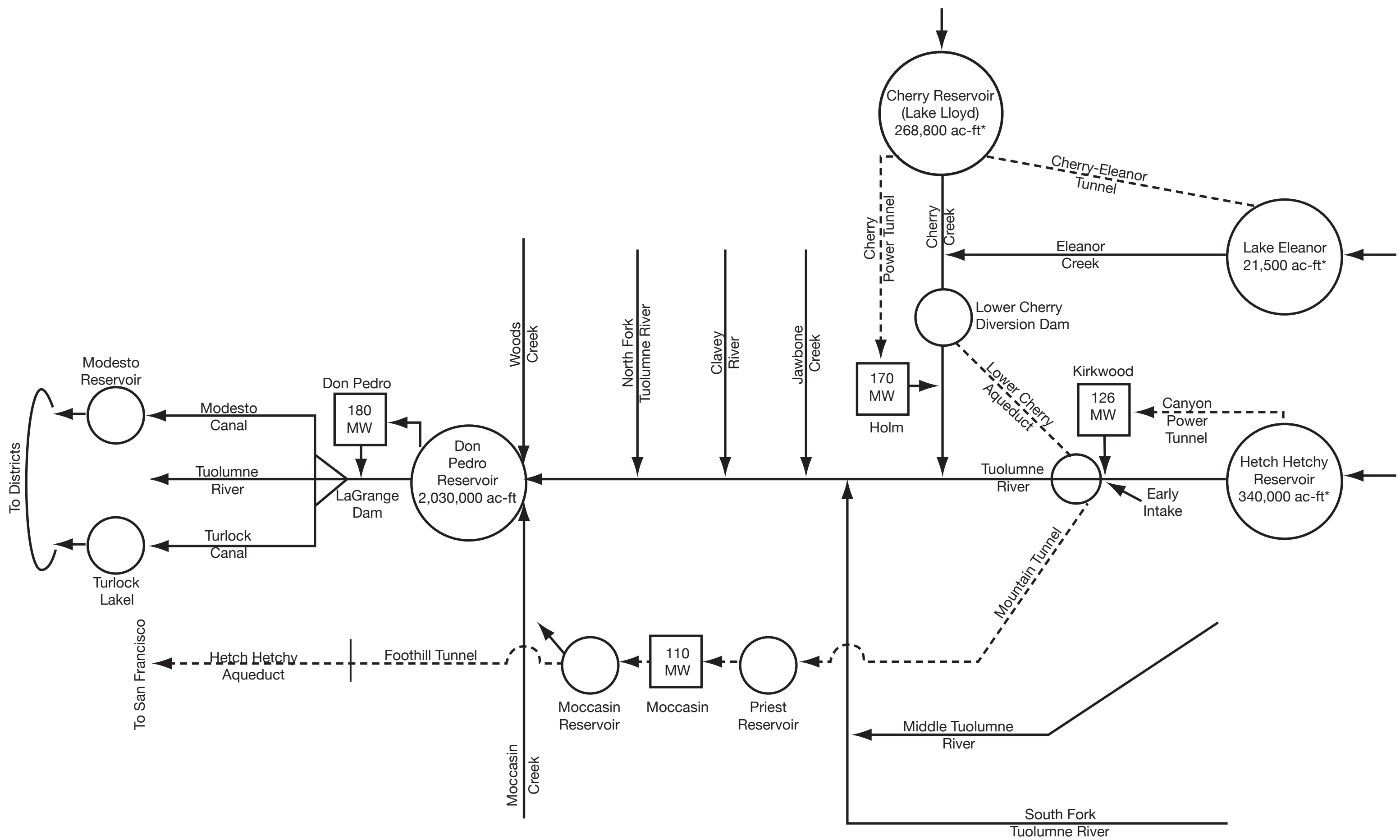
2 The SFPUC does not have direct access to its portion of storage in Don Pedro Reservoir. Instead, the SFPUC diverts water at Hetch Hetchy Reservoir by withholding water that TID and MID are entitled to receive under the Raker Act, thereby reducing the SFPUC's storage in Don Pedro Reservoir.

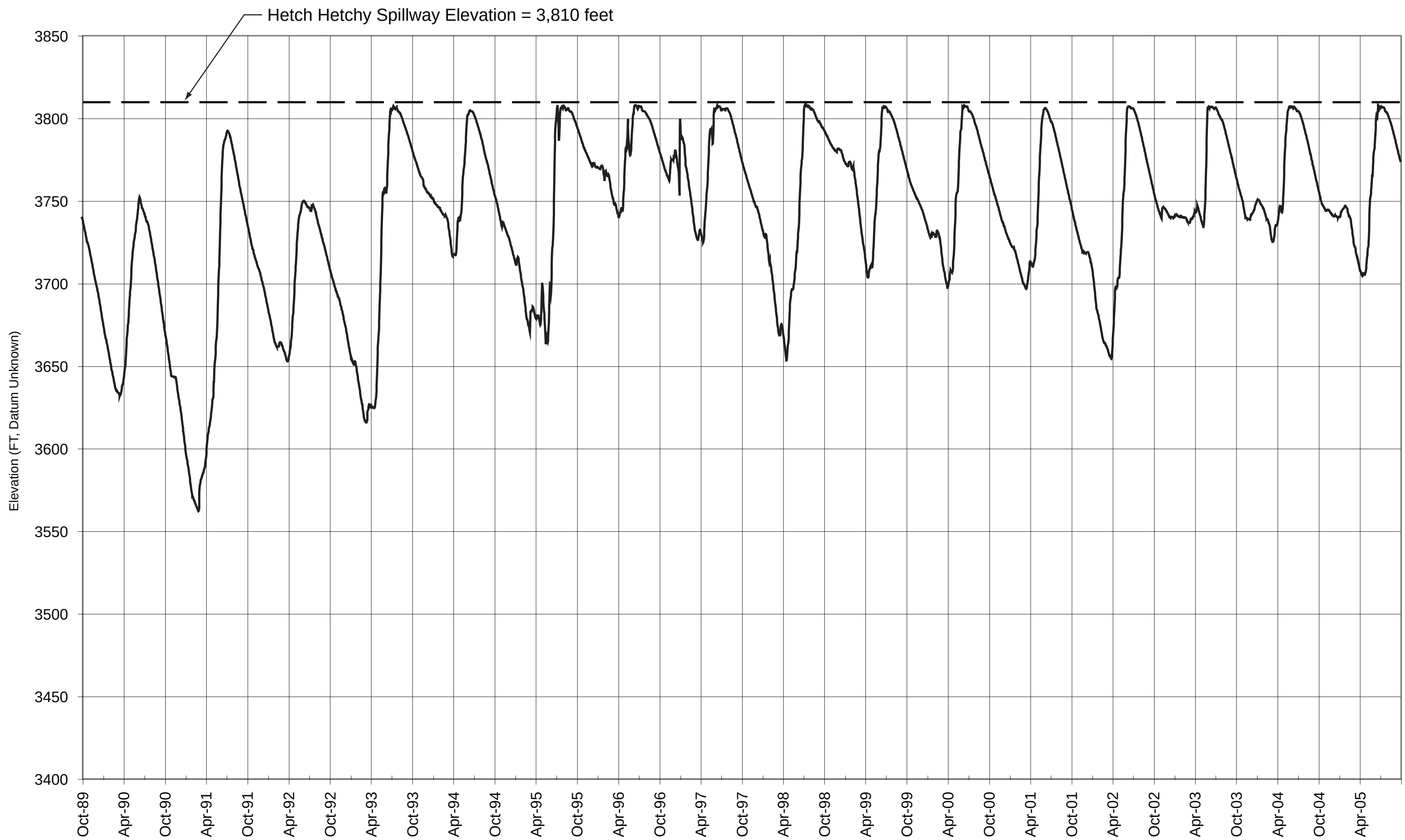


Districts = Turlock Irrigation District and Modesto Irrigation District

*Reservoir capacities without flashboards installed and with drum gates lowered.

SOURCE: Beck, 1992; SFPUC, 2004

Figure 5.3.1-2
Tuolumne River Schematic
Showing Water and Hydropower Facilities



SOURCE: SFPUC, 2007

Figure 5.3.1-3
Hetch Hetchy Reservoir, Historical Water Levels, 1989 to 2005

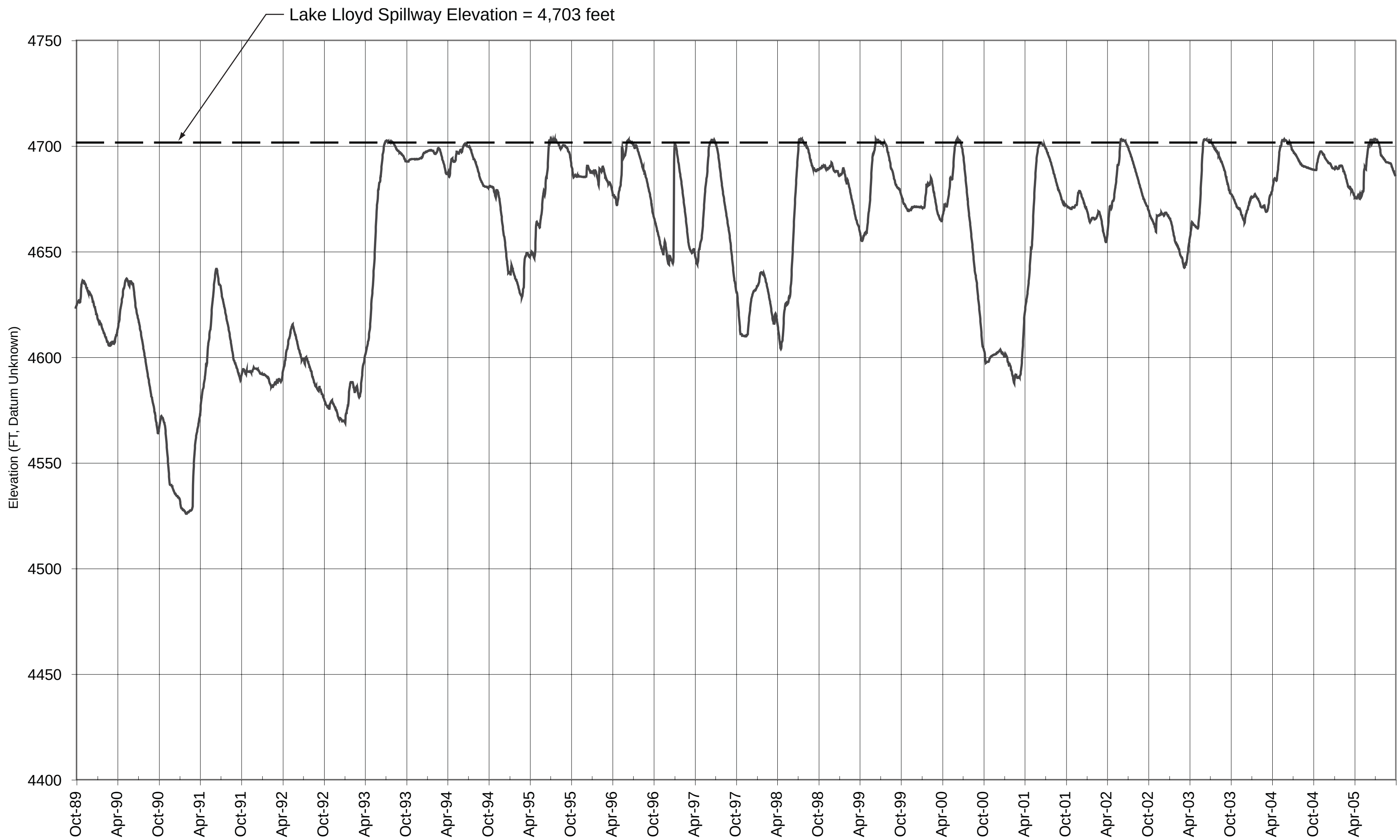
The SFPUC uses most of the water impounded in Lake Lloyd to generate electrical power at Holm Powerhouse. Water released from the powerhouse returns to Cherry Creek and is used to satisfy TID's and MID's flow entitlement. Water impounded in Lake Eleanor is conveyed to Lake Lloyd and then to Holm Powerhouse for electric power generation. **Figures 5.3.1-4** and **5.3.1-5** show the historical record of water storage in Lake Lloyd and Lake Eleanor, respectively, as reflected in water levels, from 1989 to 2005.

TID and MID divert water from the Tuolumne River at La Grange Dam. Water is conveyed to users in the two districts' service areas via the Modesto and Turlock Canals. Most of the users of water from the two canals are farmers, but some water is used for municipal supply by the city of Modesto. TID and MID divert an annual average of about 867,000 acre-feet from the Tuolumne River. **Figure 5.3.1-6** shows the historical record of water storage in Don Pedro Reservoir, as reflected in water levels, from 1989 to 2005. Average annual unimpaired runoff at La Grange Dam is estimated to be 1,850,000 acre-feet. Thus, TID and MID currently divert 49.6 percent of the estimated average unimpaired flow of the Tuolumne River at La Grange. Together, the SFPUC, TID, and MID divert and use about 62.8 percent of the estimated average unimpaired flow of the Tuolumne River at La Grange.

Table 5.3.1-1 shows monthly average flows in the Tuolumne River below Hetch Hetchy Reservoir, below La Grange Dam, and at Modesto under current conditions, calculated from stream gaging records. Monthly average flows below Hetch Hetchy Reservoir range from 382 to 2,293 cubic feet per second (cfs) and peak in the late spring and early summer as the snow in the Sierra Nevada melts. Monthly average flows in the Tuolumne River below La Grange range from 243 to 1,884 cfs. Monthly average flows in the river at Modesto range from 431 to 2,236 cfs. Monthly average flows below La Grange and at Modesto peak in the late winter and early spring as a result of rainfall runoff and releases from Don Pedro Reservoir. Water may be released from Don Pedro Reservoir in the late winter and spring to provide capacity in the reservoir for floodwaters and snowmelt.

Reservoirs and diversions have altered the magnitude and seasonal patterns of flow in the Tuolumne River. Prior to construction of the reservoirs, the river experienced large and sustained flows in the spring as snow melted at higher elevations in the watershed. Now a portion of the spring flows is stored in the reservoirs for later municipal or agricultural use. Peak flows below reservoirs, particularly the large Don Pedro Reservoir, are greatly reduced from their historical value. The two-year return-period flood flow in the Tuolumne River downstream of La Grange Dam is 4,100 cfs; its predevelopment value was 21,000 cfs. The 20-year return-period flood flow on the Tuolumne River downstream of La Grange Dam is 11,000 cfs; its predevelopment value was 59,000 cfs (FERC, 1996).

As discussed below, various regulations and agreements require that reservoir operators maintain minimum flows in the Tuolumne River and its tributaries downstream of dams. During the late summer and early fall, the required minimum flows may be greater than those that occurred prior to development.



SOURCE: SFPUC, 2007

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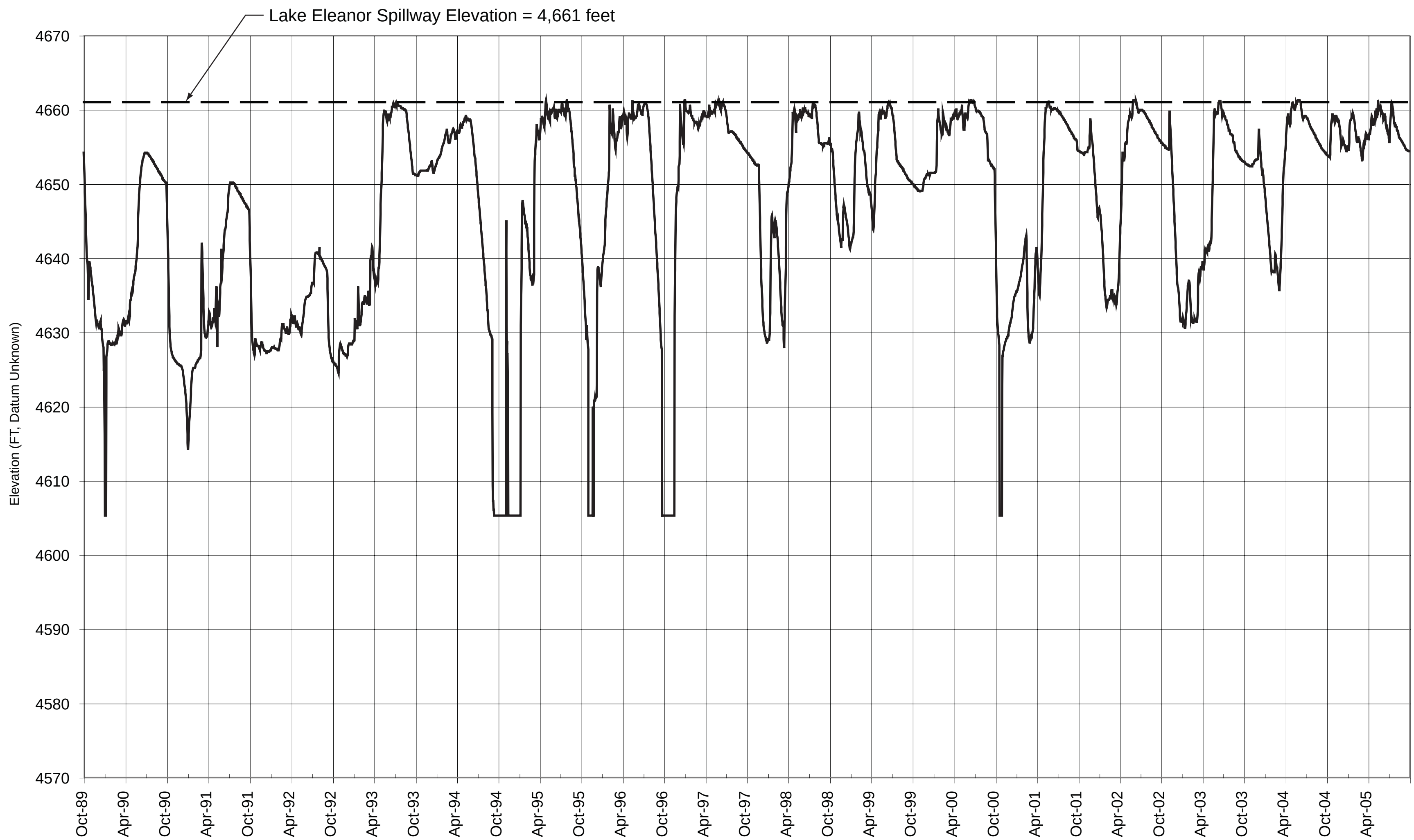
Figure 5.3.1-4
Lake Lloyd, Historical Water Levels, 1989 to 2005



SOURCE: SFPUC, 2007

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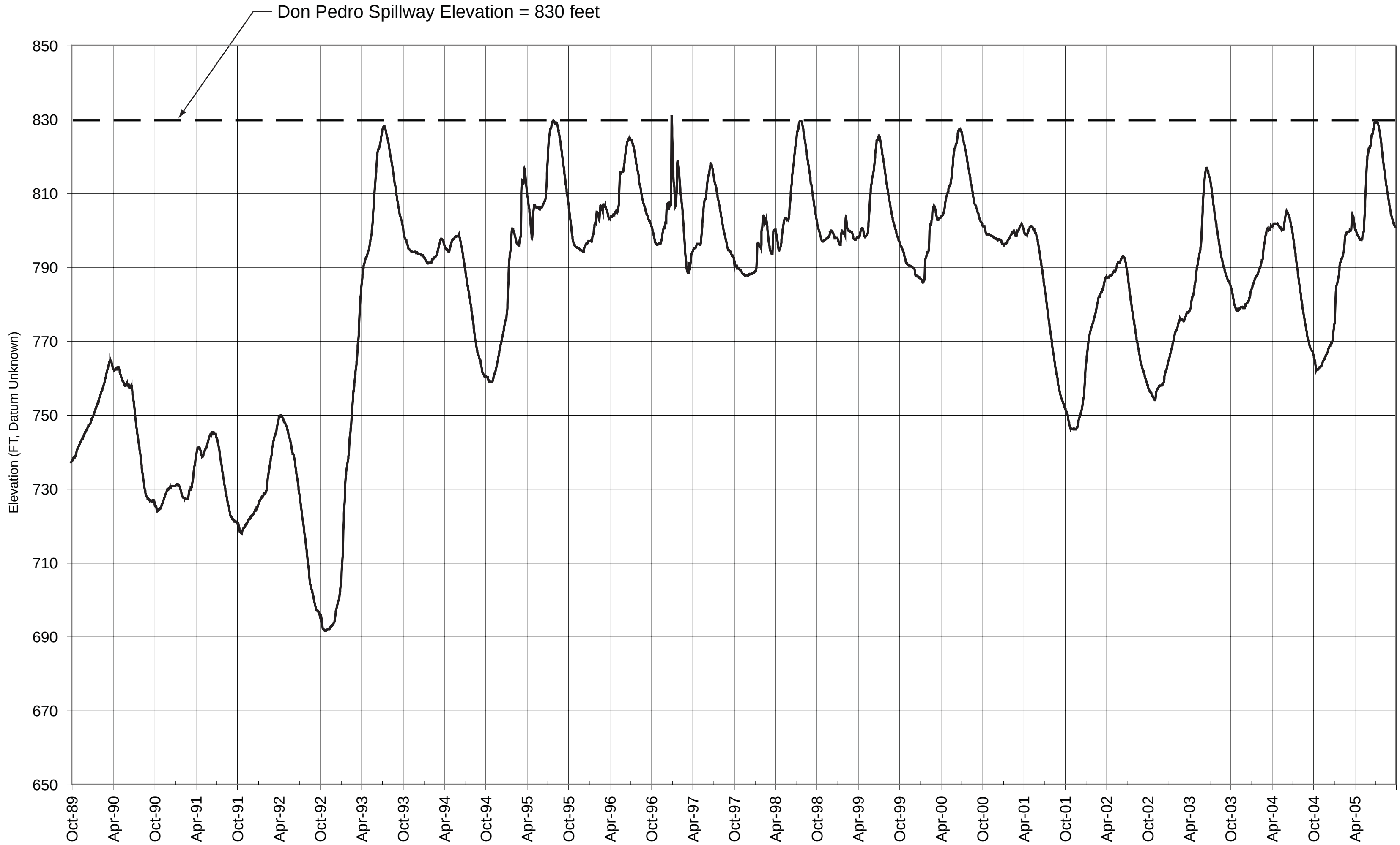
Figure 5.3.1-5
Lake Eleanor, Historical Water Levels, 1989 to 2005



SOURCE: SFPUC, 2007

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Figure 5.3.1-6
Don Pedro Reservoir, Historical Water Levels, 1989 to 2005

**TABLE 5.3.1-1
MEAN MONTHLY STREAM FLOWS AT SELECTED LOCATIONS ON WATERWAYS POTENTIALLY AFFECTED BY THE WSIP
(cubic feet per second)**

Location	Tuolumne River below Hetch Hetchy	Tuolumne River below La Grange	Tuolumne River at Modesto	San Joaquin River at Newman	San Joaquin River at Vernalis	Delta Freshwater Outflow
Period	1937–2003	1974–2004	1974–2004	1942–2004	1943–2004	1984–2004
January	384	1,484	1,840	2,334	5,353	44,035
February	351	1,884	2,236	3,249	6,947	61,511
March	374	1,845	2,209	3,186	7,061	50,090
April	565	1,591	1,835	2,989	6,586	25,326
May	1,344	1,417	1,644	2,847	6,730	21,166
June	2,293	694	899	2,274	5,181	13,077
July	1,116	438	615	1,008	2,322	8,715
August	461	243	431	510	1,496	6,075
September	402	498	711	600	1,880	6,427
October	385	681	937	704	2,422	6,946
November	382	368	724	679	2,386	11,394
December	403	854	1,142	1,189	3,710	23,820

SOURCES: USGS, 2005a, 2005b, 2005c; DWR, 2007.

Minimum Releases to Support Fisheries

Dams and reservoirs alter the pattern of flow in the streams they impound. Depending on their size and type of use, these facilities can completely eliminate flow in the streams below the dams. The owners of some dams and reservoirs, including the SFPUC, MID, and TID, have agreed to make minimum releases to stream channels below dams to support fish and aquatic life.

Below Hetch Hetchy Reservoir. In accordance with an agreement with the U.S. Department of the Interior, the SFPUC releases a minimum stream flow from Hetch Hetchy Reservoir.[3] Minimum flow requirements depend on the hydrologic year type and are shown in **Table 5.3.1-2**. Releases in normal, dry, and critical years total at least 59,235, 50,019, and 35,215 acre-feet. The SFPUC must release an additional 64 cfs into the river below Hetch Hetchy Reservoir when the diversion through Canyon Tunnel exceeds 920 cfs. Finally, the agreement provides for an additional supplemental release, depending on hydrologic year type, subject to the completion of a fish habitat study and the determination of appropriate timing for the release. Once made, releases cannot be diverted below O'Shaughnessy Dam (i.e., at Early Intake); they flow down the Tuolumne River, are supplemented by tributary flow and releases at Kirkwood Powerhouse, and enter Don Pedro Reservoir.

[3] Stipulation for the Amendment of Rights-of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961, to fulfill the conditions set forth in Provision 6 of said Amended Permit, dated January 31, 1985, *as modified by*, Modification for Kirkwood Powerhouse Unit No.3 to Stipulation for Amendment of Rights-of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961, to fulfill the conditions set forth in Provision 6 of said Amended Permit, as dated March 10, 1987.

TABLE 5.3.1-2
SCHEDULE OF AVERAGE DAILY MINIMUM REQUIRED RELEASES TO SUPPORT FISHERIES BELOW O'SHAUGHNESSY DAM

	Year Type A		Year Type B		Year Type C
Month	**Release**	**Criteria[a,b]**	**Release**	**Criteria[a,b]**	**Release**
January	50 cfs	8.80 inches	40 cfs	6.10 inches	35 cfs
February	60 cfs	14.00 inches	50 cfs	9.50 inches	35 cfs
March	60 cfs	18.60 inches	50 cfs	14.20 inches	35 cfs
April	75 cfs	23.00 inches	65 cfs	18.00 inches	35 cfs
May	100 cfs	26.60 inches	80 cfs	19.50 inches	50 cfs
June	125 cfs	28.45 inches	110 cfs	21.25 inches	75 cfs
July	125 cfs	575,000 acre-feet	110 cfs	390,000 acre-feet	75 cfs
August	125 cfs	640,000 acre-feet	110 cfs	400,000 acre-feet	75 cfs
September 1–14	100 cfs		80 cfs		75 cfs
September 15–30	80 cfs		65 cfs		50 cfs
October	60 cfs		50 cfs		35 cfs
November	60 cfs		50 cfs		35 cfs
December	50 cfs		40 cfs		35 cfs

[a] Precipitation indicators in inches are cumulative, measured at Hetch Hetchy Reservoir, starting October 1. For example, if October 1 through December 31 precipitation is greater than or equal to 8.80 inches, refer to year type A schedule for January.
[b] Runoff indicators in acre-feet are the calculated inflow into Hetch Hetchy Reservoir commencing on the previous October 1 of each year.

SOURCE: See Footnote 3, page 5.3.1-12.

Below Lake Lloyd. The minimum required stream flow below Lake Lloyd is 5 cfs from October through June and 15 cfs from July through September.

Below Lake Eleanor. In years when no pumping occurs between Lake Eleanor and Lake Lloyd, the minimum required stream flow below Lake Eleanor is 5 cfs from October through June and 15.5 cfs from July through September. In years when pumping occurs, the minimum required stream flow is 5 cfs from November through February, 10 cfs from March 1 through April 14, 20 cfs from April 15 through September 15, and 10 cfs from September 16 through October.

Below Don Pedro Reservoir/La Grange Dam. TID and MID are required to maintain minimum stream flows in the Tuolumne River at La Grange Bridge below Don Pedro Reservoir and La Grange Dam as a condition of their license to operate the Don Pedro Project (issued by the Federal Energy Regulatory Commission, or FERC). Minimum required releases are 100 to 300 cfs from October 1 to 15 and 150 to 300 cfs from October 16 to May 31, depending on hydrologic conditions. From June 1 to September 30, the minimum required releases range from 50 to 250 cfs depending on hydrologic conditions. Additional pulse releases must be made to assist upstream migrating adult Chinook salmon and downstream migrating juveniles. Minimum annual releases from La Grange Dam, including the pulse releases, vary from at least 94,000 acre-feet in critically dry years to approximately 300,000 acre-feet in above-normal and wet years. A detailed minimum stream flow schedule is shown in **Table 5.3.1-3**.

TABLE 5.3.1-3
MINIMUM STREAM FLOW REQUIREMENTS – TUOLUMNE RIVER AT LA GRANGE BRIDGE

Schedule	Days per Year	Critical Year and Below	Median Critical Year	Intermediate Critical – Dry Year	Median Dry	Intermediate Dry – Below-Normal Year	Median Below-Normal Year	All Years above Median Below-Normal Years
Occurrence		**6.4%**	**8.0%**	**6.1%**	**10.8%**	**9.1%**	**10.3%**	**49.3%**
October 1 – October 15	15	100 cfs 2,975 ac-ft	100 cfs 2,975 ac-ft	150 cfs 4,463 ac-ft	150 cfs 4,463 ac-ft	180 cfs 5,355 ac-ft	200 cfs 5,950 ac-ft	300 cfs 8,926 ac-ft
Attraction Pulse Flow		None	None	None	None	1,676 ac-ft	1,736 ac-ft	5,950 ac-ft
October 16 – May 31	228	150 cfs 67,835 ac-ft	150 cfs 67,835 ac-ft	150 cfs 67,835 ac-ft	150 cfs 67,835 ac-ft	180 cfs 81,402 ac-ft	175 cfs 79,140 ac-ft	300 cfs 135,669 ac-ft
Outmigration Pulse Flow		11,091 ac-ft	20,091 ac-ft	32,619 ac-ft	37,060 ac-ft	35,920 ac-ft	60,027 ac-ft	89,882 ac-ft
June 1 – September 30	122	50 cfs 12,099 ac-ft	50 cfs 12,099 ac-ft	50 cfs 12,099 ac-ft	75 cfs 18,149 ac-ft	75 cfs 18,149 ac-ft	75 cfs 18,149 ac-ft	250 cfs 60,496 ac-ft
Volume (ac-ft)	365	94,000	103,000	117,016	127,507	142,502	165,002	300,923

SOURCE: FERC, 1996.

[Additional discussion on flows in the Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues, and Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

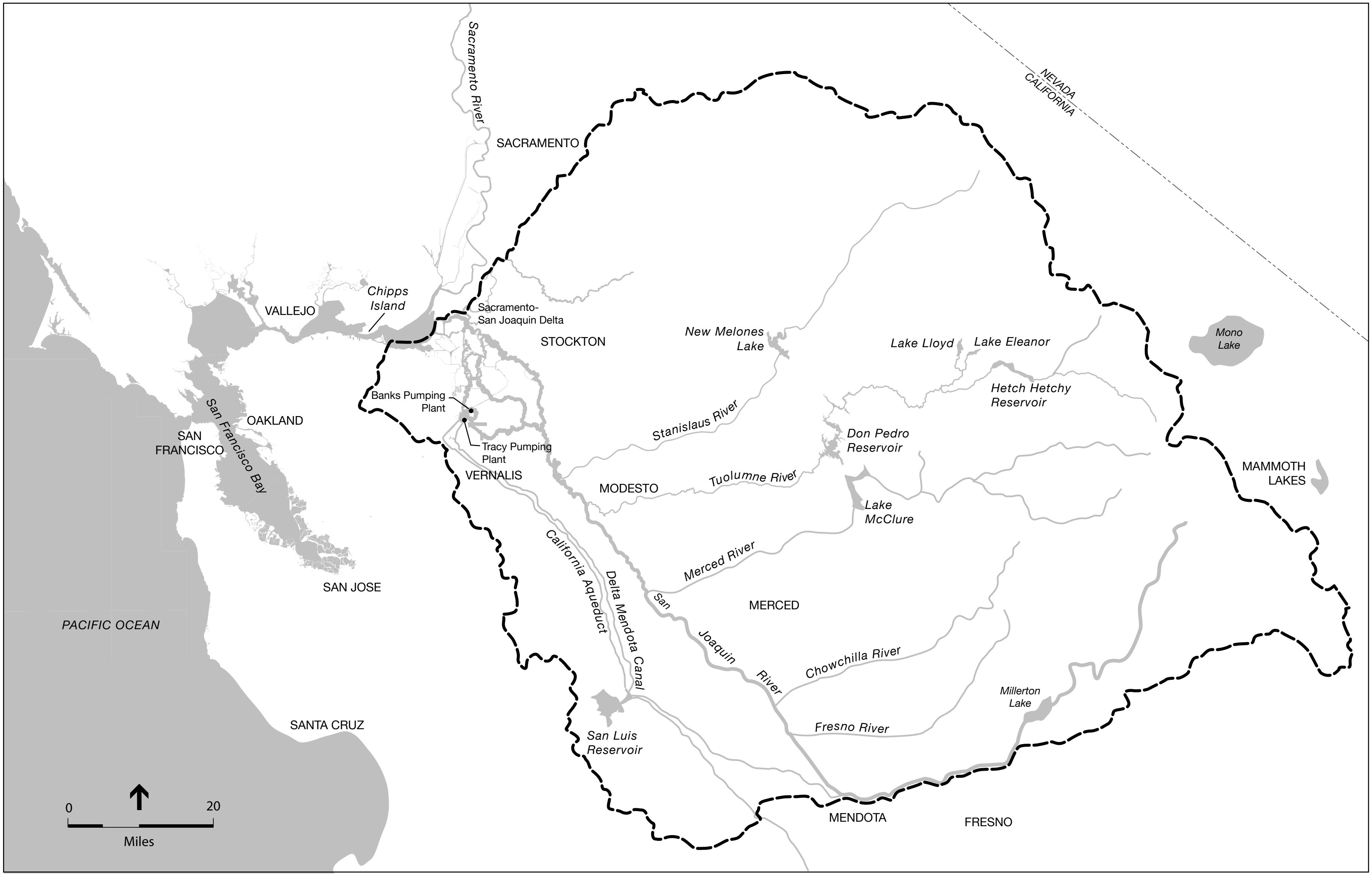
San Joaquin River

General Description

The San Joaquin River rises in the Sierra Nevada west of Mammoth Lakes and drains an area of approximately 13,500 square miles. The river flows southwestward, through the Sierra foothills, to the floor of the San Joaquin Valley near the city of Fresno. After reaching the valley floor, it turns and flows northwest for about 100 miles to the Sacramento–San Joaquin Delta. Several major tributaries join the San Joaquin River from the east, including the Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus Rivers. The San Joaquin River watershed is shown in **Figure 5.3.1-7**.

Stream Flow and Water System Operations

Flow in the San Joaquin River is controlled by releases from Millerton Lake on the main stem of the river and from several reservoirs on the San Joaquin's tributaries. Millerton Lake is part of the federal Central Valley Project. It is impounded by Friant Dam, which was completed in 1942. The Central Valley Project's Friant-Kern and Madera Canals convey most of the runoff from the San Joaquin River drainage above Millerton Reservoir to agricultural and urban water users. The U.S. Bureau of Reclamation (USBR) releases enough water at Friant Dam to maintain a flow of 5 cfs past Gravelly Ford, which is 35 miles below the dam, to meet downstream riparian water rights. The reach of the river between Gravelly Ford and Mendota is essentially dry, except when flood releases are being made. In the future, flow will be restored in the San Joaquin River between Friant Dam and the confluence with the Merced River in accordance with a recent settlement agreement between the USBR and an environmental advocacy organization, the Natural Resources Defense Council.



SOURCE: ESA + Orion

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Figure 5.3.1-7
San Joaquin River Watershed

The San Joaquin River gains water as it flows toward the Sacramento–San Joaquin Delta from agricultural irrigation return flows and tributaries. Flow in the San Joaquin River at Newman upstream of the river's confluence with the Tuolumne River averaged 1,789 cfs based on stream flow gaging records for the period between 1942 and 2004. Flow in the San Joaquin River at Vernalis, upstream of the Delta and downstream of the Tuolumne River confluence, averaged 4,328 cfs based on stream flow gaging records for the period between 1942 and 2004. Mean monthly stream flows at Newman and Vernalis are shown in Table 5.3.1-1. The highest flows occur in February, March, April, and May and the lowest in August and September. A substantial proportion of the increase in San Joaquin River flow between Newman and Vernalis is contributed by the Tuolumne River, which has an average annual flow of 1,265 cfs as measured at Modesto.

Sacramento–San Joaquin Delta

General Description

The Sacramento–San Joaquin Delta is a 600-square-mile area of channels and islands at the confluence of the Sacramento and San Joaquin Rivers. Freshwater draining from a 41,300-square-mile watershed enters the Delta from the Sacramento and San Joaquin Rivers and several smaller rivers. Some of the freshwater is diverted from the Delta channels for municipal and agricultural purposes. The remainder flows through the Delta to the San Francisco Bay Estuary.

The Delta is a tidal region. Every 12.4 hours, the tides cause water to move in and out of the Delta. Most of the time, tides cause a five- to eight-mile back and forth movement of water in the western part of the Delta. The average tidal flow into the Delta on the flood tide and out of the Delta on the ebb tide is 170,000 cfs (Miller, 1993). The movement of freshwater through the Delta is superimposed on the tidal flows. Typical freshwater flows are much smaller than tidal flows, usually in the range of 5 to 15 percent of the tidal flows.

Stream Flow and Water System Operations

On average, about 21 million acre-feet of water reaches the Delta annually, but actual inflow varies widely from year to year and within the year. In 1977, a year of extraordinary drought, Delta inflow totaled 5.9 million acre-feet. In 1983, an exceptionally wet year, Delta inflow was about 70 million acre-feet. On a seasonal basis, average monthly flow into the Delta varies by more than a factor of 10 between the highest month in the winter or spring and the lowest month in the fall (SWRCB, 1997).

The Sacramento River, which enters the Delta from the north, contributes an average of 77 percent of the inflow to the Delta. The San Joaquin River, which enters the Delta from the south, contributes about 15 percent of the inflow. The remainder is contributed by the Mokelumne, Cosumnes, and Calaveras Rivers, which enter the Delta from the east (DWR, 1998).

Most of the Delta islands are used to grow crops. Delta farmers divert water directly from the Delta channels to irrigate their land. A portion of the diverted water is returned to the Delta channels as agricultural return. The average annual net diversion of water for irrigation within the Delta is estimated to be 960,000 acre-feet (San Francisco Estuarine Project, 1992).

California's two largest engineered water systems, the Central Valley Project and the State Water Project, also divert water from the Delta. The Central Valley Project diverts water from Old River in the south Delta at the Jones Pumping Plant (formerly Tracy Pumping Plant) and exports it to Central Valley Project contractors via the Delta-Mendota Canal. Contra Costa Water District, a Central Valley Project contractor, diverts its water from Old River and Rock Slough in the south Delta and Mallard Slough in the west Delta. The State Water Project diverts water from Old River at the Banks Pumping Plant and exports it to customers via the California Aqueduct, the South Bay Aqueduct, and the Central Coast Aqueduct. The State Water Project diverts smaller amounts of water from Barker Slough in the north Delta to serve customers in Napa and Solano Counties. Between 1995 and 2004, the State Water Project diverted an average of 2.4 million afy from the Delta. The Central Valley Project diverts an average of 1.7 million afy from the Delta.

Delta freshwater outflow, commonly referred to simply as Delta outflow, is roughly equal to Delta inflow minus net water diversions in the Delta for use in the Delta and diversions for export. Like Delta inflow, Delta outflow varies widely from month to month and from year to year. Between 1984 and 2004, Delta outflow averaged 16.9 million acre-feet. The greatest annual Delta outflow in the period was 43.5 million acre-feet in 1998. The smallest Delta outflow in the period was 3.9 million acre-feet in 1990 (DWR, 2007). Average monthly Delta outflow for the same period is shown in Table 5.3.1-1. The largest Delta outflow typically occurs in January, February, and March, when surface runoff is high and demand for irrigation water is low. The smallest Delta outflow typically occurs in July, August, September, and October.

The diversion of water by the Central Valley Project, State Water Project, and others in the south Delta as well as upstream depletion of San Joaquin River flows affect the pattern of flow in the Delta channels. Historically, net flow in the Delta channels was toward the San Francisco Bay Estuary. Now, because freshwater inflow to the south Delta from the San Joaquin River is small relative to the diversions at the Banks and Tracy Pumping Plants, net flow in many south Delta channels reverses during summer and fall. Flow in the lower San Joaquin River and the south Delta channels is directed upstream toward the pumping plants rather than downstream toward the estuary (Miller, 1993).

The diminution of flow and flow reversals in the lower San Joaquin River as a result of water diversions by the State Water Project and Central Valley Project are harmful to migrating salmon. In 1990, the California Department of Water Resources (DWR) began installing temporary barriers in several waterways in the south Delta to improve conditions for migrating salmon. Temporary barriers have been placed across the Grant Line Canal, Middle River, and Old River. The purpose of the barriers is to control water levels for irrigators, improve water quality, and direct more water down the lower San Joaquin River for downstream migrating juvenile salmon in the spring and upstream migrating adults in the fall. It is expected that permanent operable barriers will replace the temporary barriers in the future years.

Flow Objectives for the Sacramento–San Joaquin Delta

As noted above, the Sacramento–San Joaquin Delta lies at the heart of California's natural and manmade water systems. The Delta's physical complexity and competing interests for water make management of the Delta difficult. Since water quality objectives alone are insufficient to protect the Delta, regulators have also established objectives for flow. These objectives have been the subject of much controversy and have frequently been revised. Some issues remain unresolved, including the degree to which parties that divert water upstream of the Delta are responsible for meeting Delta objectives. Resolution of these issues could affect all upstream diverters, including the SFPUC, TID, and MID.

The State Water Resources Control Board (SWRCB) is the agency responsible both for setting water quality objectives for the Delta and for issuing and administering water-rights permits in California. The degree to which parties that divert water upstream of the Delta are responsible for maintenance of Delta water quality and flow objectives may ultimately be resolved through a water-rights proceeding.

Water-Rights Decisions

In 1997, the SWRCB began examining long-term alternatives that would enable compliance with the flow objectives for the Delta. Water rights proceedings to determine responsibility for meeting the flow objectives began in 1998 (see Section 5.3.3 for more detail). The water-rights proceedings were to be conducted in eight phases. The SWRCB's policy in the water-rights proceedings was to encourage water agencies to resolve among themselves the responsibilities for meeting the objectives in the 1995 Water Quality Control Plan (WQCP) and to bring their proposals to the SWRCB for approval. In 1999, the SWRCB published a final EIR on the WQCP, which presented the environmental effects of a range of alternatives but did not identify a preferred alternative (SWRCB, 1999).

In late 1999, following Phases 1 through 7 of the Bay-Delta water rights proceedings, the SWRCB issued Water Rights Decision 1641. The SWRCB revised D-1641 in early 2000 by issuing Order WR 2000-02, and again in 2001 by issuing Order WR 2001-05. D-1641 and Order WR 2001-05 contain the water-right requirements to implement the flow objectives for the Delta. D-1641 includes both long-term and temporary requirements that will remain in effect for up to 35 years. Order WR 2001-05 called for partial implementation of the requirements.

In D-1641 and Order WR 2001-05, the SWRCB assigned responsibilities to water-rights holders for specified periods, including the USBR and DWR, in certain watersheds tributary to the Delta. The SWRCB accepted with modifications the proposals made by some water agencies and groups of water agencies with respect to their responsibilities for meeting flow objectives in the Delta. The responsibilities of various parties, including water users in the Sacramento, San Joaquin, Mokelumne, Calaveras, and Cosumnes River watersheds, were defined in D-1641. These responsibilities require that the water users in these watersheds contribute specified amounts of water to protect water quality or implement agreements (including the San Joaquin River Agreement, as described below), and that the USBR and/or DWR ensure the objectives are met in the Delta.

Phase 8 of the water-rights proceedings would have ultimately determined the responsibilities of the Sacramento Valley water-rights holders for meeting the objectives in the 1995 WQCP. The SWRCB's Order WR 2001-05 stayed Phase 8 of the proceedings and required the USBR and DWR to continue to meet certain objectives in the 1995 WQCP until adoption of another decision assigning responsibility for meeting the objectives. During 2002, the USBR, DWR, Sacramento Valley upstream water users, and certain downstream users negotiated a settlement in lieu of continuing Phase 8 of the water-rights proceedings. Beginning in December 2002, the parties to the negotiations executed the Sacramento Valley Water Management Agreement, or Short Term Settlement Agreement. The agreement establishes a planning process for actions that would help meet objectives in the Delta.

Vernalis Adaptive Management Program

Shortly after the Bay-Delta WQCP was published, an association of users of San Joaquin River water filed suit against the SWRCB, challenging the flow objectives in the WQCP. The association claimed that the flow objectives were based on an inadequate understanding of the relationship between flow and salmon survival. In an effort to settle the issue out of court, the San Joaquin River interests collaborated with other water users, environmental groups, and government agencies to develop an alternative that would provide an equivalent level of fishery protection to that provided by the Bay-Delta WQCP. The result was the San Joaquin River Agreement, of which the Vernalis Adaptive Management Program (VAMP) was a key component (San Joaquin River Group Authority, 2007).

The VAMP is an experimental management program designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Delta. The San Joaquin River Agreement, including the VAMP, was submitted to the SWRCB as a proposal. It was accepted by the SWRCB and made a part of D-1641. In February 2006, however, the Third Appellate District overturned that part of D-1641 and ordered to SWRCB to commence further proceedings to either assign responsibility for meeting the Vernalis pulse-flow objectives in full or to modify those objectives. In December 2006, the SWRCB adopted amendments to the 1995 Bay-Delta WQCP, including allowing for staged implementation through the San Joaquin River Agreement until December 2011.

The VAMP provides for a 31-day pulse flow in the San Joaquin River at Vernalis, together with a reduction in State Water Project and Central Valley Project exports from the south Delta. The pulse usually occurs from mid-April to mid-May, but its timing may be adjusted based on hydrology and fishery conditions. The effects of different flow rates in the lower San Joaquin River and different State Water Project and Central Valley Project export rates on juvenile and smolt Chinook salmon survival are being studied as part of the VAMP. The VAMP is scheduled to end in 2011.

5.3.1.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to stream flow and reservoir water levels, but generally considers that implementation of the proposed program would have a significant impact if it were to:

- Substantially alter stream flows such that they are outside of the range of pre-project conditions and result in adverse hydrologic effects

The stream flow significance threshold is based on the fact that natural stream flows and controlled reservoir levels have varied substantially in the past 50 years, and such variations are a part of the existing baseline. Therefore, variations substantially outside of these past levels due to implementation of the proposed program that would result in an adverse hydrologic effect (such as flooding, dewatering, drainage alteration, or erosion, among others) would be considered a significant direct impact.

This PEIR also considers indirect impacts due to changes in stream flows and reservoir levels. However, for organizational purposes, the indirect impacts are not described in this section of this chapter, but rather in the sections describing the resources that would be indirectly affected by changes in flows and reservoir levels. These include geomorphology, surface water quality, surface water supplies, groundwater, fisheries, terrestrial biological resources, and recreational and visual resources. It should be noted that there might be cases where significant indirect impacts could result from less-than-significant direct flow impacts.

Approach to Analysis

Changes in flow in rivers and streams and changes in reservoir storage and water levels attributable to the WSIP were estimated using the Hetch Hetchy/Local Simulation Model (HH/LSM). An overview of the model is presented in Section 5.1. The HH/LSM simulates water deliveries, reservoir storage, and releases to rivers under different conditions using hydrologic data from the 82-year period 1920 to 2002. Detailed information on the model and the assumptions that underlie it is provided in Appendix H.

The following section addresses the impacts of the WSIP on water levels in Hetchy Hetchy and Don Pedro Reservoirs and flow along the Tuolumne River. WSIP impacts on flow along the San Joaquin River and Sacramento-San Joaquin Delta are also described. In applying the above significance criteria, very infrequent changes in reservoir levels and/or flow are not generally considered to generate a significant effect.

Impact Summary

Table 5.3.1-4 presents a summary of the impacts on stream flow and reservoir levels in the Tuolumne River system and downstream water bodies that could result from implementation of the proposed water supply and system operations.

**TABLE 5.3.1-4
SUMMARY OF IMPACTS – STREAM FLOW IN THE
TUOLUMNE RIVER SYSTEM AND DOWNSTREAM WATERBODIES**

Impact	Significance Determination
Impact 5.3.1-1: Effects on flow along the Tuolumne River below O'Shaughnessy Dam	LS
Impact 5.3.1-2: Effects on flow along Cherry Creek below Cherry Dam	LS
Impact 5.3.1-3: Effects on flow along Eleanor Creek below Eleanor Dam	LS
Impact 5.3.1-4: Effects on flow along the Tuolumne River below La Grange Dam	LS
Impact 5.3.1-5: Effects on flow along the San Joaquin River and the Sacramento–San Joaquin Delta	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.1-1: Effects on flow along the Tuolumne River below O'Shaughnessy Dam.

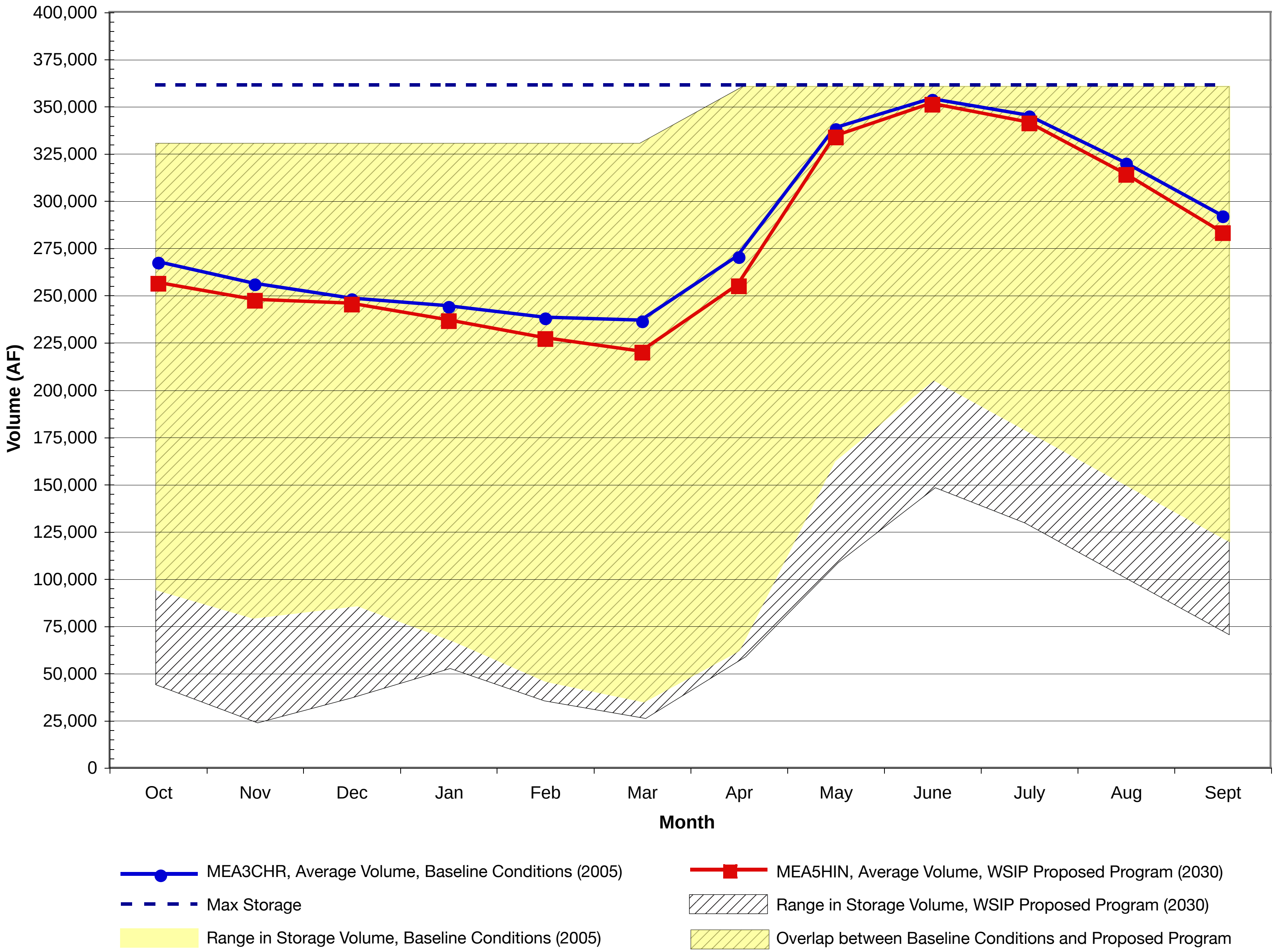
Reservoir Operations

Hetch Hetchy Reservoir stores water from the upper reaches of the Tuolumne River within Yosemite National Park. During the snowmelt season the reservoir is filled. During the rest of the year, when flow into the reservoir is reduced, the reservoir is drawn down to meet water demand in the service areas of the SFPUC and its customers, instream flow release requirements, and, if necessary, TID's and MID's Raker Act entitlements. Most years, the SFPUC is able to completely refill the reservoir during the snowmelt season. One of the SFPUC's operating goals is to fill the reservoir by the end of June. The WSIP would not change this or any of the SFPUC's other operational goals for Hetch Hetchy Reservoir, but it would affect water levels in the reservoir and the magnitude and timing of releases to the Tuolumne River.

Water Storage and Water Levels in Hetch Hetchy Reservoir

The WSIP would reduce average monthly storage in Hetch Hetchy Reservoir compared to the existing condition. **Figure 5.3.1-8** shows average monthly storage and the range of monthly storage in the reservoir with the WSIP and under existing conditions. The decrease in storage is primarily attributable to increased water demand in the service areas of the SFPUC and its customers. As demand increases, so would diversions of water from Hetch Hetchy Reservoir to supply the SFPUC's customers. Because of the decrease in storage in Hetch Hetchy Reservoir with the WSIP, monthly average water levels would fall by 1 to 10 feet compared to the existing condition.

Figure 5.3.1-9 shows modeled chronological storage in Hetch Hetchy Reservoir and releases to the Tuolumne River using hydrology from the 82-year period 1920 to 2002. The figure compares the WSIP 2030 condition to the existing condition. It shows that, under the existing condition, the SFPUC normally fills Hetch Hetchy Reservoir in the spring and early summer and draws from



SOURCE: SFPUC, HH/LSM (see Appendix H)

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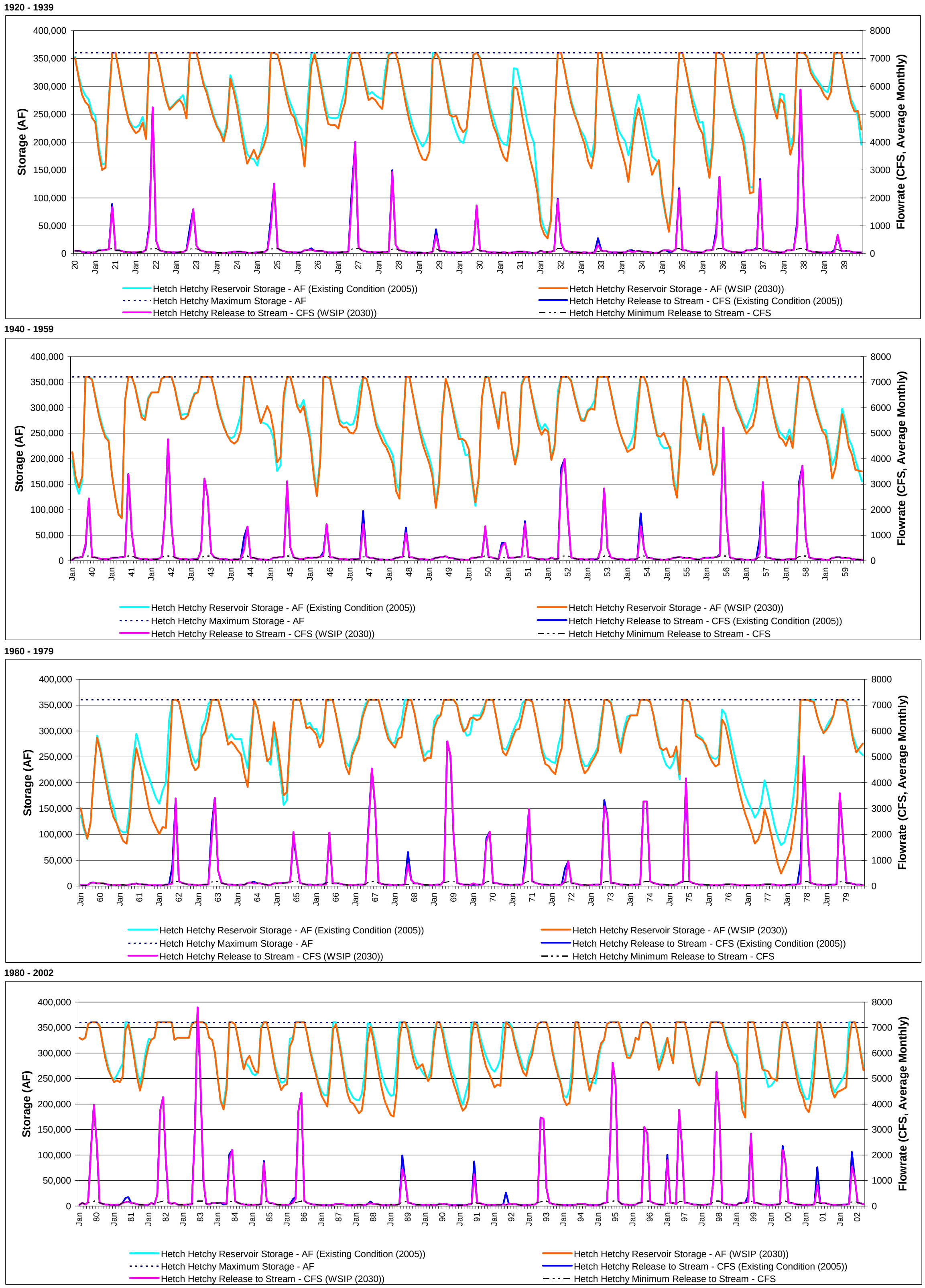
Figure 5.3.1-8
Average Monthly Storage Volume,
Hetch Hetchy Reservoir



SOURCE: SFPUC, HH/LSM (see Appendix H).

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Figure 5.3.1-9
Hetch Hetchy Storage and Releases to the Tuolumne River

storage to meet water demand in the summer, fall, and winter. In the early spring, the SFPUC may additionally draw water from the reservoir for power generation, provided it is confident that the coming snowmelt will fill the reservoir.

In the future with the WSIP, the SFPUC would continue to fill the reservoir in the spring and early summer and draw it down during the rest of the year, but the magnitude of the drawdown would be greater than under the existing condition. The reductions in storage and the lowering of water levels attributable to the WSIP would be the greatest in dry years. In average dry years, Hetch Hetchy Reservoir would be drawn down 18 feet more in March (just before refilling begins) than under the existing condition. The WSIP would lower water levels in Hetch Hetchy Reservoir in some months of severe droughts by up to 64 feet compared to the existing condition.

Beginning in July, when the reservoir is usually full, the rate of drawdown with the WSIP would be greater than under the existing condition. As shown in Figure 5.3.1-8, the difference in storage between the two scenarios would increase steadily through the summer, fall, and winter in most years. The pattern would be altered every five years when, with the WSIP, the SFPUC would take a portion of the conveyance system between Hetch Hetchy Reservoir and the Bay Area out of service so it can be maintained. During maintenance, water demand in the Bay Area would be met from local reservoirs, and drawdown of Hetch Hetchy Reservoir would cease for several weeks. On completion of maintenance, drawdown of Hetch Hetchy Reservoir would recommence at an accelerated rate as water is moved to storage in the local reservoirs. The WSIP would not alter water levels in Hetch Hetchy Reservoir such that they would be substantially outside the range experienced under the existing condition. Under the existing condition and in almost all years, the reservoir fills to its maximum capacity of 360,400 acre-feet in the spring and early summer and then is drawn down through the rest of the year. Maximum storage corresponds with a water surface level of 3,806 feet above mean sea level. Only rarely does storage in the reservoir decline below 150,000 acre-feet. A storage capacity of 150,000 acre-feet corresponds with a water surface level of 3,684 feet above mean sea level. Thus, under the existing condition and almost all of the time, the water level fluctuates between 3,806 feet and 3,684 feet, a range of 122 feet. With the WSIP, the water level in Hetch Hetchy Reservoir would fluctuate within the same range almost all of the time.

Occasionally in extended droughts, storage in Hetch Hetchy Reservoir would be drawn down severely. Under the existing condition, the water level in the reservoir would be drawn down to 3,573 feet, or 233 feet below the maximum, once in the 82-year hydrologic record. With the WSIP, the water level would be drawn down to 3,562 feet, or 244 feet below the maximum, once in the hydrologic record. Thus, water levels with the WSIP would remain substantially within the same range as occurs under the existing condition, although very infrequently water levels would decline slightly below the lower end of the range.

Flow in the Tuolumne River Between O'Shaugnessy Dam and Early Intake

Figure 5.3.1-9 shows the frequency and magnitude of modeled chronological releases from Hetch Hetchy Reservoir to the Tuolumne River under the existing condition and with the WSIP. Under the existing condition, releases to the Tuolumne River are at least equal to the required releases to support fisheries shown in Table 5.3.1-2. In many years, the volume of spring snowmelt from the watershed upstream of Hetch Hetchy Reservoir exceeds the capacity of the reservoir and the SFPUC's ability to divert water through Canyon Tunnel. Water that cannot be stored or diverted through Canyon Tunnel is released to the Tuolumne River. Occasionally, during the winter, the SFPUC will release excess inflow produced by warm storms to the Tuolumne River.

In the future with the WSIP, the SFPUC would draw the reservoir down farther in most years than it would under the existing condition. Consequently, with the WSIP, the SFPUC would capture a greater proportion of spring runoff to refill the reservoir. As a result, the volume of water released to the Tuolumne River would be reduced compared to the existing condition.

This circumstance is illustrated by the hydrology that occurred in 1991 and 1992. As shown in Figure 5.3.1-9, by the end of the 1991 conditions, Hetch Hetchy Reservoir would be drawn down to a lower level after WSIP implementation than it would under the existing condition. To refill the reservoir in the fairly dry spring of 1992, the SFPUC would have to capture a larger portion of the spring runoff, with the consequence that releases from the reservoir and flow in the Tuolumne River below the reservoir would be reduced, as indicated in the figure.

Table 5.3.1-5 shows average monthly flows in the Tuolumne River immediately below Hetch Hetchy Reservoir in different hydrologic year types for the existing condition and after WSIP implementation. The percentage change in average monthly flow attributable to the WSIP is also shown in the table. The WSIP would have little or no effect on average monthly flow in most summer, fall, and winter months in all hydrologic year types. In most summer, fall, and winter months, only the required fishery release would be made under the existing condition and with the WSIP. With the WSIP, the number of months in which only the required fishery release would be made would increase slightly. Under the existing condition, the model indicates that the minimum release would be made 85.1 percent of the time (837 months in the 984-month hydrologic record); with the WSIP the minimum release would be made 85.7 percent of the time (843 months in the 984-month hydrologic record).

The WSIP would result in reductions in average monthly flow of up to 30 percent in April, May, and June when the SFPUC fills Hetch Hetchy Reservoir with snowmelt. The greatest percentage reduction in flow would occur in normal, below-normal, and dry years because, in these year types, a greater proportion of the snowmelt currently released to the river would be needed to fill the reservoir. For example, in May of an average dry year, flow in the Tuolumne River below O'Shaughnessy Dam would be 224 cfs under the existing condition; with the WSIP it would be 157 cfs, a reduction of 30 percent.

In individual months in the 82-year hydrologic simulation, the absolute and percentage changes in flow in the Tuolumne River below O'Shaughnessy Dam attributable to the WSIP vary widely. The chronological analysis shows that the maximum percentage reduction in average monthly flow would be 80 to 90 percent, occurring three times in the 82-year hydrologic simulation. For example, under the existing condition, May 1992 flow would be 520 cfs; with the WSIP it would be 50 cfs. Reductions in average monthly flow of 30 percent or more would occur in some months of 20 springs in the 82-year simulation, or about once in every four springs on average.

TABLE 5.3.1-5
ESTIMATED AVERAGE MONTHLY FLOWS FOR THE TUOLUMNE RIVER BELOW O'SHAUGNESSSY DAM UNDER VARIOUS CONDITIONS
(cubic feet per second)

	Wet		Above Normal		Normal		Below Normal		Dry		All	
Existing Condition (2005)												
Oct	55		55		54		55		53		54	
Nov	51		96		54		55		53		62	
Dec	51		88		50		46		44		56	
Jan	180		66		51		43		40		75	
Feb	88		88		74		51		44		69	
Mar	93		86		74		63		50		73	
Apr	148		131		98		91		64		107	
May	2,518		1,273		1,479		758		224		1,245	
June	4,534		3,092		1,913		768		168		2,091	
July	2,034		379		167		113		86		548	
Aug	184		125		122		111		86		125	
Sept	90		89		86		73		65		81	
Future with WSIP (2030)												
Oct	55		55		54		55		53		54	
Nov	51		89		54		55		53		61	
Dec	51		88		50		46		44		56	
Jan	167		66		55		43		40		74	
Feb	88		88		74		51		44		69	
Mar	84		94		74		63		50		73	
Apr	144		131		98		88		56		103	
May	2,416		1,187		1,260		564		157		1,111	
June	4,548		3,095		1,907		709		139		2,075	
July	2,034		379		167		113		86		548	
Aug	184		125		122		111		86		125	
Sept	89		89		86		73		65		81	
Difference and Percent Change, Existing Condition (2005) vs WSIP (2030)												
Oct	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Nov	0	[0%]	-8	[-8%]	0	[0%]	0	[0%]	0	[0%]	-2	-[3%]
Dec	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Jan	-12	-[7%]	0	[0%]	4	[8%]	0	[0%]	0	[0%]	-2	-[2%]
Feb	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Mar	-9	-[9%]	8	[9%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Apr	-4	-[3%]	0	[0%]	0	[0%]	-4	-[4%]	-8	-[12%]	-3	-[3%]
May	-103	-[4%]	-86	-[7%]	-220	-[15%]	-195	-[26%]	-67	-[30%]	-134	-[11%]
June	14	[0%]	3	[0%]	-6	[0%]	-59	-[8%]	-29	-[17%]	-16	-[1%]
July	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Aug	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]
Sept	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]

Key
- (blue) > 0%
- (yellow) < 0 to -5%
- (orange) < -5%

SOURCE: SFPUC, HH/LSM (see Appendix H).

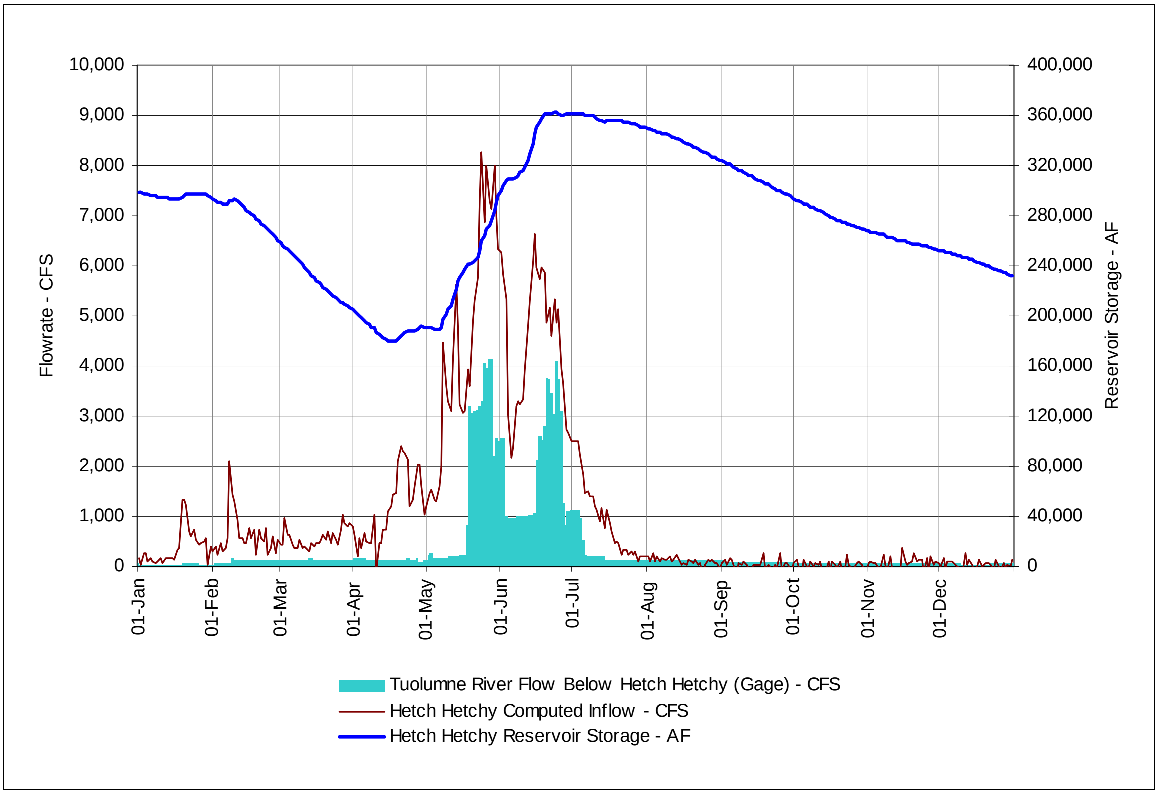
The results presented above are described in terms of average monthly flows because the HH/LSM is a monthly time-step model. The SFPUC's actual operational decisions may occur in smaller time increments, perhaps daily or weekly, depending on meteorological and operational circumstances. For example, if inflow to Hetch Hetchy Reservoir increases rapidly, operators may decide to adjust the rate at which water is routed to Canyon Tunnel or released to the river several times within a month. These within-month operational changes cannot be simulated with the HH/LSM, nor can the model be used to estimate the effects of the WSIP on peak flows in the river, because the peaks may only last for a few hours or days.

Insight into the effects of the WSIP on peak flows below O'Shaughnessy Dam can be obtained by examination of operational data. **Figure 5.3.1-10** shows actual data for 1999, an above-normal year; the greatest effects on peak flows would occur in wet and above-normal years. The figure shows storage in Hetch Hetchy Reservoir falling in the first four months of the year because the rate of withdrawal from the reservoir exceeds the rate of inflow into the reservoir. In April, inflow into the reservoir increases and continues to do so through May. In June, inflow into the reservoir decreases from its peak but remains considerable. Storage in the reservoir increases from its minimum value of about 190,000 acre-feet in mid-April to its maximum value of 360,000 acre-feet in mid-June. The SFPUC reacted to increasing reservoir inflow and diminishing reservoir storage around the middle of May by increasing releases to the Tuolumne River. Measured flow in the Tuolumne River below O'Shaughnessy Dam shows a number of step increases and decreases in flow during May and June lasting several days, as operators balanced reservoir inflow, gains in storage, and releases to the river in response to changing conditions.

If the WSIP had been in place in 1999, and water demand was at 2030 levels, storage in mid-April in Hetch Hetchy Reservoir would have been about 175,000 acre-feet. With the WSIP, operators would need to capture 185,000 acre-feet of runoff to fill the reservoir. Under the existing condition, the operators had to capture 160,000 acre-feet. Needing to capture a higher proportion of runoff with the WSIP than under the existing condition, operators would likely delay releases of water to the Tuolumne River by two to three days. After the initial delay, the releases to the river with the WSIP would follow the same pattern as under the existing condition and would be of a similar magnitude.

The pattern and magnitude of releases from Hetch Hetchy Reservoir to the Tuolumne River with the WSIP in any particular year would depend on meteorological and operational circumstances, as they do under the existing condition. Under the existing condition, there would be no releases from the reservoir to the river in excess of the minimum required release in 15 years of the 82-year hydrologic record. With the WSIP, there would be no releases above the minimum required in 18 years of the 82-year hydrologic record. In years when a release above the minimum required is made, the WSIP would delay the release of water and reduce the total volume of releases to the river in the snowmelt period compared to the existing condition. The WSIP would delay the release of water in excess of minimum requirements by an average of one to two days and could delay the release by up to eight days.[4] The infrequent large peak flows (greater than

[4] The estimates of delay in spring releases are based on the assumption that operators would release water from Hetch Hetchy Reservoir at a rate of 3,000 cfs. A review of past practice indicates that this springtime release rate is typical. If the release rate were to be reduced, as might happen in a dry year, the delay would be extended.



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SOURCE: SFPUC, HH/LSM (see Appendix H).

Figure 5.3.1-10
Hetch Hetchy Reservoir Storage and Inflow, Calendar Year 1999

5,000 cfs) in the river below O'Shaughnessy Dam produced by rapidly melting abundant snowpack would not be affected by the WSIP. Peak flows in years when runoff is less (dry years) might be reduced by the WSIP, depending on decisions made by reservoir operators.

Impact Conclusions

The WSIP would not alter stream flow in the Tuolumne River below O'Shaughnessy Dam such that it would be substantially outside the range experienced under the existing condition, nor would the flow alterations result in adverse hydrologic effects or be sufficient to change the character of the river. Large, infrequent peak flows under the existing condition and with the WSIP would be similar in magnitude. Minimum flows are the subject of an agreement with the U.S. Department of the Interior and would be the same with the WSIP as under the existing condition. The Department of the Interior could increase the minimum flows in the future based on the fish habitat study referred to above. Overall, the effects of the WSIP on flow along the Tuolumne River below O'Shaughnessy Dam would be *less than significant*, and no mitigation measures would be required.

[Additional discussion on impacts on flow in the upper Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues (Vol. 7, Chapter 14).]

Impact 5.3.1-2: Effects on flow along Cherry Creek below Cherry Dam.

Reservoir Operations

Lake Lloyd stores water from the upper reaches of Cherry Creek. During the snowmelt season the reservoir is filled. During the rest of the year, when flow into the lake is reduced, the reservoir is drawn down to generate hydroelectric power at the Holm Powerhouse. The releases, which are sized and timed for power generation purposes, also provide opportunities for river rafting and contribute to the releases that the SFPUC must make to satisfy TID's and MID's flow entitlements. Most years, the SFPUC is able to completely refill the lake during the snowmelt season. The WSIP would not change the SFPUC's operational goals for Lake Lloyd, and it would have little or no effect on water levels in the lake and the magnitude and timing of releases to Cherry Creek.

Water Storage and Water Levels in Lake Lloyd

The WSIP would not alter water levels in Lake Lloyd such that they would be substantially outside the range experienced under the existing condition. The WSIP would reduce year-round average monthly storage in Lake Lloyd by about 1,000 acre-feet and average monthly water levels by about 1 foot. Most of the time, storage in Lake Lloyd would be the same with the WSIP as under the existing condition. Infrequent reductions in storage attributable to the WSIP would occur at the end of dry periods, similar to the period that occurred between 1987 and 1992. At the end of dry periods, the SFPUC might release additional water from Lake Lloyd to offset the WSIP-induced reduction in releases from Hetch Hetchy Reservoir. The releases would be needed to satisfy TID's and MID's flow entitlements.

Flow in Cherry Creek

Releases from Lake Lloyd with the WSIP and under the existing condition would be the same and would be at least equal to the fishery release schedule. Thus, the WSIP would have no effect on flow in Cherry Creek.

Impact Conclusions

The WSIP would not alter releases from Lake Lloyd to Cherry Creek. Adverse impacts on flow in Cherry Creek would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.1-3: Effects on flow along Eleanor Creek below Eleanor Dam.

Reservoir Operations

Lake Eleanor stores water from the upper reaches of Eleanor Creek; it fills in the winter and spring of each year and is drawn down in the summer as water is transferred to the lake. The WSIP would not change the SFPUC's operational goals for Lake Eleanor, and it would have little effect on water levels in the lake and the magnitude and timing of releases to Eleanor Creek.

Water Storage and Water Levels in Lake Eleanor

The WSIP would have essentially no effect on monthly storage or water levels in Lake Eleanor compared to the existing condition. The only change in modeled chronological storage using hydrology from the period 1920 to 2002 occurs during the last year of the 1987–1992 drought. Under 2002 conditions with the WSIP, additional water would be transferred from Lake Eleanor to supplement storage in Lake Lloyd. Such a transfer would occur very infrequently. The WSIP would not alter water levels in Lake Eleanor such that they would be substantially outside the range experienced under the existing condition.

Flow in Eleanor Creek below Eleanor Dam

Releases from Lake Eleanor with the WSIP and under the existing condition would be the same and would be at least equal to the fishery release schedule. Thus, the WSIP would have no effect on flow in Eleanor Creek.

Impact Conclusions

The WSIP would not alter releases to Eleanor Creek. Adverse impacts on flow in Eleanor Creek would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.1-4: Effects on flow along the Tuolumne River below La Grange Dam.

Reservoir Operations

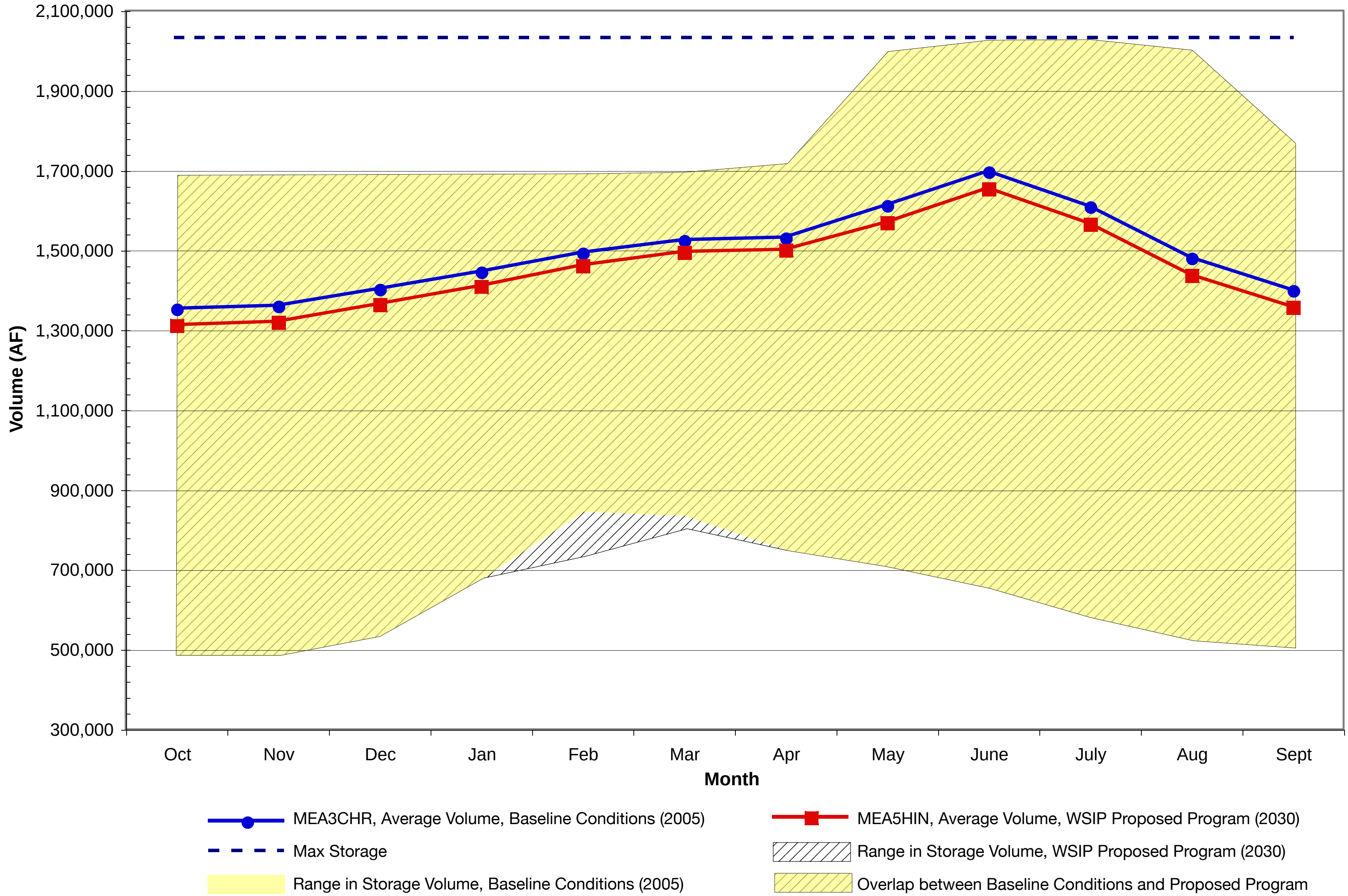
Don Pedro Reservoir, operated by TID, stores water from the upper Tuolumne River. Under typical conditions, the reservoir begins to fill with rainfall runoff from lower elevations in November and continues to fill through the winter and spring with a combination of rainfall runoff and snowmelt from higher elevations. The reservoir is drawn down from June through October to meet demand for irrigation supply in the TID and MID service areas.

Don Pedro Reservoir is a multipurpose facility that provides water supply and flood control benefits as well as recreational opportunities. To provide a prescribed level of downstream flood protection, storage space must be kept available in Don Pedro Reservoir to store floods that might occur. The space maintained in the reservoir for floodwater is referred to as the “flood control reservation.” It increases from zero on September 8 to 340,000 acre-feet on October 7. The reservation is maintained at 340,000 acre-feet until April 27, after which it declines to zero again by June 3.

The WSIP would not change TID’s operational goals for Don Pedro Reservoir or the flood control reservation requirements, but it would affect water levels in the reservoir and the magnitude and timing of releases to the Tuolumne River.

Water Storage and Water Levels in Don Pedro Reservoir

The WSIP would reduce average monthly storage in Don Pedro Reservoir year-round compared to the existing condition. **Figure 5.3.1-11** shows the average monthly storage and the range of monthly storage in the reservoir with the WSIP and under the existing condition. The



SOURCE: SFPUC, HH/LSM (see Appendix H)

Figure 5.3.1-11
Average Monthly Storage Volume,
Don Pedro Reservoir

decrease in stored volume is primarily attributable to increased water demand in the service areas of the SFPUC and its customers. As demand increases, so do diversions of water at Hetch Hetchy Reservoir for delivery to the Bay Area. As a result, less water flows down the Tuolumne River to Don Pedro Reservoir. Because of the decrease in stored volume in Don Pedro Reservoir with the WSIP, monthly average water levels would fall by 1 to 10 feet compared to the existing condition.

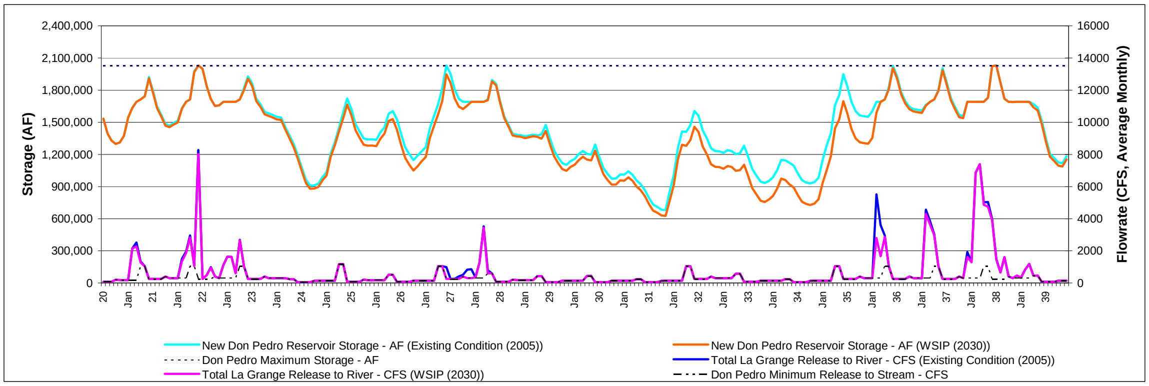
Figure 5.3.1-12 shows modeled chronological storage in Don Pedro Reservoir and releases to the Tuolumne River at La Grange Dam using hydrology from the period 1920 to 2002. The figure compares the WSIP to the existing condition. It shows that, under the existing condition, TID and MID fills Don Pedro Reservoir in the winter and draws from storage to meet agricultural water demand in the summer and early fall. Because the storage capacity of Don Pedro Reservoir is greater than the average volume of runoff produced in its watershed, TID and MID is unable to fill the reservoir completely every year. Currently, TID and MID is able to fill to its allowable October to April maximum storage capacity about 51 percent of the time and to its maximum physical capacity about 27 percent of the time. In the future with the WSIP, these values would be reduced to 48 percent and 21 percent.

The reductions in stored volume and lowering of water levels attributable to the WSIP would be greatest in critically dry years, particularly following a sequence of dry years. In average critically dry years, Don Pedro Reservoir would be drawn down 10 feet more in September than under the existing condition. The WSIP would lower water levels in Don Pedro Reservoir in some months during severe droughts by up to 27 feet compared to the existing condition.

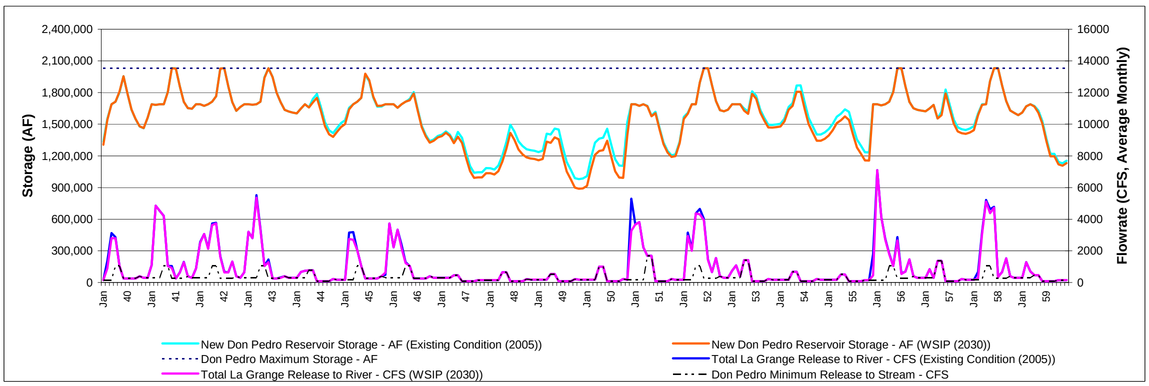
The WSIP would not alter water levels in Don Pedro Reservoir such that they would be substantially outside the range experienced under the existing condition. Almost all of the time, storage in Don Pedro Reservoir fluctuates between its maximum capacity of 2,080,000 acre-feet, which corresponds with a water level of 834 feet above mean sea level, and 900,000 acre-feet, which corresponds with a water level of 714 feet. Thus, under the existing condition and almost all of the time, the water level fluctuates between 834 feet and 714 feet, a range of 120 feet. With the WSIP, the water level in Don Pedro Reservoir would fluctuate within the same range almost all of the time.

Occasionally, in extended droughts, storage in Don Pedro Reservoir would be drawn down severely. Under the existing condition, the water level in the reservoir would be drawn down to 643 feet, or 191 feet below the maximum, once in the 82-year hydrologic record. With the WSIP, the water level would be drawn down to essentially the same level once in the 82-year hydrologic record, but it would never be drawn down below that level. Thus, water levels with the WSIP would remain substantially within the same range as occurs under the existing condition.

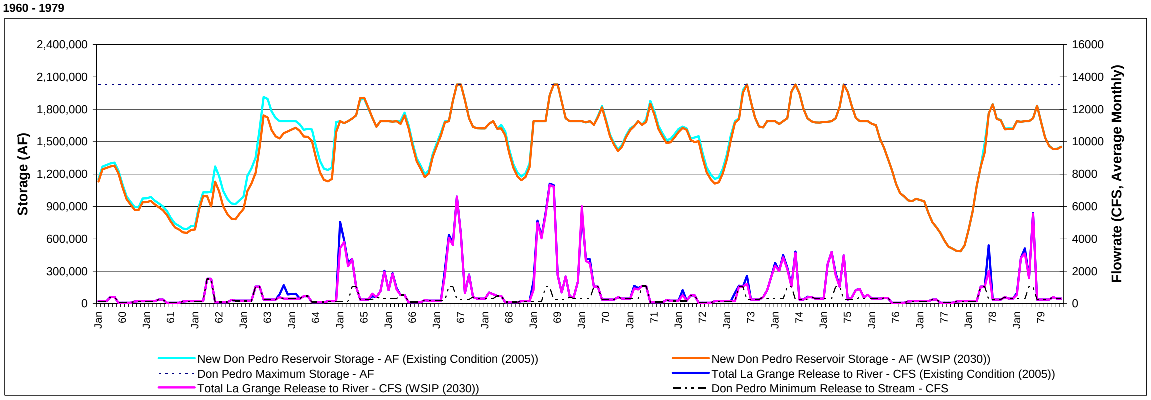
1920 - 1939



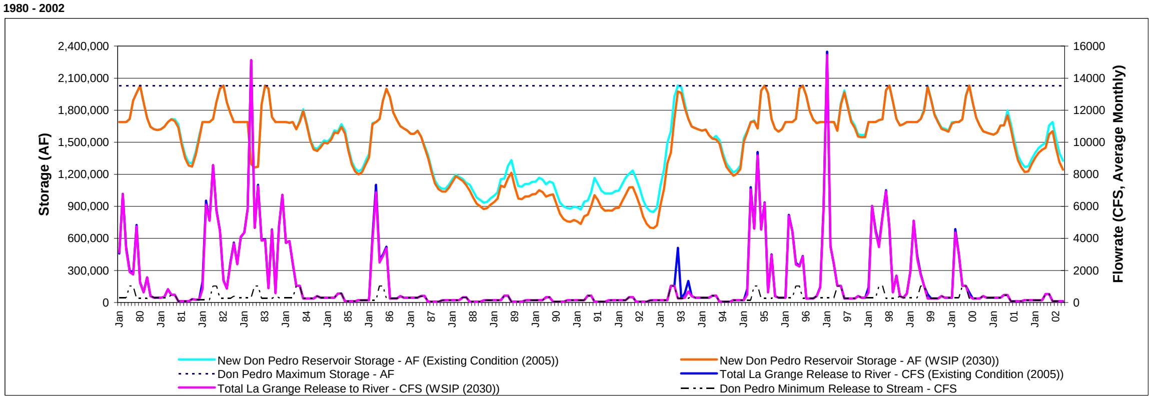
1940 - 1959



1960 - 1979



1980 - 2002



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SOURCE: SFPUC, HH/LSM (see Appendix H).

Figure 5.3.1-12
Don Pedro Storage and La Grange Releases to the Tuolumne River

Flow in the Tuolumne River below La Grange Dam

Figure 5.3.1-12 shows the frequency and magnitude of modeled chronological releases from La Grange to the Tuolumne River under the existing condition and with the WSIP. Under the existing condition, releases to the Tuolumne River are at least equal to the fishery release schedule shown in Table 5.3.1-3. In most below-normal or drier years, almost all the winter and spring runoff from the watershed upstream of Don Pedro is captured in the reservoir. In years when the reservoir fills, usually wet or above-normal years, excess water is released to the Tuolumne River.

In the future with the WSIP, MID and TID would draw Don Pedro Reservoir down farther in many years than it would under the existing condition as shown in Figure 5.3.1-12. Consequently, MID and TID would have to capture a greater proportion of spring runoff to refill the reservoir with the WSIP. As a result, the volume of water released to the Tuolumne River would be reduced compared to the existing condition but would be at least equal to the required releases to support fisheries shown in Table 5.3.1-3.

Average monthly flows in the Tuolumne River immediately below La Grange Dam in different hydrologic year types for the existing condition and with the WSIP are shown in **Table 5.3.1-6**. The percentage change in average monthly flow attributable to the WSIP is also shown in the table. The WSIP would have little or no effect on average monthly flow in most summer, fall, and winter months in all hydrologic year types. The WSIP would have no effect on average monthly flow in any months of critically dry years or in most summer months of dry, below-normal, and above-normal years. Only the required fishery release would be made in these months under the existing condition and with the WSIP. With the WSIP, the number of months in which only the required fishery release would be made would increase slightly. Under the existing condition, the model indicates that the minimum release would be made 72.9 percent of the time (717 months in the 984-month hydrologic record); with the WSIP the minimum release would be made 74.6 percent of the time (734 months in the 984-month hydrologic record).

The WSIP would typically result in reductions of less than 10 percent in average monthly flow in the Tuolumne River below La Grange Dam in the November through June period when TID fills Don Pedro Reservoir, although reductions in average monthly flow could be as high as 25 percent. Reductions in flow would occur in some months of all year types, except for critically dry years. For example, in June of an average above-normal year, flow in the Tuolumne River below La Grange Dam would be 408 cfs under the existing condition; with the WSIP it would be 306 cfs, a reduction of 25 percent.

The absolute and percentage changes in flow in the Tuolumne River below La Grange Dam in individual months of wet, above-normal, below-normal, and dry years in the 82-year hydrologic simulation attributable to the WSIP vary widely. The chronological analysis shows that the maximum percentage reduction in average monthly flow attributable to the WSIP would be about 92 percent, occurring in one month in the 82-year hydrologic simulation. In that month, June 1993, the flow below La Grange Dam under the existing condition would be 3,409 cfs; with the WSIP it would be 250 cfs. Reductions in average monthly flow of 30 percent or more would occur in some months of 17 springs in the 82-year simulation, or about once in every four springs on average.

TABLE 5.3.1-6
ESTIMATED AVERAGE MONTHLY FLOWS FOR THE TUOLUMNE RIVER BELOW LA GRANGE DAM UNDER VARIOUS CONDITIONS
(cubic feet per second)

	Wet		Above Normal		Below Normal		Dry		Critical Dry		All	
Existing Condition (2005)												
Oct	431		298		294		351		236		333	
Nov	374		507		314		324		195		350	
Dec	857		1,230		422		292		204		654	
Jan	2,161		1,257		318		285		189		1,022	
Feb	3,493		2,381		647		478		188		1,723	
Mar	4,096		1,969		654		421		189		1,806	
Apr	3,424		1,568		958		497		344		1,613	
May	3,161		1,348		943		497		344		1,489	
June	3,633		408		75		73		50		1,180	
July	1,300		240		75		73		50		463	
Aug	516		240		75		73		50		233	
Sept	1,299		249		75		73		50		464	
Future with WSIP (2030)												
Oct	429		292		284		337		236		327	
Nov	371		515		270		260		195		334	
Dec	790		1,111		370		272		204		599	
Jan	2,023		1,272		318		262		189		981	
Feb	3,400		2,152		630		432		188		1,638	
Mar	3,990		1,708		630		421		189		1,718	
Apr	3,350		1,539		943		497		344		1,584	
May	3,081		1,346		943		497		344		1,465	
June	3,369		306		75		73		50		1,082	
July	1,282		240		75		73		50		457	
Aug	503		240		75		73		50		229	
Sept	1,263		240		75		73		50		452	
Difference and Percent Change, Existing Condition (2005) vs WSIP (2030)												
Oct	-2	[0%]	-6	-[2%]	-9	-[3%]	-14	-[4%]	0	[0%]	-5	-[2%]
Nov	-3	-[1%]	8	[2%]	-44	-[14%]	-64	-[20%]	0	[0%]	-16	-[4%]
Dec	-67	-[8%]	-119	-[10%]	-52	-[12%]	-20	-[7%]	0	[0%]	-55	-[8%]
Jan	-138	-[6%]	14	[1%]	0	[0%]	-23	-[8%]	0	[0%]	-41	-[4%]
Feb	-93	-[3%]	-229	-[10%]	-16	-[3%]	-47	-[10%]	0	[0%]	-85	-[5%]
Mar	-107	-[3%]	-261	-[13%]	-24	-[4%]	0	[0%]	0	[0%]	-89	-[5%]
Apr	-74	-[2%]	-28	-[2%]	-15	-[2%]	0	[0%]	0	[0%]	-30	-[2%]
May	-81	-[3%]	-2	[0%]	0	[0%]	0	[0%]	0	[0%]	-24	-[2%]
June	-264	-[7%]	-102	-[25%]	0	[0%]	0	[0%]	0	[0%]	-98	-[8%]
July	-19	-[1%]	0	[0%]	0	[0%]	0	[0%]	0	[0%]	-5	-[1%]
Aug	-13	-[2%]	-1	[0%]	0	[0%]	0	[0%]	0	[0%]	-4	-[2%]
Sept	-36	-[3%]	-9	-[4%]	0	[0%]	0	[0%]	0	[0%]	-12	-[3%]

Key
- > 0%
- < 0 to -5%
- < -5%

SOURCE: SFPUC, HH/LSM (see Appendix H).

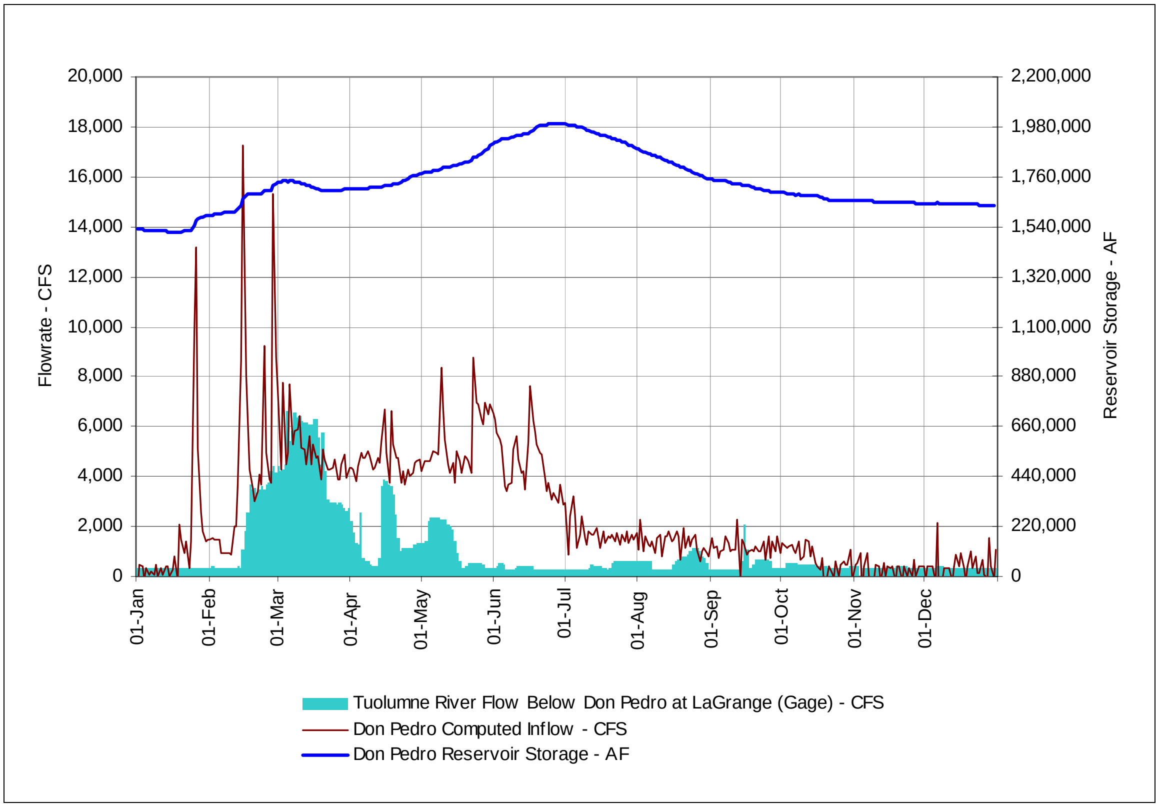
The results presented above are described in terms of average monthly flows because the HH/LSM is a monthly time-step model. TID's actual operational decisions may occur in smaller time steps, perhaps daily or weekly, depending on meteorological and operational circumstances. These within-month operational changes cannot be simulated with the HH/LSM, nor can the model be used to estimate the effects of the WSIP on peak flows in the river, because the peaks may only last for a few hours or days.

Insight into the effects of the WSIP on peak flows below La Grange Dam can be obtained by examining operational data. **Figure 5.3.1-13** shows actual data for 2000, an above-normal year; the greatest effects on peak flows would occur in wet and above-normal years. The figure shows storage in Don Pedro Reservoir falling slightly in the first half of January and then increasing to a maximum of about 2 million acre-feet at the end of June, as first rainfall runoff and then snowmelt enters the reservoir. Through January and the first half of February, TID added to storage in the reservoir and released only the minimum required to the Tuolumne River below La Grange Dam. In mid-February, faced with increasing quantities of rainfall runoff, the operators began to release water to the Tuolumne River in excess of the minimum required in order to maintain the required flood control storage reservation. Releases in excess of the minimum continued though March, April, and the first half of May. Beginning in April, the required flood control reservation decreased, enabling TID to add more water to storage. In mid-May, the operators reduced releases to the river, which remained at or close to the minimum for the remainder of the year. Measured flow in the Tuolumne River below La Grange Dam shows a number of step increases and decreases in flow from mid-February to mid-May lasting several days, as operators sought to balance reservoir inflow, gains in storage, and releases to the river in response to changing conditions.

If the WSIP had been in place in 1999, and water demand was at 2030 levels, storage during December in Don Pedro Reservoir (its seasonal low point) would have been about 1,600,000 acre-feet, similar to but less than under the existing condition. Needing to capture a slightly higher proportion of runoff with the WSIP than under the existing condition, operators would likely delay releases of water to the lower Tuolumne River in excess of minimum requirements by a few days. After the initial delay, the releases to the river with the WSIP would follow the same pattern as under the existing condition and would be of a similar magnitude.

The pattern and magnitude of releases from La Grange Dam to the Tuolumne River with the WSIP in any particular year would depend on meteorological and operational circumstances, as they do under the existing condition. Under the existing condition, there would be no releases from the dam to the river in excess of the minimum required release in 31 years of the 82-year hydrologic record. With the WSIP, there would be no releases above the minimum required in 33 years of the hydrologic record. In years when a release above the minimum required is made, the WSIP would delay the release of water and reduce the total volume of releases to the river in the winter and spring compared to the existing condition.

Releases from Don Pedro Reservoir and La Grange Dam follow a different pattern than releases from Hetchy Hetchy Reservoir. Hetch Hetchy Reservoir typically receives most of its water from



SOURCE: SFPUC, HH/LSM (see Appendix H).

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Figure 5.3.1-13
Don Pedro Reservoir Storage and Inflow, Calendar Year 2000

snowmelt between early May and late July. Don Pedro Reservoir receives runoff over a longer period from both winter rainstorms and snowmelt. Furthermore, unlike Hetch Hetchy Reservoir, Don Pedro Reservoir is used to reduce downstream flooding. As a consequence, management of Don Pedro Reservoir is complex, and releases from the reservoir often occur in a series of pulses rather than in single episode as typically occurs at Hetch Hetchy Reservoir. In years when several pulse releases above the minimum required are made, the WSIP might eliminate one or more of the pulse releases and would delay others by several days or weeks.

After an unusual series of dry years, when Don Pedro Reservoir is drawn down substantially farther with the WSIP than under the existing condition, winter and spring releases above the minimum required would occasionally be eliminated or almost eliminated. This circumstance is illustrated by the sequence of hydrologic conditions that occurred between 1986 and 1993. Although the WSIP would commonly reduce winter and spring flow in the river below La Grange Dam, it would not affect very infrequent large peak flows produced primarily by rainstorms.

Impact Conclusions

The WSIP would not alter stream flow in the Tuolumne River below La Grange Dam such that it would be substantially outside the range experienced under the existing condition, nor would the flow alterations result in adverse hydrologic effects or be sufficient to change the character of the river. Large, infrequent peak flows under the existing condition and with the WSIP would be similar in magnitude. Minimum flows are the subject of an agreement with the FERC and would the same with the WSIP as under the existing condition.

Overall, the effects of the WSIP on flow along the Tuolumne River below La Grange Dam would be *less than significant*, and no mitigation measures would be required.

[Additional discussion on impacts on flow in the lower Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

Impact 5.3.1-5: Effects on flow along the San Joaquin River and the Sacramento–San Joaquin Delta.

The Tuolumne River joins the San Joaquin River about 50 miles downstream of La Grange Dam. The reductions in flow in the Tuolumne River below La Grange Dam attributable to the WSIP are shown in Table 5.3.1-6. The WSIP would reduce flows in the Tuolumne River between La Grange Dam and its confluence with the San Joaquin River, and in the San Joaquin River from the confluence to the Delta. Most of the reductions in flow would occur from January through June in wet or above-normal years, when flow in the San Joaquin River is at its seasonal maximum. The greatest reductions would occur in years following extended droughts when storage in Don Pedro Reservoir is being replenished. For example, under hydrologic conditions that prevailed in February 1936, average monthly flow in the San Joaquin River between the Tuolumne and Stanislaus River confluences would be reduced from about 10,000 cfs to 7,500 cfs under the WSIP compared to existing conditions. Similarly, under June 1993 conditions, average monthly flows would be reduced from about 7,000 cfs to 3,500 cfs. Flow reductions of these magnitudes would be rare events occurring four or five times in the 82-year period of hydrologic record.

The SWRCB has established flow objectives for the San Joaquin River at Vernalis, just upstream of the Sacramento–San Joaquin Delta. Almost all of the time, the reductions in San Joaquin River flow attributable to the WSIP would not be sufficient to cause flow in the river at Vernalis to fall below the objective. Very infrequently, following protracted droughts, reductions in San Joaquin River flow attributable to the WSIP would be sufficient to cause flow in the river at Vernalis to fall below the objective. Under these circumstances, the USBR, the agency responsible for compliance with objectives for the San Joaquin River, would be expected to increase releases from New Melones Reservoir on the Stanislaus River to meet the flow objectives at Vernalis. Thus, the WSIP would not alter flow in the San Joaquin River below its confluence with the Tuolumne River such that it would be substantially outside the range experienced under existing conditions nor result in a violation of flow objectives.

The reductions in flow in the Tuolumne River below La Grange Dam attributable to the WSIP would also reduce inflow to the Sacramento–San Joaquin Delta. The SWRCB has established objectives for Delta outflow as measured at Chipps Island, just upstream of Suisun Bay. Almost all of the time, the reductions in Delta inflow attributable to the WSIP would not be sufficient to cause Delta outflow to fall below the objective. Very infrequently, following protracted droughts, reductions in Delta inflow attributable to the WSIP would be sufficient to cause Delta outflow to fall below the objective. Under these circumstances, the USBR and DWR, the respective operators of the Central Valley Project and State Water Project, would be expected to decrease their diversions so that the Delta outflow objectives were met. Thus, the WSIP would not alter flow in the Sacramento–San Joaquin Delta such that it would be substantially outside the range experienced under the existing condition.

Overall, the effects of the WSIP on flow along San Joaquin River and in the Delta would be *less than significant*, and no mitigation measures would be required. Additional information on the effects of the WSIP on flows in the San Joaquin River and the Delta is provided in Section 5.3.4.

[Additional discussion on effects of WSIP on the San Joaquin River and Delta was prepared in response to comments on the Draft PEIR. Please refer to Section 14.8, Master Response on Delta and San Joaquin River Issues (Vol. 7, Chapter 14).]

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5.3.2 Geomorphology

Channel morphology, or river form, reflects the interactions among watershed geology, flow, the supply of sediment and large woody debris, tectonic uplift and subsidence, and glacial advances and retreats. River channels are in a state of dynamic equilibrium with their watersheds. Although they may change each year, particularly in response to high flows, their characteristics remain stable in the medium term, provided conditions in the watershed also remain stable. When conditions in a watershed change, the dynamic equilibrium is disturbed, and river form will adjust to the new watershed condition (Knighton, 1984).

Over the last century, flow in the Tuolumne River between Hetch Hetchy Reservoir and Don Pedro Reservoir and below La Grange Dam has been progressively reduced by dam operations and the diversion of water for hydropower generation, flood control, and municipal and agricultural water supply. The WSIP would cause further changes in river flow over the next 25 years, as described in Section 5.3.1. Thus, WSIP-induced changes in river flow have the potential to further affect river channel characteristics.

5.3.2.1 Setting

The Tuolumne River drains a 1,960-square-mile watershed on the western slope of the Sierra Nevada range and is the largest of three major tributaries to the San Joaquin River. The river originates in Yosemite National Park and flows southwest to its confluence with the San Joaquin River, approximately 10 miles west of the city of Modesto. Deep canyons, granite river channels, and forested, mountainous terrain characterize the watershed between its crest and La Grange Dam. Near the town of La Grange, the river exits the Sierra Nevada foothills and flows through a gently sloping alluvial valley that is incised into Pleistocene alluvial fans.

Upper Tuolumne River and Tributaries

Upstream of Don Pedro Reservoir, the Tuolumne River and its tributaries flow through steep narrow valleys that confine the river channel. In most of this reach, the river channel is steep and alternates between bedrock chutes,[1] boulder cascades, and pools. Except in the Poopenaut Valley (a 2.5-mile reach below O’Shaughnessy Dam) and downstream of the Clavey River confluence, alluvial deposits are limited to small or medium-sized patches associated with flow obstructions (such as boulders and bedrock outcrops). For the first 2.5 miles below O’Shaughnessy Dam, the Tuolumne River flows through a U-shaped glaciated valley. The river channel is V-shaped and sinuous in the approximately 10 miles of river from the Poopenaut Valley to Early Intake. While the average channel gradient in this reach of the river is steep (averaging 2 percent), subreach-scale variation in channel gradient and valley confinement provides very diverse channel morphology. Channel morphology in this reach ranges from the low-gradient, sand-bedded channel and broad wetland meadow of the Poopenaut Valley to the steep, bedrock-confined channel found in most of the rest of the Tuolumne River (McBain & Trush and RMC, 2006).

1 A chute in this context is an inclined trough or channel feature such as a waterfall or rapid.

From Early Intake, the river flows about 10 miles to its confluence with the South Fork of the Tuolumne River. The river is confined in a deeply incised, V-shaped canyon with steep, competent side slopes. Channel gradient in this reach also averages about 2 percent, but is as steep as 4 percent in one section. For most of its length, the channel consists of a series of pools separated by steep cascades over boulders. Alluvial bars and side-channels are present throughout the reach where the valley widens or where bedrock constraints reduce channel gradient.

From the South Fork confluence to the upper end of Don Pedro Reservoir, the average channel gradient decreases to less than 1 percent. In the upper section of this reach, from the confluence with the South Fork to the confluence with the Clavey River, the river channel consists of boulder cascades separated by medium-length pools. Downstream of the Clavey River confluence, the channel gradient decreases, and the channel becomes semi-alluvial. Large boulder bars are common.

Cherry Creek is a tributary to the Tuolumne River. From Cherry Dam, Cherry Creek flows about 12 miles to its confluence with the Tuolumne River (1.3 miles downstream of Early Intake). For most of this length, Cherry Creek is confined within a narrow bedrock canyon, and channel gradient is steep (5 percent). The bed consists primarily of boulders and bedrock, although a large volume of sand is stored in pools. Immediately downstream of the dam, however, the channel alternates between low-gradient, gravel-bedded reaches separated by steep, bedrock chutes. In the gravel-bedded reaches of the upper five-mile reach between the dam and the confluence with Eleanor Creek, riparian and upland vegetation has encroached onto formerly active alluvial bars since completion of Cherry Dam.

Eleanor Creek flows into Cherry Creek seven miles upstream of the Tuolumne River and extends 3.5 miles from Eleanor Dam to Cherry Creek. For most of its length, Eleanor Creek flows through a steep bedrock canyon, and the channel is a series of pools and falls. The average channel gradient is 6 percent.

A common perception is that bedrock channel morphology is static compared to alluvial channels and therefore relatively insensitive to flow and sediment supply changes (e.g., Montgomery and Buffington, 1997). Bedrock channels, however, are often highly dynamic depositional environments; though principally erosional, they also exhibit abundant depositional features. Large, geomorphically derived hydraulic controls, such as width constrictions or expansions and resistant bedrock outcrops, remain stable over decades or centuries and define an overall limit for coarse sediment deposition in each segment of the bedrock channel. These geomorphic controls induce coarse depositional features that in turn perform as smaller hydraulic controls to induce finer and more transitory secondary depositional features. The occurrence of smaller hydraulic controls within larger hydraulic controls gives rise to a complex, nested depositional channel morphology that provides diverse aquatic and riparian habitats (McBain and Trush, 2004).

Short channel segments where channel gradient decreases and/or valley width increases may support unique and/or more diverse aquatic and riparian communities. These atypical channel segments exhibit prominent depositional features, such as alluvial bars, side channels, and limited floodplains. While these alluvial subreaches and patches constitute a small portion of the channel in this reach, they provide important establishment sites for riparian vegetation, habitat for aquatic flora and fauna and native amphibians, and low-velocity rearing habitat for juvenile fish.

Sediment is supplied to bedrock rivers primarily through “mass wasting.” Hill-slope mass wasting, such as rock falls and bedrock shearing from canyon walls, episodically delivers coarse sediment of sufficient volume and/or caliber to create large depositional features in the channel or to function as large-scale hydraulic controls capable of generating other prominent depositional features. Bedrock rivers have a huge potential transport capacity for coarse sediment, but a small storage capacity for coarse and fine sediment. Hydraulic complexity and channel form, expressed as nested hydraulic controls in a variable flow regime, exert the greatest control on storage capacity. The annual coarse bedload[2] transported may fluctuate dramatically without significantly affecting the volume of coarse sediment stored in a channel segment. Although storage capacity is low, the ecological implications for maintaining these limited depositional features can be great.

In bedrock rivers, diverse erosional and depositional features are created and maintained by a broad range of floods. For example, sand patches are scoured and deposited during small floods, while boulder ribs are mobilized only during very large, infrequent floods. Flow thresholds that mobilize depositional features in bedrock rivers are not well understood. Recent, though limited, observations of the Clavey River (a tributary to the Tuolumne River) suggest that:

- Common small floods that occur every one to three years scour and deposit sand at pools and bars
- Moderate-sized floods that occur every 12 to 17 years move gravel and cobbles, reshape side channels, and may move large woody debris
- Very large floods that occur every 70 to 100 years erode large bars, remove and create side channels, and move large boulders over short distances

Tuolumne River from La Grange Dam to the San Joaquin River

Near the town of La Grange, the Tuolumne River exits the Sierra Nevada foothills and flows through a gently sloping alluvial valley incised into Pleistocene alluvial fans. The valley walls confine the river corridor to as narrow as 500 feet near Waterford, about 20 miles downstream of La Grange, whereas the river reaches downstream of Modesto are virtually unconfined. In some locations, bedrock outcrops control the gradient of the river; in others, the bedrock is up to 50 feet below the riverbed.

Within the alluvial valley, the river can be divided into two geomorphic units defined by channel slope and bed composition: the gravel-bedded reach, which extends about 28 miles from La Grange Dam to below Geer Road, and the sand-bedded reach, which extends about 24 miles from below Geer Road to the confluence with the San Joaquin River. The gravel-bedded reach has moderate slopes (0.03–0.15 percent), and extensive alteration of the channel and floodplain

[2] Refers to the amount of cobbles, gravel, and sand transported along the stream bottom (as opposed to suspended in the stream flow).

has occurred as a result of past gold dredging operations and past and current aggregate mining. Channel gradient decreases to less than 0.03 percent in the sand-bedded reach, and the channel is characterized by a meandering, alternate bar morphology. Under current conditions, coarse sediment sources are limited to tributaries downstream of La Grange Dam and to bed and bank erosion, so little coarse sediment enters the lower river. Most of the sediment that is currently contributed to the channel downstream of the dam consists of sand and finer-sized particles. While dams have eliminated upstream sediment supply, gold dredging and aggregate mining have removed sediment stored in the river channel and floodplain. Since sediment supply to the lower river has been cut off by upstream dams, the river cannot recover from past in-channel dredging and mining.

Operation of Don Pedro Reservoir has reduced the magnitude of peak flow in the lower river, and the reduction in peak flows has altered channel characteristics below La Grange Dam. Flood releases from the reservoir are dictated by three factors:

- Maximum releases through the dam outlet works (14,000 cfs)
- U.S. Army Corps of Engineers flood control rules, which limit flows to 9,000 cfs, as measured at the Modesto gauge (which includes inflows from Dry Creek)
- Maximum release capacity through the powerhouse turbines (5,500 cfs)

A number of agencies and nonprofit groups, including the SFPUC, TID, MID, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (CDFG), Friends of the Tuolumne, and the Tuolumne River Preservation Trust, are cooperating in efforts to restore the lower Tuolumne River corridor. In 2000, the Tuolumne River Technical Advisory Committee completed the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain & Trush, 2000). The goal of the plan is to improve the river's value as fish and wildlife habitat. The plan recommends several measures to improve ecological function in the lower river, including increased frequency and magnitude of high flows, channel reconstruction, and coarse and fine sediment management. Recommended increases in flood flows, which would be achieved through revisions to operating criteria during flood control release periods, would increase the magnitude of bankfull[3] flows to more effectively move sediment. Of the 14 channel restoration projects identified in the plan, two have been constructed, two will be constructed in 2007, and three have complete designs and are in various stages of funding and implementation planning. Peak flows below La Grange Dam are usually in the range of 5,000 to 5,500 cfs as a result of reservoir releases for power generation purposes. Consequently, all of these restoration projects are designed to function based on a bankfull flow and two-year flood of 5,000 cfs (McBain *et al*., 2004).

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3 A bankfull channel conveys commonly occurring flows, with larger flows spilling over the banks and onto the floodplain.

5.3.2.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to geomorphology, but generally considers that implementation of the proposed program would have a significant impact if it were to:

- Substantially change the topography such that ecological, hydrologic or aesthetic functions are adversely affected, or substantially change any unique geologic or physical features of the site or area
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of the stream or river, in a manner that would result in substantial erosion or siltation or adversely affect the ecological, hydrologic or aesthetic functions of the site or area

Although the "substantial change in topography" criterion is typically applied to upland areas, it is considered applicable to stream channel/bank topography in this instance because of the sensitivity of the resources that depend on the topography of those features (i.e., riparian vegetation and fisheries).

Approach to Analysis

This impact section presents a discussion of the potential changes in sediment transport and geomorphology that could result from WSIP-related changes in stream flow, reservoir storage, and reservoir water levels, as described in Section 5.3.1. A qualitative assessment of potential effects was conducted based on generalized channel bed/bank characteristics and a consideration of the program-induced changes in stream flow. No modeling or field measurements have been performed to estimate program-generated changes in sediment transport in the Tuolumne River system.

As indicated in Section 5.3.1, the WSIP would have no effect on flow in Cherry Creek or Eleanor Creek. Consequently, the impact analysis focuses on the Tuolumne River between Hetch Hetchy Reservoir and the confluence with the San Joaquin River, a reach of the river that would be affected by WSIP-induced changes in stream flow.

Impact Summary

Table 5.3.2-1 presents a summary of the impacts on sediment transport and geomorphology in the Tuolumne River system and downstream water bodies that could result from implementation of the proposed water supply and system operations.

**TABLE 5.3.2-1
SUMMARY OF IMPACTS –
GEOMORPHOLOGY OF THE TUOLUMNE RIVER SYSTEM AND DOWNSTREAM WATERBODIES**

Impact	Significance Determination
Impact 5.3.2-1: Effects on sediment transport and channel characteristics between O'Shaughnessy Dam and Don Pedro Reservoir	LS
Impact 5.3.2-2: Effects on sediment transport and channel characteristics below La Grange Dam	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.2-1: Effects on sediment transport and channel characteristics between O'Shaughnessy Dam and Don Pedro Reservoir.

Sediment transport and channel characteristics are primarily influenced by peak flows rather than by smaller common flows. As noted above, studies of the Clavey River indicate that peak flows that occur every one to three years produce enough energy to move sand; peak flows that occur every 12 to 17 years produce enough energy move gravel and cobbles; and peak flows that occur every 70 to 100 years produce enough energy to move boulders. Although the relationship between peak flows and the transport of sand, gravel, and boulders for the Clavey River cannot be directly applied to the main stem of the Tuolumne River, it provides an indication of the frequency of peak flows that mobilize depositional features in steep, mountain streams.

As discussed in Section 5.3.1 and illustrated in Figure 5.3.1-9, the WSIP would have little effect on the very large and infrequent floods in the Tuolumne River between O'Shaughnessy Dam and Don Pedro Reservoir that are capable of moving boulders and altering the characteristics of the bedrock channels. When the volume of runoff from the watershed above Hetch Hetchy Reservoir is great, the reservoir fills rapidly, after which all flow in excess of the capacity of the reservoir and Mountain Tunnel is released to the river. Under these conditions, the WSIP would extend the reservoir refill period and delay releases from the reservoir slightly (for a few days), after which releases to the river would follow the same pattern as they do under the existing condition. Because the WSIP would not affect the frequency or magnitude of large and infrequent floods, it would have a less-than-significant effect on the bedrock channel characteristics of the Tuolumne River below O'Shaughnessy Dam, and no mitigation measures would be required.

Flow in the Tuolumne River between O'Shaughnessy Dam and Early Intake consists predominantly of controlled releases from Hetch Hetchy Reservoir, except during large storms or snowmelt runoff. Under certain conditions (e.g., in normal hydrologic years that follow extended droughts), the WSIP could reduce the magnitude and duration of bankfull peak flows that are released from the reservoir every one to three years. As shown Figure 5.3.1-9, reductions in peak flows of this type occur infrequently in the 82-year hydrologic record. Thus, the WSIP could affect the rate and amount of sediment deposition and erosion in side channels and in the vicinity of the few streamside meadows that exist in this reach of the river. However, because the changes in peak flow would occur infrequently, they would not be expected to result in a substantial change in erosion or siltation rates. The impact would be *less than significant*, and mitigation measures would not be required.

[Additional discussion on impacts on geomorphology in the upper Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues Issues (Vol. 7, Chapter 14).]

Impact 5.3.2-2: Effects on sediment transport and channel characteristics below La Grange Dam.

As noted above, the bankfull peak flows that occur every one to three years are the primary channel-forming events in the reach of the Tuolumne River below La Grange Dam, although larger floods are also important. The WSIP would have little effect on very large and infrequent floods within the Tuolumne River below La Grange Dam, such as the flood that occurred in 1997, but could affect the magnitude of the bankfull peak flows.

The WSIP would increase the drawdown of Don Pedro Reservoir by a small amount each year and by a considerable amount in an extended drought. To refill the reservoir in the winter and spring, TID and MID would capture a larger proportion of runoff than it does under the existing condition. In some years, when runoff is great compared to the storage deficit, the WSIP might extend the reservoir refill period and delay releases from Don Pedro Reservoir by several days, after which releases from the reservoir would follow the same pattern as they do under the existing condition. Under these conditions, the WSIP would have little or no effect on channel geomorphology. Occasionally, refilling the reservoir would require most or all runoff in excess of the minimum required fish release, and flows below La Grange Dam would be substantially reduced compared to the existing condition. In these years, sediment transport in the river below La Grange Dam would be reduced. However, because WSIP-induced changes in peak flow would occur infrequently, they would not be expected to result in a substantial change in erosion rates, siltation rates, or channel form. The impact would be *less than significant*, and mitigation measures would not be required.

[Additional discussion on impacts on geomorphology in the lower Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

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5.3.3 Surface Water Quality

The following setting section describes surface water quality in streams and reservoirs in the Tuolumne watershed and downstream water bodies that could be affected by the WSIP. The impact section (Section 5.3.3.2) provides a description of the changes in water quality in streams and reservoirs that would result from WSIP-induced changes in stream flow and reservoir water levels.

5.3.3.1 Setting

The Tuolumne River flows from the crest of the Sierra Nevada westward to its confluence with the San Joaquin River. The San Joaquin River flows north to the Sacramento–San Joaquin Delta. Water from the Delta discharges to the San Francisco Bay Estuary and the Pacific Ocean. The Tuolumne River system and downstream water bodies are shown in Figure 5.1-1. Beneficial uses of the Tuolumne River, as designated in the *Water Quality Control Plan for the Sacramento and San Joaquin River Basins*, include the following:

- Source to (New) Don Pedro Reservoir: Municipal and Domestic Supply (MUN); Agricultural Supply (AGR); Hydropower Generation (POW); Water Contact Recreation (REC-1); Non-water Contact Recreation (REC-2); Warm Freshwater Habitat (WARM); Cold Freshwater Habitat (COLD); and Wildlife Habitat (WILD)
- New Don Pedro Reservoir: MUN (Potential); POW; REC-1; REC-2; WARM; COLD; and WILD
- New Don Pedro Dam to San Joaquin River: MUN (Potential); AGR; REC-1; REC-2; WARM; COLD; Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and/or Early Development (SPWN); and WILD

The WSIP would affect flow in the Tuolumne River, the San Joaquin River, and the Sacramento–San Joaquin Delta as well as water levels in Hetch Hetchy Reservoir and Don Pedro Reservoir, as described in Section 5.3.1. WSIP-induced changes in flow and water levels could affect water quality in these streams and reservoirs. The WSIP would have minor effects on flow in Eleanor and Cherry Creeks and on water levels in Lake Eleanor and Lake Lloyd, but the changes would be too small to affect water quality.

The water supply and system operations components of the WSIP would not involve the discharge of pollutants into water bodies and therefore would have a limited potential to affect water quality. WSIP-related changes in water quality, such as changes in water temperature or dissolved oxygen, would stem from changes in stream flow and changes in water levels in reservoirs. Accordingly, the water quality data presented in this section are limited to those water quality characteristics that could be altered by elements of the proposed program or that are needed to provide a general understanding of potentially affected water bodies.

Tuolumne River

Water quality in the upper Tuolumne River basin is excellent. The Tuolumne River drainage above Hetch Hetchy Reservoir lies entirely within the less developed parts of Yosemite National

Park. The combination of a high-altitude granitic drainage basin and minimal human influences results in river water that is cold, clear, and free of contaminants. Water quality in Hetch Hetchy Reservoir is also excellent. Plant nutrients such as nitrogen and phosphorus are typically near or below detection limits, and dissolved oxygen concentrations are typically at or near saturation. Total dissolved solids concentrations are less than 10 milligrams per liter (mg/L), and average total organic carbon concentrations are less than 2 mg/L. The SFPUC samples water quality at various depths in Hetch Hetchy Reservoir. As shown in **Table 5.3.3-1**, monthly water temperatures at a depth of 140 feet below the water surface for the period from 1997 to the present ranged between 6.5 and 13.8 degrees Celsius (°C). This depth, which is approximately the middle of the water column, is representative of water released to the Tuolumne River.

TABLE 5.3.3-1
SUMMARY OF TEMPERATURE DATA (°C), HETCH HETCHY RESERVOIR

Year	Flow Index[a]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	109.6	6.5	–	–	–	–	–	11.7	12.0	12.3	12.7	13.8	11.4
1998	119.7	8.0	7.1	6.6	6.7	7.1	–	10.6	12.0	12.2	12.7	12.8	–
1999	110.2	8.3	7.5	7.1	7.1	7.5	9.2	11.0	11.4	11.8	–	–	11.7
2000	107.4	9.8	8.9	7.6	7.7	8.5	9.8	11.2	11.6	12.0	12.4	12.3	11.1
2001	74.6	–	6.9	6.7	7.0	8.4	10.0	10.4	10.7	–	11.1	11.4	–
2002	93.4	8.2	6.5	6.5	7.3	8.0	–	10.8	11.1	11.5	11.7	–	11.7
2003	100.9	9.1	7.7	–	7.5	8.0	10.2	11.4	11.8	12.1	12.5	–	12.1
2004	89.7	9.1	–	7.1	7.4	8.9	10.6	11.1	11.4	11.7	11.9	12.1	9.6
2005	117.2	7.5	6.8	7.0	7.0	7.5	9.5	11.6	12.0	12.5	12.8	13.0	11.7
avg	–	8.3	7.3	6.9	7.2	8.0	9.9	11.1	11.6	12.0	12.2	12.6	11.3

[a] Flow Index is the year's total runoff as a percentage of the long-term average.

SOURCES: SFPUC (raw data); Merritt-Smith Consultants (data reduction).

Water quality in the reach of the Tuolumne River between Hetch Hetchy and Don Pedro Reservoirs is very good, but its dissolved mineral and plant nutrient content increases somewhat in a downstream direction. MID samples water from the outlet of Modesto Reservoir on the Modesto Canal. The samples are reasonably representative of water quality in the Tuolumne River at La Grange Dam. Total dissolved solids have been measured twice daily since 1997. These data show total dissolved solids concentrations that range from 15 to 26 mg/L, with an average of about 20 mg/L.

Below Don Pedro Reservoir, Tuolumne River water quality deteriorates somewhat as a result of agricultural irrigation return flow, urban and agricultural runoff, and recreation in and around the river and in Don Pedro Reservoir itself. In the warmer months, water temperature increases in a downstream direction as the river leaves the foothills of the Sierra Nevada and flows on to the floor of the San Joaquin Valley. Total dissolved solids content and turbidity also increase in a downstream direction.

Water temperature at several stations on the Tuolumne River downstream of La Grange Dam has been recorded for many years, but most intensively and reliably in the last decade in the course of a 2005 TID/MID study. La Grange Dam is located at river mile (RM) 52.2; that is, it is 52.2 miles upstream of the Tuolumne River's confluence with the San Joaquin River. Daily average water temperature at RM 51.8, about one-half mile below La Grange Dam, was usually in the range of 9 to 14 °C between 1996 and 2004. Daily average temperature at RM 36.7, about 15 miles below La Grange Dam, was usually in the range of 9 to 26 °C, and at RM 3.4, about 50 miles below La Grange Dam, was usually in the range of 9 to 29 °C. Daily average wintertime water temperature is similar for the entire river reach from La Grange Dam to the confluence with the San Joaquin River. The maximum temperatures experienced in the summer and fall from 1996 to 2004 at several locations are shown in **Table 5.3.3-2**. Seasonal variation at RM 43.4, about nine miles below La Grange Dam is shown in **Figure 5.3.3-1**.

TABLE 5.3.3-2
MAXIMUM SUMMER–FALL WATER TEMPERATURES IN THE TUOLUMNE RIVER FROM LA GRANGE DAM TO MODESTO[a]
1996–2004

Year	Water Year Type	Maximum Water Temperature (Summer–Fall) (°C rounded to nearest 0.5)				
		RM 49	RM 43.4	RM 36.7	RM 23.6	RM 3.4
1996	AN-W	18.5	**21**	**25**	NA	**29**
1997	AN-W	16	**20**	**23**	**26**	**28**
1998	W	14	16	17	**21**	**23**
1999	BN-AN	16	18	**23**	**27**	**29**
2000	BN-AN	NA	19	**23**	**27**	**28**
2001	D	**22**	**28**	**30**	**31**	NA
2002	D	**20**	**26**	**30**	**30**	**31**
2003	BN	16	19	**23**	**26**	**30**
2004	D	18	**24**	**27**	**30**	NA

[a] La Grange Dam is located approximately at RM 49 and Modesto at RM 3.4.

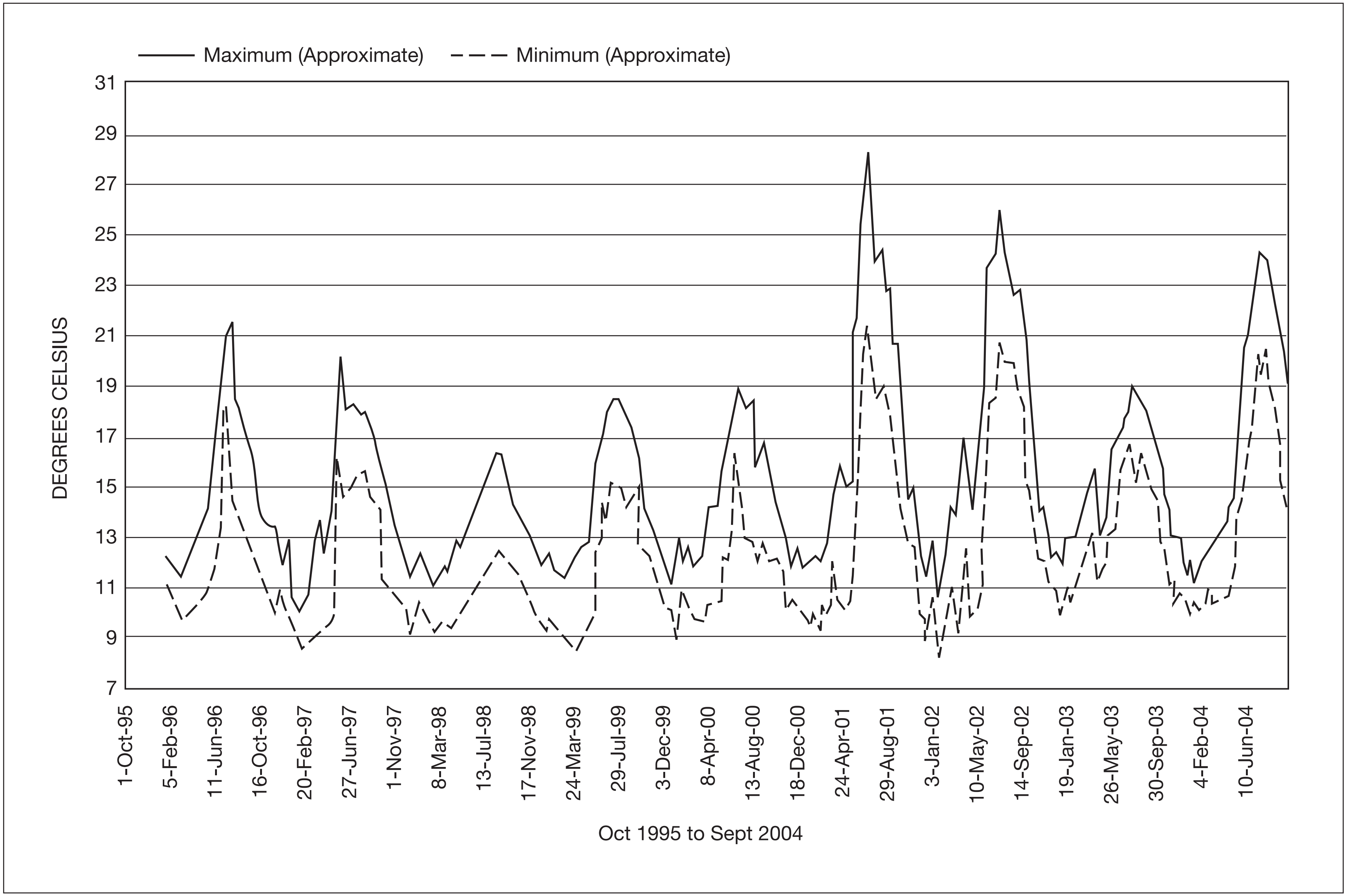
W = wet; AN = above normal; BN = below normal; D = dry; C = critically dry; RM = river mile
Temperatures ≥20 °C are shown in **bold** type.

The TID/MID study describes some general trends in water temperature:

- In all year types from 1996 to 2004, releases from Don Pedro Reservoir varied seasonally from a low of about 8 °C to a high of about 16 °C, with low temperatures occurring during the spring snowmelt and the highest temperatures occurring in late summer.
- In the reaches below Don Pedro Reservoir and La Grange Dam (RM 51.8 to RM 36.7), there is a clear relationship between hydrologic year type (and thus flow) and river temperatures during the summer and fall. This probably reflects the influence of surface-area-to-volume relationships. The effect becomes increasingly pronounced from upstream to downstream due to high summer temperatures in the San Joaquin Valley (Table 5.3.3-2). Even in wet years, peak summer temperatures in the reach downstream of RM 23.6 are above 20 °C. In all but the summer of 1998 following the extremely wet 1997/1998 floods, peak water temperatures exceed 20 °C up to RM 36.7.
- In downstream reaches of the river (RM 23.6 and below), the period of average daily temperatures in excess of 21 to 23 °C is frequently two to four months long.

The water temperature data from TID/MID(2005) are generally consistent with those reported in a 1996 FERC study. The FERC report notes that water temperature in the river is probably affected by the lack of riparian shade, and that leakage of water from diversion reservoirs and upwelling of groundwater probably provide some pockets of cool water in the summer.

Some water quality characteristics in the Tuolumne River are affected by reservoir operations and by changes in river flow attributable to water supply and hydropower generation activities. Primary among them is water temperature, which in turn may affect dissolved oxygen content. Water temperature in flowing streams depends on the water source, air temperature, flow, surface area, and exposure to solar radiation. Reductions in stream flow when air temperature is high usually



SOURCE: Turlock and Modesto Irrigation Districts

Figure 5.3.3-1
Tuolumne River Water Temperature at River Mile 43.4

result in increases in water temperature. Storage of water in reservoirs may increase or decrease water temperatures. Hetch Hetchy and Don Pedro Reservoirs fill with cool water in the winter and spring. During the summer, water near the surface is heated by solar radiation, but because the reservoirs are deep they retain a large volume of cool water nearer the bottom. The boundary between the warmer surface waters and cooler waters below is referred to as the thermocline. The portions of the reservoir above and below the thermocline are referred to respectively as the epilimnion and the hypolimnion. The thermocline is quite distinct in most deep reservoirs in the Sierra Nevada and is typically at a depth of 25 to 50 feet below the water surface. **Figure 5.3.3-2** shows typical August temperature profiles for Hetch Hetchy and Don Pedro Reservoirs in August. Typical summertime water temperatures in the epilimnion and hypolimnion at Hetch Hetchy Reservoir are 20 °C and 10 °C, respectively. Corresponding values for Don Pedro Reservoir are 27 °C and 12 °C.

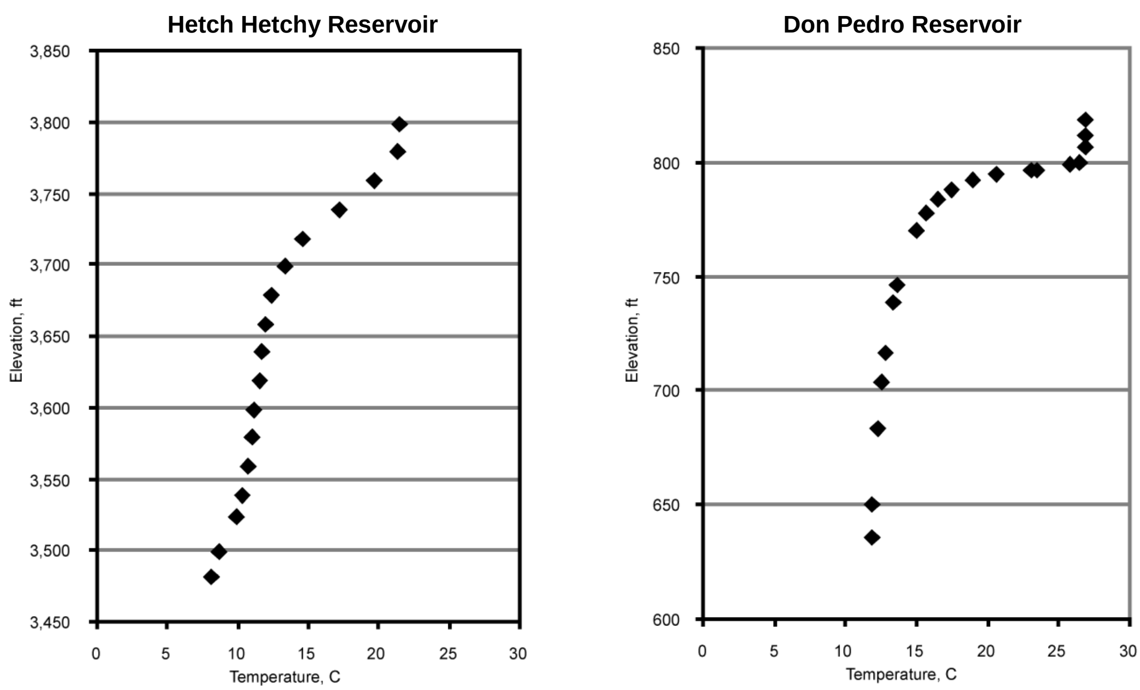


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Figure 5.3.3-2
Typical Summertime Water Temperature Gradient in Hetch Hetchy and Don Pedro Reservoirs

Water is typically released to streams from outlets near the bottom of reservoirs. If water is released from a reservoir in the summer from below the thermocline, it is typically cooler than stream water would be if the reservoir did not exist. When reservoirs are drawn down in the late summer and fall, the thermocline moves downward, closer to the reservoir outlet. Releases from reservoirs at such times may be a mixture of cool bottom water and warmer water from nearer the surface, with a consequent increase in water temperature in the stream below the reservoir.

San Joaquin River

Water quality in the San Joaquin River at Vernalis is shown in **Table 5.3.3-3**. Vernalis is located just upstream of the Sacramento–San Joaquin Delta and about 10 miles downstream of the San Joaquin River's confluence with the Tuolumne River. The total dissolved solids and total organic carbon concentrations in the San Joaquin River are high for natural waters and are considerably higher than for Tuolumne River water. The total dissolved solids concentration (a measure of dissolved minerals) averages 380 mg/L, and the total organic carbon concentration (a measure of dissolved and particulate organic matter) averages 3.6 mg/L. The total dissolved solids concentration in San Joaquin River water at Patterson, about 10 miles upstream from the San Joaquin River and Tuolumne River confluence, averages more than 600 mg/L. The improvement in San Joaquin River water quality between Patterson and Vernalis is attributable to mixing with higher quality water from the Tuolumne and Stanislaus Rivers.

TABLE 5.3.3-3
WATER QUALITY DATA SUMMARY, SAN JOAQUIN RIVER AT VERNALIS
ABOVE NORMAL (2000)/DRY (2002)

	Average Total Organic Carbon (mg/L)	Average Total Dissolved Solids (mg/L)	Average Nitrate (NO_3) (mg/L)	Average Total Phosphorus (mg/L)	pH
October	3.0/3.4	350/410	9.8/8.5	–	–
November	3.4/2.8	350/260	7.8/6.0	–	–
December	3.1/3.5	480/410	9.1/6.2	–	–
January	2.7/3.3	500/460	5.8/6.5	–	–
February	6.0/4.0	420/590	8.4/6.7	–	–
March	4.5/4.0	150/590	4.0/11.2	–	–
April	3.5/3.9	250/550	3.2/6.8	–	–
May	2.5/2.5	180/230	4.0/3.7	–	–
June	2.6/2.7	260/290	5.2/6.6	–	–
July	3.4/4.0	370/390	8.9/6.5	–	–
August	3.5/4.3	350/410	8.6/6.0	–	–
September	3.1/4.2	260/450	6.6/8.2	–	–
Average (1999–2003)	3.6	380	6.9	0.23	7.8

SOURCE: DWR 2003; 2005.

The primary causes of degraded water quality in the San Joaquin River are the unsolved agricultural drainage problem in the San Joaquin Valley, urban wastewater and stormwater discharges, discharges from wildlife refuges, and flow depletion in some months of some years. Inadequate drainage and accumulating salts have been persistent problems in parts of the San Joaquin Valley for more than a century. Farmers in arid areas must apply irrigation water to their crops in excess of crop needs to flush salts out of the root zone. In parts of the valley, this practice has caused shallow groundwater levels to rise close to the ground surface. To prevent land from becoming unproductive, farmers install tile drains under their fields in an effort to lower groundwater levels and remove salt from the soil. The tile drains convey saline water to perimeter ditches, which are typically routed to the nearest natural stream channel. In the San Joaquin Valley, the natural channels are tributary to the San Joaquin River or Tulare Lake. In the 1960s and 1970s, the USBR attempted to solve the drainage problem in the San Joaquin Valley by constructing an agricultural drainage system for the valley that routed drainage water away from the San Joaquin River. The project was only partially built and failed to solve the problem (U.S. Department of the Interior/California Resources Agency, 1990).

Sacramento–San Joaquin Delta

Water quality in the Delta is governed by the Delta's complex hydrodynamics. Freshwater enters the Delta from its tributary rivers and, with the tides, saline water enters the Delta from Suisun Bay, the northern reach of the San Francisco Bay Estuary. When freshwater flow through the Delta is great, saline water is repelled and the waters of the Delta exhibit little salinity. When freshwater flow is small, tidal flow enables saline water to penetrate into the Delta. Under these circumstances, water quality in some parts of the Delta becomes brackish and unsuitable (or less suitable) for use as a source of potable and irrigation water. The reversal of flow in the lower San Joaquin River and many south Delta channels as a result of water diversion by the State Water Project and Central Valley Project increases the tendency for saline water to penetrate into the Delta.

Table 5.3.3-4 shows water quality characteristics at selected locations in the Delta. In general, water quality in the Delta declines in a southerly and westerly direction. This is illustrated by the pattern of chloride concentrations. For Sacramento River water entering the Delta from the north, the chloride content is low. Chloride, a constituent of seawater, enters the Delta from the west. The chloride concentration at the State Water Project's Banks Pumping Plant is higher than in the Sacramento River because low-chloride Sacramento River water mixes with saline water entering from Suisun Bay. Water quality at the Banks Pumping Plant, one of the two large pumping plants in the south Delta, is shown in **Table 5.3.3-5**.

The water quality parameters in Delta waters that are of greatest concern to municipal water supply agencies are total dissolved solids (salinity), bromide, and total organic carbon content. Elevated salinity levels in drinking water supplies may make it unpalatable. Farmers are also concerned about salinity because elevated levels may make water unsuitable for irrigating certain salt-sensitive crops.

Organic carbon compounds are present in water in the form of microscopic plants and animals and the products of bacterial degradation of plant and animal material. Total organic carbon levels rise in the Delta in the winter and spring primarily as a result of the drainage of peat soils on the Delta islands. Organic carbon reacts with chemicals used to disinfect drinking water to form trihalomethanes and other disinfection byproducts. Trihalomethanes are known to cause cancer in humans and are regulated under the Safe Drinking Water Act. Bromine also reacts with organic matter and disinfection agents to form trihalomethanes and other brominated disinfection byproducts. Saline water from San Francisco Bay is the main source of bromine in the Delta.

Diminution of flow and flow reversal in the lower San Joaquin River as a result of water diversions by the State Water Project and the Central Valley Project are harmful to migrating salmon. In 1990, DWR began installing temporary barriers in several waterways in the south Delta to improve conditions for migrating salmon. Temporary barriers have been placed across

TABLE 5.3.3-4
WATER QUALITY CHARACTERISTICS AT SELECTED STATIONS WITHIN THE DELTA

Location	Sacramento River at Green's Landing	North Bay Aqueduct at Barker Slough	Banks Pumping Plant	Contra Costa Intake at Rock Slough	San Joaquin River at Vernalis
Mean Total Dissolved Solids (mg/L)	100	192	258	305	459
Mean Electrical Conductivity (µS/cm)	160	332	482	533	749
Mean Bromide, Dissolved (mg/L)	0.018	0.015	0.269	0.455	0.313
Mean Total Organic Carbon (mg/L)	2.5	5.3	3.7	3.4	3.9
Mean Chloride, Dissolved (mg/L)	6.8	26	81	109	102

NOTE: Sampling period varies, depending on the location and constituent, but is generally between 1990 and 1998.

mg/L = milligrams per liter
µS/cm = microsiemens per centimeter

SOURCE: CALFED, 2000.

TABLE 5.3.3-5
WATER QUALITY DATA SUMMARY, BANKS PUMPING PLANT
ABOVE NORMAL (2000)/DRY (2002)

	Total Organic Carbon (mg/L)	Total Dissolved Solids (mg/L)	Nitrate (NO_3) (mg/L)	Total Phosphorus (mg/L)	pH
October	2.9/2.8	310/420	1.4/1.6	0.08/0.11	–
November	2.4/2.5	240/310	1.6/3.2	0.07/0.08	–
December	3.2/4.4	390/290	2.9/3.8	0.08/0.10	–
January	4.0/8.5	260/230	3.2/6.5	0.07/0.12	–
February	6.3/4.3	220/270	5.2/4.2	0.17/0.09	–
March	3.8/3.8	150/240	2.8/3.4	0.10/0.12	–
April	3.2/3.5	160/180	1.5/1.8	0.08/0.10	–
May	5.2/3.5	210/240	2.9/2.8	0.09/0.13	–
June	3.1/3.3	160/190	1.3/1.8	0.10/0.13	–
July	2.3/2.3	120/190	1.0/1.0	0.10/0.10	–
August	2.4/2.0	110/310	0.4/0.9	0.09/0.10	–
September	2.2/2.3	180/410	0.9/0.8	0.08/0.09	–
Annual Average (1999–2003)	3.5	233	2.5	0.11	7.4

SOURCES: DWR, 2003; 2005.

the Grant Line Canal, Middle River, and Old River. The purpose of the barriers is to control water levels for irrigators, improve water quality, and direct more water down the lower San Joaquin River for downstream migrating juvenile salmon in the spring and upstream migrating adults in the fall. It is expected that permanent operable barriers will replace the temporary barriers in the next few years.

Beneficial Uses and Water Quality Objectives

Water quality is regulated in California pursuant to the federal Clean Water Act and California's Porter-Cologne Water Quality Control Act of 1969. Responding to public concern in California, state legislators enacted a law designed to curb water pollution several years before passage of the Clean Water Act. The Porter-Cologne Act established regional water quality control boards and gave them defined responsibilities for water quality management.

The Porter-Cologne Act requires the regional water quality control boards to prepare regional WQCPs, often referred to as basin plans. The WQCPs must identify present and future beneficial uses of California's waters and establish water quality objectives to protect them. California's beneficial use designations and water quality objectives are the functional equivalent of the federal ambient water quality standards. After passage of the Federal Water Pollution Control Act Amendments in 1972, later known as the Clean Water Act, California's water quality objectives served as federal water quality standards, following review and approval by the U.S. Environmental Protection Agency (U.S. EPA).

WQCPs are adopted and amended by the regional water quality control boards and are subject to CEQA review. WQCPs, and amendments to WQCPs, do not become effective until approved by the SWRCB. Adoption or revision of surface water objectives/standards is subject to the approval of the U.S. EPA. The regional WQCPs complement statewide WQCPs adopted by the SWRCB, such as the WQCP for temperature control and the WQCP for ocean waters.

Two WQCPs govern management of surface and ground waters that could be affected by the WSIP. The Central Valley WQCP covers the Sacramento and San Joaquin River basins, including an area bounded on the east by the crests of the Sierra Nevada and Cascade Range and on the west by the Coast Ranges and Klamath Mountains. The San Francisco Bay/Delta WQCP covers those portions of Alameda, Contra Costa, Marin, Napa, San Mateo, San Francisco, Santa Clara, Solano, and Sonoma Counties that drain to the San Francisco Bay Estuary, including the Delta.

Each WQCP identifies existing and potential beneficial uses of surface waters and establishes water quality objectives within its part of California. Surface waters in the WQCP areas are in compliance with objectives, except for those waters contained in the SWRCB's Section 303(d) list of impaired water bodies.

Section 303(d) of the Clean Water Act requires that states periodically prepare a list of surface water bodies that do not meet ambient water quality standards after conventional water pollution control measures have been applied. The states must then establish the total maximum daily loads of pollutants that can be discharged to the water body without violating ambient water quality standards. Pollutant discharges must be cut back until they are in compliance with the total maximum daily loads.

Tuolumne River

Water quality objectives for the San Joaquin River Basin, including the Tuolumne River from the town of Waterford to La Grange Dam, are shown in **Table 5.3.3-6**. The only numerical water quality objective for the Tuolumne River is the objective for dissolved oxygen, which applies to

TABLE 5.3.3-6
PERTINENT WATER QUALITY OBJECTIVES FOR THE SAN JOAQUIN RIVER BASIN

Parameter	Water Body	Beneficial Use	Water Quality Objective
Dissolved Oxygen	San Joaquin River (Turner Cut to Stockton)	Chinook Salmon	6.0 mg/L (September 1 to November 30) and 5.0 mg/L (December 1 to August 30)
	Other Delta Waters	WARM COLD SPWN	5.0 mg/L 7.0 mg/L 7.0 mg/L
	Tuolumne River (Waterford to La Grange)		8.0 mg/L (or >95% saturation) (October 15 to June 15)
Salinity	San Joaquin River (Antioch Water Works)	MUN IND	Chloride: Maximum mean daily >150 mg/L Number of days per year <150 mg/L: Wet – 240 (66%) Above Normal – 190 (52%) Below Normal – 175 (48%) Dry – 165 (45%) Critical – 155 (42%)
	San Joaquin River (at Vernalis)	AGR	Electrical conductivity (maximum 30-day average): 0.7 (April 1 to August 31) 1.0 (September 1 to March 31)
Temperature	San Joaquin River (at Vernalis)	Chinook Salmon	April 1 to June 30 September 1 to November 3 Average daily water temperature may not be elevated by controllable factors above 68 °F.
	All	COLD WARM	Maximum 5 °F increase, as specified in Central Valley RWQCB objectives

Key: MUN (Municipal and Domestic Supply; AGR (Agriculture); IND (Industrial Use); WARM (Warm Freshwater Habitat); COLD (Cold Freshwater Habitat); SPWN (Fish Spawning).

SOURCE: SWRCB, 1995.

most of the river below La Grange Dam between October 15 and June 15. The objective is intended to protect spawning salmonids and their eggs.

Impaired water bodies on the Tuolumne River are shown in **Table 5.3.3-7**. Don Pedro Reservoir is listed under Section 303(d) for mercury. The elevated mercury concentrations are a result of past gold mining in the Tuolumne River watershed. The reach of the river below Don Pedro Reservoir is listed for pesticides and unknown toxicity.

San Joaquin River

Water quality objectives for the San Joaquin River are shown in Table 5.3.3-6. The objectives include dissolved oxygen and water temperature objectives designed to protect migrating Chinook salmon and salinity objectives designed to protect municipal, industrial, and agricultural water supplies. As shown in Table 5.3.3-7, the San Joaquin River is listed as impaired under Section 303(d) for mercury, boron, various pesticides, salinity, and unknown toxicity.

Sacramento–San Joaquin Delta

As noted above, the Sacramento–San Joaquin Delta lies at the heart of California's natural and manmade water systems. The Delta's physical complexity and competing interests for water

TABLE 5.3.3-7
SECTION 303(d) LIST OF IMPAIRED WATER BODIES

Segment Name	Pollutant	Potential Source	Total Maximum Daily Load Priority
Don Pedro Reservoir	Mercury	Resource Extraction	Low
Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Diazanon	Agriculture	Medium
	Group A Pesticides	Agriculture	Low
	Unknown Toxicity	Source Unknown	Low
San Joaquin River (Merced River to Vernalis)	Boron	Agriculture	High
	Chlorpyrifos	Agriculture	High
	DDT	Agriculture	Low
	Diazinon	Agriculture	High
	Electrical Conductivity	Agriculture	High
	Group A Pesticides	Agriculture	Low
	Mercury	Resource Extraction	Medium
	Unknown Toxicity	Source Unknown	Low
Sacramento–San Joaquin River Delta	Chlorpyrifos	Agriculture/Urban Runoff	High
	DDT	Agriculture	Low
	Diazinon	Agriculture/Urban Runoff	High
	Electrical Conductivity	Agriculture	Medium
	Group A Pesticides	Agriculture	Low
	Mercury	Resource Extraction	Medium
	Unknown Toxicity	Source Unknown	Low
	Exotic Species (proposed)	Ballast Water	NA

SOURCE: SWRCB, 1995.

make management of the Delta difficult. Water quality and flow objectives for the Delta have been the subject of much controversy and have frequently been revised. Some issues remain unresolved, including the degree to which parties that divert water upstream of the Delta are responsible for meeting Delta objectives. Resolution of these issues could affect all upstream diverters, including the SFPUC, TID, and MID.

The San Francisco Region WQCP, published in the early 1970s, designated beneficial uses and water quality objectives for both San Francisco Bay and the Delta. In 1978, a WQCP for the Sacramento–San Joaquin Delta and Suisun Marsh was published. In 1991, a WQCP for salinity in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta estuary) was published. When the Monterey Agreement was signed in December 1994, the beneficial uses and water quality objectives contained in the 1978 and 1991 WQCPs were in effect. In May 1995, as the first elements of the Monterey Amendment were being implemented, the SWRCB adopted a new WQCP for San Francisco Bay and the Delta that superseded both the 1978 and 1991 plans (SWRCB, 1995).

The SWRCB is responsible for issuing and administering water-rights permits in California. In 1978, the SWRCB adopted Water Rights Decision 1485 (D-1485), which established minimum flows in the Delta and limited exports of water by the State Water Project and Central Valley Project. The purpose of D-1485 was to ensure compliance with then-current water quality objectives. D-1485 superseded all earlier water-rights decisions for State Water Project and Central Valley Project operations in the Delta. Various interests filed lawsuits challenging D-1485. In 1986, a ruling known as the Racanelli Decision affirmed the SWRCB's broad authority and obligation to establish water quality objectives and set water-rights permit terms that provide reasonable protection to the beneficial uses of Delta waters (DWR, 1998). In 1987, the SWRCB began hearings to adopt new Delta objectives and a new water-rights decision.

Although the SWRCB adopted new water quality and flow objectives in 1995 as part of the 1995 Bay-Delta WQCP, D-1485 remained in effect until 1999.

Water Quality and Flow Objectives. The WQCP for San Francisco Bay and the Delta, published in 1995, included water quality and flow objectives for the Delta. A draft EIR on the WQCP was published in 1997 (SWRCB, 1997). In the EIR, the SWRCB acknowledged that the flow objectives can only be achieved by limiting diversions of water in the Sacramento and San Joaquin River watersheds and within the Delta itself. The EIR noted that the SWRCB intended to implement the objectives, to the extent feasible, through amendments to the permits of water-rights holders in the Central Valley. However, the EIR also noted that some of the objectives cannot reasonably be achieved through changes to water-rights permits exclusively. Water quality and the health of aquatic resources in the Delta and San Francisco Bay are dependent on many factors outside the regulatory authority of the SWRCB. These factors include salt buildup in the San Joaquin Valley, introduction of non-native aquatic species, legal and illegal fishing, and degradation of upstream spawning habitat for fish that migrate through the Delta.

In the years following publication of the WQCP, most of the objectives of the WQCP were implemented through biological opinions issued by the USFWS and the NMFS pursuant to the Federal Endangered Species Act and through D-1485 and SWRCB Order WR 98-9. Under the biological opinions, D-1485, and WR 98-9, responsibility for meeting most of the objectives was assigned to the State Water Project and the Central Valley Project (SWRCB, 1999).

The SWRCB established separate Delta water quality objectives for municipal and industrial, agricultural, and fish and wildlife beneficial uses. The objectives for municipal and industrial beneficial uses require that certain chloride levels be maintained at certain locations in the Delta during certain hydrologic year types. The objectives for agricultural beneficial uses require that certain electrical conductivity levels be maintained at certain locations in the Delta during certain months of the year. The objectives for fish and wildlife beneficial uses require that certain electrical conductivity levels be maintained at certain locations in the Delta during certain months of the year. They also require that certain minimum levels of Delta outflow and maximum levels of export by the State Water Project and Central Valley Project be maintained during certain hydrologic year types.

5.3.3.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to surface water quality, but generally considers that implementation of the proposed program would have a significant impact if it were to:

- Substantially impair a water body's ability to support beneficial uses designated by the State Water Resources Control Board or Regional Water Quality Control Board
- Otherwise substantially degrade water quality

Approach to Analysis

This section describes the impacts of the WSIP on surface water quality in the Tuolumne River watershed. The changes in surface water quality would result from WSIP-induced changes in stream flow and reservoir water levels. The effects of the WSIP on stream flow and reservoir water levels are described in Section 5.3.1. In general, effects are found to be significant if they would frequently exceed water quality objectives. Very infrequent exceedances of water quality objectives would not be considered significant here because the exceedances would not substantially impair designated beneficial uses or substantially degrade water quality.

Changes in flow in rivers and streams and changes in reservoir storage and water levels attributable to WSIP implementation were estimated using the HH/LSM. An overview of the model is presented in Section 5.1. Detailed information on the model and the assumptions that underlie it is provided in Appendix H. A second model, VR_Temp, was used to assess the effects of the WSIP on water temperature in the Tuolumne River below La Grange Dam. It is also described in Appendix H.

Beth Neilson at Utah State University and Dr. Steve Chapra at Tufts University developed VR_Temp for application to the Virgin River in Utah. VR_Temp is a one-dimensional, surface heat balance and kinematic flow routing model developed based on the derivations found in Chapra (1997). The model is able to estimate maximum daily water temperatures and was constructed to allow different input time steps for meteorological data as well as point and distributed inflow sources. The model allows a single stream or river segment to be divided into computational cells or elements; stream networks are not modeled and tributaries are treated as a time-series input. VR_Temp was adapted for use on the Tuolumne River by Mike Deas for Merritt-Smith Consultants.

Impact Summary

Table 5.3.3-8 presents a summary of the impacts on surface water quality in the Tuolumne River system and downstream water bodies that could result from implementation of the proposed water supply and system operations.

TABLE 5.3.3-8
SUMMARY OF IMPACTS – SURFACE WATER QUALITY
IN THE TUOLUMNE RIVER SYSTEM AND DOWNSTREAM WATER BODIES

Impact	Significance Determination
Impact 5.3.3-1: Effects on water quality in Hetch Hetchy Reservoir and along the Tuolumne River below O'Shaughnessy Dam	LS
Impact 5.3.3-2: Effects on water quality in Don Pedro Reservoir and along the Tuolumne River below La Grange Dam	LS
Impact 5.3.3-3: Effects on water quality along the San Joaquin River and the Sacramento–San Joaquin Delta	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.3-1: Effects on water quality in Hetch Hetchy Reservoir and along the Tuolumne River below O'Shaughnessy Dam.

The primary water quality parameters of concern in Hetch Hetchy Reservoir and the Tuolumne River below the reservoir are water temperature and dissolved oxygen. Most fish species that inhabit the reservoir and the Tuolumne River below O'Shaughnessy Dam are adapted to cool temperatures and well-oxygenated water. Water entering Hetch Hetchy Reservoir in the spring is cold and well oxygenated. Rising air temperatures and solar radiation in the summer heat the surface waters of the reservoir, but deeper water (25 to 50 feet below the surface) remains cold. The oxygen content of deeper waters declines somewhat through the summer as a result of biochemical reactions, but oxygen depletion is limited by the lack of plant nutrients in Hetch Hetchy water. The reductions in storage and water levels in Hetch Hetchy Reservoir attributable to the proposed program under average (or even average dry) conditions would be too small to have much effect on water temperature or dissolved oxygen content. Because the WSIP would have little effect on reservoir water quality, it would have little effect on the quality of water released from the reservoir to the Tuolumne River below the reservoir.

However, reductions in storage and water levels could have a greater effect on reservoir water quality and the quality of water released to the Tuolumne River during extremely dry periods. As noted above and shown diagrammatically in Figure 5.3.3-2, deep reservoirs in the Sierra Nevada stratify in the summer. Normally, water released from Hetch Hetchy Reservoir to the Tuolumne River is drawn from the cool pool of water below the thermocline. If the reservoir is drawn down sufficiently, releases to the river could exhaust the pool of cool water, and warmer water from above the thermocline would be released.

Conditions that would result during droughts similar to those that occurred in 1923–1935, 1986–1993, and 1976–1977 were examined using the HH/LSM with the proposed program and under existing conditions. In a drought similar to the 1986–1993 drought, the water level in Hetch

Hetchy Reservoir would never be drawn down sufficiently to affect water temperature in the Tuolumne River below the reservoir. In a drought similar to the 1923–1935 drought, the water level in Hetch Hetchy Reservoir would be drawn down to very low levels in January through April of the tenth year of the drought. However, in these months the reservoir is not stratified and so the drawdown would have little or no effect on downstream water temperatures.

In a drought similar to the 1976–1977 drought, the water level in Hetch Hetchy Reservoir would be drawn down to very low levels in October through January of the second and third years of the drought with the WSIP, as shown in Figure 5.3.1-9. In October and November, the reservoir would normally be stratified; that is, water above the thermocline, which would be at a depth of about 60 to 80 feet, would be 10 or 12 °C warmer than water below the thermocline. The drawdown in September and October would destratify the reservoir and would result in an increase in the temperature of water released to the Tuolumne River, from about 8 °C to perhaps 14 to 18 °C. This phenomenon would occur in a drought similar to the 1976–1977 drought under the existing condition as well as with the proposed program. However, as shown in Figure 5.3.1-9, the drawdown in Hetch Hetchy Reservoir with the WSIP would be greater than under the existing condition, and thus the adverse water quality effects would likely last longer by several days or weeks.

The dissolved oxygen content of water released from Hetch Hetchy Reservoir varies depending on water temperature and the depth from which it is drawn. Most of the time, the water drawn from the reservoir is well oxygenated. Any water with depleted oxygen levels is rapidly reoxygenated as a result of its turbulent release to the Tuolumne River. The WSIP would have little or no effect on dissolved oxygen levels in water released to river.

Water quality in the Tuolumne River would occasionally be affected by WSIP-induced changes in the temperature of releases from Hetch Hetchy Reservoir, as described above. It could also be affected by WSIP-induced changes in stream flow in the Tuolumne River below Hetch Hetchy Reservoir. However, the effects of the two phenomena would not coincide because the former would occur in early fall and the latter in the late spring and early summer.

The proposed program would have little or no effect on flow below Hetch Hetchy Reservoir in most summer, fall, and winter months, as described previously, and consequently would have little or no effect on water temperature. Water temperature would only be affected if the WSIP resulted in a substantial reduction in flow at a time when air temperatures and solar radiation are sufficient to heat the diminished flowing stream. **Table 5.3.3-9** shows the five months in the 964-month hydrologic record during which the WSIP would reduce flows in the river substantially; as the table indicates, the proposed program would reduce flow by 50 percent or more compared to the existing condition and would reduce flows to below 200 cfs. All five occurrences would be in the month of May.

Even in the fairly extreme conditions shown in Table 5.3.3-9, it is questionable whether water temperatures in the Tuolumne River below Hetch Hetchy Reservoir would become elevated compared to the existing condition. In May, average daily air temperatures are moderate and accumulated snow is melting. Snowmelt runoff into the Tuolumne River, both directly and from

TABLE 5.3.3-9
AVERAGE FLOWS FOR CONDITIONS WHERE WATER TEMPERATURES COULD BE ADVERSELY AFFECTED (TUOLUMNE RIVER BELOW HETCH HETCHY)
(cubic feet per second)

Date	Existing Condition	Proposed Program	Difference
May 1962	777	100	-677
May 1978	857	100	-757
May 1981	413	144	-169
May 1992	530	50	-470
May 1999	383	164	-219

SOURCE: SFPUC, HH/LSM (see Appendix H).

tributaries (including Cherry Creek and the Clavey River) between Hetch Hetchy Reservoir and Don Pedro Reservoir would minimize any temperature increases resulting from WSIP-induced reductions in flow.

In general, the WSIP would have very little effect on water quality in Hetch Hetchy Reservoir or the Tuolumne River below the reservoir. WSIP-induced reductions in flow in the Tuolumne River below the reservoir would occur primarily in May and would not be expected to result in sufficient changes in water temperature to affect the river’s ability to support its designated beneficial uses, including support of a coldwater fishery. On very rare occasions under existing conditions and during extreme droughts (once in the 82-year hydrologic record), warm water is released from Hetch Hetchy Reservoir to the Tuolumne River. At such times, the water quality objective that limits increases in water temperature to 5 degrees Fahrenheit (°F) to protect coldwater fish would likely be exceeded. With the WSIP, the release of warm water would continue to be a rare occurrence (once in the 82-year hydrologic record), but the period during which warm water would be released from Hetch Hetchy Reservoir, and the water quality objective exceeded, would be extended by several days or weeks.

Exceedances of the water quality objective that limits temperature changes have probably occurred very infrequently under the existing condition (modeling indicates that it may have occurred once in the 82-year period of hydrologic record). In the future with the WSIP, very infrequent exceedances of the water quality objective would continue to occur, but could last longer by several days or weeks than under the existing condition. Infrequent exceedances of the standard would not substantially affect the Tuolumne River’s ability to support its designated beneficial uses, including support of a coldwater fishery. This is because, during times when an exceedance of the objective occurred, water temperatures would still remain within an acceptable range for coldwater fish (see Section 5.3.6). Thus, the impact of the WSIP on water quality in Hetch Hetchy Reservoir and the Tuolumne River would be *less than significant*, and no mitigation measures would be required.

[Additional discussion on impacts on water quality in the upper Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues Issues (Vol. 7, Chapter 14).]

Impact 5.3.3-2: Effects on water quality in Don Pedro Reservoir and along the Tuolumne River below La Grange Dam.

The primary water quality parameter of concern in Don Pedro Reservoir is water temperature. Like Hetch Hetchy Reservoir, Don Pedro Reservoir stratifies in the summer months. If the WSIP caused the reservoir to be greatly drawn down, then it would adversely affect water temperature in the Tuolumne River below La Grange Dam. Reservoir drawdown would be at its greatest during extended dry periods.

Conditions that would result in Don Pedro Reservoir during droughts similar to those that occurred in 1923–1935, 1986–1993, and 1976–1977 were examined using the HH/LSM. As indicated in Figure 5.3.1-12, although Don Pedro Reservoir would be drawn down greatly in each of the droughts, storage in the reservoir would never decrease much below 500,000 acre-feet. **Table 5.3.3-10** compares storage in Don Pedro Reservoir in the 1923–1935 and 1986–1993 droughts with the proposed program and under existing conditions. It also shows the elevation of the thermocline and the volume of the cool water pool under both conditions. Although the WSIP would lower the elevation of the thermocline when storage in the reservoir is at a minimum, the thermocline would still be considerably above the elevation of the outlet from Don Pedro Reservoir. The outlet is an 18.5-foot-diameter tunnel with a crest elevation of 543.5 feet above mean sea level (msl). Releases from the reservoir with the WSIP in place would still be from the cool water pool below the thermocline. Thus, the changes in water level in Don Pedro Reservoir attributable to the proposed program would not increase the temperature of water released to the Tuolumne River below La Grange Dam.

TABLE 5.3.3-10
COMPARISON OF STORAGE, COOL WATER POOL VOLUMES, AND DEPTH TO THERMOCLINE FOR DON PEDRO RESERVOIR UNDER EXISTING CONDITIONS AND WITH THE WSIP

Drought Conditions	Minimum Storage (acre-feet)		Cool Water Pool (acre-feet)		Thermocline Elevation (feet msl)	
	Existing	WSIP	Existing	WSIP	Existing	WSIP
1923–1935	680,066	623,932	360,000	320,000	614	604
1986–1994	823,654	695,955	450,000	370,000	636	616

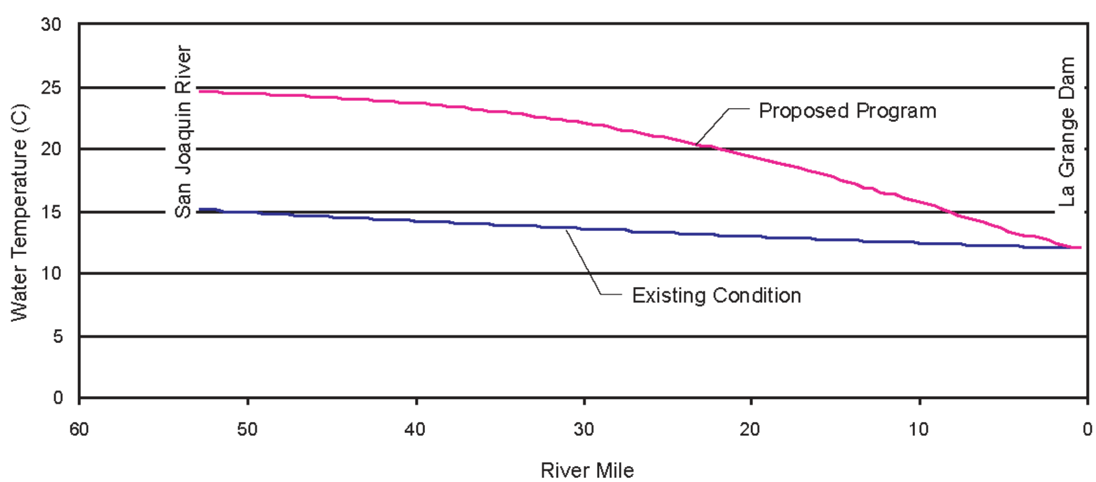
SOURCE: Merritt-Smith Consultants (raw data).

Although water temperature in the Tuolumne River would not be affected by WSIP-induced changes in releases from Don Pedro Reservoir, it could be affected by WSIP-induced changes in stream flow. The proposed program would have little effect on flow below Don Pedro Reservoir in most summer, fall, and winter months, but it could cause reductions in flow of up to 95 percent compared to the existing condition under certain circumstances. For example, under hydrologic conditions similar to those that occurred in June 1999, the release to the Tuolumne River under the existing condition would be 523 cfs; with the WSIP it would be 250 cfs, a reduction of 52 percent.

Most of the large-percentage reductions in flow in the Tuolumne River below La Grange Dam would occur in April, May, and June following dry periods, when Don Pedro Reservoir would be drawn down. Reductions in flow in the late spring and early summer as a result of the proposed program could affect water temperatures under certain circumstances. These circumstances might include reductions in flow of 50 percent or more and flows of less than 400 cfs that result from WSIP-induced flow reductions. The results of the simulation of flows below La Grange Dam using 82 years of hydrologic data were examined to determine how frequently these circumstances occur. The analysis indicates that there are only three months over the 984-month hydrologic record when the circumstances would occur, and thus the condition has the potential to occur very infrequently.

The VR_Temp model was used to examine the effects on water temperature of WSIP-induced reductions in flow below La Grange Dam. Two conditions were simulated: the June 1993 and June 1999 events. The June 1993 event is an extreme event with over a 90 percent reduction in flow. Such a reduction only occurs once in the 82-year hydrologic record, as shown in Figure 5.3.1-12. The June 1999 event is less extreme than the June 1993 event, but it would still be rare. It involves a reduction in flow of 50 percent.

Water released from La Grange Dam in June is considerably cooler than the average daily air temperature. As water flows downstream, its temperature increases. The smaller the thermal mass of the water, the faster its temperature increases. **Figure 5.3.3-3** shows estimated mean daily water temperature in the Tuolumne River between La Grange Dam and the confluence with the San Joaquin River under June 1993 conditions with the proposed program and under existing conditions. Water temperature rises more rapidly with the proposed program than under existing conditions. Mean daily temperature in the Tuolumne River just upstream of the confluence with the San Joaquin River would be about 10 °C higher with the WSIP than under current conditions.

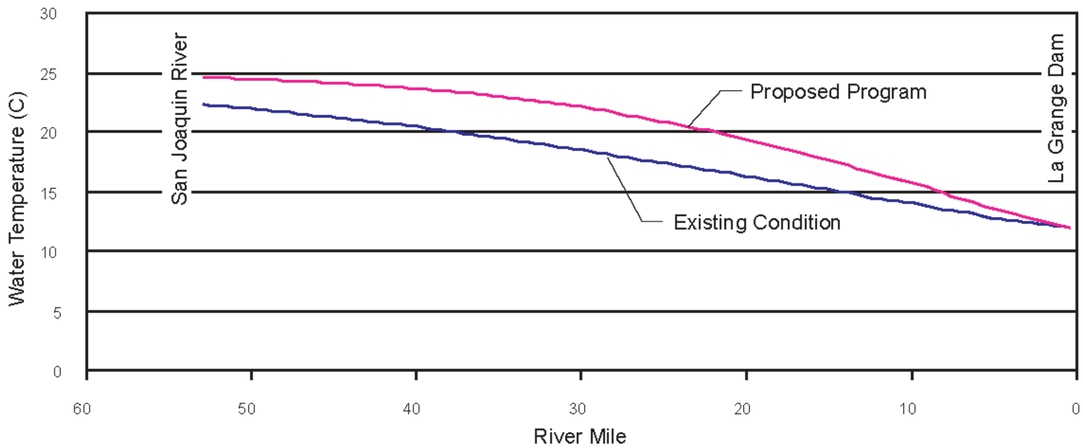


SOURCE: Merritt-Smith Consultants (raw data)

SFPUC Water System Improvement Program ▪ 203287

Figure 5.3.3-3
Longitudinal Profile of Simulated Mean Daily Water Temperature from La Grange Dam to the San Joaquin River, June 1993

Figure 5.3.3-4 shows similar information for June 1999 conditions. In this case, the temperature increase produced by the WSIP at the confluence with the San Joaquin River would be about 2°C.



SFPUC Water System Improvement Program ▪ 203287

SOURCE: Merritt-Smith Consultants (raw data)

Figure 5.3.3-4
Longitudinal Profile of Simulated Mean Daily Water Temperature from La Grange Dam to the San Joaquin River, June 1999

Almost all of the time, WSIP-induced flow reductions in the Tuolumne River below La Grange Dam would have no effect on water temperature. On infrequent occasions, 12 months in the 82-year period of hydrologic record, WSIP-induced flow reductions would cause mean daily temperature increases in the Tuolumne River of 1 or 2 °C. On very rare occasions, one month in the 82-year period of hydrologic record, WSIP-induced flow reductions would cause mean daily temperature increases of 10 °C.

Water quality objectives for the Tuolumne River require that water temperatures not be increased by more than 5 °F (2.8 °C). The WSIP would comply with this objective almost all of the time. On rare occasions, estimated at three or four months in the 82-year period of hydrologic record, there would be exceedances of the objective, but these rare exceedances would not impair the river's ability to support the designated beneficial uses that the objective is designed to protect, including coldwater fisheries. Consequently, this impact would be *less than significant*, and no mitigation measures would be required.

[Additional discussion on impacts on water quality in the lower Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

Impact 5.3.3-3: Effects on water quality along the San Joaquin River and the Sacramento–San Joaquin Delta.

The Tuolumne River joins the San Joaquin River about 50 miles downstream of La Grange Dam. The reductions in flow in the Tuolumne River below La Grange Dam attributable to the WSIP (as shown in Table 5.3.1-6) would reduce flows in the Tuolumne River between La Grange Dam and its confluence with the San Joaquin River, and in the San Joaquin River from the confluence to the Delta. There is a potential for reductions in flow to affect water quality. However, most of the reductions in flow would occur from February through June in wet or above-normal years when flow in the San Joaquin River is at its seasonal maximum. As a consequence, most of the time, WSIP-induced changes in flow would have little effect on water quality in the San Joaquin River.

The SWRCB has established water quality objectives for the San Joaquin River at Vernalis, just upstream of the Sacramento–San Joaquin Delta. The objectives are expressed in term of electroconductivity, a measure of salinity. The salinity of river water at Vernalis becomes elevated when flow in the river is insufficient to repel saltwater entering from Suisun Bay. Almost all of the time, the reductions in San Joaquin River flow attributable to the WSIP would not be sufficient to cause salinity in the river at Vernalis to rise above the objective. Very infrequently, following protracted droughts, reductions in San Joaquin River flow attributable to the WSIP could be sufficient to cause salinity in the river at Vernalis to rise above the objective. Under these circumstances, the USBR, the agency responsible for compliance with objectives for the San Joaquin River, would increase releases from New Melones Reservoir on the Stanislaus River to meet the water quality objectives at Vernalis. Thus, the WSIP would not alter water quality in the San Joaquin River below its confluence with the Tuolumne River such that it would be substantially outside the range experienced under the existing condition. The impact would be *less than significant*, and no mitigation measures would be required.

The reductions in flow in the Tuolumne River below La Grange Dam attributable to the WSIP would also reduce inflow to the Sacramento–San Joaquin Delta. The changes in Delta inflow as a result of the WSIP would be too small to have much effect on water quality in the Delta, particularly as the changes would occur when flow through the Delta is at its seasonal maximum. The impact would be *less than significant*, and no mitigation measures would be required.

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5.3.4 Surface Water Supplies

The following setting section describes downstream water users whose water supply could be affected by the WSIP. The impact section (Section 5.3.4.2) provides a description of the changes in water availability and quality for downstream users resulting from WSIP-induced changes in stream flow.

5.3.4.1 Setting

The Tuolumne River flows from the crest of the Sierra Nevada westward to its confluence with the San Joaquin River. The San Joaquin River flows north to the Sacramento–San Joaquin Delta. Water from the Delta discharges to the San Francisco Bay Estuary and the Pacific Ocean. Because the WSIP would result in increased diversions of water from the Tuolumne River at Hetch Hetchy Reservoir, high in the Tuolumne River watershed, flow in the Tuolumne and San Joaquin Rivers and inflow to the Sacramento–San Joaquin Delta would be decreased in some months of some hydrologic year types. The changes in flow attributable to the WSIP are described in Section 5.3.1.

A number of water agencies and other diverters obtain their water supplies from the Tuolumne and San Joaquin Rivers and from the Delta. The water supplies of these agencies and other diverters could potentially be affected by the WSIP. Water agencies and others divert water from the rivers and the Delta in accordance with riparian water rights, pre-1914 appropriative water rights, and appropriative water-rights permits granted by the SWRCB.

In California, two doctrines govern surface water rights, the riparian doctrine and the doctrine of prior appropriation. A riparian water right is the right to use water for a reasonable and beneficial purpose as a result of the ownership of property that abuts a natural waterway. An appropriative water right is the right to use a specific quantity of water for a reasonable purpose at a specific location. The historical principle underlying the appropriation doctrine is “first-in-time, first-in-right.” An entity that first appropriates and uses water for a reasonable beneficial purpose has a right that is superior to the rights of later appropriators. When water is short and insufficient to meet the needs of all holders of appropriative water rights, the rights of senior water-rights holders must be satisfied before those of junior water-rights holders.

Prior to 1914, an entity followed certain procedures to obtain an appropriative water right but did not need to obtain a permit from the State of California. A change in state law in 1914 provided that all water within the state is the property of the people of the state and made it a requirement that appropriators obtain a permit to divert surface water. San Francisco holds pre-1914 rights to divert water from the Tuolumne River. The SWRCB does not regulate pre-1914 water rights.

Two of California’s largest water storage and conveyance projects, the federal Central Valley Project and the State Water Project, divert water from the Delta. The USBR, which operates the Central Valley Project, and the DWR, which operates the State Water Project, hold post-1914 appropriative rights to divert water from the Delta. These rights are junior to San Francisco’s Tuolumne River water rights.

Because of the size of the diversions made by the Central Valley Project and State Water Project, the nature of their authorizing legislation, and the priority of their water rights, the SWRCB assigned unique responsibilities to the USBR and DWR for compliance with Delta water quality and flow objectives. The USBR and DWR must operate the Central Valley Project and State Water Project in a manner that maintains compliance with Delta objectives. They are not permitted to fully exercise their water rights in the Delta if to do so would cause a violation of Delta water quality or flow objectives.

San Joaquin River and Sacramento–San Joaquin Delta

The San Joaquin River rises in the Sierra Nevada and drains an area of 13,500 square miles. After reaching the floor of the San Joaquin Valley near Fresno, the river flows westward towards the community of Mendota, then northwest for about 100 miles to the Sacramento–San Joaquin Delta. Some reaches of the river upstream and downstream of Mendota are dry, except when flood releases are made from Millerton Reservoir. The river begins to flow again generally downstream of the Mariposa Bypass as it gains water from agricultural irrigation, wildlife area management return flows, and tributaries. Major tributaries that join the San Joaquin River upstream of its confluence with the Delta include the Merced, Tuolumne, and Stanislaus Rivers. The San Joaquin River watershed is shown in Figure 5.3.1-7.

State Water Project

The State Water Project is California's second-largest water project; it operates Oroville Reservoir, with a capacity of about 3.5 million acre-feet, on the Feather River. Water from Oroville Reservoir is released to the Feather River and flows downstream to the Sacramento River and the Delta. Water is diverted from the south Delta at the State Water Project's Banks Pumping Plant and conveyed southward in the California Aqueduct to the State Water Project's contractors and to San Luis Reservoir, a joint-use facility of the Central Valley and State Water Projects. On average, the State Water Project delivers 2.4 million acre-feet each year for municipal and agricultural use, almost all of which is diverted from the Delta at the Banks Pumping Plant.

Central Valley Project

The Central Valley Project is California's largest water project. On average, the Central Valley Project delivers 5.6 million acre-feet of water each year for agricultural, wildlife management, and municipal use.

North of the Delta, the Central Valley Project operates reservoirs on the Sacramento, Trinity, and American Rivers. Shasta Reservoir, on the upper Sacramento River, has a capacity of 4.5 million acre-feet. Claire Engle Lake is located on the Trinity River, which flows to the Klamath River and to the Pacific Ocean near the California/Oregon border. Claire Engle Lake has a capacity of 2.4 million acre-feet. Water from the lake is diverted through a tunnel to the Sacramento River, where it combines with releases from Shasta Reservoir. Folsom Reservoir is located on the American River and has a capacity of 1 million acre-feet. Releases from all three reservoirs flow downstream to the Delta.

Water is diverted from the south Delta at the Central Valley Project's Tracy Pumping Plant and conveyed southward to Central Valley Project contractors on the western side of the San Joaquin Valley via the Delta-Mendota Canal and for delivery to San Luis Reservoir. The Central Valley Project's diversions at the Tracy Pumping Plant average about 1.7 million acre-feet per year. Smaller amounts of Central Valley Project water are diverted at the State Water Project's Banks Pumping Plant and conveyed southward in the California Aqueduct. The USBR supplies water to Central Valley Project contractors on the eastern side of the San Joaquin Valley from Millerton Reservoir on the San Joaquin River and several other reservoirs on tributaries of the San Joaquin River, including New Melones Reservoir on the Stanislaus River.

Flow and Water Quality Objectives for the San Joaquin River and the Delta

The SWRCB has established numerous flow and water quality objectives for the San Joaquin River at Vernalis and for the Sacramento–San Joaquin Delta. These objectives are prescribed in Decision 1641. Illustrative of these objectives are the flow and quality objectives for the San Joaquin River at Vernalis shown in **Table 5.3.4-1**. Outflow requirements from the Delta could be the specific flow objectives or the required flow to maintain salinity objectives at certain locations in the Delta. Specific flow objectives at Chipps Island are shown in **Table 5.3.4-2**.

TABLE 5.3.4-1
FLOW AND WATER QUALITY OBJECTIVES FOR SAN JOAQUIN RIVER AT VERNALIS

Year Type	Dates	Minimum Monthly Average Flow (cfs)[a]
Wet, above normal	February – April 14	2,130 or 3,420
Below normal, dry	February 1 – April 14	1,420 or 2,280
Critical	February 1 – April 14	710 or 1,140
Wet	April 15 – May 15	7,330 or 8,620
Above normal	April 15 – May 15	5,730 or 7,020
Below normal	April 15 – May 15	4,620 or 5,480
Dry	April 15 – May 15	4,020 or 4,880
Critical	April 15 – May 15	3,110 or 3,540
Wet, above normal	May 16 – June 30	2,130 or 3,420
Below normal, dry	May 16 – June 30	1,420 or 2,280
Critical	May 16 – June 30	710 or 1,140
All	October	1,000
All Years	April – August	0.7 mmhos/cm[b]
All Years	September – March	1.0 mmhos/cm[b]

[a] The higher flow objective applies when the 2 parts per thousand isohaline is required to be at or west of Chipps Island. An isohaline is a line drawn through places that have equal values of water salinity. The April 15–May 15 flow objective is currently replaced by the protocols of the San Joaquin River Agreement and the Vernalis Adaptive Management Program, which provides flows during this period ranging between 3,200 cfs and 7,000 cfs.
[b] The water quality objective is to be met on a 30-day running average of mean daily water electroconductivity, which provides a measure of water salinity. The units of electroconductivity are millisiemens per centimeter.

SOURCE: SWRCB, 1995.

TABLE 5.3.4-2
FLOW OBJECTIVES FOR SACRAMENTO–SAN JOAQUIN DELTA

Year Type	Dates	Minimum Monthly Delta Outflow (cfs)[a]
All	January	4,500[b]
All	February – June	7,100[c]
Wet, above normal	July	8,000
Below normal	July	6,500
Dry	July	5,000
Critical	July	4,000
Wet, above normal, below normal	August	4,000
Dry	August	3,500
Critical	August	3,000
All	September	3,000
Wet, above normal, below normal, dry	October	4,000
Critical	October	3,000
Wet, above normal, below normal, dry	November – December	4,500
Critical	November – December	3,500

[a] Flow as determined by the Net Delta Outflow Index. For the May–January objectives, if the value is less than or equal to 5,000 cfs, the 7-day running average shall not be less than 1,000 cfs below the value; if the value is greater than 5,000 cfs, the 7-day running average shall not be less than 80 percent of the value.
[b] The objective is increased to 6,000 cfs if the best available estimate of unimpaired Delta inflow for December is greater than 800,000 acre-feet.
[c] The minimum Delta outflow required may be reduced under certain conditions described in the San Francisco Bay–Delta Water Quality Control Plan.

5.3.4.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to water supplies, but generally considers that implementation of the proposed program would have a significant water supply impact if it were to:

- Result in substantial adverse changes in operations or substantial decreases in water deliveries for water users, as measured by significant changes in reservoir storage, timing or rate of river flows, or water quality
- Violate any water quality standards or otherwise substantially degrade water quality

Approach to Analysis

Changes in flow in rivers and streams and changes in reservoir storage and water levels in the Tuolumne River watershed attributable to the WSIP were estimated using the HH/LSM. An overview of the model is presented in Section 5.1. The HH/LSM simulates water deliveries, reservoir storage, and releases to rivers under different conditions using hydrologic data from the period 1920 to 2002. Detailed information on the model and the assumptions that underlie it is provided in Appendix H. Changes in stream flow were then used to estimate the effects on water availability and water quality for downstream users.

Impact Summary

Table 5.3.4-3 presents a summary of the impacts on the water supply of downstream users that could result from implementation of the proposed program.

TABLE 5.3.4-3
SUMMARY OF IMPACTS – SURFACE WATER SUPPLIES OF DOWNSTREAM USERS

Impact	Significance Determination
Impact 5.3.4-1: Effects on Tuolumne River, San Joaquin River, and Stanislaus River water users	LS
Impact 5.3.4-2: Effects on Delta water users	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.4-1: Effects on Tuolumne River, San Joaquin River, and Stanislaus River water users.

Like the CCSF, TID and MID hold pre-1914 rights to Tuolumne River water. When the federal government passed the Raker Act in 1913, it granted the CCSF the rights-of-way and public lands necessary to construct the Hetch Hetchy system. The Raker Act includes various conditions, one of which is that the CCSF must recognize TID's and MID's prior rights to water from the Tuolumne River. In the same year the Raker Act was passed, the CCSF reached agreement with TID and MID on the amount of water needed to satisfy their prior water rights. All of the SFPUC's existing water supply facilities are operated in compliance with the provisions of the Raker Act and would continue to be operated in compliance with the act after the WSIP has been implemented. Consequently, the WSIP would have no adverse effect on the availability of Tuolumne River water to TID and MID or on the quality of water available to them.

Changes in flow in the Tuolumne River below La Grange Dam attributable to the WSIP would affect flows in the San Joaquin River from its confluence with the Tuolumne River to the Delta. The Delta standards include flow and quality objectives for the San Joaquin River at Vernalis, just upstream of the point where the San Joaquin River flows into the Delta. Very infrequently, following protracted droughts, reductions in San Joaquin River flow attributable to the WSIP could make it necessary for the USBR, the agency responsible for compliance with water quality and flow objectives for the San Joaquin River, to increase releases from New Melones Reservoir to meet the objectives at Vernalis.

As described in Section 5.3.1, under existing conditions in the majority of years classified as below-normal or drier, almost all of the winter and spring runoff from the watershed upstream of Don Pedro Reservoir on the Tuolumne River is captured in the reservoir. Only the minimum required releases to the Tuolumne River below La Grange Dam are made. The WSIP would have no effect on flow in the Tuolumne River below La Grange Dam or the San Joaquin River in months when only the minimum flows are currently released. In years when the reservoir fills, usually wet or above-normal years, excess water is released in some months to the Tuolumne River. In the future with the WSIP, TID and MID would draw Don Pedro Reservoir down farther in most years than they would under the existing condition, and consequently a greater proportion of spring runoff would be needed to refill the reservoir. As a result, the volume of excess water released to the Tuolumne River would be reduced in all wet years, most above-normal years, and occasional below-normal and dry years.

Table 5.3.4-4 shows the change in modeled releases from La Grange Dam attributable to the WSIP for the 82-year hydrologic simulation, by year type and descending order of wetness. The magnitudes of modeled releases with and without the WSIP are shown in Table 5.3.1-6. Flow in the Tuolumne River below La Grange Dam and flow in the San Joaquin River below its confluence with the Tuolumne River would reflect the changes. As shown in the table, most of the changes in releases and the greatest changes in releases would occur in wet and above-normal years following a series of dry years. Many of the changes are small in magnitude compared to the required minimum stream flow releases shown in Table 5.3.1-3. Furthermore, most of the changes in releases would occur from February through June of the affected years, with an occasional occurrence during other months. When they occur, the changes in average monthly flows are usually in the hundreds of cubic feet per second (an average monthly flow of 100 cfs is equal to a monthly volume of about 6,000 acre-feet). Occasionally, changes are in the range of 1,000 cfs to a little over 3,000 cfs. The greatest changes would potentially occur infrequently during wetter years following protracted droughts.

The changes in flow described above would affect the Tuolumne River below La Grange Dam and the San Joaquin River below its confluence with the Tuolumne River. **Table 5.3.4-5** shows measured flows in the San Joaquin River at Vernalis for the period 1969 through 2002, arranged by descending order of wetness. As can be seen by the record, average monthly flows in the San Joaquin River vary seasonally and by year type. During wet years in February through June (the period when WSIP effects would mostly occur), flows generally range from a low of 5,000 cfs to over 40,000 cfs. During the summer, flows can diminish to as low as 1,500 cfs. During above-normal years in February through March (the period when WSIP effects mostly occur within this year type), flows are generally in excess of 7,000 cfs. A comparison between Tables 5.3.4-4 and 5.3.4-5 indicates that, although flows would be reduced with the WSIP, they would still exceed the flow objectives during wet and above-normal hydrologic conditions. Typically, during wet and above-normal years, there is sufficient tributary flow in the San Joaquin River basin to meet water quality objectives at Vernalis. Under these conditions, the USBR does not need to release water from New Melones Reservoir on the Stanislaus River to meet flow or water quality objectives at Vernalis.

As noted above, if the WSIP caused flow in the San Joaquin River at Vernalis to fall below the flow objective or caused water quality at Vernalis to fall below objectives, the USBR would have to increase releases from New Melones Reservoir or other San Joaquin Valley Central Valley Project facilities to compensate. During wet and above-normal years, when most of the effects of the WSIP would be felt, flow and water quality objectives at Vernalis would be met and the USBR would not have to release extra water from the reservoir. Thus, the WSIP would have no

TABLE 5.3.4-4
AVERAGE MONTHLY CHANGES IN TUOLUMNE RIVER FLOW BELOW LA GRANGE DAM ATTRIBUTABLE TO THE WSIP
(cubic feet per second)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year Type
1983	-48	-31	43	0	0	0	0	-94	-46	-37	0	-38	Wet
1969	0	0	0	-549	-129	-106	-130	-84	-84	-37	0	0	Wet
1995	0	0	0	0	-339	-132	0	-211	-62	-37	0	-38	Wet
1938	0	0	-306	0	0	0	-154	-295	-84	-37	0	0	Wet
1998	0	0	0	-327	0	-112	-149	-40	-63	-37	0	0	Wet
1982	0	0	0	-453	-244	-15	0	-46	-46	-37	0	-75	Wet
1967	0	0	0	0	0	-354	-168	-133	0	-37	0	-38	Wet
1952	0	0	0	0	-219	-133	0	-346	-84	-37	0	0	Wet
1958	0	0	0	0	-405	-148	-102	-252	-48	-37	0	0	Wet
1980	0	0	0	76	0	-139	-84	-84	-84	-37	0	0	Wet
1978	0	0	0	0	0	0	0	0	-1,583	0	0	0	Wet
1922	0	0	0	0	-157	-95	-124	-92	-245	0	-11	-27	Wet
1956	0	0	-1,350	0	0	-71	-47	0	-223	-37	0	0	Wet
1942	0	0	0	-61	0	-62	-93	-46	-46	-37	0	0	Wet
1941	0	0	0	2	-9	-5	-8	0	-121	0	-11	-27	Wet
1986	0	0	0	0	-291	-463	-190	-84	-84	0	0	0	Wet
1993	0	0	0	0	0	0	0	0	-3,159	0	-275	-659	Wet
1997	0	-38	0	-196	0	0	0	0	0	0	0	0	Wet
1996	0	0	0	0	-65	0	-114	-37	-37	0	0	0	Wet
1943	0	0	0	0	0	-159	-84	0	-170	0	0	-38	Wet
1937	0	0	0	0	-268	-213	-60	0	0	0	0	0	Wet
1974	0	0	0	-186	0	-139	-93	-93	-74	0	0	-38	Wet
1975	0	0	0	0	0	0	-139	0	-2	0	-11	-27	Wet
1965	0	0	0	-1,630	-110	-219	-29	0	0	0	0	150	Wet
1936	0	0	0	0	-2,702	-1,935	-85	0	0	0	0	0	AN
1984	-98	0	0	0	0	64	0	0	0	0	0	0	AN
1979	0	0	0	-110	0	-325	-37	-37	0	0	0	0	AN
1945	0	0	0	0	-394	-488	-3	0	0	0	0	0	AN
1999	0	0	0	0	0	-186	-52	0	-273	0	0	0	AN
1963	0	0	0	0	0	0	0	0	0	0	0	0	AN
1927	0	0	0	0	0	0	0	0	-737	0	-10	-161	AN
1935	0	0	0	0	0	0	0	0	0	0	0	0	AN
1946	0	137	0	0	0	-215	-64	0	0	0	0	0	AN
1973	0	0	0	0	0	-513	-63	0	-474	0	0	0	AN
1932	0	0	0	0	0	0	0	0	0	0	0	0	AN
2000	0	0	0	0	-205	0	0	0	-248	0	0	0	AN
1940	0	0	0	0	-464	-317	-74	0	0	0	0	0	AN
1923	0	0	0	0	0	0	-37	0	0	0	0	0	AN
1921	0	0	0	0	-2	-256	-62	0	0	0	0	0	AN
1970	0	0	0	352	-128	-262	0	0	0	0	0	0	AN
1951	0	0	-2,021	0	0	0	0	0	0	0	0	0	AN
1962	0	0	0	0	0	0	0	0	0	0	0	0	BN
1953	0	0	0	0	0	0	0	0	0	0	0	0	BN
1957	0	0	0	0	0	0	0	0	0	0	0	0	BN
1925	0	0	0	0	0	0	0	0	0	0	0	0	BN
1971	0	0	0	0	-159	-97	0	0	0	0	0	0	BN
1950	0	0	0	0	0	0	0	0	0	0	0	0	BN
1944	0	0	0	0	0	0	0	0	0	0	0	0	BN
1954	0	0	0	0	0	0	0	0	0	0	0	0	BN
1948	0	0	0	0	0	0	0	0	0	0	0	0	BN
1928	-112	-526	-557	0	0	-87	-181	0	0	0	0	0	BN
1949	0	0	0	0	0	0	0	0	0	0	0	0	BN
1966	0	0	-71	0	-38	-99	0	0	0	0	0	0	BN
1933	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1981	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1985	0	0	0	0	0	0	0	0	0	0	0	0	Dry
2002	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1926	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1955	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1959	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1968	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1939	0	0	0	0	0	0	0	0	0	0	0	0	Dry
2001	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1964	-182	-832	-255	-295	-294	0	0	0	0	0	0	0	Dry
1947	0	0	0	0	0	0	0	0	0	0	0	0	Dry
1972	0	0	0	0	-313	0	0	0	0	0	0	0	Dry
1994	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1930	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1929	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1989	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1991	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1987	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1960	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1976	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1992	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1990	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1988	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1934	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1924	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1961	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1931	0	0	0	0	0	0	0	0	0	0	0	0	Critical
1977	0	0	0	0	0	0	0	0	0	0	0	0	Critical

NOTES: Hydrologic year types were determined based on DWR's San Joaquin River Basin Index.
Year Types: Wet, AN – Above Normal, BN – Below Normal, Dry, and Critical

SOURCE: SFPUC, HH/LSM (see Appendix H).

TABLE 5.3.4-5
RECORDED SAN JOAQUIN RIVER FLOW AT VERNALIS (1969–2002)
(cubic feet per second)

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
1983	8,179	6,974	16,494	19,068	31,604	40,035	36,447	31,771	26,083	19,227	9,035	11,310	Wet
1969	1,384	1,604	2,533	13,815	32,554	30,874	22,117	24,613	27,887	5,803	2,325	3,255	Wet
1995	1,370	1,288	1,295	4,599	6,559	14,612	19,933	22,187	14,011	9,881	3,925	4,734	Wet
1998	2,706	1,981	2,116	6,025	28,121	19,352	21,937	17,948	17,760	13,193	5,442	5,758	Wet
1982	1,386	1,564	1,852	3,889	6,645	10,062	22,963	18,654	7,584	6,163	4,017	6,129	Wet
1980	2,790	2,311	2,487	13,069	18,776	25,297	10,249	9,912	5,305	3,384	1,969	3,802	Wet
1978	246	430	506	2,276	7,319	11,475	20,030	19,119	7,069	1,908	1,418	2,730	Wet
1986	2,072	1,929	2,205	2,060	8,744	25,035	19,590	8,764	6,233	2,894	3,183	4,181	Wet
1993	849	956	982	4,120	3,035	2,702	3,421	3,610	2,341	1,510	1,998	2,771	Wet
1997	2,691	2,715	12,192	30,377	35,057	13,035	4,728	4,785	2,647	1,756	1,875	2,069	Wet
1996	5,692	2,428	2,250	2,431	11,473	15,071	7,500	8,422	3,739	2,209	2,034	2,164	Wet
1974	2,546	2,281	3,586	7,781	5,094	4,817	5,850	4,106	3,860	1,636	1,615	2,846	Wet
1975	3,497	3,891	4,162	3,766	6,212	5,685	3,957	3,972	5,708	1,718	1,680	2,652	Wet
1984	13,316	10,675	19,126	25,632	10,833	7,502	4,285	3,240	2,297	1,904	2,179	2,917	AN
1979	3,327	3,498	2,812	5,233	7,138	8,652	3,506	2,524	2,254	1,334	1,451	1,841	AN
1999	6,153	3,290	4,331	4,730	11,696	8,332	6,437	5,551	3,016	2,094	1,969	2,037	AN
1973	1,992	2,216	2,502	4,059	7,988	7,611	4,203	2,937	2,576	1,082	1,067	1,471	AN
2000	2,532	2,158	1,688	2,136	7,559	12,098	5,013	4,814	2,772	1,898	2,171	2,330	AN
1970	4,462	4,628	4,012	11,116	9,191	7,180	1,673	2,393	2,704	1,330	1,044	1,319	AN
1971	1,466	1,655	5,044	5,204	4,391	2,589	1,961	1,833	2,322	1,066	892	1,097	BN
1981	4,072	3,278	2,949	3,251	2,879	3,122	2,532	1,967	1,499	1,265	1,269	1,181	Dry
1985	3,814	2,822	4,771	4,065	3,241	2,736	2,466	2,132	1,748	2,557	2,601	1,925	Dry
2002	2,003	2,096	2,064	2,662	1,898	2,134	2,598	2,739	1,407	1,227	1,116	1,175	Dry
2001	2,826	2,526	2,238	2,442	3,092	3,430	3,008	3,527	1,549	1,400	1,330	1,376	Dry
1972	2,253	1,646	2,398	3,117	2,701	1,380	1,037	744	587	481	543	1,563	Dry
1994	3,041	1,759	1,628	1,773	1,987	2,206	1,863	1,973	1,109	1,135	867	869	Critical
1989	1,127	1,274	1,372	1,255	1,234	2,023	1,915	1,949	1,583	1,284	1,169	1,353	Critical
1991	993	1,115	918	816	758	1,779	1,168	1,049	568	594	537	574	Critical
1987	3,741	2,808	3,706	2,305	2,136	3,415	2,867	2,178	1,990	1,632	1,627	1,597	Critical
1976	4,543	3,906	3,745	3,326	2,115	1,823	1,293	939	798	671	1,055	1,067	Critical
1992	788	1,084	895	959	2,091	1,470	1,418	892	481	447	483	635	Critical
1990	1,401	1,404	1,381	1,242	1,365	1,760	1,309	1,279	1,116	1,009	1,033	876	Critical
1988	1,370	1,548	1,278	1,483	1,389	2,241	2,146	1,781	1,711	1,357	1,557	1,452	Critical
1977	1,274	1,136	965	1,091	789	524	212	400	118	93	124	179	Critical

NOTES: Hydrologic year types were determined based on DWR's San Joaquin River Basin Index. Flows in some years do not meet current flow objectives, because the flow objectives did not come into effect until 1999.
Year Types: Wet, AN – Above Normal, BN – Below Normal, Dry, and Critical

SOURCES: U.S. Geological Survey (http://waterdata.usgs.gov/nwis/sw).

effect on the availability of Stanislaus River water to the USBR and the water supply agencies that receive water from New Melones Reservoir, except possibly on rare occasions following protracted droughts.

As indicated in Table 5.3.4-4, in many years and during certain seasons, the WSIP would not alter flow in the Tuolumne River below La Grange Dam and would, in turn, have no effect on flow in the San Joaquin River. Thus, under these conditions, the WSIP would have no effect on water availability or quality at the intakes of water agencies and diverters that use San Joaquin River water. In some wet and above-normal years, the WSIP would have an effect on flow in the San Joaquin River between the confluence with the Tuolumne River and the confluence with the Delta. Because the changes in San Joaquin River flow would be small in most wet and above-normal years, and because the changes would occur in periods when flow in the river is at its seasonal maximum, the effects of the flow changes on water quality would also be small. Water quality is at its seasonal best during the period when the WSIP-induced changes in flow would occur, and thus the quality of water at water agencies' and irrigators' diversion points would not change appreciably. All water quality objectives would be met, and specifically by releases from New Melones Reservoir or other San Joaquin Valley Central Valley Project facilities, if such action were necessary.

The WSIP would have a less-than-significant impact on water quality and the availability of water at water agencies' and irrigators' diversion points on the Tuolumne, Stanislaus, and San Joaquin Rivers. Therefore, WSIP impacts on Tuolumne, Stanislaus, and San Joaquin River water users would be *less than significant*, and no mitigation measures would be required.

Impacts 5.3.4-2: Effects on Delta water users.

Changes in flow in the Tuolumne River below La Grange Dam attributable to the WSIP would affect Sacramento–San Joaquin Delta inflow. The Delta standards include flow objectives for Delta outflow, and outflow at times is required for maintenance of water quality objectives within the Delta. Reductions in Delta inflow attributable to the WSIP could make it necessary for the DWR and USBR, the agencies responsible for compliance with objectives for the Delta, to increase reservoir releases and/or decrease diversions at the Banks and Tracy Pumping Plants to meet the objectives. At other times, the DWR and USBR could be limited in their export capacity by an objective that relates allowable export to Delta inflow.

Table 5.3.4-4 shows the changes in releases from La Grange Dam attributable to the WSIP. The changes would be reflected downstream as a change in Delta inflow. As shown in the table, most of the changes in releases and the greatest changes in releases would occur in wet and above-normal years. Furthermore, most of the changes in releases would occur from February through June of the affected years, with an occasional occurrence during other months. When they occur, the changes in average monthly flows are usually in the hundreds of cubic feet per second.

Occasionally, changes are in the range of 1,000 cfs to a little over 3,000 cfs. The greatest changes would potentially occur infrequently during wetter years following protracted droughts.

The WSIP would increase the SFPUC's diversions from the Tuolumne River almost every year, which would result in a decrease in inflow to Don Pedro Reservoir almost every year. During protracted droughts, WSIP-induced reductions in storage in Don Pedro Reservoir would accumulate for several years. When the drought ends, a large volume of water would be needed to refill or partially refill Don Pedro Reservoir. Much or all of the winter and spring runoff would be retained in Don Pedro Reservoir, and only minimum required releases would be made below La Grange Dam. Under these fairly rare conditions, WSIP-induced reductions in flow in the Tuolumne River below La Grange and in the San Joaquin River compared to the existing condition would be in the range 1,000 to 3,000 cfs.

Delta inflow varies widely from year-to-year and depends on hydrologic conditions and the magnitude of diversions upstream of the Delta. Delta outflow depends on hydrologic conditions, the magnitude of diversions upstream of the Delta, and the magnitude of diversions within the Delta, including diversions by the State Water Project and Central Valley Project.

Certain objectives for Delta outflow are shown in Table 5.3.4-2. The table is not an exhaustive compilation of all requirements for flow, nor does it specify the amount of flow needed to meet water quality objectives for the Delta.

Compliance with Delta outflow objectives is the responsibility of the DWR and the USBR and is achieved by releasing water from reservoirs upstream of the Delta or by limiting pumping at the Banks and Tracy Pumping Plants. When Delta inflow exceeds the sum of the Delta outflow objectives and the water needs of the State Water Project, Central Valley Project, and other diverters, the Delta is regarded as in "excess conditions." When the Delta is in excess conditions, there are no limits on pumping as a result of the export limits that are a part of D-1641. Exports are limited to 35 percent of Delta inflow from February through June and to 65 percent of Delta inflow from July through January. When Delta inflow is generally equal to the sum of the Delta outflow objectives and the water needs of the State Water Project, Central Valley Project, and other diverters, the Delta is regarded as in "balanced conditions."

The Delta is typically in excess conditions from December through May and balanced conditions from June through November. However, Delta inflow can vary by a factor of 10 or more, so there is considerable year-to-year variability in the periods of excess and balanced conditions.

The WSIP would typically reduce Delta inflow in wet and above-normal years when the Delta is in excess conditions and Delta outflow is so great that the export limits do not limit pumping by the State Water Project and Central Valley Project. Under these conditions, the WSIP would reduce Delta inflow and outflow by the same amount, but would have no effect on the State Water Project's and Central Valley Project's ability to pump water from the Delta. There could be rare occasions when the WSIP would reduce Delta inflow during excess conditions but when the export limits do affect pumping by the State Water Project and Central Valley Project. Under these conditions, the WSIP would reduce Delta outflow and could potentially reduce pumping by the State Water Project and Central Valley Project by 35 percent of the WSIP-induced reduction in Delta inflow. However, the State Water Project and Central Valley Project may choose to comply with the export limits by releasing more water from upstream reservoirs rather than by limiting pumping.

In the winter and spring of wet and above-normal years, when the effects of the WSIP on Delta inflow would be felt, Delta outflow would typically be in the range of 13,000 to 63,000 cfs. In almost all cases, the reduction in Delta ouflow attributable to the WSIP would be less than 500 cfs, a small proportion of total outflow. In very rare circumstances, during a wetter year that follows a multi-year drought period (six or more years), the WSIP-induced reduction in Delta inflow would be greater than 500 cfs, in the range 1,000 to 3,000 cfs.

When the Delta is in balanced conditions, the DWR and USBR must balance reservoir releases and pumping at the Banks and Tracy Pumping Plants in order to meet the Delta objectives. There could be occasions between June and September during some wet and above-normal years when WSIP-induced reductions in Delta inflow would occur during balanced conditions in the Delta. Under these rare circumstances, the State Water Project and Central Valley Project would have to increase releases from upstream reservoirs or curtail pumping in order to meet flow objectives for the Delta.

WSIP-induced decreases in Delta inflow would not lead to violations of Delta objectives. The State Water Project and Central Valley Project, the parties responsible for compliance with Delta standards, would react to changes in Delta inflow and ensure that the standards were met. WSIP-induced decreases in Delta inflow would not necessarily lead to reductions in water deliveries by the State Water Project and Central Valley Project. Table 5.3.4-4 shows the reductions in flow below La Grange Dam attributable to the WSIP, which would also be reflected as WSIP-induced reductions in Delta inflow. The inflow difference that would occur when the Delta is in balanced conditions and when pumping might be curtailed to comply with export limits would typically amount to an annual volume of 20,000 acre-feet, a small fraction of the average annual Delta inflow of about 21 million acre-feet. A WSIP-induced reduction in Delta inflow would likely be compensated for by releases from upstream reservoirs. In any particular year, the Delta inflow difference attributable to the WSIP would contribute to an increase in risk to water deliveries in a subsequent year, and would only be realized in a series of dry years.

Given the very small magnitude and low frequency of potential effects on Delta flows, the impact of the WSIP on water availability and quality at water agencies' and other diverters' diversion points in the Delta would be *less than significant*, and no mitigation measures would be required.

[Additional discussion on Delta water users was prepared in response to comments on the Draft PEIR. Please refer to Section 14.8, Master Response on Delta and San Joaquin River Issues (Vol. 7, Chapter 14).]

References – Surface Water Supplies

State Water Resources Control Board (SWRCB), *Water Quality Control Plan for San Francisco Bay/Sacramento–San Joaquin Delta Estuary*, 1995.

5.3.5 Groundwater

The following setting section identifies groundwater bodies in the Tuolumne River watershed that could be affected by the WSIP; they include those that are hydraulically connected to the Tuolumne River and its tributaries. The impact section (Section 5.3.5.2) provides a description of the changes in groundwater levels and quality that would result from WSIP-induced changes in stream flow.

5.3.5.1 Setting

The Tuolumne River flows from the crest of the Sierra Nevada westward to its confluence with the San Joaquin River. The San Joaquin River flows north to the Sacramento–San Joaquin Delta. The Tuolumne River system and downstream water bodies are shown in Figure 5.3.1-1. Unless otherwise designated by the California Regional Water Quality Control Board, all groundwaters in the Central Valley region are considered to be suitable or potentially suitable, at a minimum, for municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply.

From Hetch Hetchy Reservoir to Don Pedro Reservoir, the Tuolumne River flows through a deep canyon in mountainous terrain. The hydrogeologic units underlying the river exhibit low permeability. There are no large groundwater bodies along this reach of the river. Below Don Pedro Reservoir, the Tuolumne River flows through the Sierra Nevada foothills and on to the floor of the San Joaquin Valley. Permeable hydrogeologic units of the San Joaquin Valley Groundwater Basin underlie the foothills and valley floor.

This section is focused on the effects of WSIP-induced flow and water quality changes on groundwater bodies along the reach of the Tuolumne River between La Grange Dam and the confluence with the San Joaquin River. As described in Section 5.3.1, the proposed program would alter flows and water quality in the Tuolumne River and, to a lesser extent, in the San Joaquin River and Delta. Because a dynamic balance exists between rivers and the groundwater basins they flow through, changes in river flow can affect groundwater levels and quality. The San Joaquin Valley Groundwater Basin is bounded on the west by the Coast Ranges, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada, and on the north by the Delta and Sacramento Valley. Within this basin, the Modesto Groundwater Subbasin lies between the Stanislaus River to the north, the Tuolumne River to the south, the San Joaquin River to the west, and the Sierra Nevada to the east. The Turlock Groundwater Subbasin shares the east and west boundaries with the Modesto Groundwater Subbasin, with the Tuolumne River forming the northern boundary and the Merced River forming the southern boundary (USGS, 2004).

Modesto Groundwater Subbasin

The Modesto Subbasin covers approximately 385 square miles, with lands primarily in the Modesto Irrigation District (MID), Oakdale Irrigation District, and the city of Modesto. The aquifer system is complex; primary hydrogeologic units include both consolidated and unconsolidated sedimentary deposits. The consolidated deposits lie in the eastern portion of the subbasin and include the Ione, Valley Springs, and Mehrten Formations; of these three, the Mehrten Formation is a high-yielding aquifer. Unconsolidated deposits include continental and alluvium deposits and are the main water-yielding units; Corcoran Clay separates older and younger alluvium, with generally unconfined conditions above and confined conditions below.[1] Groundwater recharge is primarily from deep percolation of applied irrigation water, canal seepage from irrigation facilities, seepage from Modesto Reservoir, and precipitation. The primary groundwater discharge is from extensive pumping for agricultural and municipal uses. Groundwater flow is primarily to the southwest; on average, water levels within the subbasin declined nearly 15 feet from 1970 through 2000 (DWR, 2003).

In general, groundwater quality is suitable for most urban and agricultural uses but is subject to some impairment. Total dissolved solids levels typically range from 200 to 500 milligrams per liter, with substantially higher levels along the east side of the subbasin (DWR, 2003). Other water quality impairment results from elevated levels of radionuclides, pesticides (especially dibromochloropropane, or DBCP), volatile organic compounds, hardness, chlorides, boron, nitrate, iron, and manganese. Localized areas of contamination from gasoline and solvents are also present (Stanislaus and Tuolumne Rivers Groundwater Basin Association, 2005).

Groundwater wells provide approximately 60 percent Modesto's municipal water supply; the remainder is provided by treated surface water from the Tuolumne River. As of 2000, the City operated 118 municipal wells, although several wells had been taken out of service due to water quality concerns (City of Modesto, 2000). The City has calculated its municipal safe yield from the groundwater basin to be 50,000 acre-feet per year.

Turlock Groundwater Subbasin

The Turlock Subbasin covers an area of about 542 square miles and includes lands in the city of Turlock, the Turlock Irrigation District (TID), the Ballico-Cortez Water District, the Eastside Water District, and a small portion of the MID. In general, the characteristics of the Turlock Subbasin are similar to those in the Modesto Subbasin. On average, water levels in the subbasin declined nearly 7 feet between 1970 and 2000 (DWR, 2003).

The City of Turlock obtains its drinking water from the lower confined aquifer, beneath the Corcoran Clay, and presently meets all municipal demands from groundwater wells. The City plans to develop additional sources of supply in the future, which could include using recycled wastewater, withdrawing water from the shallow unconfined aquifer for sub-potable uses, constructing new wells, and purchasing treated water from TID for potable uses (City of Turlock, 2005).

Tuolumne River/Groundwater Interaction

Based on groundwater-level monitoring data, the Tuolumne River is generally a "gaining" river[2] for most of its length between La Grange Dam and its confluence with the San Joaquin River. However, this situation is reversed for an approximately five-mile-long reach near central

[1] The permeable materials that surround an unconfined aquifer allow the water table to fluctuate in response to recharge (precipitation in the wet season) and discharge (evapotranspiration in the dry season). A confined aquifer lies below impermeable materials and, as a result, is not recharged directly from above.
[2] A gaining river receives water from the groundwater.

Modesto, where a pumping depression has formed; and this reach is considered a "losing" reach[3] (Stanislaus and Tuolumne Rivers Groundwater Basin Association, 2005). The gaining and losing reaches likely change depending upon the season and hydrologic year type.

Beneficial Uses and Water Quality Objectives

The Central Valley Regional Water Quality Control Board, which has regulatory authority over water bodies in the Central Valley watershed, has prepared the *Water Quality Control Plan* (Basin Plan) to implement plans, policies, and other provisions for water quality management. The Basin Plan establishes beneficial uses for the groundwater basin; these include Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), Industrial Service Supply (IND), and Industrial Process Supply (PRO) (SWRCB, 1995).

5.3.5.2 Impacts

Significance Criteria

The City and County of San Francisco has not formally adopted significance standards for impacts related to groundwater, but generally considers that implementation of the proposed program would have a significant groundwater impact if it were to:

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)
- Substantially impair a water body's ability to support beneficial uses designated by the State Water Resources Control Board or Regional Water Quality Control Board
- Otherwise substantially degrade water quality

Approach to Analysis

Information on potentially affected groundwater bodies was obtained from published sources and through interviews with individuals who are knowledgeable about the hydrogeology of the area or involved with groundwater management in the potentially affected area. Impact assessments were performed by reviewing WSIP-induced changes in stream flow and examining their potential to affect groundwater levels or quality.

Impact Summary

Table 5.3.5-1 presents a summary of the impacts on groundwater bodies in the Tuolumne River watershed that could result from implementation of the proposed water supply and system operations.

[3] A losing river reach loses water to the groundwater.

TABLE 5.3.5-1
SUMMARY OF IMPACTS – GROUNDWATER BODIES IN THE TUOLUMNE RIVER WATERSHED

Impact	Significance Determination
Impact 5.3.5-1: Alteration of stream flows along the Tuolumne River, which could affect local groundwater recharge and groundwater levels	LS
Impact 5.3.5-2: Alteration of stream flows along the Tuolumne River, which could affect local groundwater quality	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.5-1: Alteration of stream flows along the Tuolumne River, which could affect local groundwater recharge and groundwater levels.

At present, the reach of the Tuolumne River below La Grange Dam generally gains flow for most of its length, except for the reach in the vicinity of Modesto, where a groundwater pumping depression exists, causing the river to lose flow. The proposed program would result in lowered stream flows in the Tuolumne River in the winter and spring, as compared to existing conditions and described in Section 5.3.1. This means that there could be a slight increase in groundwater discharge to the river in the areas where the river is gaining flow, due to the slight drop in surface water level. Correspondingly, there would be a slight reduction in the loss of stream flow to the groundwater basin in the vicinity of Modesto, where a pumping depression exists. This effect would be minor, and effects on groundwater levels would be limited to the shallow, unconfined aquifer in the vicinity of the river, which is not used as a source of municipal water supply. In addition, these effects could largely cancel each other out, as discharge of groundwater to the river would be increased in some reaches, and percolation to shallow groundwater would be increased in another. The WSIP would have little or no effect on groundwater levels and would not affect the production rate of existing wells in the vicinity. Overall, considering the scale of water resource development in the area, the withdrawals for agricultural and municipal supply, and variations in the hydrologic cycle, the effects of the WSIP on groundwater levels and groundwater recharge would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.5-2: Alteration of stream flows along the Tuolumne River, which could affect local groundwater quality.

As described above, any effects on groundwater would be slight and would be limited to the shallow, unconfined aquifer in the vicinity of the bed of the Tuolumne River; this aquifer is not used as a source of municipal water supply, but rather for agricultural or other sub-potable uses. As such, any effects on groundwater quality are expected to be minimal, and no adverse effects on any identified beneficial uses of the groundwater basin would occur. The effects of the WSIP on local groundwater quality in groundwater bodies adjacent to the Tuolumne River below La Grange Dam would be *less than significant*, and no mitigation measures would be required.

References – Groundwater

California Department of Water Resources (DWR), *Bulletin 118: California's Groundwater*, Updated October 2003.

City of Modesto, *2000 Urban Water Management Plan*, 2000.

City of Turlock, *Urban Water Management Plan*, 2005.

Stanislaus and Tuolumne Rivers Groundwater Basin Association, *Integrated Regional Groundwater Management Plan*, Final Draft, June 2005.

State Water Resources Control Board (SWRCB), *Water Quality Control Plan for San Francisco Bay/Sacramento–San Joaquin Delta Estuary*, 1995.

U.S. Geological Survey (USGS), *Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California*, Scientific Investigations Report 2004-5232, 2004.

5.3.6 Fisheries

The following setting section describes the fisheries resources in the Tuolumne River watershed that could be affected by the WSIP. The impact section (Section 5.3.6-2) provides a description of the changes in fisheries resources that would result from WSIP-induced changes in stream flow and reservoir water levels.

5.3.6.1 Setting

The Tuolumne River flows from the crest of the Sierra Nevada westward to its confluence with the San Joaquin River. The San Joaquin River flows north to the Sacramento–San Joaquin Delta. Water from the Delta discharges to the San Francisco Bay Estuary and the Pacific Ocean. The Tuolumne River system and downstream water bodies are shown in Figure 5.3.1-1 in Section 5.3.1, Stream Flow and Reservoir Water Levels.

Because the WSIP would affect flows in the Tuolumne River (as discussed in Section 5.3.1), this section examines potential effects on the aquatic resources in the Tuolumne River between Hetch Hetchy Reservoir and the San Joaquin River, the San Joaquin River itself, and the Sacramento–San Joaquin Delta. This analysis examined the aquatic habitats of the three tributary streams (Cherry, Eleanor, and Moccasin Creeks) as well as water storage in several reservoirs (Hetch Hetchy Reservoir, Lake Lloyd, Lake Eleanor, and Don Pedro Reservoir) that feed the Tuolumne River; hydrologic and operational modeling indicates that the WSIP would not affect Moccasin or Eleanor Creeks, and that the effects on Cherry Creek would be minimal to none.

The headwaters of the Tuolumne River are at an elevation of approximately 13,000 feet above mean sea level. As the river moves downstream from the headwaters, it flows westerly across the Tuolumne Meadows in Yosemite National Park and into Hetch Hetchy Valley. The upper Tuolumne River in the reach downstream of Hetch Hetchy Reservoir is a high-elevation, relatively steep-gradient river located on the western slope of the southern Sierra Nevada mountains.

Tuolumne River Between Hetch Hetchy and Don Pedro Reservoirs

General Description of Aquatic Habitat

In 1923, the Hetch Hetchy Valley was dammed by O’Shaughnessy Dam, which created Hetch Hetchy Reservoir. Downstream of O’Shaughnessy Dam, the Tuolumne River is characterized by a series of pools, cascades, riffles,[1] and pocket water (USFWS, 1992a). The river passes through an extremely deep gorge downstream of Poopenaut Valley and flows to the upper reaches of Don Pedro Reservoir.

Flow in the Tuolumne River is regulated, to a large extent, by operations of Hetch Hetchy Reservoir and minimum stream flow releases from O’Shaughnessy Dam. The hydrology of the river downstream of Hetch Hetchy Reservoir is characterized by relatively stable releases

[1] A stretch of choppy water caused by stones or other objects in a river or stream.

between the fall and spring, followed by a substantial increase in flow during the late spring and summer months (May–July) in response to snowmelt runoff. The SFPUC makes minimum releases from Hetch Hetchy Reservoir to support resident fisheries downstream of O'Shaughnessy Dam (see Table 5.3.1-2, Section 5.3.1). The SFPUC has initiated a fishery monitoring program within the river to assess potential effects of project operations on habitat quality and availability for resident trout and other fish species that over time will provide additional site-specific information on the effects of seasonal and interannual variation in stream flows on fishery populations inhabiting the river (Hanson, 2007).

Flows in the Tuolumne River downstream of its confluence with Cherry Creek are manipulated during the summer months to provide sufficient flow for whitewater rafting. The SFPUC releases pulses of water from Lake Lloyd via Holm Powerhouse to support rafting for several hours on most summer days. Short-duration increases and decreases in flows associated with whitewater rafting influence habitat conditions for resident trout and may affect the vulnerability of trout and other fish to stranding and habitat displacement as flows quickly change within the reach. Because the releases for whitewater rafting would be the same with and without the proposed program, this section does not evaluate the effects of flow fluctuations on habitat selection, habitat quality, growth, and survival, or associated effects on the macroinvertebrate community that trout rely on as a primary food resource.

Resident Fish and their Habitat

The Tuolumne River downstream of Hetch Hetchy Reservoir supports a resident community of fish, including rainbow trout, brown trout, California roach, sculpin, and suckers (USFWS, 1992b). The USFWS (1990; cited in USFWS, 1992b) conducted fishery surveys within the river and estimated that approximately 7,000 adult rainbow and brown trout inhabited the 12.1-mile reach between O'Shaughnessy Dam and Early Intake. Field observations within the river made at various times between October 20, 1987 and June 14, 1990 have confirmed successful reproduction, rearing, and maintenance of adult populations of both rainbow and brown trout.

The USFWS (1992b) documented the preliminary results of an instream flow field study designed to provide information on the relationship between habitat and instream flows for various life-history stages of rainbow and brown trout. Rainbow trout spawning within the Tuolumne River downstream of Hetch Hetchy Reservoir occurs primarily between mid-February and mid-June, with juvenile emergence occurring from about mid-March to early July. Juvenile and adult rearing occurs within the river throughout the year. Brown trout spawning occurs primarily in November and December, with juvenile emergence between April and September followed by juvenile and adult rearing throughout the year. In developing release recommendations, the USWFS considered the seasonal timing of spawning activity and other life-history stages within the river as well as the effects of seasonal water temperatures on habitat suitability for trout.

As part of the stream flow study, the USFWS identified 12 habitat types within the river reach extending from O'Shaughnessy Dam downstream to Early Intake, which included deep pools, shallow pools, pocket waters, cascades, cascades/deep pools, cascades/pocket waters, chutes, riffles, runs, glides, side channels, and backwaters. Among the habitat types, deep pools, shallow pools, pocket waters, runs, riffles, and cascades/pocket water represented 93.9 percent of the total habitat surveyed. Steep-gradient, high-velocity cascades, chute habitats, and a combination of cascades/deep pool habitats represented 4.6 percent of the river reach surveyed. Low-gradient glides, side channels, and backwater habitats represented 1.5 percent of the river habitat area. The results of habitat typing are characteristic of high-gradient, high-elevation Sierra streams and rivers that support populations of trout and other resident species. Among the habitat types observed within the river, deep pools, runs and riffles, and pocket waters are typically the most suitable for resident trout, and these habitat types were present in a majority of the reaches surveyed. The stream flow study did not identify physical habitat as a major limiting factor, although seasonal water temperatures were identified as a factor affecting both brown and rainbow trout within the river.

The quality and suitability of habitat for resident trout depend on various environmental factors, including seasonal stream flow, stream gradient, stream cover, habitat diversity and complexity, water depths, water velocities, and water quality. Trout are coldwater fishes; therefore, seasonal water temperatures within many stream and river systems in California affect habitat suitability. Optimum water temperatures for juvenile and adult trout growth are typically 13 to 21 °C. Trout experience increasing levels of stress, reduced growth rates, increased susceptibility to disease, and, under severe conditions, mortality within the temperature range of 21 to 28 °C. Water temperatures in excess of 28 °C are unsuitable for trout. Incubating trout eggs are more sensitive to elevated water temperatures than either juvenile or adult trout; suitable temperatures for trout egg incubation are approximately 8 and 18 °C, with mortality increasing rapidly at higher temperatures.

Water temperatures within the Tuolumne River between Hetch Hetchy and Don Pedro Reservoirs during the summer months (June–July) have been observed to exceed the maximum daily temperatures of 21 °C, although nighttime temperatures during the summer months are lower. Winter water temperatures are typically low and may be limiting successful egg incubation and hatching for brown trout, which spawn during the winter. The recommended instream flows developed by the USFWS (1992b) therefore included consideration of both physical habitat and seasonal water temperatures.

Tuolumne River Tributaries and Lakes: Hetch Hetchy Reservoir to Don Pedro Reservoir

The rivers, lakes, and reservoirs within the Sierra Nevada provide habitat for a diverse assemblage of native and introduced fish species. Moyle et al. (1996) report that 40 species of native fish inhabit the range, of which 22 are reported for the Sacramento–San Joaquin drainage. The abundance, species composition, and geographic distribution of fish within the watersheds have been influenced by a number of factors. The construction and operation of water impoundments designed for water supply, flood protection, and hydroelectric power generation have affected hydrologic conditions within many of these watersheds as well as modified fishery habitat and limited migration and movement of fish from one part of the watershed to another. The introduction of non-native species, many of which were planted in watersheds to support recreational fisheries, has resulted in substantial changes to the fishery communities. The production and planting of fish, such as various species of trout, to support local recreational fisheries has also affected the aquatic communities within many areas of the upper Tuolumne River watershed and elsewhere within the range. Inventories of fish species inhabiting the water bodies between Hetch Hetchy and Don Pedro Reservoirs have been fairly limited in recent years; the fish surveys that were conducted have been primarily limited to direct visual observations (Knapp and MSI, 1996). Fish species found in the Tuolumne River watershed above La Grange Dam are listed in **Table 5.3.6-1**.

Hetch Hetchy Reservoir, Lake Lloyd, and Lake Eleanor

Although a variety of fish inhabit the Tuolumne River upstream of and within Hetch Hetchy Reservoir, various species of trout that support local recreational fisheries have received the greatest attention. Rainbow trout, brown trout, and eastern brook trout have been reported to inhabit Hetch Hetchy Reservoir (Johnston, 1985). Resident trout within the upper watershed and reservoir include fish planted from hatchery production to support local recreational fisheries. The condition of the trout populations upstream of Hetch Hetchy Reservoir prior to the completion of O'Shaughnessy Dam is unknown, except that the populations are thought to have included both hatchery plantings and native stocks (Snyder, 1993). It is unclear whether or not anadromous[2] salmon or steelhead historically migrated upstream through the Hetch Hetchy reach of the river prior to the construction of the dam, since a number of natural impediments and barriers to passage exist within the watershed that are thought to have prevented access to upstream habitats (Snyder, 1993).

Similarly, it is unclear whether rainbow trout were native to the Hetch Hetchy Reservoir area prior to the construction of O'Shaughnessy Dam. While historical literature suggests that rainbow trout are native, other sources indicate that trout planting during the 19th century resulted in a population that would otherwise not exist (Moyle, 1976). It is also possible that impediments to passage may have prevented the migration of steelhead/rainbow trout upstream to the Hetch Hetchy Reservoir site on the Tuolumne River but that such impediments were not present on the Merced River, thus enabling rainbow trout to establish themselves in Yosemite (Moyle, 1999; cited in Cherrigan, 1999). Waterfalls just below the Hetch Hetchy Reservoir site would have prevented the upstream migration, and other sources have noted that this reach of the Tuolumne River was fishless (Muir, 1902).

Lake Eleanor, which was completed in 1917, is located on Eleanor Creek and is hydraulically connected to Lake Lloyd. Surveys of the lake conducted by the CDFG in the 1960s and 1970s indicated the presence of suckers, brown trout, rainbow trout, and sunfish, among other species. The fish population within Lake Eleanor probably parallels that at Cherry Lake due to its hydraulic connection (CDFG, 2006b), although recent published data on fisheries at these reservoirs are limited (Knapp and MSI, 1996).

[2] Anadromous fish species migrate from the ocean to spawn in freshwater streams and rivers.

TABLE 5.3.6-1
FISH SPECIES KNOWN TO INHABIT TUOLUMNE RIVER TRIBUTARIES, HETCH HETCHY AND DON PEDRO RESERVOIRS, LAKE LLOYD, AND LAKE ELEANOR[a]

			Reservoirs				Tributaries (Upper Tuolumne River)		
Common Name	**Scientific Name**	**Native (N) Introduced (I)**	**Don Pedro Reservoir**	**Hetch Hetchy Reservoir**	**Lake Lloyd**	**Lake Eleanor**	**Cherry Creek**	**Moccasin Creek**	**Eleanor Creek**
Rainbow trout/steelhead	*Oncorhynchus mykiss*	?[b]	x	x	x	x	x	x	x
German brown trout	*Salmo trutta*	I	x	x	x	x		x	x
Eastern brook trout	*Salvelinus fontinalis*	I	x	x	x	x		x	
Golden trout[c]	*Oncorhynchus aguabonita*	I			x	x			
Lake trout	*Salvelinus namaycush*	I			x	x			
Largemouth bass	*Micropterus salmoides*	I	x						
Smallmouth bass	*Micropterus dolomieu*	I	x						
Sacramento sucker	*Catostomus occidentalis*	N			x	x	x	x	x
Green sunfish	*Lepomis cyanellus*	I	x						
Black crappie	*Pomoxis nigromaculatus*	I	x						
Bluegill	*Lepomis macrochirus*	I	x						
Golden shiner	*Notemigonus crysoleucas*	I	x		x	x			
Threadfin shad	*Dorosoma petenense*	I	x						
Riffle sculpin	*Cottus gulosus*	N					x		
California roach	*Lavinia symmetricus*	I					x		
Coho salmon	*Oncorhynchus kisutch*	I	x						
King (Chinook) salmon	*Oncorhynchus tschywstcha*	I	x[d]						
Kokanee salmon	*Oncorhynchus nerka*	I	x		x	x			
Channel catfish	*Ictalurus punctatus*	I	x						

NOTE: Fish populations in the interconnected Lake Lloyd and Lake Eleanor are known to be the same (CDFG, 2006b).

a This table is principally based on unpublished CDFG data.
b It is not clear whether the California-native steelhead/rainbow trout was introduced to the area or planted early on to establish a fish population.
c Among the fish species present in the watershed, only golden trout has been identified by the CDFG as a species of special concern.
d Don Pedro Reservoir is regularly planted with hatchery-reared Chinook salmon.

SOURCES: Bacher, 1999; CDFG, 2006a, 2006b; USDA, 2007.

Lake Lloyd is located on Cherry Creek. The principal fish species found in Lake Lloyd include rainbow trout, brown trout, and brook trout (CDFG, 1987; Dirksen and Reeves, 1990; DWR, 1993). Golden shiner, green sunfish, and an abundance of Sacramento sucker also inhabit the lake. Salmon are probably not present in Lake Lloyd today—previous populations of salmon were a product of hatchery planting that occurred until the 1970s to support local recreational fisheries in the lake. Salmon were documented in the lake during gillnet surveys conducted by the CDFG in the 1960s and 1970s (CDFG, unpubl. data; CDFG, 2006b).

Eleanor and Cherry Creeks

Cherry Creek, a tributary to the main stem Tuolumne River about one mile below Early Intake, has a fishery population comprised mostly of rainbow trout (CDFG, 2006a). It has been hypothesized that Cherry Creek may have provided habitat for historical populations of steelhead and/or spring-run Chinook salmon. Major dams and reservoirs downstream within the Tuolumne River currently prevent anadromous fish such as steelhead and salmon from accessing the upper parts of the watershed. Sacramento sucker, riffle sculpin, and California roach have been observed during stream surveys between Early Intake and Preston Falls and have been observed within Cherry Creek as well, particularly in the reaches closest to the confluence of the Tuolumne River where water temperatures become warmer (CDFG, 2006a).

Eleanor Creek fish populations are mostly comprised of brown trout and rainbow trout (CDFG, 2006a). The creek is not stocked, although a hatchery was operated on Frog Creek until the 1950s. The trout raised in the hatchery originated from Lake Eleanor (CDFG, 2006a). Suckers, sculpin, and roach may also be present in Eleanor Creek and would be expected to occur in greater abundance farther downstream towards the confluence of Cherry Creek, where water temperatures become slightly warmer.

Moccasin Creek

Moccasin Creek, a tributary located downstream from the confluence of the Tuolumne River and Cherry Creek, has a fishery community consisting of California roach, Sacramento sucker, sculpin, and rainbow trout (CDFG, unpubl. data). Moccasin Creek is stocked with hatchery-reared rainbow trout on a weekly basis during trout season to support a local recreational fishery, and is considered a popular angling location (CDFG, 2006a). Each year this hatchery raises more than 1 million catchable rainbow trout, which are then planted in 40 heavily fished lakes and streams in the region. This hatchery also produces more than 1 million trout fingerlings for aerial planting in alpine lakes (Moyle et al., 1996).

Don Pedro Reservoir

The principal fish species in Don Pedro Reservoir are game fish, including trout (e.g., rainbow, brown, and brook trout), catfish, bluegill, crappie, sunfish, coho salmon, king and kokanee salmon, and largemouth and smallmouth bass (CDFG, 1987; Dirksen and Reeves, 1990; DWR, 1993). The salmon fishery population supports a local recreational fishery within the reservoir based on annual stocking conducted by the CDFG. Salmon species such as kokanee salmon (landlocked sockeye salmon) have proven sustainable through ecosystem management, including successful reproduction by the reservoir population. Threadfin shad and plankton also exist in abundant quantities in the lake. No special-status species are known to inhabit the reservoir (TID, 2005).

Species Life Histories

Steelhead/Rainbow Trout (*Oncorhynchus mykiss*).[3] Anadromous trout populations can convert to the resident form when drought events or the damming of rivers block their access to the ocean. Conversely, resident trout populations can become anadromous if ocean access becomes available. It is typical for both life-history patterns to occur in the same stream, and anadromous parents can produce offspring of both varieties. It has been speculated that a food-availability-related trigger determines whether a particular fish will emigrate to the ocean or remain in the stream; according to this hypothesis, if there is abundant food in the stream and a fish is growing at a rapid rate, it may remain in the stream. If food is limited and growth is slow, the fish will have a tendency to emigrate. A variety of biological and environmental factors, in addition to food supply, affect the migratory patterns and life history of steelhead/rainbow trout within a river.

This dual life-history pattern of steelhead and rainbow trout makes the species more adaptable to changing environmental conditions. At the southernmost limits of steelhead distribution, this adaptability is particularly important due to the unstable, variable climatic and hydrologic conditions.

Most steelhead spawn from December through April in small streams and tributaries where cool, well-oxygenated water is available year-round. The female selects a site with gravel substrate where there is good flow through the gravel. She digs a nest, called a redd, and deposits eggs, which the male then fertilizes. These eggs are covered by gravel and cobbles when the female excavates another redd slightly upstream.

The length of time it takes for eggs to hatch is heavily dependent on water temperature. In hatcheries with carefully controlled conditions, steelhead eggs hatch after 30 days at a temperature of 11 °C. The optimal temperature for egg incubation is between 7 and 10 °C. Eggs hatch sooner in warmer water, but the young fish are smaller and generally have lower survival rates. If the temperature goes too high, eggs will not hatch at all. After hatching, the developing steelhead (called “alevins”) remain in the gravel for another four to six weeks. During this time, they obtain nutrients from a yolk sack attached to their body. When they emerge from the gravel, they are called fry, and are able to catch their own food.

Newly emerged fry move to shallow, protected areas of the stream (usually in the stream margins). They establish and defend feeding areas. Most juveniles can be found in riffles, although larger ones will move to pools or deep runs.

Resident rainbow trout support one of the most popular recreational fisheries within lakes and streams in the higher elevation areas of California. Because of the popularity of this species, the

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3 Rainbow trout and steelhead are the same species of trout (*Oncorhynchus mykiss*). Rainbow trout spend their whole life in freshwater; steelhead spend much of their life in the ocean but return to freshwater to spawn.

CDFG produces juvenile, sub-catchable, and catchable rainbow trout in hatcheries and plants them in lakes, reservoirs, and streams, primarily during the spring, summer, and fall. Rainbow trout are also able to successfully reproduce in many of the streams and lakes where water temperatures and other environmental conditions are suitable.

German Brown Trout (*Salmo trutta*). Brown trout live in cold or cool streams, rivers, lakes, and impoundments and are known to be more tolerant of siltation and higher water temperatures than a species such as brook trout. They are also somewhat tolerant of acidity and are adaptable to stream changes.

Brown trout prefer temperatures similar to those preferred by rainbow trout, with upper tolerance limits of about 24 to 27 °C. Lower critical levels for trout are not as well known and tend to vary based on acclimation, exemplified by studies showing that hatchery-reared salmon tend to prefer warmer temperatures, perhaps due to hatchery conditions.

Brown trout spawn in the fall and early winter, a little later than brook trout, when water temperatures are in the mid- to high 40s. Eggs are deposited in a stream gravel depression that the female prepares with swimming actions of her fins and body. Large females produce 4,000 to 12,000 eggs. Several males may accompany the female during spawning. The eggs hatch the following spring, with no parental attention. Brown trout eat aquatic and terrestrial insects, crayfish and other crustaceans, and especially fish. The big ones may also eat small mammals (like mice), salamanders, frogs, and turtles. Large brown trout feed mainly at night, especially during the summer. Their life span in the wild can be 10 to 12 years. Brown trout support a popular recreational fishery.

Eastern Brook Trout (*Salvelinus fontinalis*). Brook trout, an introduced species in California, originated from northeastern America (Knapp and MSI, 1996). Brook trout range in size from 5 to 8 inches in length and usually spawn between September and December. The females lay eggs in the gravel of coldwater streams, such as in the mountains. After hatching, young brook trout feed on zooplankton, while adult fish feed mainly on insects and aquatic invertebrates. Adults also tend to eat small frogs, fish, and snails. Brook trout generally do not live past the age of four. Brook trout are a popular recreational species.

Golden trout (*Oncorhynchus aguabonita*). Wild naturally reproducing populations of golden trout inhabit the Sierran streams. Golden trout are also raised in hatcheries, and most fish are released in selected water bodies during the spring. Some fish are kept in the hatcheries for broodstock. Anglers fishing for golden trout typically use bait such as worms small spinner baits and flies.

Largemouth Bass (*Micropterus Salmoides*). Largemouth bass (commonly known by anglers as black bass) eat minnows, carp, and practically any other available fish species including their own. Young largemouth fall prey to larger bass, crappie, bluegill, and other predatory fish. Both largemouth and smallmouth bass are parasitized by the bass tapeworm, black spot, and yellow grub, none of which pose a threat to human health.

Largemouth bass live in shallow water habitats among reeds, water lilies, and other vegetation; they are adapted to warm waters of 27 to 28 °C and are seldom found deeper than 20 feet. They prefer clear waters with no noticeable current and do not tolerate excessive turbidity and siltation. In winter they dwell on or near the lake bottom, but stay fairly active throughout the season.

Like smallmouth bass, largemouth bass spawn in late spring or early summer. The male constructs a nest on rocky or gravelly bottoms, although occasionally the eggs are deposited on leaves and rootlets of submerged vegetation. The eggs, which are smaller than those of the smallmouth bass, hatch in three to four days. The fry rise up out of the nest in five to eight days and form a tight school. This school feeds over the nest and later the nursery area while the male stands guard. The school breaks up about a month after hatching, when the fry are about an inch long. Largemouth bass support an active recreational fishery in lakes and reservoirs.

Smallmouth Bass (*Micropterus dolomieu*). Smallmouth bass prefer deep, cool water lakes, cool streams, and gravel substrate habitat. Smallmouth bass spawn in spring; when water temperatures approach 16 °C, males move into spawning areas. Nests are usually located near the shore in lakes, or downstream from boulders or some other obstruction that offers protection against strong currents in streams. Hatching time is typically about 10 days if water temperatures are around 10 °C, but fish can hatch in two to three days if temperatures are warmer. Males guard the eggs for about a month, until fry begin to disperse. Like largemouth bass, fry begin to feed on zooplankton, switching to insect larvae and finally fish and crayfish as they grow.

Golden Shiner (*Notemigonus crysoleucas*). Golden shiners are a deep-bodied minnow species with a distinctive golden-olive/silvery color. Their fins may appear from golden brown to orange-reddish in hue. Older fish have a more golden color than their younger, silvery counterpart. This species has a distinctive scaleless strip on its underside between the pelvic fin and the bottom. Golden shiners are common in medium to large bodies of slow-moving or standing water, including reservoirs, and require good water quality and aquatic vegetation to thrive. They prefer quiet, clear water over sand-, gravel-, or organic-debris-covered bottoms. They spawn over a variety of materials, including sand, gravel, vegetation, and other objects. Anglers do not target golden shiners, although shiners are considered effective bait for a wide variety of species and are easy to keep alive. Golden shiners are collected with a dip net or seine.

Kokanee Salmon (*Oncorhynchus nerka*). Also known as sockeye, these fishes are unique in that they require a lake to rear in as fry, which means that the river system they choose to spawn in must have a lake. They can adapt to a range of water velocities and substrates. Juveniles rear for one or two years in a lake, although they are also found in the inlet and outlet streams of the lake. The fry are often preyed on by resident lake fish, and because they use freshwater year-round, the fry are susceptible to low water quality. Sockeye salmon feed on zooplankton within the lake. Because of the popularity of sockeye salmon as a recreational sport species in cooler mountain lakes and reservoirs, the CDFG plants hatchery-produced young sockeye salmon in a number of Sierran lakes each year. In many of the lakes, sockeye salmon are not able to successfully reproduce, so some populations are supported by annual juvenile plantings from the hatcheries.

Green Sunfish (*Lepomis cyanellus*). Native to the eastern United States, these fishes inhabit quiet pools and backwaters of sluggish streams, lakes, and ponds. Green sunfish spawn in spring and summer, hatching in about two days. They deposit their eggs in a single or colonial nest made by the male, often on fine gravel or sandy silt in shallow water near cover. They prefer warm streams and slow-moving to sedentary waters, ponds, and shallow weedy margins of lakes. They can usually be found in the vicinity of weed beds (Moyle, 1976).

Threadfin Shad (***Dorosoma petenense***)**.** This non-native fish species occurs mainly in freshwater in large rivers, reservoirs, lakes, and swamps, although it is also found in estuarine waters. Threadfin shad are typically found within the top 5 feet of the water column and spawn at approximately 7 °C. This species breeds in the spring and autumn in freshwater, near or over plants or other objects, and their eggs adhere to aquatic vegetation. Anglers also use threadfin shad as baitfish (Moyle, 1976).

California Roach (*Lavinia symmetricus*). Considered a minnow, this species prefers lower elevation streams, particularly sections that dwindle to seasonal pools. Roaches are usually the most abundant fish in the middle-elevation zones of local creeks. California roaches feed on invertebrates and filamentous (threadlike) algae (Moyle, 1976).

Riffle Sculpin (*Cottus gulosus*). This species spawns mostly in small streams with sandy to rocky bottoms. Riffle sculpin tend to inhabit sand and gravel riffles of headwaters and creeks and are also found in sand-gravel runs and backwaters of small to large rivers. They demonstrate resiliency and can withstand substantial changes in habitat. Within California, riffle sculpin are an abundant species (Moyle, 1976).

Sacramento Sucker (*Catostomus occidentalis*). Sacramento suckers prefer tributary streams with gravel or cobble. Foothill streams usually have two subpopulations: a resident one and one that migrates into the creek to spawn in the spring then returns to the river, although some may strand in low-water years. Suckers use their specialized mouths to scrape aquatic insects from the substratum. Spawning typically occurs in waters with temperatures ranging from approximately 6 to 10 °C in February to June, although the species is tolerant of a wide range of temperature conditions.

Bluegill (***Lepomis macrochirus***)**.** Originally introduced into California waters in 1908, bluegill have become a favorite of many anglers, and populations exist in mountain lakes as high as 5,000 feet. They breed in large colonies in which big, dark-colored males vigorously defend nests, embryos, and young against predators and other males. One problem for nesting males of this species is that small males often hang out near the nests and sneak or streak in to spawn (Moyle, 1976). Bluegill support a popular sport fishery, particularly in low- to mid-elevation lakes and reservoirs.

Coho Salmon (*Oncorhynchus kisutch*). Coho salmon, commonly known as silver salmon, occur naturally only in the Pacific Ocean and its tributary drainage, although it can also be found in some freshwater areas, including the Great Lakes. Adult coho salmon are usually 18 to 24 inches long and weigh 8 to 12 pounds. Adults in the ocean are steel blue to slightly green in color, with silver sides, white bellies, and small black spots on the back. Historically, coho salmon (along with other species) was a staple in the diet of several Native American tribes, which would also trade it with tribes farther inland. Coho salmon produced in hatcheries have been planted as juveniles in a number of coldwater lakes and reservoirs to support local recreational fisheries.

Black Crappie (*Pomoxis nigromaculatus*). Spawning varies according to latitude. In the northern states this species usually spawns in May and June. In the South, spawning takes place earlier in the year, beginning as early as March. Favorable spawning temperatures range from 18 to 20 ºC. The male sweeps out a nest in sand or fine gravel and guards the nest and defends the young until they start to feed.

Channel Catfish (*Ictalurus punctatus*). Channel catfish are freshwater fish, native to the central and eastern United States and southern Canada. In California, they were planted in Stockton in about 1874. These fish are readily distinguished by their scaleless bodies; broad, flat heads; sharp, heavy pectoral and dorsal spines; and long, whisker-like barbels[4] around the mouth. They are mostly nocturnal and use their barbels to locate food in the dark recesses of deep water. They prefer water temperatures of about 21 °C. Although this catfish does well in many muddy, dirt-bottom lakes, it prefers a clear, warm-water lake with a sandy bottom.

Lake Trout (*Salvelinus namaycush*). Lake trout prefer deep, coldwater lakes. They spawn in the fall, but the time varies among lakes and depends on such factors as latitude, weather, and the size and topography of the lake. Spawning most often occurs over a large boulder or rubble lake bottom at depths of less than 40 feet, and sometimes as shallow as 1 foot for inland lakes. Spawning takes place at night when the trout scatter their eggs over a rocky lake bottom; the eggs remain among the rocks for weeks and hatch the following spring. Lake trout support an active recreational fishery in a number of lakes and reservoirs.

King (Chinook) Salmon (*Oncorhynchus tshawytscha*). Fall-run Chinook salmon are anadromous, with spawning and juvenile rearing occurring within freshwater rivers and streams and juvenile and adult rearing occurring within coastal marine waters; however, Chinook salmon that are landlocked and/or hatchery-reared are not anadromous and not capable of natural reproduction. (Anglers commonly refer to landlocked, hatchery-reared salmon as king salmon). Native, non-hatchery-reared adult fall-run Chinook salmon migrate from the coastal marine waters upstream through San Francisco Bay, Suisun Bay, and the central Delta during late summer and early fall (approximately late July through early December). Adult fall-run Chinook salmon then migrate upstream to areas characterized by suitable spawning conditions, which include the availability of clean spawning gravels, cold water (considered to be less than 13 °C, and relatively high water velocities. Fall-run Chinook salmon spawning is similar to that described for other Chinook salmon, including the creation of redds where eggs are deposited and incubate. Fall-run Chinook salmon spawning occurs between October and December, with the greatest spawning activity typically in November and early December.

4 A long, thin, fleshy growth projecting from the mouths or nostrils of some fishes.

The lower Tuolumne River supports a population of anadromous fall-run Chinook salmon. These fish support an active recreational fishery within both ocean and inland waters. Juvenile Chinook salmon produced in fish hatcheries are also planted in mid- to high-elevation lakes and reservoirs to support recreational fisheries.

Tuolumne River Below Don Pedro Reservoir

Aquatic Habitat

Aquatic habitats in the Tuolumne River downstream of La Grange Dam are influenced by a number of factors, many of them related to former gold mining and gravel mining. From La Grange Dam to RM 25, a distance of about 25 miles, the river flows through the Sierra foothills into the alluvial San Joaquin Valley. In the first 10 miles downstream of the dam, the channel is constrained by extensive fields of dredge tailings that include large cobbles to finer sediments. These tailings, which extend to Roberts Ferry (approximately RM 40), restrict river meander and access to alluvial sediments, thus reducing the delivery of gravel to the river. Some sections of the river are armored by cobbles, and replenishment of smaller gravels is necessary. Riparian vegetation in this reach is also limited by the dredge tailings. In some reaches upstream of Roberts Ferry, the interaction of modified flow regimes and areas of dredge tailings has altered channel characteristics and flow regimes, creating areas of lake-cascade habitat instead of the pool-riffle habitat typical of the pre-mining channels.

Downstream of Roberts Ferry, the lower gradient river meanders through low hills and valleys bordered by grazing land, tree crops, and irrigated row crops. In this reach, the river passes through several large gravel-mining pits, in part due to failure of the levees separating the river from these pits during the floods of 1997 (TID/MID, 2005). At approximately RM 25, the river is generally channelized and flows through sandy loam soils. In this lower reach, the channel is characterized by slow-velocity run habitat with a sandy-silty bottom and no riffles; the area is not suitable for salmonid spawning, and no spawning was observed during the 1996–2005 survey period.

Substantial habitat restoration has occurred in the lower Tuolumne River under the FERC Settlement Agreement (FSA) (see Chapter 2 for a description of the agreement). In 2000 the Tuolumne River Technical Advisory Committee completed a report titled “Habitat Restoration Plan for the Lower Tuolumne River Corridor” that provides guidance on the priorities and design of habitat enhancement projects to benefit salmon and other aquatic resources (McBain and Trush 2000). The plan identifies several measures to improve the ecological functions of the lower river including increasing the frequency of periodic high flows, channel reconstruction, and gravel and sediment management. A total of 14 channel restoration projects have been identified in the plan. Two of the projects have been completed and two additional projects will be constructed in 2007. Other planned restoration actions under the FSA include:

- Additional riffle cleaning to remove fine sediments from potential salmon spawning habitats
- Construction of a sedimentation basin on Gasburg Creek upstream of La Grange Dam

- Placement of up to 300,000 cubic yards of screened aggregate in the reach between La Grange Dam and Roberts Ferry

- Rehabilitation of pool-riffle habitats in areas now characterized as lake-cascade habitat

The effectiveness of recent riparian restoration has not been fully evaluated, in part because the restoration at such sites as the pool downstream of Fox Grove County Park is relatively immature.

Chinook Salmon

General Description. Chinook salmon are present in the major San Joaquin River tributaries, including the Tuolumne River, which supports a fall run of Chinook salmon. Based on a literature review for the 1996 FERC report, adults begin to arrive in the Tuolumne River in October, and the spawning run continues into January; spawning occurs primarily in October through January but can extend into March. Most egg incubation occurs from October through March but can extend into May. Juveniles begin to emerge from spawning gravels in December. The period of juvenile rearing ranges from January through June (FERC, 1996).

There is no fish hatchery on the Tuolumne River, but Tuolumne River Chinook salmon stocks have been influenced by fish straying from other Central Valley hatcheries and by releases of large quantities of hatchery juveniles and smolts in the river for smolt survival tests. Tuolumne River Chinook salmon are probably not a unique stock (FERC, 1996). Recovery of coded-wire-tagged fish indicates that Chinook salmon stocked in the Tuolumne River are contributing to the ocean commercial and recreational fishery and to adults returning to the river to spawn.

The general trends in the life history of Tuolumne River Chinook salmon are subject to substantial variation, probably depending on flow and water temperature (FERC, 1996), ocean rearing conditions, recreational and commercial harvest, and other factors. The extent of this variation is shown in the *2005 Ten Year Summary Report for the Don Pedro Project* (TID/MID, 2005). From 1998 to 2002, sampling of juveniles using rotary screw traps was extended to cover the period from late January through as late as June 30. This sampling found that the peak period of juvenile migration at the lower rotary screw traps varied by year:

Year	Period of Peak Juvenile Catch in Rotary Screw Traps at River Mile 5
1998	February 15 – March 15
1999	January 25 – February 15
2000	February 15 – March 1
2001	February 15 – March 18
2002	April 15 – May 10

Variable juvenile migration times may reflect variability in spawning and incubation times and/or variation in the duration of juvenile rearing based on flow and temperature conditions. In 2000 and 2001, juveniles were captured at RM 5 over a period of more than three months. In other years, juvenile emigration appears to have occurred over a shorter period of time. At various life-history stages, Chinook salmon may therefore be found in the Tuolumne River from October through May, although there is also some potential for a small number of juveniles to oversummer in cooler reaches of the river (FERC, 1996). In 1994, the USFWS (FERC, 1996) evaluated habitat availability by life-history stage and determined that:

- For spawning, habitat was optimized at flows of about 150 to 350 cfs, which optimized depth over spawning riffles.
- For juvenile rearing, habitat was optimized at low flows (50 to 150 cfs), which optimized low-velocity habitat.
- For egg rearing, habitat was optimized at flows from about 100 cfs to 800 cfs, which defined the optimal amount of riffle and run habitat and minimized the conversion of runs to pools.

Population Trends. TID/MID (2005) summarizes 1971–2004 population trends for adult Chinook salmon in the Tuolumne River and notes that the return of adult salmon to the river follows the general pattern observed in other major San Joaquin River tributaries:

- From 1971 through 2004, the estimated number of adult salmon returning to the Tuolumne River ranged from a low of 77 fish to a high of 40,332 fish (see **Table 5.3.6-2**).
- During the period of record, there were two periods when the CDFG carcass counts built up to peaks of over 5,000 carcasses, with intervening periods where runs declined to below 100 carcasses.
- Estimates of adult escapement based on carcass counts begin to build during years characterized by higher precipitation and flow (and the associated somewhat cooler water temperatures), and to decline with the onset of drought conditions and warmer water temperatures.
- Tagged carcasses (hatchery fish) accounted for 6.4 to 65 percent of the total carcass count, with an average of about 38 percent of carcasses carrying hatchery tags.
- The percentage of females ranged from 25 to 67 percent, with an average of 51 percent. Females made up less that 35 percent of the total carcass count in only 4 of 33 years (all of which were dominated by two-year-old fish).
- Based on redd (salmon nests) counts from 1981 to 2003, spawning is concentrated in the reaches between RM 34 and La Grange Dam (RM 52.2), with the density of redds greatest between RM 47 and La Grange Dam. In this reach, the average redds per mile was about 85, while in the reaches downstream, average redd count over the 24-year period of record was 18.5 redds per mile.
- Reach 2, from RM 47.4 to 50.5 (3.1 miles), contributed from 17 to 42 percent of the total run during 1981 to 2003, while the longer Reach 3 (RM 42.0 to 47.4; 5.4 miles) contributed from 13 to 36 percent of the total run during the same period.
- There was virtually no spawning activity below Fox Grove (RM 24.1), except in 1988 and 1989 when 30 redds were counted in this downstream reach.

TABLE 5.3.6-2
TUOLUMNE RIVER SPAWNING SURVEY SUMMARY

Year	Carcass Count	% Female	Estimated Run
1971	2,283	58	21,885
1972	537	52	5,100
1973	351	59	1,989
1974	90	55	1,150
1975	130	60	1,600
1976	336	51	1,700
1977	45	62	450
1978	116	67	1,300
1979	305	51	1,184
1980	248	61	559
1981	5,819	44	14,253
1982	2,135	60	7,126
1983	1,280	25	14,836
1984	3,841	34	13,689
1985	11,651	56	40,322
1986	2,463	48	7,288
1987	5,280	31	14,751
1988	3,011	60	6,349
1989	625	52	1,274
1990	37	32	96
1991	30	45	77
1992	55	43	132
1993	187	61	431
1994	215	50	513
1995	461	54	928
1996	1,301	35	4,362
1997	1,520	59	7,548
1998	2,712	51	8,967
1999	3,980	46	7,730
2000	6,884	63	17,873
2001	5,400	54	9,222
2002	4,702	54	7,125
2003	1,489	60	2,961
2004	1,224		1,900

SOURCE: TID/MID, 2005.

The TID/MID (2005) data are generally consistent with data from FERC (1996) in that they indicate a majority of spawning occurs in the 15-mile reach below La Grange Dam. Although the nine-year data set from 1996 through 2004 is too small to be the basis for long-term trend analysis, it is noteworthy that the dry years from 2001 to 2005 do not show the dramatic declines in carcass counts and estimated runs that characterized previous dry periods—possibly a function of the minimum release provisions of the FSA, ocean rearing conditions, or other factors.

Spawning. The distribution of Chinook salmon spawning and rearing is strongly influenced by the availability of spawning gravels, with spawning often concentrated in areas at the head of riffles where subsurface flows increase water flows and oxygen through the gravel (FERC, 1996).

Chinook salmon spawning takes place in a variety of habitats that vary in terms of depth, velocity, and substrate (Healey, 1991; cited in FERC, 1996). Spawning can occur within substrates ranging from fine to coarse gravel, as well as over a wide range of water temperatures; however, optimum spawning temperatures are probably in the 8 to 16 °C range. In the Tuolumne River, this temperature range occurs most consistently in the 15-mile reach below La Grange Dam. The distribution and quality of spawning habitat changes in response to flow, as evidenced by major shifts in the distribution of spawning gravels during the 1997 flood, which involved flood-control releases of over 50,000 cfs. TID/MID (2005) compared the estimated area of riffles in the reaches of the river below La Grange Dam for the years 1988 and 2000. In the three upper reaches of the river, the total area of riffle habitat decreased by over four acres (a loss of 15 percent), much of which was attributed to scour during the 1997 floods. However, the general distribution of riffle habitat was not substantially altered. The area of lost riffle habitat was replaced in 2002 and 2003 when the CDFG placed approximately 27,000 cubic yards of gravel in the reach below La Grange Dam. Further riffle restoration activities are projected to restore approximately 70 to 100 additional acres of riffle habitats.

Restoration activities, such as construction of pool-riffle habitats, incidentally reduce the total area of wetted channel, thus reducing the total area of juvenile rearing habitat while likely increasing food production (insects and other macroinvertebrates) and usable rearing floodplain habitat during higher flows (TID/MID, 2005). Post-restoration monitoring of spawning and juvenile rearing suggests that, based on redd counts, spawning has doubled on reconstructed riffle areas.

Juvenile Rearing. When juveniles emerge from the gravel they initially prefer pool habitats, with the distribution in pools affected by fish size (and thus dominance relationships). Habitat selection appears to be determined by food availability and other habitat characteristics, and dominant juveniles tend to select rearing locations at the head of pools where feeding is optimized (Chapman and Bjornn, 1969; cited in FERC, 1996). Larger juveniles can adapt to greater depth and higher velocity flow, and thus juveniles may move into riffle habitats as they grow. Juveniles can rear successfully over a wide range of temperatures, depending on food availability. Optimal rearing temperatures are generally considered to be 12 to 18 °C, but juveniles can thrive at warmer temperatures when food supplies are abundant enough to offset the increased metabolic rates associated with rearing in warmer water. Optimal temperatures are generally found in the 25 miles immediately downstream of La Grange Dam, but in very wet years may extend to the confluence with the San Joaquin River, at least into the late spring (TID/MID, 2005).

From 1986 to 2004, juvenile rearing was evaluated at 12 Tuolumne River seining locations, from the Old La Grange Bridge (RM 50.5) to the Shiloh Bridge (RM 3.4), with some sites monitored for only a portion of the 19-year period. The TID/MID data do not show any clear trend in the number of juveniles captured by seine netting before and after implementation of the FSA, although densities (fish per unit of seined volume) were marginally higher following FSA implementation. The 1986–1995 studies and 1996–2004 FSA monitoring data show expected trends in juvenile rearing and behavior:

- Young juveniles (fry typically less than approximately 45 millimeters) make up a majority of juveniles captured in January and February, with larger juveniles in excess of 65 millimeters (fingerlings and smolts) beginning to dominate captures by April.

- There are moderately strong relationships between the peak salmon juvenile density and average January 15 to March 15 salmon juvenile density and the estimated number of female spawners.

The seining data suggest a relatively stable egg-to-juvenile survival rate over a wide range of returning adult salmon abundances. The calculated relationship would be stronger if data from the very dry year of 1994 (pre-FSA) and the very wet year of 1997 were omitted from the analysis, which may indicate that egg-to-juvenile survival rates are not generally affected by variable flow. The survival of incubation eggs and juveniles is sensitive to very high flows that scour and erode spawning redds, as occurred in 1997.

The timing of juvenile movement downstream (based on rotary-screw-trap operations at lower screw traps) varied considerably from year to year; TID/MID noted that high variability in trap results makes it difficult to estimate juvenile production, and production estimates from the 1995–2004 monitoring vary by two orders of magnitude. Some preliminary mark-recapture studies of juvenile survival by river reach suggest that survival is substantially higher in the upstream spawning areas than it is in the lower reaches. Predation[5] by adult striped bass and other fish has been identified as one of the factors affecting juvenile survival within the river.

TID/MID also addressed the potential for juvenile stranding as a result of flow fluctuations, an issue of some importance since one goal of restoration is to increase areas of floodplain that may be accessed for rearing. The post-FSA stranding surveys indicated that stranding was a complex phenomenon, probably related to:

- Salmon density

- Flow reduction and the minimum flow in the fluctuation cycle, which determines the amount of potential stranding area exposed

- Salmon use of particular low-lying locations

- Slope and substrate of the channel

However, monitoring in 2005 found little post-FSA stranding and noted that restoration areas have been designed to minimize the potential for stranding (primarily by manipulating the slope of the accessible floodplain).

[Additional discussion on Chinook salmon in the lower Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

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5 The act of preying on another animal or animals.

Steelhead/Rainbow Trout

Steelhead/rainbow trout oversummer in natal streams and require relatively cooler water temperatures than Chinook salmon. Water temperatures in the lower Tuolumne River are in the 25 to 30 °C range for an extended period of time during the summer in many locations (TID/MID, 2005) and are unsuitable for steelhead. Only in the reach immediately downstream of La Grange Reservoir are water temperatures suitable for steelhead rearing. Temperatures in the San Joaquin River during the spring and summer are consistently higher than temperatures farther upstream in the Tuolumne River (see Figure 5.3.1-4) (TID/MID, 2005) and may preclude successful out-migration of juveniles. FERC (1996) concluded that no significant populations of steelhead/rainbow trout are present in the lower Tuolumne River system.

The results of rainbow trout surveys from 1982 to 2004 show rainbow trout were not found below RM 38 during this period (TID/MID, 2005). In addition, only 10 of the fish identified in this extended period of snorkel survey were in excess of 400 millimeters in length, suggesting that large anadromous steelhead probably occur in the system very infrequently. A vast majority of rainbow trout observed during snorkel surveys were found above RM 45. Nevertheless, post-1995 monitoring suggests that the range of rainbow trout in the Tuolumne River has been moderately extended downstream as a result of the FSA flow regimes. Prior to 1998, rainbow trout had not been found below RM 47. Following implementation of the FSA flow regimes, the species was found with greater frequency downstream in the reach from RM 47 to RM 38, even in the dry 2001–2004 period.

[Additional discussion on steelhead in the lower Tuolumne River was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

Other Fish Species

The lower Tuolumne River supports a number of native and non-native fish species, as shown in **Table 5.3.6-3**. From the perspective of salmon management, the most important are largemouth and smallmouth bass and striped bass due to the potential for predation, particularly on outmigrating juveniles (Orr, 1997; Cohen and Moyle, 2004).

Largemouth and Smallmouth Bass. Non-native largemouth and smallmouth bass have colonized the lower Tuolumne River, taking advantage of the low-velocity, and pond-like habitats of the river that are particularly found below RM 25. In these reaches, bass are present in relatively high abundance and feed actively during the spring out-migration of juvenile Chinook salmon. Both the low flow and high water temperatures in this reach stress juvenile salmon and enhance predation by the bass. Typical of centrarchids, smallmouth and largemouth bass are thick-bodied fish that rely on an ambush strategy for foraging. Their swimming speed over distance is low, and their ability to sustain speed is limited by their metabolism and body configuration.

TID/MID (2005) monitored largemouth and smallmouth bass in the Tuolumne River system from 1996 to 2004 and concluded:

- The population was depleted during the 1997 floods, but recovered slowly until 2003 when it reached its previous level.
- Largemouth bass are more abundant than smallmouth bass.

TABLE 5.3.6-3
NON-SALMONID SPECIES PRESENT IN THE LOWER TUOLUMNE RIVER

Species	Scientific Name	Native (N) or Introduced (I)	Observed in 1996–2004 Surveys			
			Snorkel	Upper RST	Lower RST	Seine
Pacific lamprey	*Lampetra tridentata*	N	X	X	X	X
River lamprey	*Lampetra ayresi*	N		X		
White sturgeon	*Acipenser transmontanus*	N				
American shad	*Alosa sapidissima*	I		X	X	
Threadfin shad	*Dorosoma petenense*	I		X	X	X
Common carp	*Cyprinus carpio*	I	X	X	X	
Goldfish	*Carassius auratus*	I		X	X	
Golden shiner	*Notemigonus crysoleucas*	I		X	X	X
Hitch	*Lavinia exilicauda*	N		X	X	
Sacramento blackfish	*Orthodon microlepidotus*	N			X	
Splittail	*Pogonichthys macrolepidotus*	N			X	
Hardhead	*Mylopharodon conocephalus*	N	X	X	X	X
Sacramento pikeminnow	*Ptychocheilus Grandis*	N	X	X	X	X
Red shiner	*Cyprinella Lutrensis*	I		X	X	X
Fathead minnow	*Pimephales promelas*	I				X
Sacramento sucker	*Catostomus occidentalis*	N	X	X	X	X
White catfish	*Ictalurus catus*	I	X			X
Brown bullhead	*Ictalurus nebulosus*	I		X	X	
Black bullhead	*Ictalurus melas*	I		X	X	
Channel catfish	*Ictalurus punctatus*	I		X	X	X
Wagasaki	*Hypomesus nipponensis*	I			X	
Inland silversides	*Menidia beryllina*	I			X	X
Western mosquitofish	*Gambusia affinis*	I	X	X	X	X
Prickly sculpin	*Cottus asper*	N		X	X	X
Riffle sculpin	*Cottus gulosus*	N	X	X	X	X
Striped bass	*Morone saxatilis*	I		X	X	X
Black crappie	*Pomoxis nigromaculatus*	I		X	X	
White crappie	*Pomoxis annularis*	I		X	X	
Warmmouth	*Lepomis gulosus*	I		X	X	
Green sunfish	*Lepomis Cyanellus*	I		X	X	X
Bluegill	*Lepomis macrochirus*	I	X	X	X	X
Redear sunfish	*Lepmois microlopus*	I	X	X	X	X
Largemouth bass	*Micropterus salmoides*	I	X	X	X	X
Smallmouth bass	*Micropterus dolomieui*	I	X	X	X	X
Bigscale logperch	*Percina macrolepida*	I		X	X	X
Tule perch	*Hysterocarpus traski*	N				

RST=rotary screw traps.

SOURCE: TID/MID, 2005.

- The restoration of pool-pond area downstream of Fox Grove County Park did not reduce largemouth bass density and may have increased smallmouth bass density at the site.
- Habitat modeling indicated that velocity is the key factor limiting bass habitat.
- Habitat modeling indicated that a flow of 300 cfs or higher would create limiting velocities for bass in the reach downstream of Fox Grove County Park after restoration, compared to a limiting velocity of 2,000 cfs for pre-project conditions.

Bass density could thus be reduced by recontouring the channel to enhance riffle and run habitats, combined with manipulation of flow to increase velocities. Restoration that increases the area of riffle habitat would therefore be expected to benefit out-migrating juvenile salmon.

Other Species. Based on surveys conducted from 1981 to 2004, including the TID/MID surveys conducted from 1996 to 2004 (Table 5.3.6-3), the lower Tuolumne River supports a relatively complex assemblage of fish, only 14 of 38 being native to the region. The non-natives were introduced for a variety of commercial and sport purposes, beginning in 1871 with the introduction of American shad and continuing into the 1970s with the introduction of the inland silversides as a mosquito-control fish. A majority of the introduced species are warmwater fish that thrive in the lower reaches of the rivers and in the Sacramento–San Joaquin Delta.

As the table indicates, many of the introduced fish species are more widely distributed in the lower Tuolumne River than some of the native species. TID/MID (2005) notes that warmwater introduced species were particularly well distributed in the lower 31 miles of the river, and that native species were dominant only in the short reach upstream of RM 50. The distribution of species responded to flow, with native fish whose life history involves use of riffles for spawning becoming more abundant in the year following a high-flow year.

San Joaquin River and Sacramento–San Joaquin Delta

General Ecological Description

The Sacramento–San Joaquin Delta is a 600-square-mile area of channels and islands at the confluence of the Sacramento and San Joaquin Rivers. Freshwater draining from a 41,300-square-mile watershed enters the Delta from the Sacramento and San Joaquin Rivers and several smaller rivers. Some of the water is diverted from the Delta channels for municipal and agricultural purposes. The remainder flows through the Delta to the San Francisco Bay Estuary.

The Delta is a tidal region. Every 12.4 hours, the tides cause water to move in and out of the Delta. Most of the time, tides cause a five- to eight-mile back-and-forth movement of water in the western part of the Delta. The movement of freshwater through the Delta is superimposed on the tidal flows. Typical freshwater flows are much smaller than tidal flows, usually in the range of 5 to 15 percent of the tidal flows (see Section 5.3.1).

The Bay-Delta estuary is a complex estuarine ecosystem (i.e., a transition zone between inland sources of freshwater and saltwater from the ocean). Along the salinity gradient extending from the Golden Gate upstream into the Delta, the species composition of the aquatic community changes dramatically, although the basic functional relationships among organisms (e.g., predator/prey, etc.) remain similar throughout the system. The primary energy input to the system is solar radiation, which is used, along with nutrients, by the primary producers (phytoplankton, vascular plants, and macroalgae) to convert inorganic carbon to organic matter through photosynthesis. Zooplankton (e.g., copepods, cladocerans, and mysid shrimp) prey on the phytoplankton. The vascular plants and macroalgae are grazed on and also produce detritus, which is decomposed by microbes and consumed by detritivores (e.g., polychaete worms, amphipods, cladocerans, and a diverse group of other fish and macroinvertebrates). The primary consumers are in turn preyed on by secondary consumers, consisting mainly of invertebrates (e.g., polychaete worms, snails, copepods, mysid shrimp, bay shrimp, and crabs) and fishes (northern anchovy, Pacific herring, topsmelt, white croaker, flatfish, gobies, sculpin, shad, juvenile Chinook salmon, and a variety of other resident and migratory fish species). These species in turn are preyed on by top consumers such as fish (striped bass, catfish, sturgeon, halibut, sharks, and rays), marine mammals, birds, and man. The role of a species in the food web may be different at different lifestages, or a species may utilize various levels of the food web simultaneously.

Fishery sampling within the Bay-Delta estuary has shown that 55 fish species inhabit the estuary (Baxter et al., 1999), of which approximately one-half are non-native, introduced species. Many of the fish species inhabiting the estuary, such as striped bass and American shad, were purposefully introduced to provide recreational and commercial fishing opportunities. A number of the fish species have been introduced accidentally to the estuary through movement among connecting waterways (e.g., threadfin shad and inland silversides). In recent years, a number of fish and macroinvertebrate species have been accidentally introduced into the estuary, primarily from the Orient, through ballast water discharges from commercial cargo ships (e.g., yellowfin and chameleon gobies). In addition, an estimated 100 macroinvertebrates have also been introduced, primarily through ballast water discharge, into the estuary (Carlton, 1979). These introductions of non-native fish and macroinvertebrates have contributed to a substantial change in the species composition, predator/prey interactions, and competitive interactions affecting the population dynamics of native species. Many of the introduced fish and macroinvertebrates have colonized and inhabit the lower San Joaquin River and Delta.

The lower San Joaquin River and Delta provide habitat to a diverse assemblage of resident and migratory estuarine organisms. The biological environment is a complex community of plants and animals inhabiting the saltwater, estuarine (brackish water), and freshwater habitats within the Bay-Delta estuary. This section provides a brief summary of information available on the aquatic plants, phytoplankton, zooplankton, bottom-dwelling macroinvertebrates, and common fish populations inhabiting the Bay-Delta estuary.

Fish

Fish species may utilize the estuary for any or all of their life-history stages. They may have planktonic, bottom-dwelling, and open-water life histories. The majority of fish species inhabiting the estuary have planktonic larval stages; as plankton they feed on zooplankton and in some cases phytoplankton. Many of these species forage on plankton during the larval and early juvenile lifestages, and then as juveniles and adults become more selective predators and feed on large invertebrates and fish. Bottom-dwelling fish such as sturgeon, flatfish, gobies, sculpin, and croaker are planktivorous as larvae but begin to feed on invertebrates as juveniles. Many smaller fish, including smelt, silversides, northern anchovy, and Pacific herring, are planktivorous throughout their lives.

Some estuarine fish do not rely on plankton as a major food source at any lifestage. Live-bearing surfperch, for example, predominantly feed on invertebrates such as mollusks, crustaceans, and polychaetes throughout their life. Sturgeon and sharks feed on invertebrates by shoveling through the substrate, and also feed on fish and large invertebrates in the water column. Many freshwater fish prey primarily on bottom-dwelling and drifting insect larvae and crustaceans, because zooplankton abundance is low in the swifter flowing freshwater sloughs and rivers.

The abundance and species composition of fish inhabiting the estuary vary in response to salinity gradients (Baxter et al., 1999). The most abundant fish inhabiting the high-salinity areas of the Central Bay include the schooling, bottom-dwelling forage fish such as northern anchovy, Pacific herring, topsmelt, jacksmelt, and true smelt (whitebait, surf smelt, and night smelt). Other members of the Central Bay fish community include flatfish, rockfish, surfperch, gobies, and sharks. In the low-salinity areas of Suisun Bay and the Delta, the most abundant fish include striped bass, prickly sculpin, staghorn sculpin, threadfin shad, yellowfin goby, and starry flounder. Anadromous fish species such as Chinook salmon, steelhead, American shad, striped bass, and sturgeon utilize the entire estuarine system as a migration corridor and foraging habitat.

Factors affecting the abundance and geographic distribution of fish within the estuary include water velocities, substrate, salinity gradients, water temperature, and food availability. Many of the fish species that inhabit the estuary reside in coastal marine waters and enter the estuary on a seasonal basis for foraging or reproduction. The seasonal cycles of fish abundance vary in response to migration patterns, reproductive cycles, foraging patterns, and environmental conditions occurring within both the estuary and coastal marine waters.

The fish community inhabiting the estuary is diverse and dynamic. The abundance of species can fluctuate substantially within and among years (Baxter et al., 1999) in response to both population dynamics and environmental conditions. Life-history strategies and habitat requirements also vary substantially among species within the fish community. Information on the fish community in the Delta is available from monitoring conducted by the CDFG and USFWS in addition to fish salvage monitoring at the State Water Project and Central Valley Project export facilities in the south Delta. The following sections briefly describe the species composition of the fish community in the lower San Joaquin River and Delta in the vicinity of the WSIP facilities. Information is also presented on habitat types that occur within the estuary, and habitat functions that affect species composition and habitat use. Information on habitat functions and analysis of the available fishery information was used to assess the potential adverse impacts of proposed program operations (e.g., changes in Delta hydrology) on the fish community inhabiting the lower San Joaquin River and Delta.

In recent years, the bottom-dwelling fish community, including delta and longfin smelt and other species, has experienced a significant decline in abundance. State and federal resource agencies are currently evaluating various factors that could be contributing to the decline. Hypotheses include the effects of losses at water diversions, changes in Delta hydrology, the effects of pollutants on survival, and the effects of introduced species on the Delta food web. The importance of these factors in the decline in fish abundance has not been determined.

Among the seasonal inhabitants, many species use the Bay-Delta estuary as a spawning area and/or juvenile nursery habitat on either an obligatory or nonobligatory basis (Baxter et al., 1999). For obligate species, reproduction and rearing of juveniles occurs almost exclusively within a bay or estuarine environment. Nonobligate species may or may not inhabit the estuary during any given year. The occurrence of nonobligate species varies substantially from one year to the next within the Bay-Delta estuary. These species are typically found in the more marine areas of the estuary and are not generally abundant upstream within Suisun Bay or the marsh. Opportunistic species use the Bay-Delta estuary as an extension of their habitat based on the suitability of environmental conditions. Many species that inhabit coastal marine waters, such as northern anchovy, may opportunistically move into the estuary when conditions are favorable for reproduction, juvenile rearing, and foraging. Several freshwater or low-saline species, such as white catfish and threadfin shad, may opportunistically use habitats within Suisun Bay, San Pablo Bay, or Central Bay during periods of high freshwater outflow from the river systems that results in lower salinity and more suitable habitat conditions for these species farther downstream within the system (Baxter et al., 1999).

Anadromous species such as Chinook salmon and steelhead spawn within freshwater portions of rivers and creeks tributary to the Bay-Delta estuary, including the Tuolumne River. Juvenile rearing habitat for these species is also present primarily within the freshwater or low-saline portions of the system. Juvenile Chinook salmon and steelhead emigrate from freshwater habitat and move downstream through the estuary, which is used primarily as a migratory corridor and short-term foraging habitat as the fish move into coastal waters for rearing. Adult Chinook salmon and steelhead subsequently migrate back upstream to spawn, again using the Bay-Delta estuary as a migratory corridor. Other anadromous species such as striped bass may inhabit freshwater, estuarine, and marine waters over an extended period of time as both juveniles and adults.

The open waters of the lower San Joaquin River and Delta serve as a migratory route for several species of anadromous fish whose adults migrate to the freshwater reaches of the tributary rivers to spawn and whose juveniles migrate downstream to return to the ocean. These fish include steelhead, Chinook salmon, white and green sturgeon, and striped bass. In addition, the main channel and adjacent areas support populations of resident species, including Sacramento pikeminnow, white catfish, and threadfin shad.

Regulatory Setting

Special-Status Species

A variety of special-status fish species, several of which have been listed for protection under the Federal and/or California Endangered Species Acts, are present in the Delta and the San Joaquin and Tuolumne Rivers. Special-status fish species that occur in the lower San Joaquin River and Delta include steelhead, green sturgeon, delta smelt, Chinook salmon, Sacramento splittail, and longfin smelt. Several special-status species use the Delta as a migratory corridor. The winter-run Chinook salmon is federally and state-listed as endangered. The spring-run Chinook salmon is federally and state-listed as threatened. The fall/late-fall-run Central Valley Chinook salmon is a federal candidate species and California species of special concern. The Distinct Population Segment of Central Valley steelhead is federally listed as threatened. Fall/late-fall-run Central Valley Chinook salmon use the lower San Joaquin River as a migratory corridor and spawn in the Tuolumne River below La Grange Dam. In addition, delta smelt, a federally and state-listed threatened species, and Sacramento splittail, a California species of special concern and formerly a federal threatened species, have been documented within the lower San Joaquin River and Delta (USFWS, 2003). The NMFS recently listed green sturgeon as a threatened species. Although the distribution of green sturgeon in the lower San Joaquin River is poorly understood, the species is known to reside within the Delta.

Essential Fish Habitat

The Pacific Fisheries Management Council has designated Central San Francisco Bay, Suisun Bay, and the Delta as Essential Fish Habitat (EFH) to protect and enhance habitat for coastal marine fish and macroinvertebrate species that support commercial fisheries. The major rivers tributary to the Delta, including the San Joaquin and Tuolumne Rivers, have also been identified as EFH for Pacific salmon. The amended Magnuson-Stevens Fishery Conservation and Management Act, also known as the Sustainable Fisheries Act (Public Law 104-297), requires all federal agencies to consult with the Secretary of Commerce on activities or proposed activities authorized, funded, or undertaken by that agency that may adversely affect EFH of commercially managed marine and anadromous fish species (Office of Habitat Conservation, 1999). The EFH provisions of the Sustainable Fisheries Act are designed to protect fishery habitat from being lost due to disturbance and degradation. The act requires that EFH must be identified for all species that are federally managed by the Pacific Fisheries Management Council.

5.3.6.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to fisheries, but generally considers that implementation of the proposed program would have a significant fisheries impact if it were to:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFG, NMFS, or USFWS

- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites

- Have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of an endangered, rare or threatened species

Approach to Analysis

The effects of the WSIP on river flow and reservoir water levels were determined using the HH/LSM. An overview of the model is presented in Section 5.1; detailed information on the model and the assumptions that underlie it is provided in Appendix H. The effects of the WSIP on stream flow and reservoir water levels are evaluated in Section 5.3.1 and were used as the basis for assessing the WSIP's effects on fisheries and aquatic resources. In addition, the effects on water temperature due to WSIP-induced changes in flow in the Tuolumne River below La Grange Dam were determined using a temperature model and are described in Section 5.3.3.
A professional fish biologist assessed the effects of flow, reservoir level, and water temperature changes on aquatic life.

Impact Summary

Table 5.3.6-4 presents a summary of the impacts on fisheries in the Tuolumne River system and downstream water bodies that could result from implementation of the proposed water supply and system operations.

TABLE 5.3.6-4
SUMMARY OF IMPACTS –
FISHERIES IN TUOLUMNE RIVER SYSTEM AND DOWNSTREAM WATER BODIES

Impact	Significance Determination
Impact 5.3.6-1: Effects on fishery resources in Hetch Hetchy Reservoir	LS
Impact 5.3.6-2: Effects on fishery resources along the Tuolumne River between Hetch Hetchy Reservoir and Don Pedro Reservoir	LS
Impact 5.3.6-3: Effects on fishery resources in Don Pedro Reservoir	LS
Impact 5.3.6-4: Effects on fishery resources along the Tuolumne River below La Grange Dam	PSM
Impact 5.3.6-5: Effects on fishery resources along the San Joaquin River	LS

LS = Less than Significant impact, no mitigation required
PSM = Potentially Significant impact, can be mitigated to less than significant

Impact Discussion

Impact 5.3.6-1: Effects on fishery resources in Hetch Hetchy Reservoir.

Hetch Hetchy Reservoir provides habitat for resident fish, including trout. Rainbow, brown, and eastern brook trout support a popular recreational fishery. Operational modeling (presented in Section 5.3.1) indicates that increased water demand under the WSIP would result in a general reduction in water storage elevations in Hetch Hetchy Reservoir of 1 to 10 feet in most months, and to a larger degree in some months of a severe drought. Hetch Hetchy Reservoir typically undergoes a substantial change in storage volume throughout the year, with a general declining trend during the fall and winter followed by a substantial increase in storage during the spring and summer in response to snowmelt runoff (Figure 5.3.1-8). The fish community inhabiting the reservoir typically experiences a wide range of habitat conditions under both existing and proposed future operations. Given the range of natural variation in seasonal storage within the reservoir under existing conditions and the incremental changes predicted to occur under the WSIP, impacts on resident fish habitat within the reservoir under future conditions would be *less than significant*, and no mitigation is required.

Impact 5.3.6-2: Effects on fishery resources along the Tuolumne River between Hetch Hetchy Reservoir and Don Pedro Reservoir.

The Setting section describes the aquatic habitat and fishery resources in the Tuolumne River below Hetch Hetchy Reservoir; the resident fish species present in the river include rainbow trout, brown trout, California roach, sculpin, and suckers. Instream habitat conditions for resident trout and other fish species inhabiting the Tuolumne River downstream of Hetch Hetchy Reservoir are supported through the maintenance of minimum stream flows. The minimum flow requirements below Hetch Hetchy are described in Section 5.3.1.1 and shown in Table 5.3.1-2. The SFPUC operates all facilities such that these release requirements are met.

Hydrologic modeling (see Section 5.3.1) shows that WSIP operations would have little or no effect on average monthly flow in most summer, fall, and winter months in all hydrologic year types. In these months, the required fishery release would be made under the existing condition and with the WSIP. With the WSIP, the number of months in which only the required fishery release would be made would increase slightly. The modeling analysis indicates that, under the existing condition, the minimum flow release would be made 85.1 percent of the time (837 months in the 984-month hydrologic record), while under the WSIP the minimum flow release would be made 85.4 percent of the time (in 6 more months, or 843 months in the 984-month hydrologic record). Minimum release requirements would be maintained under all conditions. The WSIP would have a less-than-significant effect on river flows and, in turn, on fisheries in these months.

In spring months (April, May, and June), however, operation of the regional water system under the WSIP would reduce average monthly flows between 4 and 30 percent as the SFPUC refills Hetch Hetchy Reservoir with snowmelt. The greatest percentage reduction would occur in normal, below-normal, and dry years because, in these year types, a greater proportion of the snowmelt currently released by the SFPUC to the river would be needed to refill the reservoir. Actual flow reductions in any single spring month during the different hydrologic year types would vary widely. As discussed previously, the modeling tool used for this analysis reports information in a monthly time-step; it cannot provide weekly or daily information about flow releases. In reality, the flow reduction would not occur evenly over a month, but instead would be the result of SFPUC reservoir operators delaying the start of spring flow releases from Hetch Hetchy Reservoir by a few days in an effort to gauge and balance reservoir refill with releases of excess snowmelt. After the initial delay of releases from the reservoir under WSIP operations, and once the SFPUC determined that adequate reservoir refill would be achieved by July, the SFPUC would resume releases for the remainder of the spring and early summer, following a similar pattern of frequency and magnitude as under existing conditions.

Many of the resident fish spawn during the spring months, but the delayed rise in flow would not be expected to have a significant effect on rainbow trout and other resident fish during the spring spawning season. The delay in spring flow releases under the WSIP would typically be on the order of days and would be within the natural interannual variation that has occurred in the past. Resident rainbow trout, and other fish species, have evolved and adapted to short-duration variation in environmental conditions. The short-duration delay in increasing stream flows above the minimum flows would be a less than significant impact on habitat conditions and the biological response of resident trout and other fish species. Adverse impacts on fishery habitat quality and availability for resident rainbow trout related to the minor delay in increased flows would be less than significant.

With respect to potential water quality and temperature effects on fisheries (as discussed in Section 5.3.3), the WSIP would have no effect or a less-than-significant effect on temperature and dissolved oxygen in Hetch Hetchy Reservoir and downstream on the Tuolumne River in most months and year types. During some extremely dry periods under both existing conditions and with the WSIP, reductions in storage in Hetch Hetchy Reservoir might result in the release of warmer water from the reservoir at times when the reservoir is stratified (warmer water at the top and colder water below). Analysis of the droughts that occurred in 1923–1935, 1976–1977, and 1986–1993 indicates that this situation could occur in a drought similar to the 1976–1977 drought, but did not occur in the two other extended drought scenarios.

Under conditions similar to those of the 1976–1977 drought, with reduced water in storage during the dry period, water released downstream to the river in September and October could eventually come from the warmer water layer on the surface of the reservoir, which could be 10 to 12 °C warmer than the colder water initially released from the lower level of the reservoir. Release of this warmer water could increase the temperature in the river from about 8 °C to perhaps 14 to 18 °C. This situation would occur in a drought similar to the 1976–1977 drought under existing conditions as well as with the WSIP. However, since reservoir drawdown in Hetch Hetchy Reservoir would be greater with the WSIP than under existing conditions, the adverse water quality effects would be similar to those under the existing condition but would last longer under the WSIP.

This potential temperature effect would result in a less-than-significant impact on the fisheries in this reach of the river for several reasons. First, it would occur very infrequently; review of the historical hydrology indicates that this situation would not occur in all drought periods but only those, such as the 1976–1977 drought, where reservoir drawdown reaches levels low enough in September and October (when the reservoir would be stratified) to result in the release of the warmer surface water. Over the modeled 82-year hydrologic record this condition occurred only once. Although this temperature increase would exceed the 5 °F limit for temperature change specified in the Central Valley RWQCB objectives for coldwater fishery beneficial uses, the resulting temperatures of 14 to 18 °C would not exceed the suitable temperature range for juvenile and adult trout (13 to 21 °C). The rainbow trout fishery would be the most sensitive to the temperature increase. Also, this temperature effect would not occur during the spawning months of the year (a sensitive stage in the fishery life cycle), but rather during the adult and juvenile rearing period. This very infrequent temperature effect would not result in a significant impact on fishery populations.

Potential impacts to resident fish population inhabiting the river are *less than significant*, and no mitigation is required.

Impact 5.3.6-3: Effects on fishery resources in Don Pedro Reservoir.

Don Pedro Reservoir supports a diverse assemblage of resident fish (Table 5.3.6-1), including rainbow, brown, and brook trout, largemouth and smallmouth bass, sunfish, shad, and several species of fish such as Chinook salmon, coho salmon, and kokanee that are reared in hatcheries and planted in the reservoir to support recreational fisheries. Operational modeling (presented in Section 5.3.1) indicates that reservoir storage under the WSIP would be reduced year-round (Figure 5.3.1-11). As a result of increased deliveries under the WSIP, inflows to Don Pedro Reservoir would be reduced, causing a reduction in storage elevations within the reservoir of 1 to 10 feet in most months, and to a larger degree in some months of a severe drought. Don Pedro Reservoir typically undergoes a substantial change in storage volume throughout the year, with a general increasing trend during the fall, winter, and early summer followed by a substantial decline in storage during the late summer and early fall (Figure 5.3.1-11). The typical variation in reservoir conditions within a year is substantially greater than the change expected to occur under WSIP operations. The fish community inhabiting the reservoir typically experiences a wide range of habitat conditions under both existing and proposed future operations. Given the range of natural variation in seasonal storage within the reservoir under existing conditions and the incremental changes predicted to occur under the WSIP, impacts on resident fish habitat within the reservoir under future conditions would be *less than significant*, and no mitigation is required.

Impact 5.3.6-4: Effects on fishery resources along the Tuolumne River below La Grange Dam.

Changes in reservoir operations, coldwater pool availability, and instream flow releases have the potential to affect the quality and availability of habitat for resident and anadromous fish species. Chinook salmon is the species of most concern in this reach of the river. On the Tuolumne River downstream of La Grange Dam, fall-run Chinook salmon use the river for migration, spawning, egg incubation, and juvenile rearing. Steelhead, which is a federally listed threatened species, may inhabit the river in low abundance. These two are the more sensitive fish species in this reach of the river and thus are the focus of this impact analysis; impacts on these species are representative of potential effects on the other species present in this reach. Potential mechanisms for adverse effects on fishery habitat include:

- Reductions in adult salmon attraction and migration flows
- Reductions in stream flows resulting in dewatering of incubating eggs
- Reductions in stream flows resulting in reductions in physical habitat for juvenile rearing
- Reductions in reservoir storage volume and coldwater pool availability resulting in elevated downstream water temperatures
- Reductions in stream flows and/or increases in seasonal water temperatures affecting juvenile emigration

The potential for each of these mechanisms to adversely affect fishery habitat as a result of proposed operations was assessed based on the reservoir storage information and monthly instream flows presented in Section 5.3.1 and the water quality/temperature effects assessment presented in Section 5.3.3.

The potential flow changes on the lower Tuolumne River under the WSIP, as discussed in Section 5.3.1, can be summarized as follows. Under existing conditions, in most below-normal or drier years, almost all of the winter and spring runoff from the watershed upstream of Don Pedro is captured in the reservoir. In years when the reservoir fills, usually wet or above-normal years, excess water is released to the Tuolumne River. In the future with the WSIP, Don Pedro Reservoir would be drawn down farther in most years than it would under the existing condition. Consequently, TID would have to capture a greater proportion of spring runoff to refill the reservoir with the WSIP. As a result, the volume of water released to the Tuolumne River would be reduced compared to the existing condition. The flow reductions that would occur under WSIP operations would primarily take place during the December to June period, when TID fills Don Pedro Reservoir.

The WSIP would have little or no effect on average monthly flow in the lower river in most summer, fall, and winter months in all hydrologic year types. The WSIP would have no effect on average monthly flow in any months of critically dry years or in most summer months of dry, below-normal, and above-normal years (see Table 5.3.1-6). Only the required fishery releases are made in these months under the existing condition, and this would remain the case under the WSIP. The WSIP would result in reductions in average monthly flow in the Tuolumne River below La Grange Dam in the November through June period in non-critically dry years. As shown in Table 5.3.1-6, reductions in flow would occur in some months of all year types except for critically dry years. Looking at monthly flows averaged by year type, the greatest average monthly reduction would be a 25 percent flow reduction in June of an above-normal year. The analysis of the 82-year hydrologic record indicates that reductions of 30 percent or more could occur in some months of 18 years out of 82, or about once in every four springs on average. A maximum flow reduction ranging from 80 to 95 percent was projected to occur once in the 82-year hydrologic simulation.

As discussed previously, the modeling tool used for this analysis reports information on a monthly time-step. As a result, while the model describes the nature and magnitude of monthly flow changes that could occur under the WSIP compared to existing conditions, it does not show the specific daily or weekly changes in reservoir operations made by the operators. The predicted flow changes would not occur uniformly over an entire month. The flow reductions on the lower Tuolumne River under the WSIP would result from Don Pedro Reservoir operators adjusting the timing and duration of reservoir releases by a matter of days as they balance reservoir refill objectives with flood control and fishery release requirements.

Adult fall-run Chinook salmon migrate upstream from September through December. Minimum instream flows in the Tuolumne River were established as part of the FSA to provide suitable habitat conditions for adult Chinook salmon migrating upstream. Minimum instream flows would continue to be maintained under the WSIP. Although flows in the lower river would be reduced in some months, the remaining flows are suitable for adult migration. Flow reductions under the WSIP would have a less-than-significant effect on adult migration.

Chinook salmon spawning and egg incubation typically occurs from approximately mid-October through March. If there were a substantial reduction in flows during egg incubation, the redds could be dewatered, resulting in mortality. During the spawning season, average monthly flows generally show an increasing trend throughout the egg incubation period under both existing conditions and with the WSIP. Although the WSIP would reduce flow relative to existing conditions, the flow reductions would not be expected to result in an increased risk of redd dewatering. Since flows during the egg incubation period are increasing under both existing and future WSIP conditions, it is expected (based on the monthly average flow estimates) that impacts on egg incubation, hatching, and fry emergence would be minor. Instream flows under existing conditions are managed on a daily basis to reduce the risk of redd dewatering. It is assumed they would be managed in the same way with the WSIP. Thus, it flow reductions under the WSIP are not anticipated to have a significant effect on incubating eggs.

Juvenile Chinook salmon rearing occurs in the lower Tuolumne River from January through May. WSIP-induced changes in river flow that are projected to occur during the juvenile Chinook salmon rearing are typically less than 10 percent of the existing baseline flows (Table 5.3.1-6), with some exceptions where a higher-percentage flow reduction could occur. Instream flow studies have been conducted on the lower river to identify the relationship between stream flow and juvenile salmon rearing habitat (USFWS, 1994). The results of these analyses were used to identify minimum instream flow requirements. The minimum instream flows would be maintained under both existing and proposed operations. In some years, the projected flow reductions would not substantially reduce rearing habitat (based on an examination of the predicted changes in stream flow during the juvenile rearing period and the flow/habitat relationships for the river), and the WSIP would have a less-than-significant effect on the salmon fishery. However, in some years, when the flow reductions are more substantial, the WSIP changes would adversely affect juvenile fall-run Chinook salmon rearing habitat.

Fall-run Chinook salmon juvenile out-migration occurs during February and March (fry) and April and May (smolts). The predicted stream flows under existing and proposed operations during the juvenile emigration period show that stream flow reductions are typically less than 10 percent when compared to the existing baseline flows. As noted above, minimum stream flow requirements identified for the river would continue to be met under both existing and proposed operations. Based on the magnitude of the stream flow changes, it is not expected that flow reductions under the WSIP would result in significant adverse impacts on juvenile fall-run Chinook salmon migration.

The largest percentage reductions in Tuolumne River stream flow downstream of La Grange Dam under WSIP operations are expected to occur in June (Table 5.3.1-6). Flow reductions in June would likely result in seasonally elevated water temperatures and a corresponding reduction in the linear extent of suitable habitat for steelhead/rainbow trout rearing. Steelhead/rainbow trout rear within the river system throughout the year. Seasonally elevated water temperatures affect habitat suitability during summer months. Although steelhead are not abundant in the Tuolumne River, these changes in stream flow and water temperature could affect habitat quality and availability for summer rearing. Changes in flow in June of average wet years (-7 percent) would have a minor effect on steelhead/rainbow trout because river flow under both existing and proposed conditions would be in excess of 1,000 cfs. The average monthly flow reduction in June of above-normal hydrologic years (-25 percent) represents a change in flow from 408 cfs under existing conditions to 306 cfs with the WSIP. A reduction in average monthly flow in June of approximately 102 cfs would cause a moderate change in habitat conditions, potentially affecting oversummering steelhead/rainbow trout as well as reducing physical habitat within the river for other aquatic species.

As discussed in Section 5.3.3 regarding water quality and temperature, the proposed program would not result in changes in reservoir storage that would adversely affect the extent of the coldwater pool available for release to the lower river. Based on the results of these analyses, it was concluded that the WSIP would not affect seasonal temperatures in water released to the river from Don Pedro Reservoir. Almost all of the time, WSIP-induced flow reductions in the Tuolumne River below La Grange Dam would have no effect on water temperature. As described in Section 5.3.3, on infrequent occasions, WSIP-induced flow reductions could cause temperature increases in early summer (June) in the Tuolumne River downstream near the confluence with the San Joaquin River. Water released from La Grange Dam in June is considerably cooler than the average daily air temperature. As water flows downstream, its temperature increases. Water temperature modeling projected that mean daily temperature increases of 1 or 2 °C could occur infrequently in the Tuolumne River downstream near the confluence with the San Joaquin River (see Section 5.3.3). On very rare occasions, WSIP-induced flow reductions would cause mean daily temperature increases of 10 °C downstream near the San Joaquin River confluence. This occurred in only one month in the modeled simulation of WSIP operations over the 82-year hydrologic record.

Overall, the flow reductions coupled with the projected infrequent water temperature increases that could result under the WSIP would have an adverse impact on habitat conditions for juvenile salmonids. The flow reductions would reduce available habitat in the entire reach of the river used by juvenile salmonids below La Grange Dam. The elevated temperatures, although infrequent, would truncate the length of the river reach suitable for juvenile salmonids. These adverse effects on flows and temperature in the river under the WSIP would not substantially alter or degrade salmonid habitat in most years or jeopardize the continuation of the salmonid populations in the lower Tuolumne River. However, WSIP effects on flow and temperature would infrequently contribute to potentially significant effects on the fishery resources. The *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush, 2000) establishes goals for fishery habitat restoration, and the NMFS and others have identified goals for fishery enhancement on the lower river. The WSIP's small but incremental contribution to adverse effects on the lower river would make planned restoration of habitat and fishery resources more difficult. As a result, the impact of the WSIP on these fishery resources in the lower Tuolumne River would be *potentially significant*. Implementation of Measure 5.3.6-4a, Avoidance of Flow Changes By Reducing Demand for Don Pedro Reservoir Water, would reduce this impact to less than significant. This measure involves some uncertainty because its implementation depends on the SFPUC reaching agreement with MID/TID and possibly other water agencies. If this measures proves to be infeasible, the SFPUC will implement Measure 5.3.6-4b, Fishery Habitat Enhancement, to enhance fishery habitat in the lower Tuolumne River. Implementation of Measure 5.3.6-4a or 5.3.6-4b would reduce these adverse impacts to a *less-than-significant* level.

[Additional discussion on Mitigation Measures 5.3.6-4a and 5.3.6-4b was prepared in response to comments on the Draft PEIR. Please refer to Section 14.7, Master Response on Lower Tuolumne River Issues (Vol. 7, Chapter 14).]

Impact 5.3.6-5: Effects on fishery resources along the San Joaquin River.

The lower San Joaquin River provides habitat for a diverse assemblage of fish, including catfish, largemouth bass, striped bass, shad, and many others. The lower river also serves as the migratory corridor for the upstream passage of adult salmon and steelhead and the downstream passage of juveniles. Although water quality (e.g., electrical conductivity, dissolved oxygen, etc.) and other factors affect habitat for these species within the San Joaquin River, seasonal flow and water temperatures have been identified as important environmental parameters affecting the health and survival of migrating salmonids.

For the San Joaquin River and its tributaries, a relationship has been established between spring flow and the subsequent survival and contribution of adults to the salmon population (USFWS, 1994). A reduction in river flow during the spring rearing and juvenile emigration period would result in an incremental contribution to reduced juvenile survival and a small incremental contribution to the cumulative reduction in juvenile survival and subsequent adult population abundance. Increased water temperatures, particularly during the late spring juvenile salmonid migration period (April–May), would also be expected to adversely affect juvenile salmon survival.

Hydrologic modeling has shown that the WSIP would affect habitat conditions within the lower San Joaquin River as a result of changes in Don Pedro Reservoir storage. This potential adverse effect of WSIP operations on fishery habitat within the lower river would be greatest during the summer months (e.g., June, July, etc.) at the end of a prolonged drought, when the reservoir storage volume would be lowest and water temperatures greatest. Inflow to the lower San Joaquin River from the Tuolumne River would not be less than the minimum stream flow specified in the FERC license for the Don Pedro Project. As a result of this minimum flow requirement, the WSIP would not have a significant impact on flows, particularly during drought conditions.

WSIP operations (as discussed above) would reduce inflow to the reservoir and, as a result, increase the seasonal (summer) temperatures in water released from the reservoir, which would also affect water temperature within the lower San Joaquin River. Under low-flow summer conditions, particularly during a drought, water temperatures increase rapidly with distance downstream of a dam and reach thermal equilibrium with ambient air temperatures. As discussed in Measure 5.3.6-4a, the SFPUC would attempt to enter into a water transfer agreement with MID/TID or other water provider that would reduce the potential for adverse impacts on habitat conditions within the Tuolumne River that would also extend downstream to the San Joaquin River. The effectiveness of increased storage in reducing water temperatures is greatest during the spring, but is reduced during the summer as air temperatures increase. As a result, water temperatures in the lower San Joaquin River could increase during the summer months in years following an extended drought, although these conditions are expected to occur infrequently. Increased water temperatures during the summer of an extended drought would not be expected to result in significant adverse impacts on salmon or steelhead migrating downstream within the San Joaquin River, since the migration would occur earlier in the year and ambient water temperatures within the river might already be elevated to a level that is highly stressful or potentially lethal to juvenile salmonids. To the extent that infrequent reductions in flow and corresponding increases in water temperature occur during the spring (April-June) WSIP operations would contribute to adverse impacts on habitat conditions for downstream migrating Chinook salmon and steelhead. However, this potential impact would occur so infrequently that it does not represent a significant impact to fishery resources. Other fish species inhabiting the river, such as largemouth bass and striped bass, are tolerant of elevated water temperatures and would not likely be affected. As a result, the impacts of WSIP operations on habitat conditions for fish within the lower San Joaquin River would be *less than significant*, and no mitigation would be required.

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5.3.7 Terrestrial Biological Resources

The following setting section describes terrestrial biological resources in the Tuolumne River watershed that could be affected by the WSIP. The impact section (Section 5.3.7-2) provides a description of the changes in terrestrial biological resources that would result from WSIP-induced changes in stream flow and reservoir water levels.

5.3.7.1 Setting

Riparian and wetland habitats form an important element in the ecology of most landscapes, whether in the Sierra Nevada or the Central Valley. This analysis deals only with those species and communities that have an essential requirement for stream or meadow conditions and whose range includes the Tuolumne River. Approximately 17 percent of Sierran plant species, 21 percent of vertebrate species, and, by definition, all aquatic invertebrate species in streams are closely associated with or dependent on riparian or wet areas (Sierra Nevada Ecosystem Project, 1996a). While Tuolumne River water does reach the San Joaquin River and the Delta, at that distance it is subject to so many other inputs and impacts, and at such larger scales, that an assessment of the biological impacts due to the WSIP alone would be speculative. As a result, this discussion focuses on the Tuolumne River from Hetch Hetchy Reservoir downstream to the confluence with the San Joaquin River, and the Tuolumne's two major mountain tributaries, Cherry Creek and Eleanor Creek.

In Chapter 4, the term "key special-status species" is used to indicate those species (principally but not exclusively those listed under the California or Federal Endangered Species Acts) that would be subject to a significant impact at the programmatic level. For all proposed WSIP projects analyzed in Chapter 4, separate, project-level CEQA review would be performed. This chapter (Chapter 5) uses a slightly expanded set of groupings. The term "sensitive habitats" has the same definition throughout this PEIR, although in Chapter 5 the term refers mainly to riparian, wetland, and associated upland habitats that could be affected by WSIP-induced changes in reservoir water levels. Because the analysis in Chapter 5 must sometimes address project-level impacts of the WSIP and no further CEQA review would be performed, two additional categories were developed to ensure that no impact category is left unaddressed: "other species of concern," which is the broader suite of species appearing on the CDFG's Special Animals or Special Plants list (CDFG, 2007) or the California Native Plant Society's (CNPS) Lists 1 or 2 (CNPS, 2001). All other biological resources are included in the widest category, "common habitats and species." This latter category evaluates project-level impacts that are great enough in scale to potentially affect species and habitats of widespread distribution (e.g., annual grasslands).

The sections that follow describe the existing conditions for terrestrial riparian resources associated with the Tuolumne River portion of the Hetch Hetchy system. Section 4.6, Biological Resources, Figure 4.6-1 shows the habitat types found along the Tuolumne River within the WSIP program area. Habitat types are broader groupings than natural communities, but are useful when describing both wildlife and vegetation resources together.

Hetch Hetchy Reservoir, the Tuolumne River, and its Tributaries from O'Shaughnessy Dam to Don Pedro Reservoir

O'Shaughnessy Dam is located in a glacial valley dominated by walls of smooth, mostly unvegetated granite. Essentially no marsh or meadow habitat has formed around the perimeter of Hetch Hetchy Reservoir because of the steep granite slopes and annual fluctuations in reservoir water levels. The vegetation around the reservoir is generally mapped as foothill woodland and lower montane coniferous forest (NPS, 2007).

The Tuolumne River below O'Shaughnessy Dam flows through the transition from a glacially carved, U-shaped valley to a river-incised, V-shaped canyon. The stairstep morphology typical of formerly glaciated streams is evident for several miles below the reservoir; there are long reaches of low relief, sometimes with extensive gravel bars, punctuated by short, steeper sections with boulders and exposed bedrock channel. The Tuolumne River below O'Shaughnessy Dam represents the lowest-elevation evidence of glaciation found anywhere in the western Sierra (NPS, 2006). The stairstep morphology combined with exceptional water quality, a seasonal flood regime, and a largely undisturbed river corridor sustains systems that are remarkable in their size and diversity (NPS, 2006). Upslope from the narrow riparian zone, the Tuolumne River canyon has a largely unvegetated section of bare granite rock scoured during high flows following rain-on-snow precipitation events. The most recent of these events took place in 1982 and January 1997. The Tuolumne River below O'Shaughnessy Dam contains extensive sections of bedrock channel confined in a narrow canyon, with a riparian zone consisting of interrupted bands of white alder (*Alnus rhombifolia*) and dusky willow (*Salix melanopsis*) with very limited understory. The riparian strip is wider and contains more extensive stands along gravel bars found on the larger river bends. Alternating with the low-diversity bedrock channel portions of the river are areas of higher species diversity on alluvial fans and terraces where tributary streams with a natural hydrograph[1] empty into the river (McBain and Trush, 2007).

The Poopenaut Valley, about two miles below the dam, represents a low-elevation limit of glaciation. The substrate in the Poopenaut Valley is primarily decomposed granite with a high proportion of sand and gravel particles. The Poopenaut Valley supports stands of tule bulrush, wet and dry meadow, willow and woodland habitats, hanging ponds, and seasonal pools (NPS, 2006). The National Park Services considers the low-elevation meadow and wetland complex of the Poopenaut Valley to be an "outstandingly remarkable value" of the Tuolumne Wild and Scenic River (NPS, 2006). The presence of hanging ponds suggests that less-pervious, possibly fine-textured layers may be present in the valley alluvium.

Lake Lloyd is situated in a steep-sided valley and has little meadow development around its perimeter. Lake Eleanor is similarly situated, but contains some gradual slopes around the periphery that support seasonal wetland vegetation. These reservoirs are also bordered by foothill woodland and lower montane coniferous forest. Lake Lloyd and Lake Eleanor are similar in that their annual fluctuations expose a broad, essentially unvegetated strip below the maximum reservoir elevation.

1 The pattern of flow in a stream over time.

Cherry Creek is a steep, rapidly flowing tributary to the Tuolumne River. Cherry Creek has experienced riparian encroachment because of diversions at Lake Lloyd. Montane black cottonwood (*Populus trichocarpa*) forest with frequent Jeffrey pines (*Pinus jeffreyi*) now occupies most of the former stream channel. Eleanor Creek is a major tributary of Cherry Creek. It supports a narrow band of riparian habitat typical of mid- to high-elevation streams, with minimal riparian vegetation encroachment into the channel (McBain and Trush, 2007).

The Tuolumne River above Don Pedro Reservoir supports a diverse assemblage of Great Valley mixed riparian forest and scrub with species similar to those found in the riparian systems of the valley floor, although the habitat in this area is confined to rather narrow canyons.

Don Pedro Reservoir and Tuolumne River below La Grange Dam

Don Pedro Reservoir is situated in the lower Sierra Nevada foothills at an elevation of 900 to 1,000 feet. The surrounding area consists of foothill woodland typically dominated by gray pine (*Pinus sabiniana*) and blue oak (*Quercus douglasii*) with a grass understory. Due to the sloping terrain and large seasonal drawdown, very little wetland habitat is present on the margins of this reservoir.

This discussion of the current setting for the lower Tuolumne River draws heavily from the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush, 2000). The restoration plan was developed after the 1995 FERC Settlement Agreement (FSA) to help the parties select and design restoration projects (see Chapter 2 for a description of the original FERC license for the New Don Pedro Project and the subsequent settlement agreement related to instream flows in the lower river).

The lower Tuolumne River extends for 52 river miles, from La Grange Dam to the confluence with the San Joaquin River. Its floodplain terraces extend up to several miles in width. Backwater channels and old oxbows are evidence of channel-forming processes that characterized historical, unimpaired flows. Prior to flow and sediment regulation, the stream flows of the Tuolumne River downstream of La Grange Dam within a given year and between years varied from 100 cfs in summer months to peak winter floods exceeding 100,000 cfs; these flows created variable and complex local channel morphologies and regularly occupied the full width of the floodplain.

Today, about 67 percent of the lower Tuolumne River water is diverted. Low flows are maintained at regulated levels, but the high flows have been greatly diminished and are dictated by flood control requirements. The lower Tuolumne River has experienced substantial encroachment from agriculture, grazing, and gravel mining

The previous alteration of physical and ecological characteristics of the lower Tuolumne River has changed the ability of the floodplain to support and sustain riparian habitat and ecological processes. The lower Tuolumne River is currently unable to mobilize its bed particles as a result of reduced flow magnitudes, among other factors. In most alluvial rivers with unimpaired flow regimes, floods with recurrence intervals of 1.5 to 2.5 years typically inundate floodplains. In the lower Tuolumne, the 1.5-year recurrence flood at the La Grange gaging station (RM 51.6) decreased from 8,600 cfs to 3,000 cfs following construction of Don Pedro Reservoir, with a consequent reduction in the frequency and amplitude of bed mobilization. McBain and Trush (2000) noted that the reduction in flows has prevented the formation of any distinct post-FSA floodplains.

Historically, willow scrub occupied the actively accumulating gravel beds and sandbars of river meanders. Broad riparian forests dominated by Fremont cottonwood (*Populus fremontii*) occupied the lower floodplain terraces. Backwater channels and oxbows (river meanders cut off from the main channel) supported a variety of seasonal and perennial wetlands dominated by shrubs, grasses, grasslike plants, and forbs. Valley oak (*Quercus lobata*) woodlands occupied the upper floodplain terraces (Conard et al., 1977).

The total historical acreage of riparian vegetation in the Tuolumne River corridor between La Grange Dam and the San Joaquin River has diminished from approximately 13,000 or more acres to less than 2,200 acres. Fremont cottonwood is commonly observed within the lower Tuolumne River corridor, but nearly all stands and individuals are old and dying, with little or no natural regeneration. Valley oaks are also found throughout the Tuolumne River corridor. Because valley oaks are not as dependent on fluvial processes for regeneration, their regeneration in the river corridor is more successful. McBain and Trush observed that where the floodplain has not experienced land use encroachment, relict riparian vegetation fragments of a much larger ecosystem are detectable.

McBain and Trush attributed the change of dominant tree species at the channel margins to the decrease in channel slope and transition from gravel-bedded to sand-bedded substrate. They concluded that, on the lower Tuolumne River, riparian regeneration (particularly Goodding's black willow (*Salix gooddingii*) and Fremont cottonwood) depends on a migrating channel that creates floodplain surfaces, flood inundation every 1.5 to 5 years, and gently receding flows following the spring snowmelt. The elimination of post-FSA floods exceeding 10,000 cfs has allowed narrow-leaf willow (*Salix exigua*), box elder (*Acer negundo* var. *californicum*), and white alder to establish and caused drier conditions on the former floodplains. As a result, the Fremont cottonwood and valley oak are beginning to die of old age.

Natural Communities, including Sensitive Natural Communities

Considering its length and elevational range, the Tuolumne River in the WSIP program area supports relatively few riparian natural communities. The California Natural Diversity Database (CNDDB) (CDFG, 2006a) lists all but the montane meadow community as sensitive. However, as indicated above, the National Park Service considers the low-elevation montane meadow in the Poopenaut Valley to be an outstandingly remarkable value of the Tuolumne Wild and Scenic River area (NPS, 2006). The natural communities along the Tuolumne River are briefly described below.

- **White alder riparian forest** is a streamside deciduous riparian forest strongly dominated by white alder with a shrubby, deciduous understory. A common associated tree species in the upper Tuolumne area is dusky willow. This natural community is associated with rapidly flowing, well-aerated perennial streams with coarse streambed sediments. White alder riparian forest is found extensively along most of the Tuolumne River below O'Shaughnessy Dam.

- **Montane meadow** is a dense herbaceous natural community dominated by sedges (*Carex* spp.) along with rushes (*Juncus* spp.), perennial grasses, and herbs. It is found on fine-textured, more or less permanently moist or wet soils. Unlike most natural communities identified by Holland (1986), montane meadow actually consists of many vegetation series dominated by a number of grass-like species associated with a wide range of elevations, soils, and hydrologic conditions. The Poopenaut Valley is considered to be an exceptional example of a low-elevation montane meadow.

- **Montane black cottonwood riparian forest** is a dense riparian forest dominated by black cottonwood with emergent Jeffrey pine. Shrub cover is fairly high, and herb cover is typically very high. Montane black cottonwood forest is found on high-flow streams below about 7,000 feet in the mid-Sierra Nevada. Small remnants of this natural community are found in the Poopenaut Valley. It is also found along Cherry Creek, where water diversions have resulted in substantial encroachment by Jeffrey pine.

- **Great Valley mixed riparian forest** is a tall, winter-deciduous, broadleaved riparian forest. Natural examples of this community include box elder, California black walnut (*Juglans hindsii* var. *californica*), California sycamore (*Platanus racemosa*), and several willow species (*Salix* spp.). The understory is a dense tangle of shade-tolerant shrubs, and California grape (*Vitis californica*) is also found in well-developed forests. Great Valley mixed riparian forest is found all along the lower Tuolumne River as well as the lower elevations of the river above Don Pedro Reservoir.

- **Great Valley cottonwood riparian forest** is similar to the preceding natural community. It is strongly dominated by Fremont cottonwood with some Goodding willow. This community is typically found on the largest streams in the Central Valley that provide ample subsurface irrigation even when the channel is dry. Great Valley cottonwood riparian forest is typically inundated yearly during spring, and cottonwood regeneration is dependent on freshly deposited, fine-textured alluvium and on the gradual ebbing of spring flows as the tiny cottonwood seedlings develop their root systems. Remnants of this community are still found along the lower Tuolumne River, although natural recruitment (i.e., growth of new vegetation) has essentially ceased.

- **Great Valley valley oak riparian forest** is a medium to tall, broadleaved, winter-deciduous, closed-canopy riparian forest dominated by valley oak. This community is found on the higher river terraces that receive periodic flooding and annual inputs of sediment. This community has become rare primarily through encroachment by agriculture, mining, and other human uses, although the cessation of flooding and sediment deposition has limited natural reproduction of the dominant species.

[Additional discussion on streamside meadows in the upper Tuolumne River watershed was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues (Vol. 7, Chapter 14).]

Key Special-Status Species and Other Species of Concern

Tables 5.3.7-1 and **5.3.7-2** present key special-status plant and animal species and other species of concern along the Tuolumne River that could be affected by the WSIP. Although the watershed as a whole supports a larger assemblage of species, the key special-status species and other species of concern considered here are limited to those that depend on riparian and river-associated habitats. Riparian, wet meadow, seep, or marsh plants were included if they appeared on CNDDB records for the 21 U.S. Geological Survey 7.5-minute quadrangles that encompass

TABLE 5.3.7-1
POTENTIAL FOR OCCURRENCE OF KEY SPECIAL-STATUS PLANTS AND PLANT SPECIES OF CONCERN IN THE WSIP TUOLUMNE WATERSHED PROGRAM AREA[a]

			WSIP Program Area	
Common Name *Scientific Name*	**CNPS Status[b]**	**Habitat**	Upper Tuolumne River	Lower Tuolumne River
Shore sedge *Carex limosa*	List 2	Bogs, fens, marshes, swamps, seeps, upper and lower montane coniferous forest	Potential	
Mariposa clarkia *Clarkia biloba ssp. australis*	List 1B	Chaparral and cismontane woodland, riparian ecotone	Potential	
Delta button-celery *Eryngium racemosum*	List 1B	Riparian scrub		Potential
Knotted rush *Juncus nodosus*	List 2	Meadows and seeps, marshes and swamps; lake margins and mesic sites	Potential	
Pansy monkeyflower *Mimulus pulchellus*	List 1B	Open sandy benches, wet meadows	Known, Poopenaut Valley	
Slender-stemmed monkeyflower *Mimulus filicaulis*	List 1B	Moist meadows, seeps in lower montane coniferous forest	Potential	
White beaked-rush *Rhynchospora alba*	List 2	Bogs, fens, marshes, swamps	Potential	
Brownish beaked rush *Rhynchospora capitellata*	List 2	Meadows, seeps, marsh, swamps, upper and lower montane coniferous forest	Potential	

[a] In this document, CNPS-listed species with no federal or state listing status are considered plant species of concern; no key special-status plants are known to occur in the Tuolumne project area.

[b] California Native Plant Society species codes are as follows:
List 1B: Rare and endangered.
List 2: Rare but not endangered.

SOURCES: CDFG, 2006b; CNPS, 2001.

the Tuolumne River from O'Shaughnessy Dam to the confluence with the San Joaquin River, Lake Lloyd, Cherry Creek, Lake Eleanor, and Eleanor Creek (CDFG, 2006b). The list of animals was compiled from the 2005 California Gap Analysis Project[2] species dependent on valley foothill riparian, montane riparian, and fresh emergent wetland habitat types. The list was then compared with CNDDB records for the 21 quadrangles encompassing the WSIP program area, and additional locality data were obtained by reviewing 2007 species occurrence records from the University of California Museum of Vertebrate Zoology. Figure 4.6-2 in Chapter 4 show the distribution of federally designated critical habitats for species listed under the Federal Endangered Species Act within the WSIP program area.

[2] The Gap Analysis Project provides regional assessments of the conservation status of native vertebrate species and natural land cover types and facilitates the application of this information to land management activities. The Gap Analysis Project is conducted as state-level projects and is coordinated by the U.S. Geological Survey Biological Resources Division.

TABLE 5.3.7-2
POTENTIAL FOR OCCURRENCE OF KEY SPECIAL-STATUS ANIMALS AND ANIMAL SPECIES OF CONCERN IN THE WSIP TUOLUMNE WATERSHED PROGRAM AREA

			WSIP Program Area	
Common Name *Scientific Name*	**USFWS/ CDFG Status[a]**	**Habitat**	**Tuolumne River watershed from O'Shaughnessy Dam to Don Pedro Reservoir**	**Tuolumne River from Don Pedro Reservoir to San Joaquin River**
Reptiles and Amphibians				
California tiger salamander *Ambystoma californiense*	FT/CSC*	Seasonal freshwater ponds with little or no emergent vegetation		Potential
Western spadefoot *Spea hammondii*	–/CSC	Seasonal ponds such as vernal pools surrounded by grassland		Potential
California red-legged frog *Rana aurora draytonii*	FT/CSC*	Slow-moving streams and ponds	Potential	Potential
Foothill yellow-legged frog *Rana boylii*	–/CSC*	Shallow, moving water with sunny banks	Potential	
Mountain yellow-legged frog *Rana muscosa*	–/CSC	Fast-moving mountain streams	Potential	
Western pond turtle *Clemmys marmorata*	–/CSC	Permanent water such as streams or ponds	Present	Present
Birds				
Double-crested cormorant *Phalacrocorax auritus* (rookery site)	–/CSC	Colonial nester on coastal cliffs and along lake margins; forages in open water		Potential
White-faced ibis *Plegadis chihi* (rookery site)	–/CSC	Forages in shallow water; winters in Central Valley		Potential
Cooper's hawk *Accipiter cooperi*	–/CSC	Nests in deciduous riparian vegetation and oaks	Potential	Potential
Northern goshawk *Accipiter gentilis*	–/CSC	Nests and forages in dense conifer and mixed forest	Potential	
Sharp-shinned hawk *Accipiter striatus*	–/CSC	Nests in deciduous riparian vegetation and oaks	Potential	Potential
Golden eagle *Aquila chrysaetos*	FP/CSC	Nests on cliffs and in large trees; forages from the air on large prey	Potential	
Ferruginous hawk *Buteo regalis* (wintering)	–/CSC	Roosts in large trees and forages over open ground; winters in Central Valley		Potential
Swainson's hawk *Buteo swainsoni* (nesting)	–/CT*	Nests in large trees; forages over open ground		Present
Great gray owl *Strix nebulosa*	–/CSC	Nests in dense forest; forages in meadows and openings	Potential	
Northern harrier *Circus cyaneus*	–/CSC	Nests and forages in wet meadows		Potential
White-tailed kite *Elanus leucurus* (nesting)	FP/CSC	Nests in large trees; forages for small animals over open country		Potential
Bald eagle *Haliaeetus leucocephalus* (nesting and wintering)	FPD/CE*	Nests on cliffs or in large trees, usually near rivers and lakes; forages on fish when available, also carrion and small mammals	Present	Potential
Osprey *Pandion haliaetus* (nesting)	–/CSC	Nests atop large trees or snags near water; diet almost entirely fish	Potential	Potential

TABLE 5.3.7-2 (Continued)
POTENTIAL FOR OCCURRENCE OF KEY SPECIAL-STATUS ANIMALS AND ANIMAL SPECIES OF CONCERN IN THE WSIP TUOLUMNE WATERSHED PROGRAM AREA

Common Name *Scientific Name*	USFWS/ CDFG Status[a]	Habitat	WSIP Program Area Tuolumne River watershed from O'Shaughnessy Dam to Don Pedro Reservoir	 Tuolumne River from Don Pedro Reservoir to San Joaquin River
Birds (cont.)				
Merlin *Falco columbarius*	–/CSC	Winter visitor in foothills, valleys		Potential
Prairie falcon *Falco mexicanus* (nesting)	–/CSC	Usually nests on cliffs; forages in open country for small birds and mammals		Potential
American peregrine falcon *Falco peregrinus anatum*	FD/CE*	Nests in cliffs and outcrops; forages near wetlands and other water	Potential	Potential
California black rail *Laterallus jamaicensis coturniculus*	FP/CT*	Mainly nests in saltmarsh but may also occur in freshwater and brackish marshes at low elevations		Potential
Greater sandhill crane *Grus canadensis tabida* (nesting and wintering)	FP/CT*	Winters in Central Valley; roosts in shallow water; forages in fields and marshes		Potential
Long-billed curlew *Numenius americanus* (nesting)	–/CSC	Winters in Central Valley, foraging in grasslands and marshes		Potential
Short-eared owl *Asio flammeus* (nesting)	–/CSC	Nests and forages in open or marshy ground	Potential	Potential
Long-eared owl *Asio otus* (nesting)	–/CSC	Roosts and nests in dense trees; forages in open country for small vertebrates		Potential
Burrowing owl *Athene cunicularia*	--/CSC*	Grasslands and open areas; nests in burrows created by digging mammals, sometimes on streambanks		Potential
California spotted owl *Strix occidentalis occidentalis*	–/CSC	Nests in dense forest; forages at night for small mammals	Potential	
Vaux's swift *Chaetura vauxi*	–/CSC	Nests in hollow trees; forages over open water, woodlands	Potential	Potential
Black swift *Cypseloides niger* (nesting)	–/CSC	Nests on sheltered cliffs, often near streams; feeds on flying insects	Present	Potential
Willow flycatcher Empidonax trailii (nesting)	–/CE*	Nests in deciduous shrubs or trees, often willows; forages on insects	Potential	
Loggerhead shrike *Lanius ludovicianus* (nesting)	–/CSC	Open country for hunting; nests in riparian woodland and open woodlands		Potential
Purple martin *Progne subis*	–/CSC	Nests in tree cavities, forages on flying insects	Potential	
Bank swallow *Riparia riparia*	–/CT*	Colonial nester in riparian cliffs; forages on flying insects		Low Potential
Yellow warbler *Dendroica petechia brewsteri*	–/CSC	Nests in low trees and shrubs in riparian zone; forages on various insects	Potential	Potential
Yellow-breasted chat *Icteria virens* (nesting)	–/CSC	Nests low in very dense riparian scrub; forages on insects and fruit	Potential	Potential
Tricolored blackbird *Agelaius tricolor* (nesting)	–/CSC	Colonial nester in emergent vegetation; forages over open water		Potential

TABLE 5.3.7-2 (Continued)
POTENTIAL FOR OCCURRENCE OF KEY SPECIAL-STATUS ANIMALS AND ANIMAL SPECIES OF CONCERN IN THE WSIP TUOLUMNE WATERSHED PROGRAM AREA

			WSIP Program Area	
Common Name *Scientific Name*	**USFWS/ CDFG Status[a]**	**Habitat**	**Tuolumne River watershed from O'Shaughnessy Dam to Don Pedro Reservoir**	**Tuolumne River from Don Pedro Reservoir to San Joaquin River**
Mammals				
Pallid bat *Antrozous pallidus*	–/CSC	Roosts in trees; forages over grassland	Potential	Potential
Pacific western big-eared bat *Corynorhinus (=Plecotus) townsendii*	–/CSC	Roosts in caves and buildings; forages in open country	Potential	Potential
Spotted bat *Euderma maculatum*	–/CSC	Requires rocky cliffs for breeding and roosting, forages primarily on moths	Potential	
Small-footed myotis *Myotis ciliolabrum*	–/CSC	Roosts in caves and trees; forages in open country		Potential
Long-eared myotis *Myotus evotis*	–/CSC	Roosts in hollow trees and buildings; forages at streams and ponds	Potential	Potential
Fringed myotis *Myotis thysanodes*	–/CSC	Roosts in hollow trees and buildings; forages at forest edge	Potential	Potential
Long-legged myotis *Myotis volans*	–/CSC	Roosts in caves, old buildings, and under bark	Potential	Potential
Yuma myotis *Myotis yumanensis*	–/CSC	Roosts in riparian vegetation; forages over open water	Potential	Potential
Western mastiff bat *Eumops perotis*	–/CSC	Roosts on cliff faces and cracks in boulders; forages on moths, crickets, and beetles	Potential	
Sierra Nevada snowshoe hare *Lepus americanus tahoensis*	–/CSC	Inhabits creekside willow thickets	Low potential	
Sierra Nevada mountain beaver *Aplodontia rufa californica*	–/CSC	Inhabits creekside thickets; forages on forbs, twigs, and fruits	Low potential	
Sierra Nevada red fox *Vulpes vulpes necator*	–/CT*	High-elevation forest and scrub dweller; forages for rodents, birds, berries, and insects	Low potential	
Pacific fisher *Martes pennanti* (*pacifica*)	FC/CSC	Inhabits mid-elevation forests; forages mostly on small mammals	Potential	
American marten *Martes americanus*	–/CSC	Inhabits dense forests; forages on small mammals	Potential	
American badger *Taxidea taxus*	–/CSC	Lives in open country; forages on burrowing animals, roots, and berries	Potential	Potential

[a] Federal (USFWS) and state (CDFG) protection status codes are as follows:
FC: Federal candidate for listing
FE: Federal endangered
FT: Federal threatened
FD: Federal delisted
FPD: Federal proposed for delisting
CE: California endangered
CT: California threatened
CSC: California species of special concern
CP: California fully protected

* Indicates key special-status species, defined here to mean federal- or state-listed as endangered or threatened. All other species listed here are defined as species of concern.

SOURCES: CDFG, 2006a, 2006b.

Plants

High-elevation plants. No key special-status plants are known to occur in habitats associated with the Tuolumne River or its tributaries in the WSIP program area. Several plant species of concern occur in montane meadows and seeps, including the pansy monkeyflower (*Mimulus pulchellus*, a CNPS List 1B plant). This species grows at the margins of wet meadows and open sandy benches. Several populations of pansy monkeyflower have been reported in the Poopenaut Valley at the edges of the meadow vegetation (CDFG, 2006a). Several other species are known to be present in wet meadows, bogs, seeps, and moist meadows. They have not been reported from this portion of the Tuolumne River watershed, but suitable habitat could be present at the Poopenaut Valley. They include slender-stemmed monkeyflower (*Mimulus filicaulis*, CNPS List 1B), shore sedge (*Carex limosa,* CNPS List 2), knotted rush (*Juncus nodosus,* CNPS List 2), white beaked-rush (*Rhynchospora alba*, CNPS List 2), and brownish beaked rush (*Rhynchospora capitellata,* CNPS List 2) (CDFG, 2006a).

Mariposa clarkia (*Clarkia biloba ssp. australis,* CNPS List 1B) grows in chaparral and cismontane woodland, sometimes on the edge of riparian habitats, in the lower Sierra Nevada at elevations below 3,000 feet.

Don Pedro Reservoir and La Grange Dam to the San Joaquin River. Delta button-celery (*Eryngium racemosum*, CNPS List 1B) grows in riparian scrub in the lower elevations of the Central Valley. Suitable habitat is present in the lowest portions of the Tuolumne River near the confluence with the San Joaquin River, although the nearest known records are from the floodplains of the San Joaquin River several miles to the north and south of the confluence with the Tuolumne River.

Reptiles and Amphibians

Hetch Hetchy Reservoir to Don Pedro Reservoir. California red-legged frog (*Rana aurora draytonii,* federal threatened, California species of special concern) is known to occur in lowlands and foothills in or near permanent sources of water with dense, shrubby, or emergent vegetation. This species has been reported from Woods Creek, a tributary to Don Pedro Reservoir in Tuolumne County, and it may once have ranged into the vicinity of the Tuolumne River (CDFG, 2006b). Foothill yellow-legged frog (*Rana boylii,* California species of special concern) is found in small permanent streams above about 660 feet in the mid-Sierra (Jennings and Hayes, 1994). Suitable habitat could be present along the Tuolumne River and its tributaries. Western pond turtle (*Clemmys marmorata,* California species of special concern) is a thoroughly aquatic turtle that inhabits permanent ponds, rivers, and even ditches. The CNDDB (CDFG, 2006b) has a record of this species at O'Shaughnessy Dam.

Mountain yellow-legged frog (*Rana muscosa*, California species of special concern) is associated with sunny, high-elevation streams that often have vegetation and sloping banks. There are no CNDDB records from the Tuolumne River watershed below O'Shaughnessy Dam. Habitat in the Poopenaut Valley and along Cherry Creek and Eleanor Creek could be suitable for this species. Although these areas are lower than the currently documented known elevation limit for this species, museum records indicate that this species historically had a lower elevational range (Jennings and Hayes, 1994). The nearest known localities for mountain yellow-legged frog are Crane Flat, Tamarack Flat, and Lake Vernon in Yosemite National Park (Museum of Vertebrate Zoology, 2007).

Don Pedro Reservoir and La Grange Dam to the San Joaquin River. California tiger salamander (*Ambystoma californiense*, federal threatened, California species of special concern) inhabits long-standing or permanent ponds and uplands that contain burrows during the dry season. It is limited to the valley floor and nearby terraces, and a number of historical records document its presence on the valley floor and floodplain of the Tuolumne River in eastern Stanislaus County. California red-legged frog could occur in suitable habitat throughout this portion of the WSIP program area, although it is more likely to be present on the terraces and foothills rather than the valley floor. Western pond turtle could occur anywhere along the Tuolumne River and at Don Pedro Reservoir; there are several recent records from several locations in the WSIP program area. Western spadefoot toad (*Spea hammondii*, California species of special concern) is typically found in association with vernal pools, but may have occurred in seasonal wetlands on floodplains as well. It is known primarily from the valley floor within the program area.

Birds

Entire Tuolumne River WSIP program area. Cooper's hawk (*Accipiter cooperi*, California species of special concern) inhabits open woodland and riparian forest, where it preys on songbirds and small mammals. Sharp-shinned hawk (*Accipiter striatus*, California species of special concern) is found in more dense forest than is Cooper's hawk, where it feeds primarily on small birds. Golden eagle (*Aquila chrysaetos*, California species of special concern) nests on cliffs and in large trees. It is likely to forage over large areas of the program area, except for the valley floor. Bald eagle (*Haliaeetus leucocephalus*, federal delisted, California endangered) nests on cliffs and in large trees, and forages on and near lakes. Suitable habitat is present at Don Pedro Reservoir, and one pair recently nested at Lake Lloyd.

Northern harrier (*Circus cyaneus*, California species of special concern) nests and forages in wet meadows over a wide elevational range that apparently includes all of the program area. Short-eared owl (*Asio flammeus*, California species of special concern) nests and forages in open or marshy ground. It apparently is resident in the higher Sierra Nevada and winters at low elevations in the Central Valley. Long-eared owl (*Asio otus*, California species of special concern) nests in dense trees and forages in open country. Its distributional range includes all of California. Yellow warbler (*Dendroica petechia brewsteri*, California species of special concern) nests in dense riparian vegetation and is found in suitable habitat throughout California. Prairie falcon (*Falco mexicanus*, California species of special concern) usually nests on cliffs and forages in open country, but could also nest in tall riparian trees. American peregrine falcon (*Falco peregrinus anatum*, federal delisted, California endangered) nests on cliffs and outcrops and forages in open country, often near meadows or marshes where small birds are abundant. There are no CNDDB records of species occurrence in the program area, but suitable habitat may be present.

Hetch Hetchy Reservoir to Don Pedro Reservoir. Northern goshawk (*Accipiter gentilis,* California species of special concern) is found in dense forest, where it forages on flying squirrels, birds, ducks, and even hares. Its elevational range may be higher than the WSIP program area, as there are no CNDDB records of species occurrence in the program area. California spotted owl (*Strix occidentalis occidentalis*, California species of special concern) inhabits thickly wooded forests, including riparian forests where it forages on small mammals such as squirrels. Great gray owl (*Strix nebulosa*, California endangered) nests in dense forest and forages in forest openings or meadows. There are several recent records indicating its occurrence in Yosemite National Park down to Pine Mountain Lake. Suitable habitat may be present within the program area. Vaux's swift (C*haetura vauxi*, California species of special concern) nests in hollow trees and forages near water. Although there are no CNDDB records of species occurrence near the program area, habitat appears suitable along much of the mountainous portion of the Tuolumne River. Black swift (*Cypseloides niger,* California species of special concern) nests on cliffs near water and forages for insects. It is reported to occur along the Tuolumne River between Tuolumne Meadows and Hetch Hetchy Reservoir (NPS, 2006). Willow flycatcher (*Empidonax trailii*, California endangered) nests and forages in dense riparian thickets and meadows in mountainous areas. Purple martin (*Progne subis*, California species of special concern) is found in mountain forests, especially near water. Suitable habitat is present in this portion of the Tuolumne River.

Don Pedro Reservoir and from La Grange Dam to the San Joaquin River. Double-crested cormorant (*Phalacrocorax auritus,* California species of special concern) nests in rookeries on cliffs and along lake margins, and forages for fish. Its wintering range includes the Central Valley. White-faced ibis (*Plegadis chihi,* California species of special concern) and greater sandhill crane (*Grus canadensis tabida,* California threatened) winters in the Central Valley, foraging in shallow water along the floodplains of the major rivers. White-tailed kite (*Elanus leucuru*s, California species of special concern) nests in trees and forages over open country. It is found mainly in the lower elevations of the program area. California black rail (*Laterallus jamaicensis coturniculus*, California threatened) is a marsh-dwelling species known primarily to occur in salt marsh, but is occasionally found inland in low-elevation marshes. Long-billed curlew (*Numenius americanus,* California species of special concern) winters in the Central Valley and forages in grassland and marshes, including floodplains. Burrowing owl (*Athene cunicularia,* California species of concern) nests in burrows that are created by digging mammals. Sometimes these burrows are located on streambanks, edges of canals, or other areas near riparian habitats. Burrowing owls are found in low-elevation areas such as the Central Valley.

Yellow-breasted chat (*Icteria virens,* California species of special concern) nests low in dense riparian vegetation, breeding in low elevations in California. Tricolored blackbird (*Agelaius tricolor,* California species of special concern) nests and forages near marshes with emergent vegetation. It is found on the valley floor, and the CNDDB has several records of breeding colonies in or near the program area. Ferruginous hawk (*Buteo regalis,* California species of special concern) winters in the Central Valley. Swainson's hawk (*Buteo swainsoni*, California threatened) nests in tall trees and forages in grassland and farmland, primarily in the Central Valley. Some known locations for this species are along the Tuolumne River. Osprey (*Pandion* *haliaetus*, California species of special concern) nests in flat-topped trees and snags near water and feeds on fish (primarily in lakes). There are no known records of this species along the Tuolumne River, although it may have once occurred there. Merlin (*Falco columbarius,* California species of special concern) is a winter visitor to the Central Valley.

Loggerhead shrike (*Lanius ludovicianus,* California species of special concern) nests in riparian woodland and forages over open grasslands, meadows, and marshes. It is resident in the Central Valley and would be expected to occur near the Tuolumne River. Bank swallow (*Riparia riparia,* California threatened) nests in banks along large rivers and forages over open water. Although this species may have once been present along the Tuolumne River, there are no current records for this species within the program area.

Mammals

Entire Tuolumne River WSIP program area. American badger (*Taxidea taxus,* California species of special concern) may be found in riparian habitats and open country throughout the program area. Several species of bats (all California species of special concern) could occur within the program area, generally roosting in riparian trees. Pallid bat (*Antrozous pallidus*) and Pacific western big-eared bat (*Corynorhinus* (=*Plecotus*) *townsendii*) roost in trees and forage over open grasslands.

Hetch Hetchy Reservoir to Don Pedro Reservoir. Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*, California species of special concern), Sierra Nevada mountain beaver (*Aplodontia rufa californica*, California species of special concern), and Sierra Nevada red fox (*Vulpes vulpes necator,* California species of special concern) inhabit riparian and forest habitats higher in elevation than the program area. American marten (*Martes americanus*, California species of special concern) and Pacific fisher (*Martes pennanti pacifica,* California species of special concern) live and forage in dense forest at mid- to high elevations in the Sierra Nevada.

Spotted bat (*Euderma maculatum*, California species of special concern) and western mastiff bat (*Eumops perotis*, California species of special concern) primarily nest on cliffs and forage in openings, sometimes near water. These species are reported to occur near the Tuolumne River between Tuolumne Meadows and Hetch Hetchy Reservoir (NPS, 2006) and may also be present along the Tuolumne River below O'Shaughnessy Dam.

Don Pedro Reservoir and from La Grange Dam to the San Joaquin River. All of the bat species except spotted bat and western mastiff bat could occur in this portion of the Tuolumne River. In addition, American badger is likely to occur throughout this portion of the Tuolumne River.

5.3.7.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to terrestrial biological resources, but generally considers that implementation of the proposed program would have a significant biological impact if it were to:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFG or USFWS
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFG or USFWS
- Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites
- Have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or substantially reduce the number or restrict the range of an endangered, rare or threatened species
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance
- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan, including the *Tuolumne Wild and Scenic River Management Plan* (USFS, 1986)

Approach to Analysis

The assessment of WSIP impacts on terrestrial biological resources is based primarily on the extent to which altered water system operations would change the existing habitat near reservoirs and creeks. This section reviews changes in hydrology (discussed in Section 5.3.1) and analyzes the related effects on riparian and wetland habitats, key special-status species, other species of concern, and common habitats and species. The discussion of riparian and wetland habitats addresses the second and third significance criteria listed above. “Key special-status species” include species that are formally listed as endangered or threatened under the California or Federal Endangered Species Acts, as well as a few other species (such as foothill yellow-legged frog and burrowing owl) that are afforded some degree of legal protection and have a high risk of local population decline or extirpation. The key special-status species discussion addresses the first significance criterion. “Other species of concern” and “common habitats and species” are more general categories relevant to the fourth and fifth significance criteria. Consistency with biological resources planning for the Tuolumne Wild and Scenic River (the last criterion) is discussed below under Impact 5.3.7-7.

River Hydrology and Riparian Ecology

At any point in a watershed, riparian ecological resources react primarily to two factors in the stream channel: geomorphic and hydrologic processes. Individual riparian species are adapted to a range of physical conditions along gradients of water table depth, soil moisture, and frequency and type of disturbance (Kondolf et al., 1996). Most riparian species depend on open sites created by flood flows for the recruitment of new individuals, and on minimum flows and the gradual return to base flows to provide subsurface soil moisture. Local climate, hydrology, geology, and geomorphology play an important role in determining the abundance, distribution, composition, and overall condition of the riparian habitat along a watercourse. The interrelationships between physical channel processes and riparian vegetation vary along the length of a stream and from river to river (Kondolf et al., 1996; McBain and Trush, 2007).

The effects of diversions on riparian ecology are complex. Reductions in stream flow generally lower species diversity and facilitate riparian encroachment into the active channel (Sierra Nevada Ecosystem Project, 1996b). Diversions and releases vary by site conditions and from year to year. Conditions may improve for one plant species and not another, and may vary from site to site along a reach of stream. Changes in riparian vegetation, in turn, affect the availability of food, cover, and structure for animal species that depend on the habitat. Moreover, causative factors tend to blur together with time: habitat structure and diversity represent an integration of influences spanning many decades. The adjustment to a substantially different flow regime requires many years, since some changes can affect the recruitment of long-lived plant species.

An assessment of impacts is complicated in an already stressed system, because some species may be at a critical stage in which further stress could cause the decline, reproductive failure, or local extirpation of mature individuals, even though they may appear robust and superficially able to adapt to change. Taking this into account, the analysis presented in this section is conservative, using reasonable worse case assumptions about the potential WSIP impacts to terrestrial biological resources that could result from program changes on reservoirs and streams.

Peak Flows

One of the most important influences on riparian structure and function is the magnitude and frequency of flood flows (also referred to as peak flows). Peak flows direct channel processes such as meandering, the formation of gravel bars, and sediment transport (Busch and Scott, 1995). Peak flows also play an important role in determining the period of saturation in the root zone during high water, which can result in a stratification of plant species along a fine topographic/soil moisture gradient up to the floodplain. Peak flows move and remove vegetation, creating open sites for the establishment of seedlings; some woody species that are uprooted or felled can later re-sprout. First, erosion of stream banks during floods carries away the vegetation. The removal or death of some plants during peak flows then creates opportunities for other plants to grow, ensuring regeneration and contributing to a structurally diverse canopy: sediment deposition can bury and damage some plants that may be able to re-sprout above the new surface, and can provide fresh substrate for other plants to thrive where competition had been reduced (Kattelmann and Embury, 1996).

Major flood events that recur only every few decades can have lasting effects on the channel form. In river systems such as the Tuolumne, very high periodic peak flows scour the channel and canyon walls for a considerable height. Many riparian species depend on such periodic disturbance for recruitment (Friedman and Lee, 2002). In meadow systems, peak flows serve a similar function, depositing sediment, facilitating channel migration, removing decadent vegetation, and creating open sites.

Diversions that reduce peak flows tend to reduce sediment transport and habitat complexity. Meandering and channel-forming processes are constrained. Without the scouring effects of high flows, riparian vegetation can encroach onto formerly active depositional surfaces (McBain and Trush, 2007). A reduction in open sand and gravel bars reduces the habitat for animal species such as foothill yellow-legged frog. Diminished cobble surface reduces the areas suitable for macroinvertebrate production, thus reducing the food supply for amphibians, bats, and many species of birds (McBain and Trush, 2007). In meadow systems, reduced peak flows reduce sediment deposition and limit the formation of openings and the removal of older vegetation.

Sustained High Flows

While peak flows are the most dramatic channel-forming events, sustained high spring flows mobilize sediment, and, as the flows recede, fresh sediment deposits are exposed. These regularly recurring high-flow events are the 1.5- to 2.5-year flows that define ordinary high water and facilitate sediment transport. Low flows and depth to groundwater determine the distribution of riparian vegetation according to ecological requirements. Channel width, meander wavelength, and rate of channel migration are all highly sensitive to discharge. Thus, a reduction in flows constrains the dynamic formation and movement of backchannel ponds, fresh sediment deposits, and other physical variation.

Meadow systems depend on sustained high flows to recharge groundwater, which determines the extent and composition of different sub-habitats such as wet meadows, dry meadows, and seasonal ponds. Wildlife respond to channel-forming processes and the microhabitats they create, and to the variety of structure and species diversity in the riparian vegetation. In addition, aquatic-dependent species such as frogs are directly affected by high flows during the breeding season, when tadpoles and eggs may be entrained and washed downstream.

Diversions that reduce high flows also reduce suitable sites for the recruitment of many riparian species, thus restricting their extent and abundance. The lack of dynamic deposition also allows upland vegetation to encroach into the riparian corridor and onto formerly active bar surfaces. An example of this phenomenon is Cherry Creek below Lake Lloyd, where encroachment has allowed Jeffrey pines to become established in the riparian zone. Reduced high flows also tend to reduce the available habitat and productivity of benthic macroinvertebrates, a food source for many riparian wildlife. Meadows affected by diversions tend to experience encroachment from upland vegetation.

The Hydrograph

The reproductive cycle of each riparian tree species is specifically tied to the timing of soil and moisture conditions that depend on the stream hydrograph (McBain and Trush, 2007). Many riparian tree species such as willows and cottonwood release large numbers of tiny seeds during a brief period in spring. These seeds are viable, or capable of germination, for only a few weeks. Their establishment depends on moist, bare soil for a period of several weeks or months while the seedling's root system develops to the depth of sustained groundwater. Each species of tree, shrub, and herb has evolved adaptations to ensure a place in the range of soil, moisture, and light conditions found in the highly dynamic riparian habitat.

Diversions that delay the highest spring flows can reduce or eliminate the required germination conditions for species adapted to early seed dispersal and germination events. A reduction in flows on the "receding limb" of the hydrograph can cause exposed sediment bars to dry out before seedlings establish their root system, thus resulting in mortality. Although very high flows can be detrimental for amphibians or other wildlife that may be swept away, a reduction in spring high flows can reduce the available extent and duration of breeding habitat.

Abrupt Changes in the Hydrograph

In a natural stream, water recedes gradually from high flows. Under a diversion scenario, these changes in flow can be much more abrupt. Especially when the flows are diminished rapidly, seedlings can become desiccated and die, and amphibian and invertebrate larvae can become stranded and die (McBain and Trush, 2007). The pattern and timing of stream releases is especially important for aquatic-dependent wildlife. Rapid increases in flow during managed releases can result in scouring and entrainment.

Terrestrial wildlife are also affected by an altered hydrograph resulting from diversions. Many animal species depend on specific plant species or vegetation structure for the completion of their life cycle; for example, willow flycatcher requires low, dense shrubby vegetation for nesting, and yellow-billed cuckoo requires large quantities of insect larvae as forage. Many insect species also have specific relationships with plant species to complete their life cycle; for example, Valley elderberry longhorn beetle requires blue elderberry shrubs of a particular stem diameter in which to lay its eggs. Alteration of the species composition, extent, or structure of the riparian habitat has direct impacts on some species, and indirect impacts on other species that depend on these species. In return, the riparian vegetation itself may be altered if the habitat is insufficient to sustain animal populations of pollinators, seed dispersers, or insectivores that keep the system in balance.

Minimum Flows

Minimum flows are a determining factor in maintaining groundwater levels. Some riparian species, such as alders, require year-round flowing water, while most others depend on groundwater, the extent of which depends to a large degree on sustained minimum flows. While the pattern of the hydrograph governs recruitment of riparian vegetation, minimum flows can determine the survival of established vegetation. Minimum flows also determine the extent and duration of surface water habitat for aquatic-phase vertebrate and invertebrate species. Similarly, these effects are also important for maintaining the extent and diversity of meadow habitats.

Diversions that substantially reduce minimum flows can cause encroachment by upland vegetation, reduction in the extent of riparian vegetation, and an overall reduction in species diversity and stand structure. Over time, constrained physical conditions reduce the micro-habitats required for the establishment of different riparian species, with an eventual reduction in riparian plant species diversity and structure. Reduced summertime flows also tend to result in higher stream temperatures. Although increased temperature does not affect riparian vegetation, it can adversely effect vertebrate and invertebrate populations, which tend to be more sensitive to water temperature. Since these effects reduce the food base and extent of riparian habitat, they also tend to result in a reduction in the species diversity and abundance of vertebrate riparian wildlife.

Sustained minimum flows deepen the stream channel, further limiting channel migration. In addition, these flows alter growing conditions, favoring plant species that require permanently flowing water for germination, establishment, and growth, such as white alder and willow. If minimum flow releases convert a seasonal stream into a perennial stream, a narrow band of water-dependent species may form along the stream.

Reservoirs

Seasonal wetlands, perennial freshwater marsh, and riparian habitats around reservoirs depend on the season, duration, and elevational range of prevailing water levels. The lower-elevation ecological range of terrestrial plants is limited by inundation, and the upper range is constrained by the limits of water availability. The more consistent the water level from year to year and throughout a season, the more favorable the conditions are for perennial freshwater marsh and a resulting overall high species diversity for both animals and plants.

The more the pattern of water levels approximates a natural regime (i.e., highest levels in spring, with a gradual reduction through the summer and fall), the greater the diversity of habitats and species. Some plant species are limited by sustained inundation when the reservoir is maintained at its highest levels, and some plants are limited by drought when the reservoir is maintained at its lowest levels. Conversely, highly variable water levels decrease plant species diversity, and annual, weedy species become more prevalent. When a reservoir is operated at a higher or lower water level, habitats respond by migrating to the appropriate elevation. Similarly, the structure and composition of riparian and wetland habitats also respond to the timing and duration of maximum and minimum reservoir elevations. Reservoir operations often expose compact, bare, gravelly soil below the sustained high water line. This area generally supports only a sparse cover of weedy annual plants, and the habitat has little value for wildlife.

While the scientific literature presents numerous approaches to assessing and predicting potential effects on riparian ecosystems resulting from water diversions and other hydrologic manipulations (e.g., Kondolf et al., 1996), many of the suggested methods amount to extensive interdisciplinary research projects.[3] The implementation of such studies is beyond the typical scope of an impact analysis under CEQA. Therefore, the following assessment, based on a review of the scientific literature, is a conservative presumption of effects on the riparian vegetation of the Tuolumne River that might be expected to occur as a result of the WSIP.

Impact Summary

Table 5.3.7-3 presents a summary of the impacts on terrestrial biological resources in the Tuolumne River system and downstream water bodies that could result from implementation of the proposed water supply and system operations.

TABLE 5.3.7-3
SUMMARY OF IMPACTS –
TERRESTRIAL BIOLOGICAL RESOURCES IN THE TUOLUMNE RIVER WATERSHED

Impacts on Terrestrial Biological Resources	Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species
Impact 5.3.7-1: Impacts on riparian habitat and related biological resources in Hetch Hetchy Reservoir and along the bedrock channel portions of the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir	LS	LS	LS	LS
Impact 5.3.7-2: Impacts on alluvial features that support meadow and riparian habitat along the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir	PSM	PSM	PSM	PSM
Impact 5.3.7-3: Impacts on biological resources in Lake Eleanor and along Eleanor Creek	LS	LS	LS	LS
Impact 5.3.7-4: Impacts on biological resources in Lake Lloyd and along Cherry Creek	LS	LS	LS	LS
Impact 5.3.7-5: Impacts on biological resources in Don Pedro Reservoir	LS	LS	LS	LS
Impact 5.3.7-6: Impacts on biological resources along the Tuolumne River below La Grange Dam	PSM	PSM	PSM	PSM
Impact 5.3.7-7: Conflicts with the provisions of adopted conservation plans or other approved biological resources plans for the Tuolumne Wild and Scenic River	LS			

LS = Less than Significant impact, no mitigation required
PSM= Potentially Significant impact, can be mitigated to less than significant

[3] For example, in a baseline analysis and long-term monitoring study conducted along Bishop Creek, California, the authors conclude: "Collection of data over the next thirty years will result in an evaluation of the effects of streamflow alteration on the riparian ecosystem on a time scale more suitable for ecological interpretation" (Nachlinger et al., 1989).

Impact Discussion

Impact 5.3.7-1: Impacts on riparian habitat and related biological resources in Hetch Hetchy Reservoir and along the bedrock channel portions of the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir.

Sensitive Habitats

The WSIP would not affect the maximum elevation of Hetch Hetchy Reservoir, and little wetland habitat has developed around the periphery of the reservoir because of the granite substrate and existing large annual fluctuations in storage. Although annual fluctuations in reservoir storage would be greater under the WSIP, the impact on riparian and wetland habitats around and above Hetch Hetchy Reservoir would be less than significant.

Under the WSIP, the delay in snowmelt releases to the Tuolumne River below O'Shaughnessy Dam could incrementally reduce the extent and frequency of germination events, seedling survivorship, plant growth rates, and species diversity in riparian habitats. In the bedrock channel portions of the river, encroachment of riparian vegetation into the channel would be minimal. Riparian tree structure is already limited, and channel incision in the bedrock channel would be insignificant.

Studies supported by the SFPUC are currently underway to assess the physical and ecological conditions in the upper river. Given the dynamic hydrology, steep banks, and rocky substrate, there are few sensitive receptors for impact, since tree structure and channel incision are resistant to change. The effects of the WSIP in the confined bedrock channel portions of the upper river area would be relatively small and therefore difficult to quantify. As a result, this impact would be less than significant for the bedrock channel portions of the Tuolumne River and Hetch Hetchy Reservoir.

Thus, the effects of the WSIP on sensitive habitats would be *less than significant*, and no mitigation measures would be required.

Key Special-Status Species

No key special-status species are reported to occur at Hetch Hetchy Reservoir. The Tuolumne River between O'Shaughnessy Dam and Don Pedro Reservoir supports or has historically supported foothill yellow-legged frog and may support California red-legged frog. It contains only marginal habitat for willow flycatcher (see also Impact 5.3.7-2). Since changes in the structure and diversity of the riparian habitat at the reservoir and in the bedrock channel portion of the river would be less than significant, this impact would also be *less than significant*. No mitigation measures would be required.

Other Species of Concern

Species of concern potentially using Hetch Hetchy Reservoir and the bedrock channel reaches of this section of the Tuolumne River include Cooper's hawk, sharp-shinned hawk, California spotted owl, great gray owl, Vaux's swift, black swift, purple martin, yellow warbler, and several bat species, including spotted bat and mastiff bat. Since the changes in the structure and diversity of the riparian habitat at the reservoir and in the bedrock channel portion of the river are expected to be less than significant, this impact would also be *less than significant*. No mitigation measures would be required.

Common Habitats and Species

Impacts of the WSIP on common habitats and species around Hetch Hetchy Reservoir and in the bedrock channel portion of the Tuolumne River below O'Shaughnessy Dam would be minimal and *less than significant;* no mitigation measures would be required.

Impact Conclusions

Overall, implementation of the proposed WSIP water supply and system operations would result in *less than significant* impacts on terrestrial biological resources in this portion of the WSIP program area. No mitigation measures would be required.

Impact 5.3.7-2: Impacts on alluvial features that support meadow and riparian habitat along the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir.

Sensitive Habitats

The alluvial area supporting the largest wetland complex in this section of the Tuolumne River is the Poopenaut Valley, although smaller alluvial areas downstream, where larger tributaries empty into the Tuolumne River, also support riparian and/or wetland habitats. A delay in snowmelt releases, reduction in flows, and the resulting reduction in meadow groundwater recharge under the WSIP could contribute to a reduction in wetland habitats and encroachment of upland vegetation. All habitats could experience a reduction in their extent as well as in germination events and stand diversity. All wetland and riparian habitats in the Poopenaut Valley are considered sensitive, including seasonal wetlands, wet meadows, hanging ponds, tule bulrush stands, dry meadows, and willow communities. Similarly, the extent and diversity of sensitive wetland and riparian areas on alluvial features farther downstream along the Tuolumne River would be affected by a reduction in the quantity and timing of releases from O'Shaughnessy Dam. This impact would be *potentially significant*.

Key Special-Status Species

Key special-status species potentially using meadows and riparian habitats on alluvial deposits in this portion of the Tuolumne River include foothill yellow-legged frog and potentially California red-legged frog in the lower section of this portion of the Tuolumne River. Potential habitat may be present for willow flycatcher in dense riparian scrub. A reduction in wetland and riparian habitat would reduce suitable breeding habitat for these species, populations of which are already critically reduced in the Sierra Nevada (Jennings and Hayes, 1994). This impact would be *potentially significant*.

Other Species of Concern

Pansy monkeyflower is present at the edges of wet meadows in the Poopenaut Valley. A reduction in wet meadow habitat and upland species encroachment could reduce suitable habitat for this species. Several other plant species of concern could occur in wetlands and riparian edges in this portion of the Tuolumne River (see Table 5.3.7-2). A reduction in the extent and diversity of wetland and riparian habitats could reduce suitable habitat for these plants. A number of animal species of concern depend on meadows and diverse riparian habitats. Mountain yellow-legged frog has not been documented in the Poopenaut Valley, but may have occurred there historically, and suitable habitat may still be present. Western pond turtle, Vaux's swift, black swift, spotted bat, and mastiff bat are known to occur in this reach of the Tuolumne River. Other species likely to be present are Cooper's hawk, sharp-shinned hawk, northern goshawk, northern harrier, California spotted owl, great gray owl, purple martin, willow flycatcher, Pacific fisher, and several bat species. Because of the potential for a reduction in habitat quality and extent, the impact on species of concern would be *potentially significant*.

Common Habitats and Species

The habitats that could be affected by the WSIP are all considered sensitive; no impacts on common habitats would occur. However, a large number of common animal species depend on meadows and larger riparian areas in the mid-elevation Sierra Nevada for food and cover. From a regional perspective, incremental impacts on meadow habitats could have a *potentially significant* impact on common wildlife species.

Impact Conclusions

Overall, implementation of the proposed WSIP water supply and system operations could result in potentially significant impacts on terrestrial biological resources due to potential effects on riparian habitat and species of concern. Implementation of Measure 5.3.7-2, Controlled Releases to Recharge Groundwater in Streamside Meadows and Other Alluvial Deposits, would manage releases from Hetch Hetchy reservoir to recharge riverside meadows, including the Poopenaut Valley. In combination with the groundwater and plant population monitoring being carried out in accordance with Provision 6 of the amended permit for the Canyon Power Project (March 1987) and further adjustment of controlled releases, timing, and magnitude in collaboration with the USFWS, it is expected that meadow conditions in the Poopenaut Valley will be maintained in the current state or improved. Therefore, controlled releases under Measure 5.3.7-2, if timed properly and of adequate volume, would be sufficient to fully mitigate these impacts to less-than-significant.

[Additional discussion on Mitigation Measure 5.3.7-2 was prepared in response to comments on the Draft PEIR. Please refer to Section 14.6, Master Response on Upper Tuolumne River Issues (Vol. 7, Chapter 14).]

Impact 5.3.7-3: Impacts on biological resources in Lake Eleanor and along Eleanor Creek.

Sensitive Habitats

Lake Eleanor supports limited wetland habitats. The WSIP would not change the level and pattern of reservoir storage in Lake Eleanor, except that increased transfers to Lake Lloyd could occur during extended droughts. This change under the WSIP could slightly reduce the extent and quality of potential suitable habitat for wetland species. Riparian habitats along Eleanor Creek would be unaffected because the quantity and timing of releases would be essentially the same as under existing conditions. Overall, impacts on sensitive riparian and wetland habitats due to the WSIP would be *less than significant*, and no mitigation measures would be required.

Key Special-Status Species

There are no records indicating the presence of key special-status species in Lake Eleanor and Eleanor Creek. However, habitat in Eleanor Creek appears to be suitable for foothill yellow-legged frog. Since habitat changes are predicted to be small, any potential effects on this species and its habitat would be *less than significant*, and no mitigation measures would be required.

Other Species of Concern

Species of concern potentially using the riparian habitats associated with Lake Eleanor and Eleanor Creek are similar to those for the Tuolumne River below O'Shaughnessy Dam. They include western pond turtle, mountain yellow-legged frog, Cooper's hawk, sharp-shinned hawk, California spotted owl, great gray owl, Vaux's swift, black swift, purple martin, willow flycatcher, and several bat species. Since WSIP-induced impacts on habitat are predicted to be very small, the impact on species of concern would also be *less than significant*, and no mitigation measures would be required.

Common Habitats and Species

Potential impacts of the WSIP on common habitats and species are expected to be *less than significant*, and no mitigation measures would be required.

Impact Conclusions

Overall, the impacts on terrestrial biological resources due to implementation of the proposed WSIP water supply and system operations would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.7-4: Impacts on biological resources in Lake Lloyd and along Cherry Creek.

Sensitive Habitats

Lake Lloyd would experience a small decrease in average reservoir water levels under the WSIP, but this lake contains little wetland habitat. The WSIP would increase releases somewhat during dry years, which could benefit riparian habitats along Cherry Creek. Overall, impacts on sensitive riparian and wetland habitats would be *less than significant*, and no mitigation measures would be required.

Key Special-Status Species

There are no records indicating the presence of key special-status species in Lake Lloyd or Cherry Creek. However, habitat in Cherry Creek appears to be suitable for foothill yellow-legged frog. Since habitat changes are predicted to be small, any potential effects on this species and its habitat would be *less than significant*, and no mitigation measures would be required.

Other Species of Concern

Species of concern potentially using the riparian habitats associated with Lake Lloyd and Cherry Creek are similar to those for the Tuolumne River below O'Shaughnessy Dam. They include western pond turtle, mountain yellow-legged frog, Cooper's hawk, sharp-shinned hawk, western spotted owl, great gray owl, Vaux's swift, black swift, purple martin, willow flycatcher, and several bat species. Since WSIP-induced impacts on habitat are predicted to be very small, the impact on species of concern would also be *less than significant,* and no mitigation measures would be required.

Common Habitats and Species

Potential impacts of the WSIP on common habitats and species are expected to be *less than significant*, and no mitigation measures would be required.

Impact Conclusions

Overall, impacts on terrestrial biological resources due to implementation of the proposed WSIP water supply and system operations would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.7-5: Impacts on biological resources in Don Pedro Reservoir.

Sensitive Habitats

Because riparian and wetland habitat at Don Pedro Reservoir is limited, the impact on sensitive habitats due to the increased drawdown under the WSIP would be *less than significant,* and no mitigation measures would be required.

Key Special-Status Species

Very limited potential habitat for California red-legged frog is present at Don Pedro Reservoir, and no other key special-status species are known to occur there. As a result, the impact on key special-status species at Don Pedro Reservoir would be *less than significant*, and no mitigation measures would be required.

Other Species of Concern

Western pond turtle could be affected by an incremental reduction in the quality and extent of habitat due to increased drawdown. An incremental but small reduction in habitat could occur for several bat species, bird species such as osprey, and bald eagle. Because of the very limited reduction in potentially suitable habitat for species of concern, this incremental impact would be *less than significant*, and no mitigation measures would be required.

Common Habitats and Species

The increased reservoir drawdown under the WSIP would not reduce any common habitats; therefore, the impact on common species would be *less than significant*, and no mitigation measures would be required.

Impact Conclusions

Overall, impacts on terrestrial biological resources at Don Pedro Reservoir due to implementation of the proposed WSIP water supply and system operations would be *less than significant*, and no mitigation measures would be required.

Impact 5.3.7-6: Impacts on biological resources along the Tuolumne River below La Grange Dam.

Sensitive Habitats

Slightly delayed spring releases as well as reductions in average peak flows and total flow in the Lower Tuolumne River (especially during and following an extended drought) would incrementally affect riparian communities through upland encroachment into the riparian habitat and riparian encroachment into the channel. Existing conditions have already eliminated conditions for Fremont cottonwood regeneration and reduced the species diversity and variety of riparian vegetation stand structure. The proposed flows under the WSIP could further reduce stand diversity and variation in structure and further reduce or eliminate suitable conditions for recruitment of some riparian species. The degree of potential impact on riparian habitat due to the WSIP is difficult to quantify. However, because it would result in an incremental adverse change in a severely stressed system, the impact of the WSIP is considered *potentially significant*.

Key Special-Status Species

The WSIP would incrementally reduce habitat for some species that depend on the riparian habitats in the lower Tuolumne River, such as California tiger salamander, Valley elderberry longhorn beetle, and Swainson’s hawk. Because of the known presence of key special-status species and the very limited amount of remaining suitable habitat along the Tuolumne River, this incremental impact would be *potentially significant.*

Other Species of Concern

Several species of concern could be affected by the incremental reduction in riparian habitat quality and extent under the WSIP. These species include western pond turtle, several bat species, and a wide variety of riparian- and marsh-associated bird species. Because of the known presence of species of concern and the very limited amount of remaining suitable habitat along the Tuolumne River, this incremental impact would be *potentially significant.*

Common Habitats and Species

Potential impacts of the WSIP on common habitats are expected to be less than significant. However, many common species depend on riparian habitats, and their populations would be incrementally affected by the alteration of habitat. As a result, this impact would be *potentially significant*.

Impact Conclusions

Overall, implementation of the proposed WSIP water supply and system operations would result in *potentially significant* impacts on terrestrial biological resources due to potential effects on riparian habitat, other species of concern, and common habitats and species. If feasible, implementation of Measure 5.3.6-4a, Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water, would result in reduced demand on Don Pedro Reservoir water. The result would offset the reduction in inflow to Don Pedro Reservoir attributable to the WSIP and the release pattern from La Grange Dam would be the same or similar to the existing condition. If fully implemented, this measure would reduce the potential impact of the WSIP on riparian resources to less than significant and no further mitigation would be required.

Due to some uncertainty regarding negotiations with MID/TID that would be necessary to implement Measure 5.3.6-4a, Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water, this measure may not be feasible. In the event that Measure 5.3.6-4a is deemed infeasible, implementation of Measure 5.3.7-6, Lower Tuolumne River Riparian Habitat Enhancement, which would require SFPUC to implement riparian habitat enhancement actions on the lower Tuolumne River, would reduce the impact of WSIP operations on riparian resources on the lower Tuolumne River to a less-than-significant level.

Impact 5.3.7-7: Conflicts with the provisions of adopted conservation plans or other approved biological resources plans for the Tuolumne Wild and Scenic River.

The U.S. Forest Service identified the Tuolumne River as a Wild and Scenic River and has developed a management plan for the 29 miles of the Tuolumne River downstream of the Yosemite National Park boundary to Don Pedro Reservoir (shown in Figure 5.2-1). The *Tuolumne Wild and Scenic River Management Plan* (Wild and Scenic Plan), approved in 1986 and administered by the U.S. Forest Service, calls for providing cover and forage habitat for fish and riparian-associated wildlife species by maintaining medium to high habitat quality according to the certain habitat quality criteria. Specific guidelines include maintaining and enhancing habitat for threatened, endangered, and sensitive indicator species, including peregrine falcon, bald eagle, mule deer, western gray squirrel, yellow warbler, and Sierra Nevada red fox and protecting streamside vegetation (USFS, 1986).

The Wild and Scenic Plan does not apply to the exercise of the CCSF's water rights under the existing Raker Act grant, as stated in the Wild and Scenic Rivers Act (Section 3 [a] [53] Tuolumne, California) as follows: "Nothing in this section is intended or shall be construed to affect any rights, obligations, privileges, or benefits granted under any prior authority of law including chapter 4 of the Act of December 13, 1913, commonly referred to as the Raker Act (38 Stat. 242) and including any agreement or administrative ruling entered into or made effective before the enactment of this paragraph [September 28, 1984].” However, although SFPUC’s operations are exempt from the provisions of the Wild and Scenic Plan, WSIP impacts on biological resources, including those specifically addressed in the Wild and Scenic Plan, are evaluated in this PEIR under CEQA.

Potential WSIP impacts on sensitive habitats and associated species of concern along the reach of the Tuolumne River covered by the Wild and Scenic Plan are included in the analyses presented in Impacts 5.3.7-1 and 5.3.7-2. As noted under Impact 5.3.7-1, impacts on riparian habitat and related biological resources along the bedrock channel portions of this reach of the Tuolumne River would be less than significant. As described in Impact 5.3.7-2, the changes in streamflow associated with implementation of the WSIP could affect streamside vegetation on alluvial features that support meadow and riparian habitats along this reach of the river; however, for the reach of the Tuolumne River downstream of the Yosemite National Park boundary to Don Pedro Reservoir, there are no notable alluvial features that support meadow and riparian habitats. Furthermore, this reach of the river receives inflow from numerous side tributaries, including Cherry Creek, which would mask any WSIP-related changes in streamflow, and no noticeable changes on sensitive habitats and associated species of concern along the reach of the Tuolumne River covered by the Wild and Scenic Plan would be expected. Therefore, impacts related to the potential conflicts related to the provisions of the adopted Wild and Scenic Plan are considered *less than significant*.

The National Park Service (NPS) has identified the Tuolumne River, and specifically the Poopenaut Valley, as an outstandingly remarkable value of the Tuolumne Wild and Scenic River corridor in Yosemite National Park (NPS, 2006). The *Tuolumne Wild and Scenic River Draft Report, Outstandingly Remarkable Values* (NPS, 2006) calls for maintaining and enhancing riparian and meadow habitats within the Tuolumne River corridor. This report is part of the NPS’s ongoing development of the management plan for the designated wild and scenic reaches of the Tuolumne River within Yosemite Park, including the Poopenaut Valley. Since this plan is still under development and not yet adopted, no impact determination is made regarding conflicts with any of its provisions.

Impacts related to the potential conflicts related to the provisions of adopted conservation plans are therefore considered *less than significant*.

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5.3.8 Recreational and Visual Resources

The following setting section describes recreational and visual resources in the Tuolumne River watershed that could be affected by the WSIP. The impact section (Section 5.3.8.2) provides a description of the changes in recreational opportunities and visual quality that would result from WSIP-induced changes in stream flow and reservoir water levels.

5.3.8.1 Setting

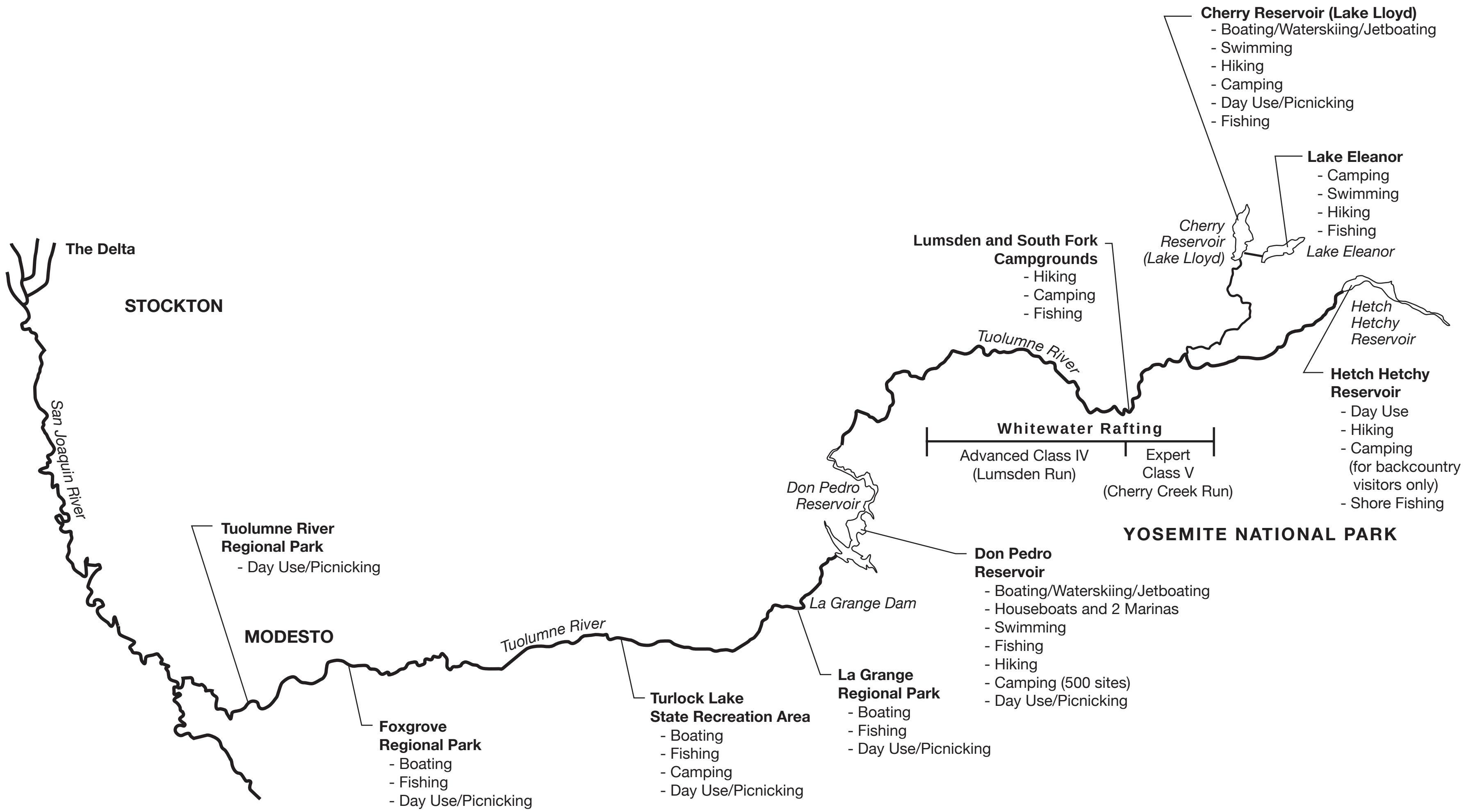
Recreational activities and facilities are dispersed throughout the Tuolumne River system (except for whitewater boating, which is limited to the upper reaches of the river above Don Pedro Reservoir). Water recreational activities in the Tuolumne River, other than whitewater rafting, include boating (often consisting of “flatwater” river kayaking or rafting), fishing, and swimming. Boating recreation is generally limited to sections of the river with suitable river access (e.g., boat ramps for hard-bottomed boats). Both fishing and swimming within the Tuolumne River is regulated. Swimming is generally discouraged due to the often hazardous currents.

Off-water river-related recreation consists of hiking, picnicking, and camping. Hiking occurs throughout the Tuolumne River system in several forms, including both vigorous trail walking and more casual sightseeing or nature viewing. Picnicking is a common activity at nearly all of the region’s recreation sites, but overnight camping along the river is mainly limited to developed campsites. Recreational resources are identified by location in order to delineate the specific impacts of the WSIP within the Tuolumne River system (see **Figure 5.3.8-1**).

Yosemite National Park and the Hetch Hetchy Watershed

Hetch Hetchy Reservoir

Hetch Hetchy Reservoir and the associated watershed lands lie mainly in Yosemite National Park. The park encompasses approximately 1,170 square miles, and about half of this area lies within Tuolumne County (the remainder is in Mariposa and Merced Counties). Yosemite receives about 4 million visitors a year and offers a wide variety of recreational activities, including camping, hiking, mountain climbing, fishing, and river rafting. The headwaters of the Tuolumne River lie within the park. The Hetch Hetchy Reservoir watershed encompasses the 459 square miles that make up the Tuolumne River watershed. There are numerous recreational facilities and activities in the watershed above Hetch Hetchy Reservoir at Tuolumne Meadows and the Glen Aulin High Sierra Camp. Tuolumne Meadows attracts by far the greatest amount of recreational use in the watershed at its large developed campground, visitor center, trailheads, and Tuolumne Meadows Lodge. Glen Aulin High Sierra Camp also generates substantial recreational use. There is also considerable backcountry visitation within the Hetch Hetchy watershed above the reservoir. Between 1990 and 2005, annual overnight use was approximately 40,000 user nights in the backcountry wilderness of the Hetch Hetchy watershed (NPS, 2006c). However, since no program-related changes would occur upstream of the reservoir, wilderness users who only visit the Hetch Hetchy watershed backcountry (i.e., do not hike along the reservoir or downstream along the Tuolumne River) would not be affected by the WSIP.



SOURCE: ESA + Orion

SFPUC Water System Improvement Program . 203287

Figure 5.3.8-1
Principal Recreational Resources
Tuolumne River System

Hetch Hetchy Reservoir sits in a dramatic valley of steep, glacier-eroded mountains. Dispersed and scrubby vegetation is predominantly clustered around the flatter portions and fissures of the surrounding mountainsides. Due to the steep slopes, most of the surrounding rock faces are bare granite rock. Around the lakeside, scoured whiter rings (referred to as the "bathtub ring") are periodically visible when the water level falls. While no recreational activities are permitted on the Hetch Hetchy Reservoir due to water quality restrictions, hiking is permitted within the watershed area, overnight backpacking is allowed with a wilderness permit, and visitors with a valid California fishing license, who comply with the rainbow trout catch-and-release policy, are allowed to fish from the reservoir shoreline. Considerable day use of the reservoir occurs from early May to early October, except during the hottest periods of late July and August when visitation typically decreases. A walk-in campsite operates at Hetch Hetchy for backpackers hiking in and out of the backcounty. Swimming in the off-reservoir streams is currently permitted, but the National Park Service is in the process of promulgating a regulation that would prohibit body contact in the tributaries within one mile of the reservoir in accordance with the sanitary provisions of the Raker Act. The road to Hetch Hetchy is generally open year-round during daylight hours, except on occasion during the winter and spring when it is closed due to extreme weather conditions (NPS, 2007).[1]

Only limited and partial past visitation data for the Hetch Hetchy entrance gate and backcounty use are available. Annual visitation frequently fluctuates considerably between years, often due to weather conditions. Over the last five years, visitation has generally averaged approximately 14,300 vehicles annually; in 2005, the number of vehicles using the entrance increased to nearly 22,000, likely due to the increased media attention on the reservoir. Based on an assumption of 2.5 visitors per vehicle, average visitation through the Hetch Hetchy entrance was approximately 35,750 visitors annually between 2000 and 2005. In comparison, visitation between 1990 and 1995 was approximately 50 percent higher, averaging 21,056 vehicles per year between April and early November. According to National Park Service staff, the majority of day-use visitors to Hetch Hetchy Reservoir and Tuolumne River trails use this entrance.

Statistics on wilderness permits for backcounty use fluctuate greatly and are considered less reliable measurements of visitor use, since not all visitors using the backcountry obtain permits. Nonetheless, based on the available wilderness permit data for 2003 to 2005, approximately 2,345 backcountry visitor permits were issued from the Hetch Hetchy location. It is estimated that these backcountry visitors stayed an average of 2.3 nights in the area (NPS, 2006a), accounting for about 5,400 user nights. Since these permits were obtained from the Hetch Hetchy location, it is presumed that the majority of these permits were likely used to hike and camp in the Hetch Hetchy area.

While a small number of other backcountry users may have obtained their permits from other park wilderness offices or from U.S. Forest Service (USFS) locations, this number, according to park staff, would represent a very small proportion of backcountry users along the Tuolumne River below Hetch Hetchy Reservoir or around the reservoir itself.

1 Due to safety concerns, access to the O'Shaughnessy Dam parking lot is limited to 8:00 a.m. to sunset, and no overnight parking is permitted.

Lake Eleanor

Lake Eleanor, another SFPUC system reservoir, also lies within Yosemite National Park. Lake Eleanor has a 79-square-mile watershed along Eleanor Creek. The lake measures three miles long and one mile wide and is situated at an elevation of 4,660 feet. Activities at and around the lake include camping, fishing, swimming, nonmotorized boating, and hiking. Trailheads connect this area to the Emigrant Wilderness, Hetch Hetchy Reservoir, and the rest of Yosemite National Park. No visitor counts are available specifically for Lake Eleanor; however, due to its lack of direct road access, Lake Eleanor is a far less popular recreational destination than Hetch Hetchy Reservoir, which better accommodates day use (NPS, 2006b).

The visual setting for Lake Eleanor is characterized by open vistas of mixed conifer forest covering most of the gradually sloped surrounding mountains. These hills and low mountains are less dramatic than those around Hetch Hetchy Reservoir, but are generally more forested.

Poopenaut Valley

All of the Tuolumne River within the Poopenaut Valley downstream to the western park boundary is classified as Wild, apart for the first mile below the O'Shaughnessy Dam (which is classified as Scenic). While there is limited hiking and other recreational access to the Wild section of the river, the *Tuolumne Wild and Scenic River Study Final EIS and Study Report* (U.S. DOI and USDA, 1979) found this segment of the river to have numerous "outstandingly remarkable values," including Scenic, Recreation, Geological, Wildlife, Historic, and Scientific values. The Tuolumne River's outstanding scenic values in this segment are based on the stunning views of verdant meadows, a glacially carved bedrock valley, large river pools, dramatic canyon walls, and a constricted slot canyon below the Poopenaut Valley (NPS, 2006d). The river's outstanding recreational values are based its opportunities for recreation in a largely undisturbed, low-elevation riparian environment dominated by natural scenery and soundscapes. In addition, the recreational opportunities are considered unique for the Sierra Nevada as a result of the rarity of such low-elevation designated wilderness.

Stanislaus National Forest

The Stanislaus National Forest, which is managed by the USFS, encompasses almost 900,000 acres to the west of Yosemite National Park. It stretches through Tuolumne, Calaveras, and Alpine Counties in a wide band from the Mokelumne River on the north to the Merced River on the south. Recreational opportunities in the Stanislaus National Forest include river rafting, hiking, and fishing. A 29-mile stretch of the Tuolumne Wild and Scenic River (described below) lies within the Stanislaus National Forest (USFS, 2007a).

Lake Lloyd, another part of the SFPUC water system, is the largest lake in the Stanislaus National Forest. It has a 114-square-mile watershed along Cherry Creek, mainly in the Emigrant Wilderness, and numerous recreational activities are permitted (SFPUC, 2007). The lake is 3.8 miles long and one mile wide and lies at an elevation of 4,702 feet. The lake is impounded by an earthen dam that was constructed in 1954 (SFPUC, 2007). Fishing and boating are common activities, as are camping, hiking, swimming, waterskiing, and jet-boating. There are

46 campsites in the Cherry Valley Campground, and shoreline boat-in camping is popular. Fish species targeted by anglers include several species of trout (rainbow trout, eastern brook trout, and German brown trout) as well as some sockeye (kokanee) salmon (Fish Sniffer, 2006).

The visual setting for Lake Lloyd is similar to that of the neighboring Lake Eleanor, generally consisting of mixed conifer forest on the surrounding High Sierra mountains. The lake is open year-round; however, the access road to Lake Lloyd can experience closures in the winter (USFS, 2007b).

Upper Tuolumne River Corridor

In 1984, Congress designated the Tuolumne River as one of the nation's Wild and Scenic Rivers. The river provides an abundance of recreational opportunities, including fishing, hiking, and whitewater rafting. In total, 83 miles of the Tuolumne River have been classified as Wild (47 miles), Scenic (23 miles), or Recreation (13 miles) (NPS, 2006c), as shown in Figure 5.2-1. Most of the river corridor within the 29 miles of the Tuolumne Wild and Scenic River located outside of Yosemite National Park is classified as Wild. The one-mile stretch of river between Early Intake and Cherry Creek is classified as Recreational because a road parallels it, and the four miles of river starting about a mile above the Lumsden Bridge is recognized as Scenic.

Whitewater rafting is the primary water recreation activity in the Tuolumne River corridor above Don Pedro Reservoir and is discussed in the section below. Other water and off-water recreational resources are discussed separately following the whitewater recreation discussion.

Whitewater Recreational Resources

There are two whitewater boating runs in the Tuolumne River watershed. The Cherry Creek Run extends from just above the Cherry Creek/Tuolumne River confluence to Lumsden Campground, and the Lumsden Run extends from Lumsden Campground to the Wards Ferry Bridge, just upstream of Don Pedro Reservoir. Both runs are located within the jurisdiction of the Groveland Ranger District of the Stanislaus National Forest and managed under the 1986 USFS *Tuolumne Wild and Scenic River Management Plan*.

Cherry Creek Run

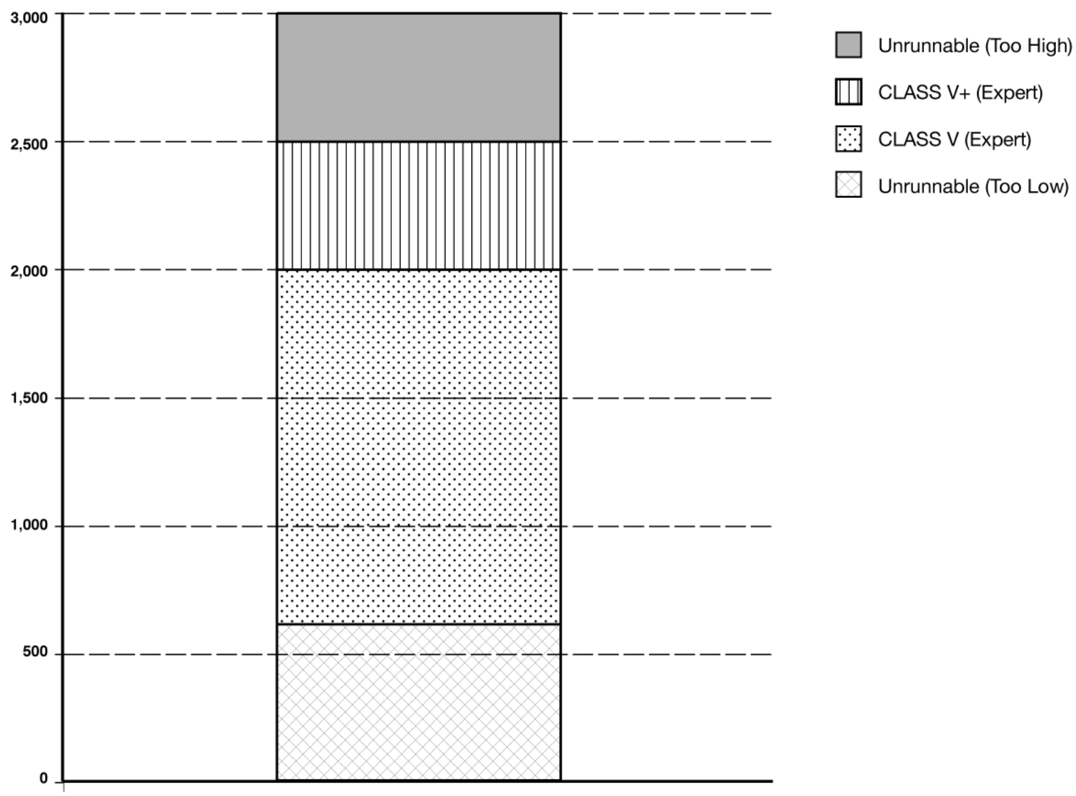
This nine-mile run begins at Holm Powerhouse on Cherry Creek and ends at Lumsden Campground on the Tuolumne River. The Cherry Creek Run is one of the most difficult whitewater boating runs on the West Coast, and is probably the most challenging run in the country that has regularly scheduled commercial boating trips. The Cherry Creek Run is suitable solely for expert boaters and can only be run during low summer flows. The run's excellent scenery, outstanding rapids, and relative proximity to the Bay Area and Sacramento make it California's most popular Class V (expert) run (Cassady, 1995). It is commonly considered to be the initiation run for boaters ready to transition from Class IV to Class V (Holbeck, 1998).

The run's gradient generally falls 110 feet per mile, although one section consists of a 200-foot descent over the course of one river mile. However, the rapids are generally formed from large, round granite boulders that are relatively forgiving for boaters and less likely to result in entrapment hazards than other comparable runs. The typical whitewater boating condition thresholds for the Cherry Creek Run are shown in **Table 5.3.8-1** and **Figure 5.3.8-2**.

TABLE 5.3.8-1
WHITEWATER RAFTING CONDITION THRESHOLDS FOR THE CHERRY CREEK RUN

River Flows	Rating	User Type
600–1,500 cfs	Class V	Expert
1,500–2,000 cfs	Class V+	Expert +
> 2,000 cfs	Unrunnable	NA

SOURCE: All-Outdoors California Whitewater Rafting, 2007.



SOURCE: Cassady, 1995; Holbeck 1998..

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Figure 5.3.8-2
Whitewater Rafting Condition Thresholds
for the Cherry Creek Run

The Cherry Creek Run is predominantly used by private kayakers in the mid- and late summer, when it is one of the few remaining suitable expert runs in the country. Earlier in the year, flows are generally above 2,000 cfs and the run is unsafe.

Lumsden Run

The lower 18-mile run on the main fork of the Tuolumne River extends from Lumsden Campground to Ward's Ferry Bridge. This stretch of the river is generally known as the Lumsden Run (Rosekrans et al., 2004). The Lumsden Run is a premier California whitewater boating run that is famous within the rafting and kayaking community. It is typically rated as a Class IV+ run and provides a high-quality experience for boaters. The Lumsden Run offers the opportunity for an overnight trip, which is rare in the central Sierra region. The run's beautiful scenery, wilderness solitude, and challenging rapids within easy driving distances from Sacramento and the Bay Area make it a popular whitewater boating location for both private and commercial boaters.

The run's gradient generally falls 40 feet per mile through difficult boulder slalom rapids. The typical whitewater boating conditions for the Lumsden Run are shown in **Table 5.3.8-2** and **Figure 5.3.8-3**.

TABLE 5.3.8-2
WHITEWATER RAFTING CONDITION THRESHOLDS FOR THE LUMSDEN RUN

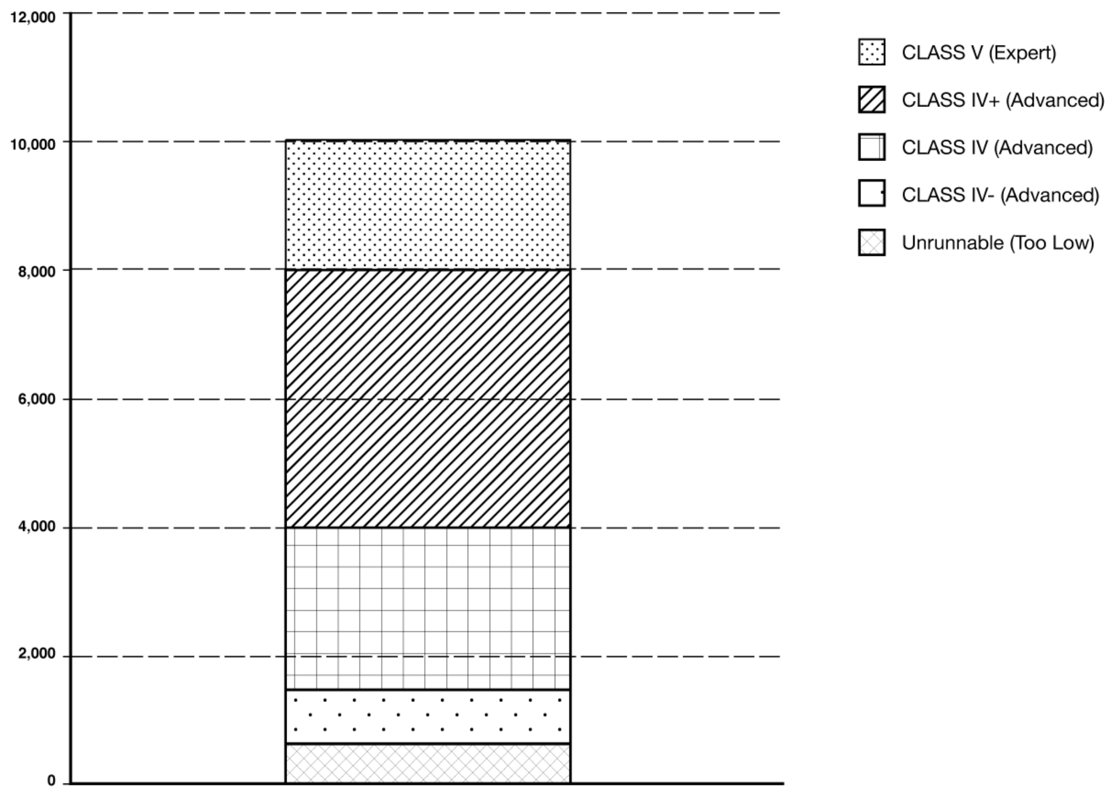
River Flows	Rating	User Type
600–1,500 cfs	Class IV-	Advanced
1,500–4,000 cfs	Class IV	Advanced
4,000–8,000 cfs	Class IV+	Advanced
> 8,000 cfs	Class V	Expert

SOURCE: All-Outdoors California Whitewater Rafting, 2007.

Current Operating Conditions

The 1995 FERC Settlement Agreement (see Chapter 2 for a description of the agreement) requires the SFPUC to consult, cooperate, and communicate with whitewater recreational interests regarding releases from the Hetch Hetchy system, but does not require the SFPUC to schedule releases for the purpose of maintaining or enhancing whitewater recreation. However, subject to the availability of water and hydropower needs, the SFPUC attempts to accommodate whitewater recreation in the Tuolumne River below its reservoirs by "shaping" releases from Holm Powerhouse on Cherry Creek, upstream of its confluence with the Tuolumne River. These "pulse" releases enable whitewater rafting during the summer season when flows are otherwise insufficient (see **Figure 5.3.8-4**).

The SFPUC meets annually with whitewater recreation representatives to develop, to the degree practicable, a schedule of releases for whitewater recreation. The schedule of these releases is developed in accordance with the duration of expected spills below the Hetch Hetchy systems' Tuolumne River watershed reservoirs and the projected availability of water in Lake Lloyd and



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SOURCE: Cassady, 1995; Holbeck 1998..

Figure 5.3.8-3
Whitewater Rafting Condition Thresholds for the Lumsden Run

Lake Eleanor beyond the amount necessary to maintain the SFPUC's water deliveries from its Tuolumne River reservoirs. The need to divert Cherry Creek water to Early Intake through the Lower Cherry Aqueduct for water supply use in the Bay Area in emergencies and extreme droughts as well as the expected price of energy and maintenance projects are also considered in establishing the schedule of releases for whitewater recreation.

The primary considerations in scheduling releases are the needs to maintain water supply, undertake maintenance, and deliver water in emergencies. The SFPUC maintains high levels of carryover storage in Lake Lloyd and Lake Eleanor because releases from these reservoirs can be used to meet TID's and MID's Raker Act water entitlements in the event that the SFPUC's storage in its water bank in Don Pedro Reservoir is exhausted. This enables continued water deliveries to Bay Area customers from Hetch Hetchy Reservoir. This operational strategy is consistent with the SFPUC's obligation to operate the Hetch Hetchy system for "water first."

The price of energy is also a consideration in establishing the annual schedule of boating releases. Once Hetch Hetchy Reservoir, Lake Lloyd, and Lake Eleanor have finished spilling spring and early summer runoff, which typically occurs by July 1, releases to streams are reduced to the minimum required flow. Flow in the Tuolumne River consists of the minimum releases from the

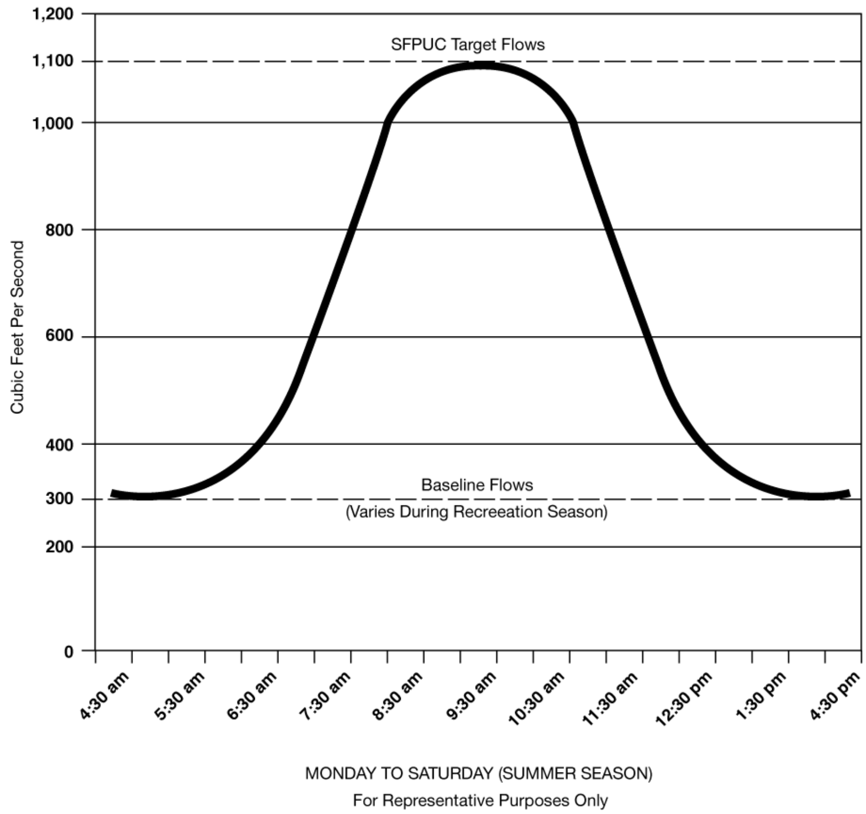

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Figure 5.3.8-4
Example of a Pulse Release
for Whitewater Recreation

reservoirs, tributary flow, and releases from Holm, Kirkwood, and Moccasin Powerhouses. Hydropower generation at Kirkwood and Mocassin Powerhouses is limited to that which is incidental to water deliveries to the Bay Area. In a typical year, hydropower from the two powerhouses is insufficient to meet the SFPUC's peak municipal and retail power demand for several months beginning at the end of June, and the SFPUC must purchase power. When the SFPUC chooses to generate hydropower at the Holm Powerhouse, it must offer some electrical power to TID and MID at an agreed upon price for their municipal needs and agricultural pumping.

Energy prices are at their seasonal maximum during the summer and fall, because the cheapest source of energy (i.e., hydropower) is no longer plentiful. In addition, the price of energy rises during the day to a peak price around midday, when energy use is the highest. If the SFPUC were to operate solely to meet its own municipal and retail demand for energy or to maximize revenue from hydropower sales, it would generate hydropower during the midday period only. To deliver a pulse flow to Lumsden Campground for boaters by 9:30 a.m., the SFPUC must begin hydropower generation at Holm Powerhouse by 7:00 a.m. Were the SFPUC to operate solely in its own interest, it would not begin generation until late morning. Operating Holm Powerhouse early in the morning to produce boating flows represents both lost revenues as well as exposure to higher energy costs when the SFPUC must purchase energy to meet its needs in the middle of the day.

Scoping comments received in response to the Notice of Preparation for this PEIR (see Appendix A) included expressions of concern that the WSIP could further restrict the quality of whitewater rafting on the Tuolumne River by reducing water release hours or flows, or by shortening the length of the summer rafting season.

Since the 1995 FERC Settlement Agreement, representatives for the commercial boating community have met annually with SFPUC staff to collaborate in determining operating and flow management schedules that can better accommodate whitewater recreation downstream of Hetch Hetchy Reservoir and Lake Lloyd. While commercial users have generally adapted their trips and operations to conform to the flow conditions, reductions in water releases (typically resulting in an earlier ending to the whitewater recreation season) inevitably reduce the commercial operators' earnings. The highest demand for whitewater use of the Tuolumne River is during the Memorial to Labor Day season. In addition, there is also considerable and frequently unmet whitewater recreational demand for the early to mid-September shoulder season. In May and early June, the colder water and weather as well as the often higher river flows are less attractive to many whitewater boaters. Furthermore, later in the summer season many other rivers are no longer runnable. As a result, the late summer whitewater opportunities on the Tuolumne River are generally in greatest demand and offer users particularly high-quality whitewater recreation experiences (Welch, 2006).

A 1,100-cfs flow at Lumsden Campground is the minimum required for whitewater paddle boats and oar boats; a 900-cfs flow is the minimum required for kayaks, and a 1,500- to 2,000-cfs flow is considered optimal. The commercial outfitters prefer an eight-hour release, but a four-hour release allows them to launch one-, two- and three-day trips. One-day trips launch first and ride the pulse down to Wards Ferry; two-day trips launch next and run nine miles down river; and three-day trips launch last and ride five miles down river. Launches of two- and three-day trips from riverside campgrounds are staged to avoid congestion at rapids.

In recent years, the water releases to the river have generally been in a daily three- to four-hour pulse release timed to reach the upper reaches of the rafting runs in the mid-morning. According to representatives of the commercial users, three hours represents a minimum adequate duration for whitewater recreation, as launchings and all associated recreation must occur during the flow of released water down the river (Welch, 2006). If the duration of flow is insufficient, crowding can decrease the quality of the recreational experience for some users. A longer duration water release pulse would provide more opportunities for users to spread out their river use and take greater advantage of the off-river hiking and other recreational opportunities.

Due to the demand for power generated from the Lake Lloyd's water releases, the weekday water releases may be larger than the Saturday releases. Typically, no water releases occur on Sunday, and, as a result, the Tuolumne River is mostly unrunnable on Sunday. Many commercial operators have adapted their weekend trips to include an off-river hiking day on Sunday. However, the absence of a Sunday release has a greater impact on private users, who generally value weekend recreational opportunities for whitewater use of the river.

Whitewater Recreational Use

As shown in **Table 5.3.8-3**, whitewater use of the Tuolumne River varies considerably from year to year. Over the last 10 years, an average of 6,000 people per year boated on the river. In recent years, use has been limited by the water release schedules from Hetch Hetchy Reservoir and Lake Lloyd. In 2005, water releases were halted on August 21 so that maintenance could be performed on upstream dam facilities. According to commercial boaters, many additional river trips would otherwise have occurred on the Lumsden Run. In 2001, during the height of the California energy crisis, water releases were only delivered between July 2 and August 11. The shortened rafting season resulted in many trip cancellations during June and later in August and early September of that year.

TABLE 5.3.8-3
ANNUAL BOATER USE ON THE TUOLUMNE RIVER
(1984–2005)

	Lumsden Run			Cherry Creek Run			Total		
Year	**Commercial**	**Private**	**Total**	**Commercial**	**Private**	**Total**	**Commercial**	**Private**	**Total**
1984	3,751	4,410	8,161	86	390	476	3,837	4,800	8,637
1985	3,536	3,540	7,076	366	620	986	3,902	4,160	8,062
1986	3,729	3,240	6,969	90	290	380	3,819	3,530	7,349
1987[a]	–	–	–	–	–	–	–	–	–
1988	1,778	1,605	3,383	37	410	447	1,815	2,015	3,830
1989	2,725	2,469	5,194	138	428	566	2,863	2,897	5,760
1990	3,012	2,120	5,132	169	519	688	3,181	2,639	5,820
1991	2,049	2,437	4,486	123	506	629	2,172	2,943	5,115
1992	2,801	2,164	4,965	218	664	882	3,019	2,828	5,847
1993	4,149	3,051	7,200	182	564	746	4,331	3,615	7,946
1994	3,641	3,323	6,964	294	1,169	1,463	3,935	4,492	8,427
1995	2,940	1,829	4,769	141	560	701	3,081	2,389	5,470
1996	3,095	2,600	5,695	141	614	755	3,236	3,214	6,450
1997	3,722	3,181	6,903	264	1,297	1,561	3,986	4,478	8,464
1998	2,729	1,572	4,301	102	964	1,066	2,831	2,536	5,367
1999	3,087	1,858	4,945	111	593	704	3,198	2,451	5,649
2000	4,446	2,615	7,061	254	1,282	1,536	4,700	3,897	8,597
2001	1,676	1,344	3,020	164	1,071	1,235	1,840	2,415	4,255
2002	2,999	2,211	5,210	150	1,311	1,461	3,149	3,522	6,671
2003	2,639	1,676	4,315	140	730	870	2,779	2,406	5,185
2004	2,634	1,899	4,533	161	513	674	2,795	2,412	5,207
2005	2,516	1,302	3,818	109	362	471	2,625	1,664	4,289
Average (1995–2005)	**2,953**	**2,008**	**4,961**	**158**	**845**	**1,003**	**3,111**	**2,853**	**5,964**

[a] Drought conditions prevented whitewater recreation in 1997.

SOURCE: USFS Groveland Ranger District, 2006b.

The majority of Tuolumne River whitewater recreation occurs on the Lumsden Run; only 17 percent of whitewater users boated the Cherry Creek Run. Since many visitors take multiple day trips down the Lumsden Run, this run accounts for an even greater proportion of whitewater recreation user days. The length of stay for both private and commercial users on the Lumsden Run averages 1.8 days. Between 1995 and 2005, the total whitewater user days on the Tuolumne River averaged 9,930 per year, of which the Lumsden Run accounted for 90 percent of the user days.

The majority of whitewater river use on the Tuolumne is by rafters. Only limited statistics on kayak use are available, but the number of annual commercial kayak trips is very small (Welch, 2006). In 2005, total kayak use among private users was approximately 44 percent, which is equivalent to 17 percent of all boaters. Although late summer rafting use was reduced due to the cessation of water releases in late August 2005, this proportion of kayak use is considered generally representative of typical river use.

A USFS analysis of Tuolumne River whitewater recreation between 1980 and 2000 concluded that total boater use on the Lumsden Run appeared to be stable, although use fluctuated considerably from year to year. Private boater use on the Lumsden Run was found to be decreasing. Over the 20-year study period, boating use was found to be relatively evenly split between commercial and private users, although since 1992 commercial use has been consistently higher than private use (this trend continued through 2005) (Norman, 2001). Between 1998 and 2000, the analysis also found commercial use to be about 30 percent higher than private use. This trend has also generally continued in the subsequent years.

While the USFS determined there were no statistically significant trends in total use (as can be seen in Table 5.3.8-3), peak use levels (6,900 users or more) have been attained periodically over the last 20 years (1984–1986, 1992–1993, 1997, and 2000) that are far higher than the average use levels between 2001 and 2005. Over the last five years, total use of the Lumsden Run has averaged 4,180 users. While reductions in river flows and releases have contributed to lower use numbers, a reduction in Groveland ranger staff since 1999 has significantly reduced permit compliance monitoring at Meral's Pool. Therefore, actual private boater levels may be significantly higher than reported. USFS analysis for a comparable management situation in Georgia determined that additional non-permit use was about 25 percent of permit use levels (Norman, 2001).

For the Cherry Creek Run, private use was found to be steadily increasing, while commercial use remains limited and stable.

The USFS statistical analysis found no significant correlation between seasonal flow averages and the private or commercial use levels for either of the two runs. However, this analysis did not examine actual daily flow levels. On high-demand weekend days, flow levels could affect user demand. However, only limited monthly river use data are available from the USFS. **Table 5.3.8-4** shows the reported monthly private boater use on the Lumsden and Cherry Creek Runs.

TABLE 5.3.8-4
PRIVATE BOATER USE BY MONTH
(1990–2002)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lumsden Run													
May	598	783	868	515	841	76	231	321	268	273	283	297	345
June	783	786	678	476	812	255	603	757	110	204	500	47	706
July	395	582	459	839	678	246	850	901	217	821	813	680	576
August	165	286	0	614	471	887	443	850	752	407	635	320	547
September	21	0	0	302	111	365	226	303	225	153	384	0	34
Total	**1,962**	**2,437**	**2,005**	**2,746**	**2,913**	**1,829**	**2,353**	**3,132**	**1,572**	**1,858**	**2,615**	**1,344**	**2,208**
Cherry Creek Run													
May	139	48	14	5	0	0	0	0	10	0	0	40	12
June	149	112	176	263	0	0	0	8	0	6	0	33	60
July	159	213	186	44	298	0	132	450	0	206	422	555	385
August	68	116	288	224	413	297	292	433	395	194	421	443	718
September	4	17	0	291	69	263	190	406	559	193	433	0	136
Total	**519**	**506**	**664**	**827**	**780**	**560**	**614**	**1,297**	**964**	**599**	**1,276**	**1,071**	**1,311**

SOURCE: USFS Groveland Ranger District, 2006b.

The USFS analysis determined that the highest private boater demand for whitewater recreational use of the Lumsden Run occurred in drier years earlier in the season (typically May through July), while in wet years, the highest demand occurred in the summer during the months of July and August. However, rather than reflecting user preferences, this finding may simply represent the availability of adequate water flows for recreational use of the river.

Commercial Rafting. Commercial rafting on the Tuolumne River began in the 1970s under permits issued by the Stanislaus National Forest. Commercial use of both the Cherry Creek and Lumsden Runs is allowed only through special-use permits issued by the USFS. There are seven commercial outfitters permitted to operate commercial rafting trips down the river. Total commercial use by these outfitters is limited to two commercial trips per day. Each of these trips is limited to a maximum of 26 passengers (each trip typically includes six guides, so there are 20 customers per commercial trip). The Groveland Ranger District is responsible for administration and oversight of the commercial operators. Although a few commercial trips are taken down Cherry Creek Run each year, the vast majority of commercial rafting occurs on the Lumsden Run (approximately 95 percent of passengers). Furthermore, since many of the commercial trips are multiday trips, an even greater proportion of the commercial operators' revenues are based on Lumsden rafting trips (USFS, 2007b).

Most of the rafting companies also operate trips on other rivers in California, although a few are small companies that primary rely on Tuolumne River trips for the majority of their business. Several of the Tuolumne operators are large rafting companies that offer river trips throughout the West and even internationally.

Commercial use has declined in recent years, in part due to the reduced water releases and flow conditions. Between 2001 and 2005, commercial use of the Tuolumne River averaged 2,640 boaters and 4,620 user days, which represents a decrease of approximately 15 percent from the 1995 to 2005 average commercial boating levels of 3,111 users (see Table 5.3.8-3).

Private Rafting. Rafters wishing to run the Lumsden and Cherry Creek Runs are required to obtain a private boater permit by telephone or in person from the USFS Groveland Ranger Station. Permits can be booked in advance and are limited to a maximum of 90 people launching per day for the Lumsden Run. There are currently no limits on private use of the Cherry Creek Run.

Private use has declined in recent years, in part due to the reduced water releases and flow conditions. Between 2001 and 2005, private boater use of the Tuolumne River averaged 2,485 passengers and 3,760 user days. During that period, private boater use of the Lumsden Run averaged 1,690 passengers and 2,960 user days. This recent decline in total private boaters is about 13 percent of the 1995 to 2005 average levels.

Other Water and Off-Water Recreational Resources

In addition to whitewater use, recreationists also hike, camp, and fish within the Tuolumne River above Don Pedro Reservoir. While a major proportion of whitewater users participate in these other recreational activities as part of their trip, many park visitors come solely to enjoy the area's non-whitewater resources. Due to its relatively remote location, many visitors camp overnight in the area as part of their trip. The majority of camping along this section of the Tuolumne River occurs at designated sites. There are three developed campgrounds along the National Forest portion of the Wild and Scenic Tuolumne River corridor. Camping is free, but the campgrounds are only open from April to October. Access to the three developed campgrounds is via a five-mile-long steep dirt road that is unsuited to trailers or motor homes. The Lumsden Bridge Campground offers the farthest upstream opportunity for developed camping. There are nine campsites, two vault toilets, grills, and tables for users at the campsite. The South Fork Campground, located near the confluence of the Tuolumne River and its south fork tributary, is approximately two miles below the Lumsden Bridge Campground site. The South Fork Campground has eight campsites, two vault toilets, grills, and tables for users. The Lumsden Campground is located a mile downstream of the South Fork Campground and consists of 11 campsites with grills and tables. There are also four vault toilets at the site.

Over a dozen undeveloped campsites are dispersed along the Tuolumne River below the Meral's Pool launch site. These sites are used by whitewater boaters as well as hikers in the area. However, hiking use along the river within most of the Tuolumne River valley is relatively limited, since there are no improved trails and the hiking conditions are difficult.

Below Hetch Hetchy Reservoir, the principal hiking trails along the Tuolumne River are the Preston Flat and Tuolumne River Canyon Trails. The Preston Flat Trail parallels the north side of the Tuolumne River upstream from the Early Intake. The trail is 4.5 miles long and is of average difficulty, with an elevation gain of 400 feet over its course. The trail generally runs near the riverside and is predominantly used by anglers to access the river. Most trail use occurs at the start of the trout season and during the late spring and early summer, when wildflowers are present and the weather is not too hot. However, even during the most popular periods, trail use is typically only about 30 to 40 visitors per day. While the canyon is generally sparsely forested, sections of the north side are moderately to densely vegetated, especially near the river's edge (USFS, 2006b).

The Tuolumne River Canyon Trail is considerably more strenuous and hiked less frequently. The trail starts a half mile from the Lumsden boat launch and follows the south side of the Tuolumne River down to its confluence with the Clavey Trail. The trail is six miles long and generally runs along the canyon sides several hundred feet above the riverbed. The steep slopes of the canyon are sparsely vegetated, although during the late spring and early summer wildflowers cover much of the hillsides.

The area's visual resources generally consist of a narrow and rocky riparian valley with limited vegetation. Much of the mostly steep-walled, V-shaped canyon is bare of vegetation. Some trees grow within the narrow floodplain on the river's edge. Along much of the river's course, a narrow band of trees stands along the riverside, while larger groupings of trees and other vegetation are occasionally present at the outer bends for river where adequate river sediment has accumulated. When the river contains sufficient flow, it provides an abundant variety of water forms, including rapids, cascades, waterfalls, and pools. When flow is sufficient, these water forms as well as the dramatic geological formations define the visual setting throughout most of the Tuolumne River's course.

Don Pedro Reservoir and Recreation Area

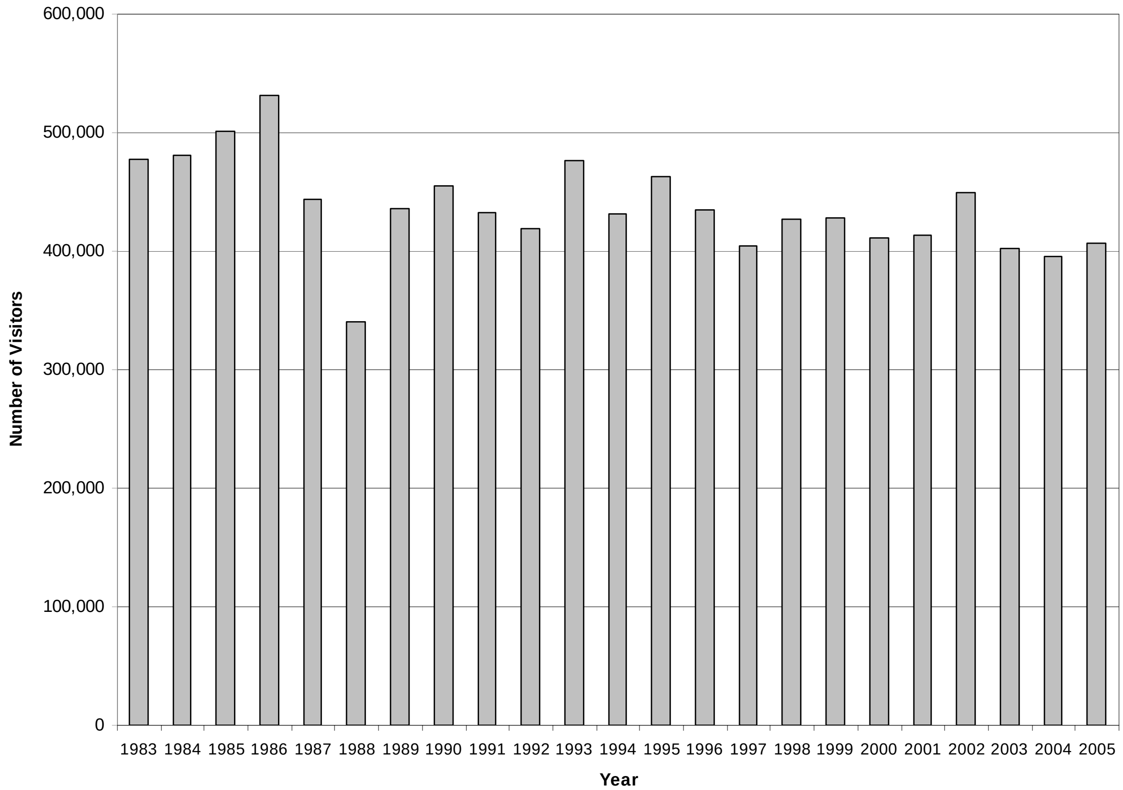
The Don Pedro Reservoir and Recreation Area is located on the Tuolumne River near the western border of Tuolumne County. The reservoir is primarily managed by the Don Pedro Lake Recreation Agency and TID. The Don Pedro Recreation Agency is an independent agency supervised by a board of directors made up of representatives from the TID, MID, and SFPUC. TID provides administrative support and day-to-day supervision. The reservoir provides 160 miles of shoreline and 13,000 surface acres of water at its maximum pool elevation of 830 feet above mean sea level (msl). Don Pedro Reservoir is the fifth largest reservoir in California.

Water recreation at Don Pedro Reservoir includes boating, swimming, waterskiing, jet skiing, windsurfing, sailing, house-boating, fishing, and boat-in camping. Boat launch facilities are located at the Fleming Meadows Recreation Area on the southern shoreline, Blue Oaks Recreation Area on the southwestern shoreline, and Moccasin Point Recreation Area on the northeastern arm of Moccasin Bay. Two full-service marinas (i.e., with docks, boat slips, mooring areas, and provisions) are located at the Flushing Meadows and Moccasin Point Recreation Areas. In addition, there are 257 privately owned houseboats and 20 rental houseboats on Don Pedro Reservoir (USBR, 1999).

Boating and waterskiing take place throughout the reservoir; swimming occurs mainly at the Fleming Meadows swimming lagoon, a two-acre pool separated from the main reservoir. The lagoon has a maximum depth of 6 feet and is surrounded by a sandy beach area. Anglers fish from the shore and boats, mainly for non-native bass, trout, salmon, crappie, bluegill, and catfish. The CDFG plants the lake with species such as brook trout from the San Joaquin River Hatchery, and sub-catchable rainbow and brown trout from the Moccasin Creek Hatchery, which is upstream from Don Pedro Reservoir on Moccasin Creek.

Off-water recreation at Don Pedro Reservoir includes picnicking, camping, and sightseeing. There are a total of 550 campsites at the Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas (Don Pedro Recreation Agency, 2007). Don Pedro is by far the largest and most popular recreation destination along the Tuolumne River system. **Figure 5.3.8-5** shows visitation at Don Pedro Reservoir since 1983. Annual visitation at the reservoir is typically more than 400,000 visitors, and even exceeded half a million in 1985 and 1986. Between 1983 and 1999, average reservoir visitation averaged approximately 446,000 per year. However, visitation has declined slightly since that time, averaging approximately 413,800 since 2000. Don Pedro Reservoir attracts considerable visitation from the Bay Area and Sacramento, and many visitors stay for several days or a week at a time (Jackson, 2006).

Beach use at Don Pedro Reservoir generally begins to decline once its elevation falls below 790 feet msl (i.e., 40 feet below its maximum pool elevation of 830 feet msl). Use of the reservoir



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SOURCE: Don Pedro Recreation Agency, 2006.

Figure 5.3.8-5
Don Pedro Reservoir Annual Visitation

declines moderately until the 750-foot level, below which use then begins to decrease more considerably. The Fleming Meadows boat ramp is out of operation when water levels fall below 600 feet msl (minimum pool). Between 710 feet and 600 feet msl, five of the reservoirs boat ramps are lost. The Moccasin Point boat ramp cannot be used below an elevation of 722 feet msl, and the Blue Oaks boat ramp cannot be used below 726 feet msl. The Fleming Meadows and Moccasin Point marina operations are limited when water levels fall below 600 and 630 feet msl, respectively. The swimming lagoon is used at all reservoir water surface elevations because it is separated from the main reservoir, and water is pumped from the reservoir into the lagoon to maintain water levels (USBR, 1997).

Don Pedro Reservoir's visual setting is characterized by its numerous long expanses of flatwater that stretch through a series of narrow valleys and inlets. The Sierra Nevada foothills surround the reservoir, rising gradually from its shoreline and giving wide and open views. The hillsides are largely covered by trees interspersed with grassland areas that remain unvegetated during the dry summer months. As the water level falls, an unvegetated ring around the entire reservoir is clearly visible.

Stanislaus County

The Tuolumne River continues through Stanislaus County for approximately 52 miles below Don Pedro Reservoir to the confluence with the San Joaquin River. This reach crosses mainly private open space and grazing lands, City of Modesto property, and several public parks. The principal recreational resources related to the Tuolumne River are described below.

Water recreation includes fishing, boating, rafting, and some swimming. These activities are dispersed along the river corridor and primarily depend on the availability of river access. No single public agency has comprehensively estimated recreational use along the river and, as a result, there is very limited recreation data for this reach of the river. Nonetheless, as with most recreational activities, summer is the peak season, and the majority of use occurs between Memorial Day and Labor Day. During the nonpeak season, winter and early spring use of the river is very limited.

The primary game fish in this stretch of the Tuolumne River are rainbow and brown trout, largemouth and smallmouth bass, striped bass, and Chinook salmon. The fishing season is from late April to mid-October; anglers are required to use barbless hooks and to release their trout catches, and are permitted to keep one salmon if it is caught in the lower reaches of the river. Between mid-October and the end of December, the CDFG increases enforcement of its fishing regulations at popular local fishing sites to protect the winter salmon run (CDFG, 2006a). The USBR has determined flow thresholds for boating recreation on the lower Tuolumne River. According to the USBR, the optimal flow range for boating activities is from 400 to 700 cfs. For swimming use, the optimal flows are between 200 and 600 cfs. Critical flows for power boating on the river occur below 500 cfs, and for canoeing and kayaking occur below 150 cfs (USBR, 1999).

La Grange Regional Park

La Grange Regional Park consists of 700 acres at 11 different sites, including an off-highway vehicle park, a Kiwanis Youth Camp, and the Joe Domecq Wilderness Area. The park has a boat ramp and a riverside picnic area as well as 225 acres of mostly undeveloped river plain areas along the Tuolumne River. Other park facilities include parking, restrooms, gravel beach area for swimming, trails and pathways, and handicapped access. Overnight camping is prohibited within the park. The majority of fishing and other river-related uses within the park take place at the Basso Bridge site, where there are approximately two acres of parkland on the river. Fishing at the river is prohibited between mid-October and the end of December to protect adult spawning salmon (Stanislaus County Department of Parks and Recreation, 2006). The visual setting of La Grange Regional Park is characterized by wide forested floodplain terraces, with some open space and turf areas. The river runs wide along major portions of its course downstream. Other parts of the park include less vegetated areas located on the dredge tailings from former gold mining operations (mostly on the northern side of the river).

Turlock Lake State Recreation Area

Turlock Lake State Recreation Area is located on the south side of the Tuolumne River, approximately 25 miles east of Modesto. Turlock Lake has 26 miles of shoreline and a surrounding area of 228 acres that is leased from TID. All of the park's 63 campsites are located in the northern area overlooking or near the Tuolumne River. Although no recreational vehicle hookups are provided, the campsites can accommodate 27-foot vehicles; each site is equipped with a grill, table, and food locker and is near to potable water, showers, and flush toilet facilities (California Department of Parks and Recreation, 2006). The park's annual visitation over the last few years has been approximately 69,000 visitors, of which more than three-quarters were day users.

There is about a mile of Tuolumne River shoreline within the park; however, the majority of the park's recreational facilities and opportunities are located lakeside. While park users can access the river, there is no beach area and most visitors instead recreate at the lake. Relatively few park visitors fish in the river due to CDFG regulations, which do not apply on the nearby Lake Turlock. The primary river-related recreation at the park occurs during the late summer, when park visitors occasionally "float" the river with inflatable rafts or inner tubes. In contrast, Turlock Lake offers a wide range of recreational opportunities, including camping, fishing, picnicking, swimming, boating, and water skiing. Lakeside recreational facilities consist of two formal picnic areas (each with nearby parking and toilet facilities), a boat launching ramp, and a swim area (although no lifeguards are on duty). As a result, the majority of the non-camping recreational use is lake-related.

The park's visual setting is similar to that of La Grange Regional Park, comprising a primarily open view of the flat, forested river floodplain within mostly undeveloped land. The river and its adjacent sloughs are forested by numerous native tree species, including interior live oak, cottonwood, and white alder. The broad riparian areas are also vegetated with underbrush that provides habitat for many birds and animals.

Fox Grove Regional Park

Fox Grove Regional Park encompasses approximately 64 acres along a one-mile river frontage, providing fishing access to the Tuolumne River. The park has a boat ramp, river access, barbecues, and picnic tables, and disabled access to the park is provided. The river runs deeper at Fox Grove than at the area's other popular river and fishing access site at Basso Bridge; as a result, flat-bottomed boat use is typically allowed at Fox Grove throughout the summer. Public access to the site is generally prohibited by the Stanislaus County Department of Parks and Recreation between mid-October and the end of December to protect the winter salmon run (Stanislaus County Department of Parks and Recreation, 2006). The visual setting at Fox Grove Regional Park is very similar to that at Turlock Lake State Recreation Area.

Tuolumne River Regional Park

The proposed Tuolumne River Regional Park lies along a seven-mile stretch of the Tuolumne River and encompasses approximately 500 acres of land (EDAW, 2005). Stanislaus County, the City of Modesto, and the City of Ceres have partnered to commence development of this project, and park plans are currently in environmental review. The majority of the parkland is located on the north side of the river, with the exception of Mancini Park and a series of small, riverfront parcels near the western end of the park.

Approximately 180 acres of the parkland has already been developed for recreational purposes, including open lawn areas within mature tree canopies as well as park amenities (e.g., park benches, picnic tables, trails, restrooms, and parking areas). The Dryden and Modesto Municipal Golf Courses are included as part of the city of Modesto's greenway areas for the park. The privately owned River Oaks Golf Course is also located along the southern bank of the river east of the Modesto Airport. However, recreational use of these golf courses is sport-focused and therefore non-river-related.

The eastern section of the park near the Modesto Airport is already developed for park use. The neighboring 50-acre Legion Park has mowed lawns, picnic tables, barbecue sites, and restrooms and is occasionally used for community special events such as the annual Cinco de Mayo celebration and Scottish Games. Mancini Park is located on the southern bank of the river and consists of 25 acres, including a children's play area, ball field, restrooms, and parking area. There is no river access from the park, and the remaining 320 acres are unimproved open space. The developed parkland areas include open space and turfed areas with scattered trees that provide shade. Sections of the park are heavily vegetated by trees and underbush that hide much of the nearby housing and other urban development. However, the majority of the undeveloped areas contain little vegetation, with much of the land consisting of denuded open or disked farmland (Tuolumne River Regional Park, 2007).

Future development of the park, proposed under the *Tuolumne River Regional Park Master Plan,* aims to restore a continuous riparian corridor along the river as well as develop a riverside bicycle and pedestrian trail. The plan also proposes to add river access at Legion Park and develop a regional sports complex in the Carpenter Road area (although this development is to be planned and approved separately from the master plan). The majority of the master plan's future park improvements would be located at the Gateway parcel site. These planned improvements include a river promenade trail and internal trail system, multi-use meadows suitable for community events and informal park activities, wetland areas for stormwater runoff, removal of Dennett Dam, a pedestrian bridge connection to the western parkland across Dry Creek, new parking, an "amphimeadow" (a grassy, outdoor amphitheater within a natural, meadow-like setting), and river access piers. Special events at the amphimeadow, construction of the river piers, and Dennet Dam removal are planned as subsequent projects to the master plan.

5.3.8.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to recreational and visual resources, but generally considers that implementation of the proposed program would have a significant impact if it were to:

Recreation

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated (Secondary impacts of growth are evaluated in Chapter 7, Growth-Inducement Potential and Indirect Effects of Growth)
- Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment (Secondary impacts of growth are evaluated in Chapter 7)
- Physically degrade existing recreational resources

The first two criteria do not apply to the analysis of the proposed water supply and system operations component of the WSIP presented in this section of the PEIR, because these components of the proposed program would not increase the use of existing parks, nor would they require the construction or expansion of recreational facilities. Therefore, only the third criterion (potential physical degradation of existing recreational resources) is considered in the impact analysis below. The physical degradation of existing resources could occur if the WSIP were to:

- Remove or damage existing recreational resources
- Cause environmental impacts (such as air quality or noise effects) that would indirectly result in deterioration in the quality of the recreational experience
- Disrupt access to existing recreational facilities (which would divide a community from some of the established amenities used by its members)

While impeding a visitor's ability to participate in recreational activities does not in itself qualify as an environmental effect under CEQA, visitor use impacts can serve as indicators of physical changes to a recreational resource.

For visual resources, significant impacts could occur if the WSIP were to:

Visual Quality

- Have a substantial adverse effect on a scenic vista
- Substantially damage scenic resources, including but not limited to trees, rock outcroppings, and other features of the built or natural environment, that contribute to a scenic public setting
- Substantially degrade the existing visual character or quality of the site and its surroundings

Approach to Analysis

The analysis of impacts on recreation generally distinguishes between recreational activities associated with the rivers and reservoirs (e.g., swimming, boating, and fishing) and off-water recreation (e.g., hiking, picnicking, and camping). However, recreational activities are not separately identified, except for whitewater rafting, which is discussed separately and in greater detail due to the potential magnitude of impacts and the unique factors related to this recreational use of the Tuolumne River.

River-related recreational use within the Tuolumne River system predominantly occurs during the summer season between Memorial Day and Labor Day. In addition, there are relatively short shoulder seasons after mid-April and late October. During the off-season from November to mid-April, there is very limited river-related recreational use. Therefore, the primary focus of this impact analysis is on the summer season, when the majority of recreational activity occurs.

This analysis also considers potential visual impacts of the WSIP. Due to the Tuolumne River's limited accessibility and visibility, any visual or aesthetic changes to the river would predominantly affect recreation users; therefore, this analysis evaluates potential program-related changes in the quality of the visual experience for recreation users. The predominant visual effect that could occur at reservoirs under the WSIP involves the "bathtub ring" at reservoirs that are also used for recreational purposes. The bathtub ring refers to the exposed shoreline below the maximum water surface elevation, which is usually devoid of vegetation. This effect is a normal and unavoidable occurrence at reservoirs as water levels decline. Nonetheless, the WSIP would reduce reservoir water levels for longer periods and thus could diminish aesthetic values at program area reservoirs. The magnitude, incidence, and duration of future changes in the reservoirs' aesthetic values are qualitatively assessed as part of this analysis.

As noted above, the changes in river recreation that could result from the WSIP are consequences of changes in stream flow and reservoir water levels. These WSIP-induced changes in stream flow and reservoir water levels were estimated using the HH/LSM. An overview of the model is presented in Section 5.1. Detailed information on the model and the assumptions that underlie it is provided in Appendix H.

Impact Summary

Table 5.3.8-5 presents a summary of the impacts on recreational and visual resources in the Tuolumne River system that could result from implementation of the proposed water supply and system operations.

TABLE 5.3.8-5
SUMMARY OF IMPACTS –
RECREATIONAL AND VISUAL RESOURCES IN THE TUOLUMNE RIVER SYSTEM

Impact	Significance Determination
Impact 5.3.8-1: Effects on reservoir recreation due to changes in water system operations	LS
Impact 5.3.8-2: Effects on river recreation due to changes in water system operations	LS
Impact 5.3.8-3: Effects on the aesthetic values of the Tuolumne Wild and Scenic River	LS

LS = Less than Significant impact, no mitigation required

Impact Discussion

Impact 5.3.8-1: Effects on reservoir recreation due to changes in water system operations.

Lake Eleanor

The WSIP would have very little effect on water levels or water quality in Lake Eleanor, as described in Sections 5.3.1 and 5.3.3. Therefore, recreational impacts at Lake Eleanor would be less than significant.

Hetch Hetchy Reservoir

The WSIP would result in an average monthly lowering of reservoir water levels by an additional 1 to 10 feet over the course of the year compared to the existing condition. During the primary recreation season (between Memorial Day and Labor Day), the WSIP-related decrease in reservoir depth would be less than 5 feet from current levels except in critically dry years, when up to a 10-foot drop in reservoir levels would be expected. In average wet to normal hydrologic years, no change in reservoir levels would occur during the months of May through July; therefore, under these conditions, no recreational impact would result.

Off-water activities such as hiking and camping are the predominant recreational use at Hetch Hetchy Reservoir, since no swimming or boating is permitted. During the summer season for non-dry years, the drop in reservoir levels would increase the size of the “bathtub ring” visible to hikers by up to 4 feet; however, this increase would not likely be perceptible to most hikers, even in foreground views. Furthermore, during most of the year, Hetch Hetchy Reservoir would appear as it does a week or so earlier under current operating conditions. Between October and late December, visual conditions at the reservoir would be typical of those seen a month later under current conditions.

Only during the period between January and March would average reservoir levels at Hetch Hetchy fall lower than they normally do under the current operating conditions. On average, the maximum extra decrease in reservoir depth would be 10 feet in March, which would represent an approximate 15 percent increase to the reservoir’s current average 65-foot drawdown. This additional drawdown could be noticeable in foreground views; however, in views across the reservoir, the increase would likely be imperceptible to most hikers. This visual impact would only occur during the off-season, when visitation to the reservoir is low. Furthermore, the bathtub ring is a typical feature of an operating reservoir and would be a familiar sight for hikers at the reservoir. Therefore, recreational impacts at Hetch Hetchy Reservoir would be less than significant.

Lake Lloyd

The potential WSIP-related impacts on Lake Lloyd would be limited. During normal and below-normal hydrologic years, no changes in the reservoir’s current operations would occur, and no recreational impacts would result.

During wet or above-normal hydrologic years, future reservoir depths would generally be reduced by 1 or 2 feet; this reduction in the reservoir’s depth (less than 1 percent) would be imperceptible to recreational users. Furthermore, no reservoir level reductions would occur during the months of June through September, when the majority of the recreational use occurs. Therefore, no impacts on recreation would result.

During the summer season of critically dry hydrologic years, Lake Lloyd's depth would be expected to decrease by a maximum of 3 or 4 feet from current levels. However, this drop in reservoir levels (less than 2 percent) would be imperceptible to water and off-water recreational users. Furthermore, the conditions for fish species inhabiting the lake would not be affected by the WSIP. These non-native fish species are acclimated to the water-level fluctuations that occur in the reservoir, and thus impacts on the lake's recreational fishery are expected to be less than significant. Use of Lake Lloyd by other water recreationists for swimming or boating would also not be impaired. Therefore, recreational impacts at Lake Lloyd would be less than significant.

Don Pedro Recreation Area

With an average of more than 400,000 visitors a year, Don Pedro Reservoir is the most popular recreational resource in the Tuolumne River system that could be affected by the WSIP. The program's proposed increase in water withdrawals from the Tuolumne River would result in lower reservoir levels, varying on average up to 4 to 6 feet lower during above-normal or wet hydrologic years over the course of the year.

During below-normal, dry, and critically dry hydrologic years, water levels in Don Pedro Reservoir would be expected to fall up to 7 to 10 feet below current levels during the May to September recreational season. The reservoir's full depth is 530 feet (with a dead pool depth[2] of 230 feet below the maximum pool level). The average decrease in water levels from current levels would be less than 1 percent, and the decrease during dry years would be approximately 2.1 percent. Given the large annual fluctuation in the reservoir's depth both during the year and between years, these decreases in reservoir levels are likely to be barely perceptible to most recreational users. Water level changes are more likely to be noticed by on-water recreational users than by off-water recreationists at the reservoir.

Past recreational studies of Don Pedro Reservoir identified a threshold of 490 feet (i.e., a 40-foot decrease from the maximum elevation) below which recreational use of the beaches declined. However, only at levels below 450 feet (i.e., 80 feet below maximum pool) would recreational use decrease considerably. All of Don Pedro's recreational facilities nonetheless remain fully operational until the reservoir depth falls to 426 feet (i.e., 104 feet below maximum pool), at which point the Blue Oaks boat ramp is no longer operational, and 422 feet (i.e., 108 feet below maximum pool), at which point the Moccasin Point boat ramp is no longer operational (USBR, 1997). Critical thresholds are also reached when water levels decrease to the point that reservoir water levels recede from hiking trails, campsites, and picnic areas. A water-level decrease below the 426-foot threshold would impair use of the lake and limit reservoir access.

Under the proposed water withdrawal schedule (as shown in **Figure 5.3.8-6**), even at its lowest levels during the months of October and November, Don Pedro Reservoir would typically remain

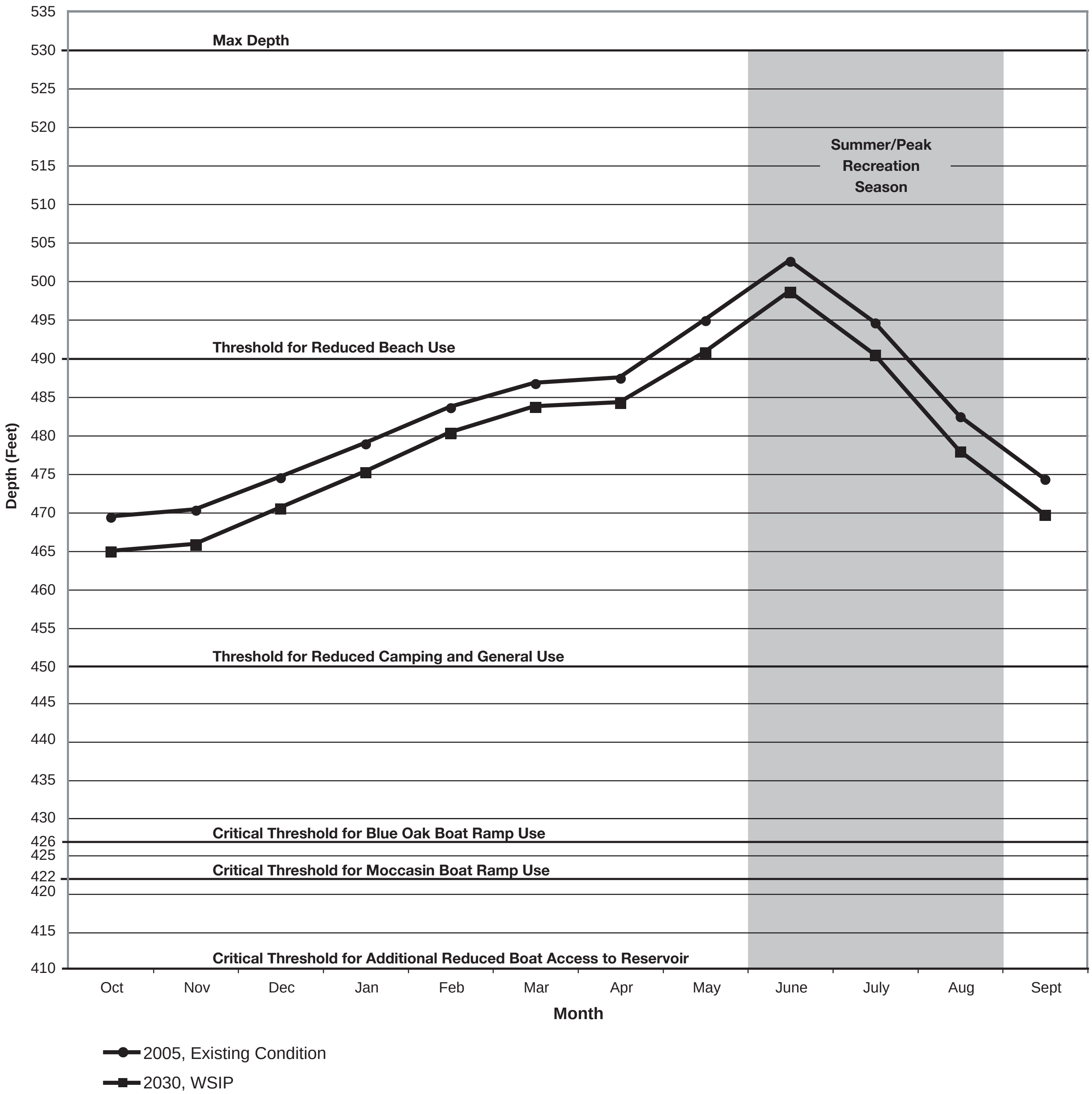
[2] Dead pool is the depth beyond which the reservoir cannot be drained.

more than 15 feet above the 450-foot threshold, below which recreational use would begin to decline significantly. Average annual reservoir levels would be 490 feet or above during the summer months of June and July, when the majority of recreational use occurs; this level is more than 40 feet above the threshold for significant recreation impacts and 64 feet above facility-use impacts. In August, the reservoir's levels would typically fall an additional 4 feet with the WSIP, but would still be 488 feet—well above the 450 foot-threshold level. Because future reservoir levels in most years are expected to remain well above the threshold for adverse effects on recreational visitation, no significant impacts on recreational use at Don Pedro Reservoir are expected.

However, following a succession of dry years, the reduction in summer storage in Don Pedro Reservoir could increase the likelihood of adverse recreation impacts. Effects on Don Pedro's water levels associated with WSIP operational changes for the summer recreation season (i.e., June through August) were projected based on the available 82-year hydrologic record. Currently, out of 82 years, there were 13 months during the summer period (June through August) when water levels at Don Pedro Reservoir would have been below the 426-foot threshold (at which the Blue Oaks boat ramp becomes unusable). Under the proposed program, the incidence would increase to 24 summer months over the 82-year period. The 12-month increase represents an approximate doubling in the amount of time boat ramp facilities would be physically impaired (equivalent to 1 out of every 20 years). However, at reservoir depths below the 450-foot threshold, boat ramp use would be reduced but would continue to be possible. At 422 feet, the Moccasin Point ramp would not be usable. Another boat ramp access point would be unavailable at 410 feet. Currently, reservoir levels would fall below this threshold a projected 9 summer months out of 82 years. Under the WSIP, future Don Pedro levels would fall below this threshold for 13 summer months—an increase of 4 months.

Therefore, future operations under the WSIP are expected to reduce access to boating facilities. However, given the limited frequency of the impacts (which would occur only in extended drought periods) and the limited lost boating ramp use (since both marinas and most boat ramps would continue to function adequately), the impact on boating due to Don Pedro's increased vulnerability to drought effects would be less than significant.

Recreational fishing would not be affected by the WSIP, as the non-native fish populations in Don Pedro Reservoir can tolerate the changes in reservoir levels. Largemouth bass and bluegill, which are a popular catch for anglers, use the lakeshore as spawning ground during the springtime; however, effects on fishing as a result of the WSIP would be less than significant.



SOURCE: ESA, 2006

SFPUC Water System Improvement Program . 203287

Figure 5.3.8-6
Don Pedro Reservoir Annual Average Reservoir Depth and Recreational Uses

Off-water activities such as hiking and camping are more indirectly related to reservoir levels. The program-related drop in reservoir levels would increase the size of the bathtub ring visible to hikers, campers, and other reservoir users by up to 7 feet in foreground views (i.e., during the summer season of drier-than-average hydrologic years). This increase would likely be noticeable only to reservoir users who are very familiar with the reservoir. Furthermore, during most of the year, Don Pedro Reservoir would appear as it does two weeks or so earlier under current operating conditions. Between October and late December, visual conditions at the reservoir would be typical of those seen a month later under current conditions.

Only during the period between October and November would average reservoir levels at Don Pedro fall lower than they do under current operations. The visual impact associated with the bathtub ring would occur in the off-peak season only, when visitation to the reservoir is low. On average, the decrease in reservoir depth would be approximately 4 feet, which would represent a less than 10 percent increase in the reservoir's current average 45-foot drawdown over the year. This additional drawdown could be noticeable in foreground views; however, in views across the reservoir, the increase would not likely be very noticeable to most reservoir users. Furthermore, the bathtub ring is a typical feature of an operating reservoir and would be a familiar sight for frequent visitors to the reservoir. If fish were spawning along the reservoir shoreline during the spring, the increase in reservoir drawdown would have the potential to affect only a limited number of spawning grounds. Therefore, recreational impacts at Don Pedro Reservoir associated with WSIP operational changes would be less than significant.

Summary of Impacts

Overall, implementation of the proposed WSIP water supply and system operations would result in *less than significant* impacts on reservoir recreation.

Impact 5.3.8-2: Effects on river recreation due to changes in water system operations.

Diversion of additional water from the Tuolumne River as a result of the WSIP could affect the availability of water for whitewater rafting uses in the upper reaches of the river. It could also decrease stream flow in lower reaches of the river, thereby reducing opportunities for (and the quality of recreational experiences at) existing and planned parks and recreational facilities located at the river's edge, such as the Tuolumne River Parkway, a 500-acre parkway to be sited along a seven-mile stretch of the Tuolumne River in the Modesto area.

Whitewater Recreation

Hetch Hetchy Reservoir and Lake Lloyd are usually drawn down to their seasonal minimum in the spring. The SFPUC captures some of the late spring/early summer snowmelt runoff to refill the reservoirs and releases the rest to the Tuolumne River and Cherry Creek.

Flow in the Tuolumne River just below the confluence with Cherry Creek, and just downstream of the launching point for the Cherry Creek whitewater run, consists of releases and spills from

Hetch Hetchy Reservoir, Lake Lloyd, and Lake Eleanor; releases from Holm and Kirkwood Powerhouses; and tributary flow. Flow at this location is at its seasonal minimum in October. Flow typically increases through the winter and early spring and then increases sharply in the May and June with the snowmelt.

Hetchy Hetchy Reservoir would be drawn down farther in the spring with the WSIP than it is under the existing condition because diversions at Hetch Hetchy Reservoir would increase to meet 2030 water demand in the Bay Area. A greater proportion of the spring runoff would be needed to refill the reservoir than under the existing condition. As a result, with the WSIP, the onset of large releases from Hetch Hetchy Reservoir would be delayed by an average of one to two days (and up to eight days) and the total volume of releases would be reduced. After the large releases begin, releases during the rest of the year would be similar with the WSIP and under the existing condition.

Table 5.3.8-6 shows flows just below the Cherry Creek confluence under the existing condition and with the WSIP. The table slightly understates flow at this location because it does not include the small amount of inflow from tributaries between Hetch Hetchy Reservoir and Cherry Creek.

The WSIP would have very little effect on flow below the Cherry Creek confluence in wet and above-normal years. It would result in reductions in average monthly flow of up to 14 percent in May of normal, below-normal, and dry years. The reductions would manifest themselves as a delay in the onset of large snowmelt flows. This situation can best be illustrated with a simplified example. Under the existing condition, flow might be 1,000 cfs for the first five days in May and then 5,000 cfs for the remaining 26 days, for an average monthly flow of 4,354 cfs. With the WSIP, flow might be 1,000 cfs for the first 10 days of May and then 5,000 cfs for the remaining 21 days, for an average monthly flow of 3,709 cfs.

Currently, whitewater recreation on the upper river from mid-June through the summer is generally only possible due to SFPUC releases from Holm Powerhouse. For rafting flows, the SFPUC attempts to provide up to 1,100 cfs on the Tuolumne River at Lumsden for about four hours in the morning, from Monday through Saturday and on holiday weekends.

Tables 5.3.8-7 and **5.5.8-8** show flows in the Tuolumne River below the Cherry Creek confluence under the existing condition and with the WSIP for the 82-year hydrologic record. Although the flows shown in the tables understate actual flows at Lumsden Campground because they do not include tributary flows, they provide insight into the effects of the WSIP on whitewater rafting.

Under the existing condition and in May, the first month the weather is warm enough for whitewater rafting, flows below Cherry Creek would exceed 1,100 cfs in 74 years of the 82-year hydrologic record. A flow of 1,100 cfs in the Tuolumne River below Cherry Creek, and at least that at Lumsden Campground, would be suitable for rafting without a pulse release from Holm Powerhouse. With the WSIP and in May, flows below Cherry Creek would exceed 1,100 cfs in 72 years of the 82-year hydrologic record. Under the existing condition and in June, flows in the Tuolumne River below Cherry Creek would exceed 1,100 cfs in 64 years of the 82-year hydrologic

TABLE 5.3.8-6
ESTIMATED AVERAGE MONTHLY FLOWS IN THE TUOLUMNE RIVER IMMEDIATELY BELOW THE CHERRY CREEK CONFLUENCE UNDER VARIOUS CONDITIONS
(cubic feet per second)

	Wet		Above Normal		Normal		Below Normal		Dry		All	
Existing Condition (2005)												
Oct	264		181		198		169		207		203	
Nov	318		570		203		197		112		283	
Dec	1,135		775		511		430		357		641	
Jan	1,305		835		572		285		218		641	
Feb	1,351		1,345		1,086		539		462		956	
Mar	1,408		1,240		1,140		819		593		1,040	
Apr	1,540		1,546		1,370		1,296		911		1,335	
May	5,057		3,444		3,486		2,448		1,111		3,105	
June	7,742		5,398		3,648		1,887		636		3,857	
July	4,028		1,401		670		300		225		1,313	
Aug	609		307		300		273		242		345	
Sept	491		379		380		365		335		390	
Future with WSIP (2030)												
Oct	264		179		198		164		207		202	
Nov	318		563		203		197		112		281	
Dec	1,100		746		507		429		358		627	
Jan	1,290		853		603		278		216		646	
Feb	1,339		1,324		1,086		544		477		953	
Mar	1,406		1,276		1,141		857		617		1,060	
Apr	1,526		1,540		1,353		1,247		907		1,316	
May	4,920		3,359		3,221		2,239		960		2,936	
June	7,715		5,380		3,642		1,770		610		3,817	
July	4,028		1,401		670		312		219		1,314	
Aug	609		307		300		265		242		343	
Sept	490		379		380		361		321		386	
Difference and Percent Change, Existing Condition (2005) vs WSIP (2030)												
Oct	0	[0%]	-2	-[1%]	0	[0%]	-5	-[3%]	0	[0%]	-1	[0%]
Nov	0	[0%]	-7	-[1%]	0	[0%]	0	[0%]	0	[0%]	-2	-[1%]
Dec	-35	-[3%]	-29	-[4%]	-4	-[1%]	-1	[0%]	1	[0%]	-14	-[2%]
Jan	-15	-[1%]	18	[2%]	31	[5%]	-7	-[2%]	-2	-[1%]	5	[1%]
Feb	-12	-[1%]	-21	-[2%]	0	[0%]	5	[1%]	15	[3%]	-3	[0%]
Mar	-2	[0%]	36	[3%]	1	[0%]	38	[5%]	24	[4%]	20	[2%]
Apr	-14	-[1%]	-6	[0%]	-17	-[1%]	-49	-[4%]	-4	[0%]	-19	-[1%]
May	-137	-[3%]	-85	-[2%]	-265	-[8%]	-209	-[9%]	-151	-[14%]	-169	-[5%]
June	-27	[0%]	-18	[0%]	-6	[0%]	-117	-[6%]	-26	-[4%]	-40	-[1%]
July	0	[0%]	0	[0%]	0	[0%]	12	[4%]	-6	-[3%]	1	[0%]
Aug	0	[0%]	0	[0%]	0	[0%]	-8	-[3%]	0	[0%]	-2	-[1%]
Sept	-1	[0%]	0	[0%]	0	[0%]	-4	-[1%]	-14	-[4%]	-4	-[1%]

Note: The data represent the summation of releases to rivers/creeks from: Hetch Hetchy Reservoir, Lake Eleanor, Lake Lloyd, Holm Powerhouse, and Kirkwood Powerhouse. The flow data are incomplete and do not include accretions from the watersheds below the dams. These accretions would remain constant under all modeling scenarios. Actual Tuolumne River flow at the Cherry Creek confluence would be greater than the values presented.

Key

(light blue)	> 0%
(yellow)	< 0 to -5%
(orange)	< -5%

**TABLE 5.3.8-7
FLOW IN THE TUOLUMNE RIVER IMMEDIATELY BELOW THE CHERRY CREEK CONFLUENCE
UNDER EXISTING CONDITIONS (cubic feet per second)**

YEAR TYPE	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
W	1983	1,823	603	1,102	1,010	1,012	1,279	1,045	5,134	12,573	8,389	2,555	573
W	1995	169	364	552	810	1,012	1,878	1,644	5,104	9,666	8,172	1,547	427
W	1969	138	475	1,000	1,182	1,012	1,025	1,978	8,994	8,566	3,774	318	390
W	1982	286	1,146	1,092	1,010	1,850	1,025	2,563	6,957	7,108	3,536	459	947
W	1938	140	115	1,906	365	1,713	1,801	1,809	4,043	9,599	3,606	344	397
W	1998	169	116	170	624	1,012	1,074	1,059	3,047	9,964	6,628	488	508
W	1997	167	621	1,449	6,087	1,381	1,662	1,372	6,358	4,437	592	308	432
W	1956	111	104	3,085	1,849	1,713	1,787	1,705	2,334	8,063	3,095	387	375
W	1967	67	408	1,007	657	1,012	1,025	1,045	4,626	7,832	5,542	468	390
W	1980	314	248	449	2,225	1,448	1,025	1,690	4,576	7,092	4,556	423	451
W	1986	296	198	954	622	1,989	2,688	2,176	6,547	7,111	1,407	325	463
W	1952	140	179	1,010	1,010	1,713	1,025	1,242	6,176	6,620	3,736	374	429
W	1978	78	81	552	789	1,012	1,025	1,045	3,423	8,499	3,955	383	801
W	1965	124	219	3,031	1,786	1,713	1,788	1,665	1,937	3,812	2,626	617	458
W	1958	152	131	251	286	1,012	1,202	1,045	5,980	7,121	2,553	404	398
W	1993	45	79	552	567	1,012	1,210	1,548	5,678	5,808	2,274	348	409
AN	1941	130	98	536	1,786	1,616	1,587	1,473	2,131	5,868	2,612	315	381
AN	1951	336	3,770	3,000	1,786	1,713	993	1,753	1,561	2,772	286	299	368
AN	1922	123	70	118	197	1,012	1,025	1,800	3,497	8,836	2,037	329	400
AN	1984	324	2,087	2,143	1,695	1,571	1,255	1,116	3,862	3,636	811	303	396
AN	1943	133	553	514	740	1,012	1,270	2,262	5,643	4,513	1,414	304	378
AN	1942	142	201	851	1,010	1,012	1,025	1,424	3,733	7,124	3,091	321	385
AN	1996	153	71	444	467	1,746	1,450	1,994	6,410	4,970	1,274	324	418
AN	1974	169	1,158	515	700	1,012	1,068	1,045	5,398	5,608	1,063	299	312
AN	1940	380	87	886	401	1,670	1,752	1,630	3,226	4,582	309	298	363
AN	1936	176	114	93	348	1,703	1,745	1,926	3,566	5,189	1,138	302	386
AN	1932	101	59	1,400	1,570	1,212	1,187	1,116	1,709	3,709	1,743	313	410
AN	1935	153	226	552	1,663	1,429	546	1,361	2,067	5,002	869	305	383
AN	1999	181	311	415	529	1,713	1,801	1,774	2,751	5,305	617	300	371
AN	1945	160	417	466	451	1,277	1,801	1,714	2,141	5,607	1,803	308	388
AN	1927	117	332	508	515	1,012	1,025	1,045	4,174	6,480	1,481	319	413
AN	1963	210	70	605	134	1,321	530	1,045	4,395	5,704	1,747	267	299
AN	1975	86	70	130	204	832	1,025	1,800	2,279	6,856	1,516	314	401
N	1973	140	133	1,000	1,010	1,012	1,025	1,044	5,434	3,784	274	279	287
N	1921	387	269	358	412	1,713	1,752	1,672	1,778	4,417	718	302	399
N	1937	139	71	157	118	1,702	1,697	1,565	2,627	4,945	542	298	391
N	1970	317	147	721	1,525	1,012	1,025	1,045	3,473	3,301	452	276	340
N	2000	113	118	102	562	1,012	1,025	1,234	5,205	3,566	315	310	422
N	1925	241	231	995	789	1,000	1,025	1,836	3,169	3,984	1,060	358	418
N	1979	125	103	139	523	1,012	1,025	1,061	5,984	3,772	362	328	445
N	1946	562	499	1,280	894	1,713	1,726	1,630	2,098	3,167	311	296	386
N	1923	144	147	377	615	1,012	778	1,790	2,842	3,496	1,626	317	493
N	1962	109	55	552	359	845	1,025	1,319	2,618	5,524	1,083	287	340
N	1971	113	418	670	645	1,012	1,025	1,045	2,772	4,409	973	280	337
N	1950	114	105	260	115	1,694	1,651	1,586	2,044	3,415	398	303	383
N	1953	138	91	150	603	794	1,015	1,205	2,082	4,557	1,852	309	385
N	1928	266	514	594	253	625	1,014	1,096	4,870	1,461	248	277	347
N	1954	138	115	123	126	469	1,057	1,543	4,393	1,984	266	282	356
N	2002	127	238	692	607	756	374	1,245	4,386	2,587	238	294	357
BN	1957	192	172	170	175	659	1,000	1,035	2,669	5,325	391	146	326
BN	1948	386	155	779	248	153	971	1,450	1,925	3,303	546	296	386
BN	1989	114	131	552	567	616	849	1,442	3,824	2,567	288	296	493
BN	1966	134	535	1,010	282	817	799	1,446	3,323	234	146	247	348
BN	1944	153	100	108	152	832	1,015	1,035	2,843	2,543	625	282	354
BN	1949	137	91	100	96	148	1,710	1,661	2,177	1,817	239	283	364
BN	1985	276	417	789	167	519	745	1,127	3,335	1,111	233	292	385
BN	1972	70	195	318	702	725	746	854	2,249	2,158	213	258	298
BN	1930	110	60	800	449	678	572	858	1,186	2,944	299	281	391
BN	1964	195	674	342	362	499	280	1,471	2,025	1,657	276	278	352
BN	1955	116	109	220	290	817	1,200	1,320	1,742	1,140	270	281	347
BN	1926	238	135	181	240	232	1,256	2,080	2,114	576	217	277	351
BN	1933	127	70	314	45	689	108	1,638	1,519	2,259	333	281	394
BN	1991	133	45	552	234	88	304	1,035	1,893	2,778	356	289	360
BN	2001	194	131	136	187	388	1,057	1,052	3,773	278	246	305	388
BN	1947	182	258	391	472	519	668	1,045	3,418	916	216	277	338
BN	1960	122	68	557	186	787	640	1,478	1,594	480	207	279	336
D	1981	70	70	98	113	669	794	1,838	2,048	1,358	248	322	417
D	1968	99	76	145	193	786	822	1,035	2,816	1,163	211	271	264
D	1959	75	86	71	355	781	1,068	1,728	1,656	761	219	275	603
D	1939	287	199	365	227	534	980	1,616	1,608	136	186	279	362
D	1929	134	78	86	87	191	594	1,005	1,356	2,399	270	279	361
D	1990	568	179	557	263	616	437	597	1,295	929	304	111	326
D	1992	154	166	557	318	616	572	1,208	2,208	570	618	111	92
D	1994	177	74	118	105	241	645	968	1,414	935	181	241	312
D	1988	158	121	552	567	626	319	411	397	528	204	241	314
D	1934	139	71	188	289	402	1,428	872	714	466	178	243	344
D	1961	116	104	1,000	314	335	184	608	359	230	185	250	321
D	1976	588	220	443	175	186	351	554	329	141	171	294	402
D	1987	188	76	76	86	236	440	1,042	655	243	172	248	324
D	1931	143	116	779	187	607	296	361	329	100	112	241	333
D	1924	266	101	121	76	331	506	570	357	119	166	241	293
D	1977	152	50	552	130	231	61	159	232	101	167	233	298

Notes: The data represent the summation of releases to rivers/creeks from: Hetch Hetchy Reservoir, Lake Eleanor, Lake Lloyd, Holm Powerhouse, and Kirkwood Powerhouse. The flow data are incomplete and do not include accretions from the watersheds below the dams. These accretions would remain constant under all modeling scenarios. Actual Tuolumne River flow at the Cherry Creek confluence would be greater than the values presented. Year Types: Wet, AN – Above Normal, BN – Below Normal, Dry, and Critical

TABLE 5.3.8-8
FLOW IN THE TUOLUMNE RIVER IMMEDIATELY BELOW THE CHERRY CREEK CONFLUENCE WITH THE WSIP (cubic feet per second)

YEAR TYPE	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
W	1983	1,823	603	1,102	1,010	1,012	1,279	1,045	5,086	12,573	8,389	2,555	573
W	1995	169	364	552	810	1,012	1,952	1,644	5,104	9,666	8,172	1,547	427
W	1969	138	475	1,000	1,182	1,012	1,025	1,978	8,994	8,566	3,774	318	390
W	1982	286	1,146	1,092	1,010	1,606	1,025	2,563	6,957	7,108	3,536	459	947
W	1938	140	115	1,917	365	1,713	1,801	1,779	3,832	9,599	3,606	344	397
W	1998	169	116	170	624	1,012	1,074	1,059	3,047	9,964	6,628	488	508
W	1997	167	621	1,449	5,891	1,381	1,849	1,212	6,358	4,437	592	308	432
W	1956	111	104	2,917	1,849	1,713	1,778	1,695	2,282	8,063	3,095	387	375
W	1967	67	408	1,007	657	1,012	1,025	1,045	4,493	7,832	5,542	468	390
W	1980	314	248	449	2,403	1,448	1,025	1,690	4,576	7,092	4,556	423	451
W	1986	296	198	863	653	2,054	2,496	2,110	6,547	7,111	1,407	325	463
W	1952	140	179	1,010	1,010	1,713	1,025	1,242	5,913	6,620	3,736	374	429
W	1978	78	81	552	789	1,012	1,025	1,045	2,100	8,499	3,955	383	796
W	1965	124	219	2,949	1,786	1,713	1,801	1,714	1,974	4,034	2,626	617	458
W	1958	152	131	251	286	1,012	1,202	1,045	5,776	7,121	2,553	404	398
W	1993	45	79	325	314	1,011	1,107	1,545	5,678	5,162	2,274	348	409
AN	1941	130	98	536	1,786	1,609	1,581	1,464	2,125	5,848	2,612	315	381
AN	1951	336	3,641	3,000	1,786	1,713	1,101	1,740	1,582	2,653	286	299	368
AN	1922	123	70	118	197	1,012	1,025	1,800	3,331	8,836	2,037	329	400
AN	1984	288	2,087	2,143	1,695	1,571	1,414	1,150	3,671	3,636	811	303	396
AN	1943	133	553	514	740	1,012	1,235	2,262	5,643	4,513	1,414	304	378
AN	1942	142	201	851	1,010	1,012	1,025	1,424	3,733	7,124	3,091	321	385
AN	1996	153	71	444	467	1,682	1,450	1,994	6,410	4,970	1,274	324	418
AN	1974	169	1,158	515	700	1,012	1,068	1,045	5,398	5,608	1,063	299	312
AN	1940	380	87	650	543	1,702	1,793	1,665	3,407	4,582	309	298	363
AN	1936	176	114	93	348	1,696	1,700	1,879	3,314	5,189	1,138	302	386
AN	1932	101	59	774	1,522	1,140	1,123	1,070	1,693	3,665	1,743	313	410
AN	1935	153	226	552	1,680	1,450	1,005	1,314	2,030	4,684	869	305	383
AN	1999	181	311	415	529	1,713	1,801	1,738	2,500	5,303	617	300	371
AN	1945	160	417	466	451	1,522	1,801	1,749	2,172	5,829	1,803	308	388
AN	1927	117	332	615	515	1,012	1,025	1,045	3,772	6,387	1,481	319	413
AN	1963	210	70	862	336	817	530	1,045	3,945	5,704	1,747	267	299
AN	1975	86	70	130	204	832	1,025	1,800	2,377	6,922	1,516	314	401
N	1973	140	133	1,000	1,010	1,012	1,025	1,044	5,200	3,784	274	279	287
N	1921	387	269	358	412	1,713	1,730	1,647	1,757	4,303	718	302	399
N	1937	139	71	157	118	1,673	1,665	1,536	2,552	4,878	542	298	391
N	1970	317	147	721	1,963	1,012	1,025	1,045	3,337	3,301	452	276	340
N	2000	113	118	102	562	1,012	1,096	1,234	5,038	3,566	315	310	422
N	1925	241	231	995	789	1,000	1,025	1,792	2,868	3,984	1,060	358	418
N	1979	125	103	139	523	1,012	1,025	1,061	5,984	3,772	362	328	445
N	1946	562	499	1,280	894	1,713	1,698	1,603	1,956	3,167	311	296	386
N	1923	144	147	377	615	1,012	778	1,790	2,565	3,496	1,626	317	493
N	1962	109	55	552	359	845	1,025	1,319	1,229	5,524	1,083	287	340
N	1971	113	418	670	645	1,012	1,025	1,045	2,399	4,409	973	280	337
N	1950	114	105	200	175	1,713	1,674	1,608	2,060	3,501	398	303	383
N	1953	138	91	150	603	794	1,015	1,051	2,077	4,557	1,852	309	385
N	1928	266	514	594	253	625	1,014	1,045	4,811	1,461	248	277	347
N	1954	138	115	123	126	469	1,071	1,580	3,889	1,984	266	282	356
N	2002	127	238	692	607	756	374	1,245	3,811	2,587	238	294	357
BN	1957	192	172	170	175	659	1,000	1,035	2,153	5,325	391	146	326
BN	1948	386	155	779	248	153	978	1,405	1,888	3,101	546	296	386
BN	1989	114	131	552	567	616	849	1,236	3,299	2,567	288	296	493
BN	1966	134	535	1,010	282	817	799	1,027	3,385	234	146	247	348
BN	1944	153	100	108	152	832	1,015	1,035	2,344	2,543	625	282	354
BN	1949	137	91	100	96	148	1,679	1,626	2,155	1,699	239	283	364
BN	1985	276	417	789	167	519	745	1,127	3,255	1,111	233	292	385
BN	1972	70	195	318	702	725	746	854	1,770	2,158	213	258	298
BN	1930	110	60	800	449	678	572	858	1,214	2,944	299	281	391
BN	1964	195	674	342	362	499	374	1,470	1,859	1,157	276	278	352
BN	1955	116	109	220	290	817	1,295	1,318	1,714	991	270	281	347
BN	1926	238	135	181	240	232	1,514	1,994	1,985	359	217	277	351
BN	1933	127	70	314	45	689	268	1,585	1,466	1,973	333	281	394
BN	1991	45	45	527	106	60	304	1,035	1,943	2,231	562	146	297
BN	2001	194	131	136	187	388	1,057	1,052	3,080	278	246	305	388
BN	1947	182	258	391	472	519	668	1,045	2,906	916	216	277	338
BN	1960	122	68	557	186	896	712	1,490	1,644	508	207	279	336
D	1981	70	70	98	113	669	794	1,838	1,878	1,169	248	322	417
D	1968	99	76	145	193	786	822	1,035	2,330	1,163	211	271	264
D	1959	75	86	71	355	781	1,318	1,666	1,420	761	219	275	603
D	1939	287	199	365	227	534	980	1,162	1,670	136	186	279	362
D	1929	134	78	86	87	191	594	1,005	1,092	2,190	270	279	361
D	1990	568	179	557	263	616	437	597	1,155	1,300	304	111	92
D	1992	154	166	557	318	616	572	1,729	1,899	608	618	111	92
D	1994	177	74	118	105	241	645	968	961	935	181	241	312
D	1988	158	121	552	567	870	319	317	359	135	123	241	314
D	1934	139	71	211	266	405	1,549	898	400	436	178	243	344
D	1961	116	104	1,000	314	335	184	608	359	230	185	250	321
D	1976	588	220	443	175	186	351	554	329	141	171	294	402
D	1987	188	76	76	86	236	440	1,042	591	228	172	248	324
D	1931	143	116	779	187	607	296	361	329	100	112	241	333
D	1924	266	101	121	76	331	506	570	357	119	166	241	293
D	1977	152	50	552	130	231	61	159	232	101	167	233	298

Notes: The data represent the summation of releases to rivers/creeks from: Hetch Hetchy Reservoir, Lake Eleanor, Lake Lloyd, Holm Powerhouse, and Kirkwood Powerhouse. The flow data are incomplete and do not include accretions from the watersheds below the dams. These accretions would remain constant under all modeling scenarios. Actual Tuolumne River flow at the Cherry Creek confluence would be greater than the values presented. Year Types: Wet, AN – Above Normal, BN – Below Normal, Dry, and Critical record. With the WSIP and in June, flows below Cherry Creek would also exceed 1,100 cfs in 64 years of the 82-year hydrologic record. Thus, during May and June, the high flow months, the WSIP would have very little effect on the number of days flow in the river is suitable for rafting and would have very little effect on the need for pulse releases from Holm Powerhouse.

Typically, inflow to the SFPUC's reservoirs in the Tuolumne River watershed is much diminished by mid-July, and large releases to the Tuolumne River have ended. Only the minimum required releases are made through the rest of the summer and early fall. Under the existing condition and in July, flows in the Tuolumne River below Cherry Creek would exceed 1,100 cfs in 28 years of the 82-year hydrologic record. With the WSIP and in July, flows below Cherry Creek would also exceed 1,100 cfs in 28 years of the 82-year hydrologic record. Under the existing condition and with the WSIP in August, flows below Cherry Creek would exceed 1,100 cfs in two years of the 82-year hydrologic record. Under the existing condition and with the WSIP in September, flows below Cherry Creek would never exceed 1,100 cfs in the 82-year hydrologic record. During many Julys, almost all Augusts, and all Septembers, releases from Holm Powerhouse would be needed to provide suitable flows for rafting under the existing condition and with the WSIP. There would be no appreciable increase in the amount of time releases would need to be made from Holm Powerhouse to provide rafting flows with the WSIP. Thus, the WSIP would have a less-than-significant effect on whitewater rafting in the Tuolumne River between the Cherry Creek confluence and Don Pedro Reservoir, and no mitigation measures would be necessary.

Comparison of the modeled controlled releases from Lake Lloyd, Lake Eleanor, and Holm Powerhouse for the existing condition and with the WSIP indicates that changes in the average monthly flow below Holm Powerhouse would occur in one or more months in 18 percent of the years in the 82-year hydrologic record. The WSIP would result in both increased and decreased flow rates; in some cases, flow would increase and decrease within the same year. These modeled changes primarily reflect slight changes in reservoir operations that may not occur during actual operations. The changes identified in the model occur rarely, and it is concluded that flow in Cherry Creek below Holm Powerhouse would be the same under either condition. Thus, the WSIP would have a less-than-significant effect on flows in the short section of the Cherry Creek Run between Holm Powerhouse and the confluence with the Tuolumne River, and no mitigation measures would be needed.

Other River Recreation Upstream of Don Pedro Reservoir

Non-rafting recreation on the Tuolumne River is limited. A majority of campers and hikers along the river are also on river rafting trips; therefore, any reductions in whitewater recreation would likely result in a related decrease in non-rafting recreational use.

However, as discussed in the Setting, some non-rafting visitors choose to recreate along the upper Tuolumne River despite the limited developed hiking trails and other recreational resources. The majority of recreational opportunities for these visitors are off-water activities, although a number of the visitors to this reach do partake in fishing. However, because no change in the flow releases for July through August are expected, no WSIP-related recreational impacts on river flow levels would occur during the peak recreational period.

Due to the considerable variance in the upper Tuolumne flow rates both seasonally and daily (as a result of the pulse releases), the relatively minor changes in river flow levels associated with the WSIP, predominantly in May and June, would be imperceptible to visitors. Therefore, impacts on non-rafting recreation along the upper Tuolumne River would be less than significant.

River Recreation Below La Grange Dam

Under existing conditions, most of the time (717 months in the 984-month hydrologic record) flow in the Tuolumne River below La Grange Dam consists of the minimum required instream flows. In average critically dry years, the releases made from La Grange Dam are those needed to sustain the minimum required instream flows. In other hydrologic year types, releases in excess of minimum flows are made primarily between November and June.

Don Pedro Reservoir would be drawn down farther in the spring with the WSIP than it is under the existing condition because diversions at Hetch Hetchy Reservoir would increase to meet 2030 water demand in the Bay Area and inflow to Don Pedro Reservoir would be reduced. A greater proportion of the winter and spring runoff would be needed to refill the reservoir than under the existing condition. As a result, with the WSIP, the onset of releases above from La Grange Dam above the minimum required would be delayed, and the total volume of releases would be reduced. After releases in excess of the minimum required begin, releases during the rest of the year would be similar with the WSIP and under the existing condition.

The effects of the WSIP on average monthly flows in the Tuolumne River below La Grange Dam in different year types are shown in Table 5.3.1-6. During the summer recreational season, when the majority of river-related recreation occurs, the WSIP would have no effect on releases from La Grange Dam in average below-normal, dry, and critically dry years. Therefore, the WSIP would have no effect on river recreation in these year types.

During average wet and above-normal years, the WSIP would reduce flow in some summer months by up to 25 percent. The greatest effect would be in June of average above-normal years, when a 25 percent reduction would occur. The next greatest proportional reduction in flow (7 percent) would occur in June of average wet years. Nonetheless, the resulting flow conditions with the WSIP in wet and above-normal years would still be appreciably higher than the typical flow conditions that now occur at that time of the year. The WSIP-induced decrease in flow in wet and above-normal years would not likely reduce accessibility or use of the area's recreational resources.

Below Don Pedro Reservoir, recreational use of the Tuolumne River is limited. The river's flow conditions, limited public access, as well as county and other agency regulations limit the type and level of river recreation. The Tuolumne County Recreation Department generally discourages swimming in the river at La Grange and Fox Grove Regional Parks due to dangerous undercurrents and the absence of lifeguard supervision. Although the CDFG annually restocks the river with fish, fishing in the Tuolumne River is regulated. Only barbless hooks and "catch and release" fishing is generally permitted, and no fishing is allowed during certain winter periods to protect the fall run of spawning adult Chinook salmon (CDFG, 2006b). Furthermore, the minimum instream flows for salmon and other fish populations would be maintained within the lower river to protect fishery habitat.

As discussed in the Setting, many local residents participate in off-water recreation in the parks along the Tuolumne River. However, this recreational use is generally independent of river flow conditions, which park visitors expect to vary considerably during the summer season. Future minimum flow conditions would be maintained under all circumstances during the summer season. Therefore, impacts river recreation along the Tuolumne River below La Grange Dam would be less than significant.

Summary of Impacts

Overall, implementation of the proposed WSIP water supply and system operations would result in *less than significant* impacts on river recreation.

Impact 5.3.8-3: Effects on the aesthetic values of the Tuolumne Wild and Scenic River.

Increasing the Hetch Hetchy system's reliance on Tuolumne River water sources could affect future stream flows within the Wild and Scenic sections of the Tuolumne River below O'Shaughnessy Dam, thereby degrading the river's visual resources. Such an impact, if it were to occur, could contravene policies of the *Tuolumne Wild and Scenic River Management Plan* (USFS, 1988) with respect to maintaining and improving the appearance of the stream and its water quality for aesthetic purposes. Reduction in the river's free-flowing condition could also diminish the management plan's policy to protect the river's outstandingly remarkable values.

Current flow conditions in the Tuolumne River vary considerably as a result of natural variations in rainfall and snowmelt in addition to the existing operation of the Hetch Hetchy system. Stream flow is only one of several qualities contributing to the river's scenic values. Other components of the river corridor's setting and scenery include geological and biological resources, which may be independent of and/or unaffected by WSIP changes in the water release schedule.

WSIP-induced changes in Tuolumne River flows would be greatest directly below O'Shaughnessy Dam. The effect of the WSIP would decrease in a downstream direction as more tributary flow and runoff enter the river, increasing river flow. As shown in Table 5.3.1-5, in most months of most hydrologic year types, flows in the Tuolumne River below O'Shaughnessy Dam with the WSIP and under the existing condition would be the same. In some months, usually in the spring, flows with the WSIP would be reduced compared to the existing condition. Average flows in May of all years would be 11 percent lower than under the existing condition. During average below-normal and dry years, the reduction in flows would be up to 30 percent in May. The WSIP would typically delay the initial spring release of water from Hetch Hetchy Reservoir by a few days, lengthening the period in which only the minimum required flow is released to the river by a few days. With the WSIP in place, flow in the Tuolumne River would remain within the range experienced under the existing condition. WSIP-related flow reductions would likely not be noticeable to most of the relatively few recreational users that hike along the Tuolumne River within the Wild sections of the Poopenaut Valley below the dam.

In addition, observers of the Tuolumne River's visual conditions are almost entirely recreational visitors. Although late-spring recreational use along the Wild and Scenic section of the river does occur, the greatest recreational use is during the summer season between Memorial Day and Labor Day. As a result, most recreationists would experience the Tuolumne River's Wild and Scenic visual resources during this period, when conditions would not be affected by the WSIP. In addition, a major proportion of the river users are whitewater rafters who also recreate on the river during the pulse flow releases, which would therefore reduce the period of time when visitors could observe any reductions to the Tuolumne's water flow conditions during non-pulse flows.

As a result, any future WSIP reductions in stream flow within the Tuolumne River would likely be imperceptible to or unobserved by most visitors. Therefore, impacts on the visual resources of the Tuolumne Wild and Scenic River would be *less than significant*, and no mitigation measures would be required.

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5.3.9 Energy Resources

This section describes the potential effects of the WSIP water supply and systemwide operations on energy resources. The impact section (Section 5.3.9.2) provides a description of the changes in hydropower generation and energy consumption that would result from implementation of the proposed program. For a discussion of overall energy production and use by the WSIP, see Chapter 4, Section 4.15.

5.3.9.1 Setting

There are four major hydropower generation facilities on the Tuolumne River. Three, the Holm, Kirkwood, and Moccasin Powerhouses, are owned by the CCSF and operated by the SFPUC. The fourth, Don Pedro Power Plant, is owned by TID and MID and operated by TID. Hydropower facilities convert the energy of flowing or falling water into electrical power. Water released from a reservoir flows through a tunnel or pipeline to a powerhouse where it rotates one or more turbines. The spinning turbines drive electricity power generators.

Water is released from Lake Lloyd and flows to Holm Powerhouse though the Cherry Power Tunnel. Holm Powerhouse is equipped with two turbine and generator sets with a maximum generation capacity of 170 megawatts (MW). After passage through the turbines, water is released from Holm Powerhouse to Cherry Creek.

Water is diverted from Hetch Hetchy Reservoir and flows to Kirkwood Powerhouse through the Canyon Tunnel. Kirkwood Powerhouse is equipped with three turbine and generator sets with a maximum generation capacity of 126 MW. After passage through the turbines, most of the water from Kirkwood Powerhouse enters Mountain Tunnel, which conveys it to Priest Regulating Reservoir. The remainder is released to the Tuolumne River.

Water is released from Priest Regulating Reservoir and flows to Moccasin Powerhouse in the Moccasin Power Tunnel. Moccasin Powerhouse is equipped with two turbine and generator sets with a maximum generation capacity of 110 MW. After passage through Mocassin Powerhouse, water is discharged to Moccasin Reregulating Reservoir. Most of the water is diverted from the reregulating reservoir into Foothill Tunnel and conveyed to the Bay Area for water supply. Some water is discharged to Moccasin Creek, which discharges to Don Pedro Reservoir.

Water stored in Don Pedro Reservoir is conveyed through Don Pedro Dam in two tunnels to the Don Pedro Powerhouse, which is located at the base of the dam. The powerhouse is equipped with two turbine and generator sets with a capacity of 161 MW. After passage through the turbines, water is released from the powerhouse to the Tuolumne River.

The amount of hydropower generated at facilities on the Tuolumne River in any particular year depends on hydrologic conditions in that year and in preceding years. On average, and under current conditions, the hydropower facilities produce about 2.2 million megawatt-hours (MWh) (see Appendix H2-1).

The regulatory framework for energy use in the area served by the WSIP is described in Chapter 4, Section 4.15. It includes the National Energy Policy, the state's Energy Action Plan II and building energy efficiency standards, and San Francisco's Sustainability Plan, Electricity Resource Plan, and Climate Action Plan.

5.3.9.2 Impacts

Significance Criteria

The CCSF has not formally adopted significance standards for impacts related to energy resources, but generally considers that implementation of the proposed program would have a significant energy resource impact if it were to:

- Encourage activities that result in the use of large amounts of fuel, water, or energy, or use these resources in a wasteful manner
- Reduce the production of renewable energy

Approach to Analysis

Changes in river flow, reservoir storage, and hydropower generation rates attributable to the WSIP were estimated using the Hetch Hetchy/Local Simulation Model. Detailed information on the model is provided in Appendix H.

Impact Summary

Table 5.3.9-1 presents a summary of the impacts on energy resources along the Tuolumne River that could result from implementation of the proposed water supply and system operations.

TABLE 5.3.9-1
SUMMARY OF IMPACTS – ENERGY RESOURCES ALONG THE TUOLUMNE RIVER SYSTEM

Impact	Significance Determination
Impact 5.3.9-1: Effects on hydropower generation at facilities along the Tuolumne River	B

B = Beneficial impact

Impact Discussion

Impact 5.3.9-1: Effects on hydropower generation at facilities along the Tuolumne River.

On average under current conditions, the SFPUC's hydropower facilities on the Tuolumne River generate 1,618,180 MWh of electricity each year. With the WSIP, this amount would rise to an average of 1,641,257 MWh, an increase of about 23,000 MWh or 1.4 percent. The increase in hydropower generation is attributable to the increase in diversion of water from Hetch Hetchy

Reservoir to meet water demand in the Bay Area. En route to the Bay Area, the water generates hydropower at the Kirkwood and Moccasin Powerhouses.

On average under current conditions, TID's and MID's facilities generate 590,180 MWh of electricity per year. With the WSIP, this amount would be reduced to an average of 576,046 MWh, a decrease of about 14,000 MWh or 2.4 percent. The decrease in hydropower generation is attributable to reduced inflow to Don Pedro Reservoir because of increased upstream diversion and a slightly lowered average water level in the reservoir.

Overall, the WSIP would increase hydropower generation on the Tuolumne River by an average of about 9,000 MWh, or 0.4 percent. Thus, the impact of the WSIP on the production of renewable energy from the Tuolumne River would be *beneficial*.