DON PEDRO HYDROELECTRIC PROJECT
FERC NO. 2299

FINAL LICENSE APPLICATION

EXHIBIT E –ENVIRONMENTAL REPORT

SECTION 3.0 (3.10 to 3.12) THROUGH SECTION 8.0

SECTION 3.0
ENVIRONMENTAL ANALYSIS
3.10 Aesthetic Resources
3.11 Cultural Resources
3.12 Socioeconomic Resources

SECTION 4.0
CUMULATIVE EFFECTS OF THE PROPOSED ACTION

SECTION 5.0
DEVELOPMENTAL ANALYSIS

SECTION 6.0
CONCLUSIONS

SECTION 7.0
LITERATURE CITED

SECTION 8.0
CONSULTATION RECORD

3.10 Aesthetic Resources

3.10.1 Existing Environment

The Don Pedro Project is located in western Tuolumne County on the Tuolumne River, about 40 miles east of the City of Modesto and 26 miles northeast of the City of Turlock, both in Stanislaus County. The Don Pedro Project is located in the Sierra foothills region, an area characterized by rolling hills, rural landscapes, native grasslands, and blue oak woodland.

The Don Pedro Project consists of Don Pedro Reservoir, Don Pedro Dam and spillway, Don Pedro powerhouse, and a number of other, primarily recreation-related, facilities. Don Pedro Reservoir has a normal maximum water surface elevation of 830 ft msl and extends about 24 miles upstream from the dam. At maximum water surface elevation, the reservoir has a surface area of 12,960 ac and 160 miles of shoreline, including islands. Don Pedro Dam is an earth-and-rockfill structure with a reinforced-concrete upstream face approximately 580 ft high, with a top elevation of 855 ft. The Don Pedro powerhouse, located at the base of Don Pedro Dam, is a semi-outdoor, above-ground concrete powerhouse.

Views of the Don Pedro Project Boundary are scenic due to the natural beauty of the Tuolumne River and Sierra foothills. Because residential and commercial development are not allowed within the Project Boundary, vegetation along the reservoir is generally well established and lands within the Project Boundary blend into the surrounding landscape. Figure 3.10-1 shows a typical spring reservoir view. However, Don Pedro Project facilities are structural elements that visually contrast with the surrounding rural or natural landscape, as described below.

Figure 3.10-1. View across Don Pedro Reservoir from the intersection of Grizzly Road and New Priest Grade Road (March 2012).

All facilities and lands within the Project Boundary are owned by TID and MID, with the exception of 4,802 ac of federal lands administered by the BLM. These federal lands are part of a larger land unit managed by the BLM in accordance with the Sierra Resource Management Plan (SRMP). The BLM has identified the lands within the Project Boundary as Visual Resource Management (VRM) areas in the SRMP. In the SRMP, the BLM described the following goals for these lands:

- protect and enhance the scenic and visual integrity of the characteristic landscape, and
- maintain the existing visual quality of the Lake Don Pedro/Highway 49 viewshed and the Red Hills ACEC.

In 2012, the Districts conducted a Visual Quality Study (TID/MID 2013a) to document current visual conditions of the Don Pedro Project as viewed from BLM lands during various times of the year and identify any adverse visual resource effects due to continued operation. The objectives of the study were to identify, map, and describe BLM inventories associated with Don Pedro Project facilities and features on land administered by BLM and document the Existing Visual Condition (EVC) of all facilities and features from associated viewsheds on land administered by BLM.

The study area included Don Pedro Reservoir and the Tuolumne River upstream to Ward's Ferry Bridge (Figure 3.10-2). The features and facilities listed below were assessed for visual quality. Greater detail regarding the delineation of the study area, basis of study site selection, and assessment methods used is included in the Visual Quality Study Report and associated appendices (TID/MID 2013a).

- Ward's Ferry Bridge,
- State Highway 49/120 Vista Point,
- Moccasin Point Recreation Area,
- State Highway 132,
- BLM dispersed use areas,
- Don Pedro Reservoir and Tuolumne River,
- Fleming Meadows Recreation Area,
- Don Pedro Dam and Powerhouse,
- DPRA Headquarters and Visitor's Center,
- Don Pedro Spillway, and
- Blue Oaks Recreation Area.

Don Pedro Reservoir is operated between elevations 690 ft and 830 ft msl, depending on hydrologic, precipitation, and water management factors. A zone of exposed soil with sparse and/or low growing vegetation is evident in the drawdown zone. As reservoir surface elevation declines and the drawdown zone expands, the visual effect is often one of strong visual contrast

(TID/MID 2013a). Where the slopes are steeper, sandy brown soils are exposed; and where slopes are gentler, grasses and low vegetation become established. In some locations the reservoir drawdown exposes large rocky areas that tend to match rocky areas above the high water mark and therefore present little visual contrast.

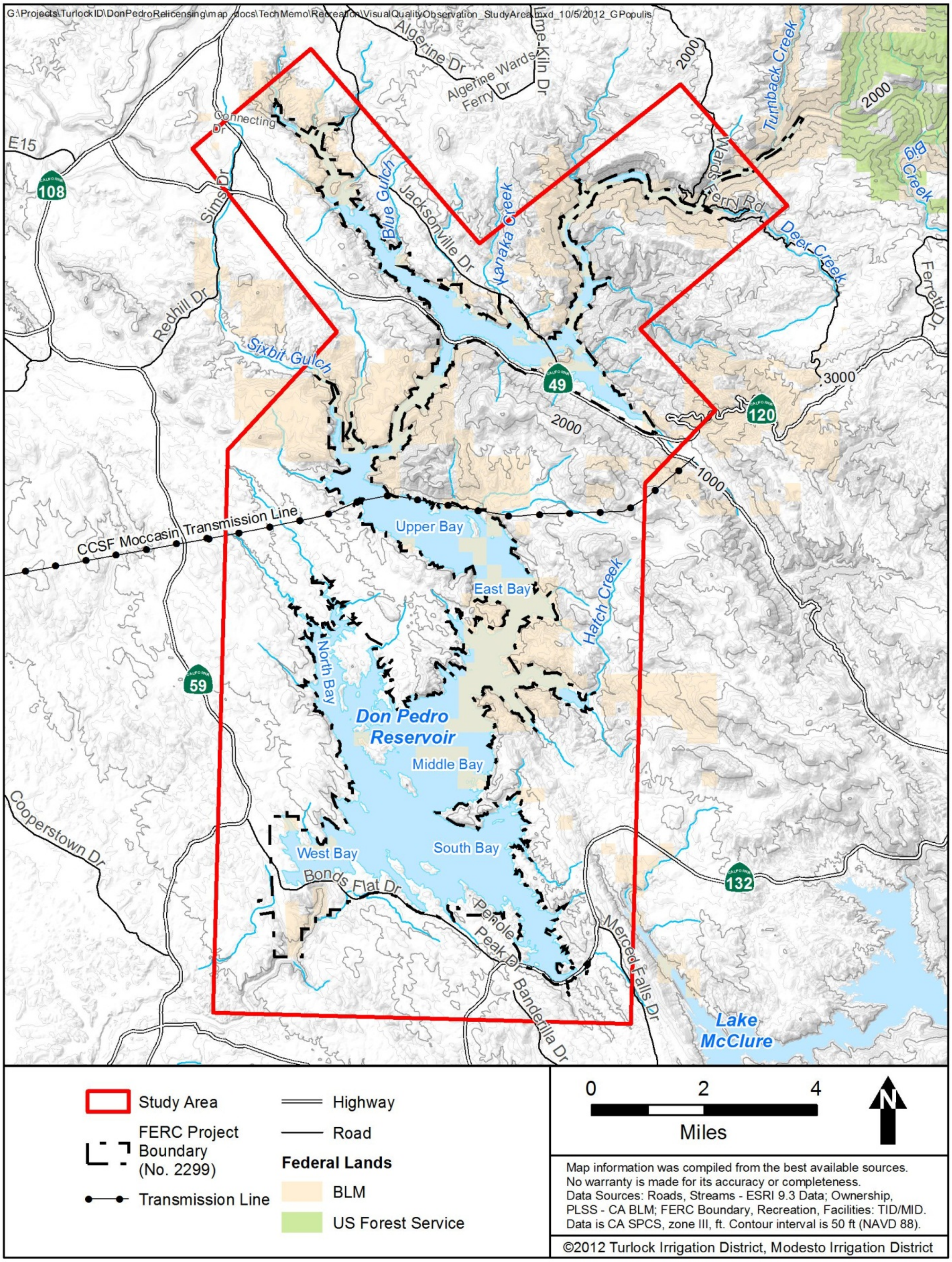

Figure 3.10-2. Visual Quality Study area.

3.10.1.1 Ward's Ferry Bridge

Ward's Ferry Bridge is located in a steep canyon in the upstream portion of the study area (Figure 3.10-3). A whitewater boating take-out, which is used primarily from April through September, is located just upstream of the bridge. Looking up- and down-river from Ward's Ferry Bridge, the effects of drawdown are evident on the steep slopes adjacent to the reservoir and present a strong visual contrast to the landscape outside the drawdown zone (TID/MID 2013a).

Figure 3.10-3. View from Ward's Ferry Bridge looking upriver (July 2012).

3.10.1.2 Moccasin Point Recreation Area

Moccasin Point Recreation Area is located south of the Jacksonville Road Bridge. No Key Observation Points (KOPs) were established in the campground because there are limited views of the reservoir and it is not located on BLM land (TID/MID 2013a). However, KOPs were selected in four locations associated with dispersed recreation areas located on BLM land where either the reservoir or Moccasin Point Recreation Area can be seen from BLM administered lands (Figure 3.10-4). Views of the reservoir from these locations are considered favorable.

Figure 3.10-4. View from the end of Grizzly Road of houseboats and Moccasin Point Recreation Area boat ramp (March 2012).

3.10.1.3 Highway 49/120 and Vista Point

Views from Highway 49/120 include Don Pedro Reservoir and BLM, District, and other private lands were recorded; Figure 3.10-5 depicts a sample view. The foreground is dominated by the reservoir, shoreline lands constitute the middle ground, and the background consists of steep foothill slopes. Hetch Hetchy pipeline can be seen to the east. This view of the reservoir is the one most often seen by people, i.e., typically those traveling to Yosemite National Park.

A few residences can be seen when looking across the reservoir. The colors and shapes of these present weak visual contrasts to the surrounding terrain (TID/MID 2013a). The Jacksonville Road Bridge can be seen to the south, which presents a moderate to strong contrast, depending on lighting.

During high water there is little to no visual contrast of the reservoir shoreline with the surrounding area. However, as reservoir water level decreases, the drawdown zone contrasts with the surrounding vegetation. This contrast, as seen from the Vista Point, was considered to be moderate when viewed in March and July 2012 (TID/MID 2013a).

Figure 3.10-5. View of Don Pedro Reservoir from Highway 49/120 Vista Point (July 2012).

3.10.1.4 State Highway 132

State Highway 132 runs east-west along the southern portion of the Don Pedro Project area, immediately adjacent to the Rogers Creek Arm of Don Pedro Reservoir. Although the reservoir can be seen along a short section (several hundred feet) of road, there are no views of facilities or recreation areas (TID/MID 2013a).

3.10.1.5 Fleming Meadows Recreation Area

The Fleming Meadows Recreation Area is located on a peninsula, with views of Don Pedro Reservoir, the dam and spillway, a marina, and three houseboat mooring areas. The strong visual contrast of the houseboat mooring areas and marina are typical of recreation management areas on reservoirs (Figure 3.10-6). The long-range views of the dam and spillway result in a weak visual contrast (TID/MID 2013a). When the reservoir is below full pool, the drawdown zone can be seen, resulting in a moderate visual contrast (TID/MID 2013a).

Figure 3.10-6. View from campsite A19 at Fleming Meadows Recreation Area looking east at Don Pedro Reservoir and houseboat marina (March 2012).

3.10.1.6 Don Pedro Dam

Don Pedro Dam can be viewed directly in the foreground from the DPRA Headquarters and Visitor's Center (Figure 3.10-7). The dam can also be viewed from the Blue Oaks Recreation Area. At both locations, the dam presents a strong visual contrast to the surrounding natural landscape (TID/MID 2013a). Because the BLM's Visual Resource Objective (VRO) maps were developed with the Don Pedro Dam present, the continued presence of the dam is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-7. View east towards the Don Pedro Dam from DPRA Headquarters and Visitor's Center (March 2012).

3.10.1.7 Don Pedro Powerhouse

The Don Pedro powerhouse can be seen briefly when traveling east along Bonds Flat Road (Figure 3.10-8). Although the powerhouse presents a strong visual contrast to the surrounding landscape, it is located at the bottom of a valley, which makes it difficult to see from a moving vehicle. The powerhouse cannot be seen from the DPRA Headquarters and Visitor's Center or elsewhere along the reservoir (TID/MID 2013a). As with the dam, BLM's VRO maps were developed with the Don Pedro Powerhouse in place, and as a result the presence of the powerhouse is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-8. View south of powerhouse from Bonds Flat Road. Picture is taken from the passenger window at the center of the dam road. The powerhouse is located at the bottom of the canyon and is in the middle ground (July 2012).

3.10.1.8 Don Pedro Recreation Agency Headquarters and Visitor's Center

The DPRA Headquarters and Visitor's Center are located adjacent to the dam, and include a viewing platform that provides views of the facilities. The dam provides a strong visual contrast to the surrounding natural landscape (TID/MID 2013a). A communications tower, water storage tank, and a DPRA maintenance building and yard are also visible from the viewing platform. These also present a strong contrast to the surrounding landscape. The Blue Oaks Recreation Area is visible from the viewing platform but presents only a moderate contrast, even when recreation use is heavy (TID/MID 2013a).

3.10.1.9 Don Pedro Spillway

The Don Pedro Spillway can be seen briefly by those traveling along Bonds Flat Road and from the Blue Oaks Recreation Area group picnic site (Figure 3.10-9). The spillway strongly contrasts with the surrounding landscape (TID/MID 2013a), but like the other facilities discussed above, its presence is consistent with BLM's objective of retaining the existing character of the landscape.

Figure 3.10-9. View east of Don Pedro Spillway from Bond Flats Road (March 2012).

3.10.1.10 Blue Oaks Recreation Area

The Blue Oaks Recreation Area is located partially on BLM land. Views from the area include the reservoir and campground in the foreground; the dam, DPRA Headquarters and Visitor's Center, a houseboat mooring area, undeveloped landscape, and rolling hills in the middle ground; and the foothills in the background. Figure 3.10-10 includes a sample view. When recreation sites are occupied, their visual contrast with the surrounding landscape is strong (TID/MID 2013a). The dam and houseboat area likewise present a strong visual contrast with the surrounding area (TID/MID 2013a). Again, because the BLM's VRO maps were developed with the Blue Oaks Recreation Area in place, the area's presence is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-10. View from campsite D-19 at Blue Oaks Recreation Area looking east at Don Pedro Reservoir and Don Pedro Dam (July 2012).

3.10.1.11 Don Pedro Reservoir

Don Pedro Reservoir is a major visual asset to the landscape, as evidenced by development of residential property with views of the reservoir (TID/MID 2013a). The reservoir, with its complex shoreline and many bays and arms, looks like a natural lake when at full pool (TID/MID 2013a). Although at lower water surface elevations the drawdown zone presents a strong contrast to the surrounding landscape, public attitudes toward the drawdown zone are not necessarily negative (TID/MID 2013a); a sample low reservoir view is shown in Figure 3.10-11. Particularly during low water years, recreationists know the reservoir will be drawn down and understand the various demands for the water stored in the reservoir. This is supported by the results of the recreation use assessment, which show that over 70 percent of respondents surveyed did not view variation in reservoir water level as an impairment of the scenic quality of the area (TID/MID 2013b).

Figure 3.10-11. View depicting low reservoir elevation condition taken from the Blue Oaks Recreation Area looking east towards Don Pedro Reservoir (Photograph provided by DPRA).

3.10.2 Resource Effects

Page 38 of FERC's SD2 identifies the following potential Don Pedro Project effects:

- *Effects of project operations, maintenance activities, and project recreation use on aesthetic resources, including the reservoirs and downstream reach, within the project area.*

Views of the Don Pedro Project Boundary are scenic due to the natural beauty of the Tuolumne River and Sierra foothills. Because residential and commercial development are not allowed within the Project Boundary, vegetation along the reservoir is generally well established and lands within the Project Boundary provide scenic landscape vistas. The Proposed Action does not include changes in the current footprint of the existing powerhouse and switchyard or other facilities. Effects on aesthetic resources during the term of the new FERC license will be the same as those described above for existing conditions.

3.10.3 Proposed Resource Measures

There are no proposed measures related to aesthetic resources.

3.10.4 Unavoidable Adverse Impacts

There will continue to be visual contrasts associated with the Don Pedro Project, as described in the previous sections. These are an unavoidable consequence associated with a water storage project and its related facilities, including those developed for recreation. However, because BLM's VRO maps were developed with the Don Pedro Project facilities in place, the continued presence of these facilities, though at times presenting a visual contrast with surrounding natural areas, is consistent with the BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

3.11 Cultural Resources

The Districts have undertaken an extensive investigation of the cultural resources at the Don Pedro Project, including efforts to identify those cultural resources that may be affected by ongoing O&M activities. The studies undertaken to investigate cultural resources include the Historic Properties Study (CR-01), which focused on archaeological and built environment resources, and the Native American Traditional Cultural Properties Study (CR-02), which focused on TCPs. These investigations substantially added to the existing information provided in the Districts' PAD. Draft study reports have been distributed to the Cultural Resources Workgroup in order to inform consultation with state and federal agencies and the potentially affected Tribes regarding the results of these studies. These studies have supported the development of a draft Historic Properties Management Plan (HPMP) [32], which is included as Appendix E-4 to this Exhibit E.

3.11.1 Existing Environment

This section describes existing cultural resources associated with the Don Pedro Project. It is presented by the following six areas: (1) regulatory context, including Section 106 consultation; (2) APEs; (3) cultural history overview; (4) existing information; (5) results of the Historic Properties Study; and (6) results of the Native American TCP Study.

3.11.1.1 Regulatory Context

Section 106 of the National Historic Preservation Act (NHPA), requires FERC to take into account the effects of licensing on properties listed or eligible for listing in the National Register of Historic Places (NRHP) prior to issuance of a new license. Pursuant to the applicable regulations found at 36 CFR 800.16, an undertaking is defined as a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those requiring a Federal permit, license or approval. In this case, the undertaking is FERC's consideration of issuing a new license for the Don Pedro Project. Potential effects that may be

[32] The draft HPMP contains sensitive information and is therefore being filed with FERC as a PRIVILEGED, non-public document.

associated with this undertaking include any Don Pedro Project-related effects associated with day-to-day operations and maintenance and any new construction activity proposed under the new license.

Historic properties are cultural resources listed or eligible for listing in the NRHP. Historic properties represent objects, structures, districts, traditional places, or archeological sites that can be either Native American or Euro-American in origin. In most cases, cultural resources less than 50 years old are not considered eligible for the NRHP. Cultural resources also must retain integrity (i.e., the ability to convey their significance) to qualify for listing in the NRHP. For example, dilapidated structures or heavily disturbed archeological sites may not retain enough integrity to relay information relative to the context in which the resource is considered to be important and, therefore, are not eligible for listing on the NRHP.

Section 106 also requires that FERC consult with the SHPO on any determinations of NRHP eligibility and findings of effect to historic properties, and allow the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on any finding of adverse effects. If Native American properties have been identified, Section 106 also requires that FERC consult with interested Native American Tribes that might attach religious or cultural significance to such properties (i.e., TCPs).

On April 8, 2011, FERC designated the Districts as their non-federal representatives for purposes of consultation under Section 106 of the NHPA. As FERC's non-federal representatives, the Districts have consulted throughout the relicensing effort with BLM, potentially affected Tribes, and SHPO, including obtaining SHPO's concurrence on the Area of Potential Effects (APE). By letter dated January 9, 2012, SHPO concurred with the Districts proposed APE. Consultation efforts further included six meetings between the Districts, interested Tribes, BLM, and SHPO that focused on the collaborative development of study plans and preliminary study results. Representatives from five Tribes, BLM, NPS, SHPO and FERC participated in these meetings, although not all parties attended each meeting.

3.11.1.2 Area of Potential Effects

The study area investigated for the Historic Properties Study and the Native American TCP Study is the APE. As defined in the applicable regulations found at 36 CFR 800.16(d), the APE is "...the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historical properties, if any such properties exist." The APE for the Don Pedro Project relicensing study effort is defined as all lands within the FERC boundary that are (1) within 100 ft beyond the normal maximum water surface elevation (830 ft), (2) within designated Don Pedro Project facilities and formal recreation use areas, (3) within informal recreation use areas identified by the DPRA[33], (4) within the Red Hills ACEC, and (5) along the reservoir edges, including reservoir reaches that contain intermittent and perennial streams.

[33] The FERC approved Historic Properties Study Plan specified that if informal recreation areas were found to extend beyond the Don Pedro Project APE during the study, these areas would be surveyed at that time and the APE expanded to incorporate the informal recreation areas up to the FERC Project Boundary. No such areas have been identified to date.

3.11.1.3 Cultural History Overview

The Don Pedro Project area has a varied and rich history related to cultural resources. This discussion is presented in two parts: prehistory and post-European settlement, and is based on research conducted during the relicensing studies.

3.11.1.3.1 Prehistory and Archaeology

The broad outline of prehistoric California cultural chronology and culture history has been established primarily by observation of basic changes through time in artifact assemblages in areas in the vicinity of the Don Pedro Project. These include overviews of the central Sierra Nevada (cf., Arnold et al. 2004:41-43; Chartkoff and Chartkoff 1984:121-124, 162-165 [Table 4.9], 176-178; Hull 2007:184, Figure 12.4; Jackson et al. 1994; Moratto 1984: Chapters 5 and 7; 1999:Table 4.9; Rosenthal et al. 2007). A number of other culture-historical schemes have also been applied to various western-slope drainages over the last several decades (e.g., Bennyhoff 1956; Elston et al. 1977; Moratto 1972; Wirth Environmental Associates 1985). Many of these schemes link back to temporal divisions originally outlined in the traditional western Great Basin projectile point chronology (e.g., Baumhoff and Byrne 1959; Bettinger and Taylor 1974; Clewlow 1967; Heizer and Baumhoff 1961; Heizer and Hester 1978; Thomas 1970, 1981), and to a lesser extent the original Central Valley chronology (Bennyhoff and Heizer 1958; Bennyhoff and Hughes 1987; Heizer 1951; Ragir 1972).

Cultural chronologies/culture histories of particular relevance to the current APE include that developed for the new Don Pedro Project by Michael Moratto who conducted a study of the reservoir locality in 1970-1971 using students from San Francisco State College (Moratto 1984:311-312; papers in Moratto 1971). In addition to the Don Pedro Reservoir area, project localities in the north-central Sierras of particular interest include the New Melones Reservoir (Moratto 2002; Moratto et al. 1988), and the Sonora Locality (papers in Rosenthal ed. 2011). These are summarized below.

Don Pedro Reservoir Cultural Chronology/Culture History

During 1970 and 1971, M. Moratto and others conducted an archaeological survey and limited excavations at the site of the new Don Pedro Reservoir, recording 28 historic-era resources and 41 prehistoric sites or features (Moratto 1984:311-312; papers in Moratto 1971). The latter were mostly small middens, bedrock milling stations, a few cupule petroglyphs, and a single rock shelter. Moratto noted that many of the sites or features had been damaged or nearly destroyed by previous earth-moving operations, including dredging, tunneling, hydraulic mining, road construction, agricultural activities, and inundation by the La Grange and the original Don Pedro reservoirs in the 1890s and 1923, respectively.

Test excavations at seven of the prehistoric sites located by Moratto suggested that they dated to the last 1,500 years, and at least four of them to the last 500 years. Despite the lack of identified older components, Moratto surmised that there were probably older settlements along the inundated reaches of the Tuolumne River. The lithic materials at the seven Don Pedro sites were dominated by local cryptocrystalline silicate (CCS) toolstone, with smaller amounts of obsidian.

Some of the later sites also yielded steatite disc beads, ornaments, and vessels; small (presumably arrow) points; small obsidian flake tools; and the remains of circular, semi-subterranean houses. Moratto reported that numerous flake and core tools "occur throughout the sequence without noticeable temporal clustering" (1971:144). One site, CA-TUO-300, produced "heavy" projectile points, a "boatstone," and disc beads made of abalone shell. Two of the sites contained a total of at least 16 burials.

Moratto (1984:311-312) recognized two well-documented cultural phases at the Don Pedro locality. One dated to c. 500-300 years before present (B.P.)[34] and was considered an expression of the Mariposa Phase, representing Miwok prehistory. The other, dated at c. 1700-500 B.P., was correlated with the Crane Flat Phase, generally associated with the Yosemite area of the Sierra Nevada and often affiliated with Yokuts prehistory. Evidence for earlier occupation of the area suggested that humans were present from c. 5,000 B.P. on. These studies documented a long and intensive history of use of the Don Pedro Reservoir area by native people.

Jackson (1971) sourced 112 obsidian artifacts from five Don Pedro locality sites, representing one of the first attempts to systematically source prehistoric obsidian artifacts from the central Sierra. Bodie Hills was the primary source, followed by Casa Diablo, and Mount Hicks. One artifact was made from Mono Glass Mountain obsidian and one from Konocti glass.

New Melones Reservoir Cultural Chronology/Culture History

Over a period of 30 years, numerous survey efforts documented over 700 archaeological sites in a cultural resource study that has become known as the New Melones Archaeological Project[35]. These archaeological investigations were initiated for the construction of the New Melones Dam and Reservoir in the 1960s/1970s. The New Melones facilities are located less than 6 miles northwest of the Don Pedro Project area on the Stanislaus River. Testing and/or data recovery, conducted by several entities for the New Melones work, occurred at 34 historic and 68 prehistoric sites. A ten-volume final report was prepared covering the investigations, and a synthesis and summary of findings has also been prepared (Moratto et al. 1988).

Moratto (2002) has summarized the prehistoric chronology/culture history of the New Melones locality in a series of temporal and formal units (Moratto 2002:36, Figure 7; see also pp. 31-35, Figures 2-6 for locations of archaeological sites associated with each major time period). Peak and Crew (1990) defined the earliest signs of human occupancy at New Melones.

Between c. 9450 and 5450 B.P., stemmed series projectile points occur, joined after c. 5950 B.P. by Pinto and Humboldt Series points. The Clarks Flat Phase occurred from c. 9450 B.P. to c. 6950/6450 B.P., followed by the Stanislaus Phase (c. 6950/5950 B.P. to 6200 B.P.), and a terminal period of undesignated components (c. 6200-5450 B.P.). During Early Clarks Flat Subphase times (c. 9450-7950 B.P.), bipointed, foliate, and stemmed points occurred, along with scrapers, notched tools, and beaked gravers. Great Basin transverse points (i.e., "crescents")

[34] Years before present (B.P.) is a time scale used in archaeology, geology, and other scientific disciplines to specify when events in the past occurred. Because the "present" time changes, standard practice is to use the year 1950 as the arbitrary origin of the age scale (i.e., the present).

[35] See Moratto 2002 for a summary of Don Pedro Project history, and a bibliography of relevant resultant literature.

may be associated with this or possibly an earlier, undesignated phase. Several sites appear to have functioned as hunting camps. Low assemblage diversity and artifact densities suggest limited, temporary use of sites during this time period.

During the subsequent Late Clarks Flat Subphase, c. 7950-6950/6450 B.P., Early Clarks Flat flaked stone tool types continue with the addition of milling slabs, handstones, a variety of scrapers, and Western Stemmed Series points. The "Stanislaus Phase" is characterized by continuance of Late Clarks Flat artifact types, with the addition of Stanislaus Broad-Stemmed points, and abundant milling tools. Pinto and Humboldt Series points begin to appear after c. 5950 B.P. Increasing artifact densities and assemblage diversity occurs during the Late Clarks Flat through Stanislaus Phase sequence. This is thought to reflect diversification of economic pursuits, especially those resulting from expanding use of plant resources, and occupational intensification. Some New Melones sites contain poorly documented assemblages with Pinto and Humboldt Series points which appear unrelated to the Clarks Flat-Stanislaus continuum.

The period c. 5450-4750 B.P. witnessed the Texas Charley Phase, typified by the presence of Pinto and Humboldt points, large lanceolate bifaces, and distinctive scrapers. A hiatus in the New Melones archaeological records appears to have occurred after the Texas Charley Phase until c. 4450 B.P. when the Calaveras Phase commenced, marked by the presence of Pinto and Humboldt Series points and milling stones. For a period after the Calaveras Phase ended, c. 3950 B.P., the New Melones archaeological record is poorly known, with traces of minimal site occupancy noted.

Between c. 2950 B.P. and 1450 B.P., the Sierra Phase took place. Typical artifacts include Elko Series, Sierra Concave Base, and Sierra Side-Notched projectile points, bowl mortars, cylindrical pestles, and Olivella F and G Series beads (the Olivella bead types are based on Bennyhoff and Hughes 1987). This phase is marked by economic diversity, acorn use, large populations, intensive occupation, middens and structural remains, cemeteries, use of mortuary caves, abundant funerary artifacts, and signs of extensive material conveyance.

From c. 1450-950 B.P., the Redbud Phase occurred. Typical artifacts are Rosegate Series projectile points, and Olivella D, K, and M Series beads. After c. 950 B.P., other as yet undefined phases may have occurred until c. 650 B.P. Throughout this time, ephemeral site use by small populations engaged in minimal material conveyance seems to have occurred in the New Melones region. During the later part of this time, this may reflect unfavorable climatic conditions resulting from the Medieval Climatic Anomaly.

The Horseshoe Bend Phase, c. 600 B.P. to Anno Domini (A.D.) 1848 – the beginning of the gold rush – was marked by Stockton Serrated, Cottonwood Triangular, Desert Side-Notched, and Gunther Barbed projectile points, and Olivella E, K, and M Series beads. At this time, the New Melones region was occupied by large numbers of people, who intensively occupied the area. These were ancestral Sierra Miwok speakers who practiced an intensified acorn-based economy, and lived in year-round settlements.

Between A.D. 1848 and 1910, the Peoria Basin Phase is associated with historic Sierra Miwok village communities. Associated artifacts include glass trade beads and Desert Side-Notched and

Cottonwood Triangular points. During this period, the Sierra Miwok experienced severe depopulation from a variety of causes along with the effects of acculturation with introduced elements of Euro-American culture.

The Sonora Region Cultural Chronology/Culture History

The original cultural chronology/cultural history for the Sonora area, located roughly eight miles from the Don Pedro Reservoir, was developed during the New Melones Reservoir project (Moratto et al. 1988; Moratto 2002). The New Melones chronology, which was the first systematic attempt to organize the local archaeological record, distinguishes six major time periods. As described above, from youngest to oldest they include: Peoria Basin, Horseshoe Bend, Redbud, Sierra, Calaveras/Texas Charley, Stanislaus, and Clarks Flat, with temporal divisions between them occurring at 650 B.P., 1450 B.P., 2950 B.P., 5450 B.P., and 7950 B.P. Each of these breaks was thought to represent a significant transition in the archaeological record, distinguishable through changes in technology and land use.

Subsequent recent and ongoing research in the Sonora region of Tuolumne County by Far Western and Sonoma State University, directed by archaeologists Jeffrey Rosenthal and Jack Meyer (e.g., Meyer 2008, 2011; Meyer and Dalldorf 2004; Meyer et al. 2005; Rosenthal 2008; Rosenthal ed. 2011; Rosenthal et al. 2008; Whitaker and Rosenthal 2009) has resulted in development of a more inclusive regional cultural/chronology/culture history. This scheme was developed for the Sonora region based on a synthesis of chronological information from more than 100 excavated sites in the watersheds of the Mokelumne, Calaveras, Stanislaus, and Tuolumne rivers, including those excavated as part of the New Melones project (cf., papers in Rosenthal ed. 2011). Based on spatial and stratigraphic analyses of more than 200 radiocarbon dates, more than 4,000 source-specific obsidian hydration readings, slightly more than 875 projectile points, and close to 600 shell beads, five major time periods were defined, including the Early Archaic, Middle Archaic, Late Archaic, Recent Prehistoric I, and Recent Prehistoric II (Table 3.11-1).

Also identified were dominant projectile point styles and obsidian hydration brackets associated with each time period, facilitating interpretation of calendric ages of Bodie Hills hydration readings below 4,000 ft (1,219 meters) in elevation (Rosenthal 2011b:48, Table 16). This new chronology revises the one developed for New Melones, and provides a framework for timing of major prehistoric technological, subsistence, and land-use changes occurring in the central Sierra Nevada (cf., papers in Rosenthal ed. 2011).

Table 3.11-1. Archaeological chronology of the West-Central Sierra Nevada developed for the Sonora Region.

Period	Age Range (cal B.P.)[1]	Hydration Range (microns)[2]
Recent Prehistoric II	610-100	2.4-0.9
Recent Prehistoric I	1100-610	3.1-2.5
Late Archaic	3000-1100	4.7-3.2
Middle Archaic	7000-3000	6.8-4.8
Early Archaic	11,500-7000	8.6-6.9

[1] "cal" refers to calibrated. Uncorrected, or 'conventional' radiocarbon ages are calculated using an assumption that the concentration of naturally occurring radiocarbon in the atmosphere is constant. Calibration of these conventional ages to calendar years corrects for known minor variations over time in the concentration of atmospheric radiocarbon. This calibration

also corrects for an error in the estimate of 'half-life,' or the rate at which radiocarbon decays. While the half-life of radiocarbon is now known to be slightly longer than was estimated when the technique was invented, laboratories continue to report radiocarbon dates using the older, less accurate value, hence the term 'conventional.' Because of this, uncalibrated dates earlier than about 2000 years B.P. tend to be substantially 'younger' than calibrated dates.

2 Bodie Hills Obsidian; applicable only below 4,000 ft (below snow line). From Rosenthal (2008), based on Rosenthal and Meyer (2004).

3.11.1.3.2 General Prehistoric Chronological Sequence

The general chronological sequences described in this section reflect the new regional chronology for the Sonora region that is based on the research conducted by Jeffrey Rosenthal and Jack Meyer (e.g., Meyer 2008, 2011; Meyer and Dalldorf 2004; Meyer et al. 2005; Rosenthal 2008; Rosenthal ed. 2011; Rosenthal et al. 2008; Whitaker and Rosenthal 2009), as described above.

Early Archaic (11,500-7000 cal B.P.)

Like most places in California, well-dated deposits from the Early Archaic are quite rare in the Sierra Nevada foothills. To date, they have been identified at Skyrocket (CA-CAL-629/630) in Salt Springs Valley and at Clark's Flat (CA-CAL-342), located upstream from New Melones Reservoir along the Stanislaus River. Both sites were observed in buried stratigraphic contexts. Artifacts included large numbers of Wide-stem and Large-stemmed dart points, as well as very small numbers of other notched and stemmed projectile points.

The Early Archaic stratum at the Skyrocket site contained hundreds of handstones and milling slabs, and a variety of cobble-core tools, large percussion-flaked "greenstone" bifaces, and comparatively high frequencies of obsidian from the Bodie Hills and Casa Diablo sources located east of the Sierra crest (La Jeunesse and Pryor 1996). Milling equipment was substantially less abundant at the Clark's Flat site. Plant macrofossil assemblages recovered from Skyrocket are dominated by gray pine and acorn nutshell, but include few if any small seeds or other spring- and summer-ripening plant foods (e.g., manzanita). This suggests that the site was primarily used during the fall and early winter when nuts were available. Plant remains were not sampled at Clarks Flat.

The large accumulation of ground stone in the early stratum at CA-CAL-629/630 probably represents sustained residential use or the residue of repeated seasonal occupations occurring over many millennia. This pattern of repeated or extended occupation suggests that Early Archaic land use in the western central Sierra was seasonally structured, and was not the wide-ranging, highly mobile lifestyle often believed to characterize the Early Archaic throughout the mountain west. This conclusion is further supported by the almost exclusive use of local toolstone for the manufacture of bifaces and projectile points at both Skyrocket and Clark's Flat.

Other sites with evidence of Early Archaic occupation include Taylor's Bar (CA-CAL-1180) on the Calaveras River. There, large stemmed points and an early Holocene radiocarbon date are reported from buried soil. This material was mixed with a substantial Late Holocene deposit (Milliken et al. 1997). In addition, the Poppy Hills site (CA-TUO-2797/H), located downslope from Sonora near Jamestown, produced Early Holocene radiocarbon dates and obsidian hydration readings from a buried soil mixed with Middle Archaic material (Whitaker and Rosenthal 2010).

Middle Archaic (7000-3000 cal B.P.)

The Middle Archaic has traditionally been the most misunderstood portion of the central Sierra Nevada archaeological record, with sites from this time period once thought to be quite rare in many foothill areas (e.g., Moratto et al. 1988). However, the apparent absence of this record can be attributed primarily to long-standing confusion over the timing of corner-notched dart points on the western slope. The common assumption has been that they date to only the last 3,000 years, and that either broad-stem points (e.g., Stanislaus Broad Stem), or Pinto and Humboldt Concave points, are diagnostic of this period (cf., Moratto 2002; Moratto et al. 1988; Peak and Crew 1990). However, recent excavations of several well-dated and stratified Middle Archaic sites clearly indicate that Corner-notched dart points were the predominant projectile point form used on the western slope of the north-central Sierra Nevada from about 7,000 to 1,100 years ago (Rosenthal 2011a; Rosenthal and McGuire 2004). Other stemmed and notched dart points also were used during the Middle Archaic, but in significantly lower numbers.

Like the Early Archaic, most known Middle Archaic deposits from the western Sierran slope have been identified in buried stratigraphic contexts. These often include large numbers of handstones and milling slabs, a variety of cobble-based pounding, chopping, and milling tools; and an occasional mortar and pestle (found only at the most intensively occupied sites). The earliest house structures identified so far on the western slope were present in a Middle Archaic stratum at the Edgemont Knoll site (CA-TUO-4559) at Sonora, associated with large subterranean storage pits (Meyer 2008).

A diverse assemblage of flaked, ground, and battered stone tools, along with comparatively high densities of dietary debris (i.e., plant remains and animal bone) suggests that the Edgemont site served as a primary residential encampment. Archaeobotanical remains, dominated by gray pine and acorn nutshell, reveal that the site was used primarily in the fall and winter, when large quantities of nuts were stored in underground granaries. The overwhelming abundance of nut crops at other Middle Archaic sites in the foothill woodlands suggests a similar season of occupation. In contrast, summer-ripening berries and other fruits are dominant in higher elevation sites located in the Lower Montane Forest.

These differences indicate a pattern of seasonal transhumance, with fall and winter villages placed below the snow line in the Blue Oak-Gray Pine Woodland, and summer camps situated in the conifer forest zone where annual roots, bulbs, seeds, and fruits were common during warmer months. Faunal assemblages from Middle Archaic sites are dominated by large mammal remains (e.g., deer), a pattern that continued throughout the remainder of the prehistoric sequence. The presence of atlatl weights and spurs in these deposits confirms that the dart and atlatl were the primary hunting implements. Soapstone “frying pans” and other vessels first appear in the local record during the Middle Archaic, along with various types of stone pendants, incised slate, and stone beads.

Late Archaic (3000-1100 cal B.P.)

Late Archaic sites are among the most common on the western slope, with many of these also occurring in buried stratigraphic contexts (Meyer 2011). Late Archaic lifeways, technologies, and subsistence patterns were quite similar to that of the previous Middle Archaic period, the primary difference being an increase in the use of obsidian. Handstones and milling slabs made up the vast majority of ground stone implements, and Corner-notched dart points were the most common projectile.

Various expedient, cobble-core tools, battered cobbles, and heavily used flake-based implements are common in Late Archaic foothill deposits. These heavy-duty tools were probably associated with the processing of pine nuts, the primary plant-food refuse present in Late Archaic foothill sites. Fall-ripening acorn nutshell also occurs regularly. Summer grass seeds and fruit and berry pits continue to be rare in foothill deposits, and common in higher elevation sites, indicating that seasonal mobility remained the primary strategy for overcoming spatial and seasonal differences in the availability of important plant foods.

This pattern of seasonal movements between the foothills and conifer forest is further supported by the distribution of different toolstones. Chert, only available in the western Sierra foothills below about 3,000 ft, is common at Archaic sites in the Lower Montane Forest up to about 6,000 ft. Above that elevation, flaked stone assemblages on the western slope are composed almost entirely of obsidian (>80%). This suggests groups using the upper elevations of the western Sierra traveled from the east side, where obsidian was the primary toolstone.

Recent Prehistoric I and II (1100-100 cal B.P.)

Moratto (2002; Moratto et al. 1978, 1988) pointed out that sites dating to the Recent Prehistoric I Period are under-represented in the foothills of the western Sierra Nevada, a pattern that continues to be apparent in subsequent studies (e.g., Rosenthal 2008). He suggested that pervasive drought in the Sierra Nevada may be responsible for wide-spread settlement disruption (Moratto 1984:338; 2002; Moratto et al. 1988). Subsequent research has shown that this period coincides with a region-wide interval of reduced precipitation and higher temperatures, the Medieval Climatic Anomaly.

During this period, among the most important changes in the archaeological record of the western slope is the introduction of the bow and arrow at about 1100 calibrated (cal) B.P., an innovation apparently borrowed from neighboring groups to the north or east. This shift in technology is clearly reflected by the dominance of Small-stemmed and Corner-notched arrow points in the earlier Recent Prehistoric I sites. It remains unclear whether bedrock mortars were first widely used during this period. Their common occurrence at Recent Prehistoric II sites in the Sonora vicinity suggests that they had become an important milling technology by 610 cal B.P. Unlike the earliest arrow points, bedrock mortar technology appears to have developed west of the Sierra Nevada, the center of distribution for these milling features.

Unfortunately, too few single-component Recent Prehistoric I assemblages exist to adequately describe the basic lifeways and subsistence patterns characterizing this period. For the Recent

Prehistoric II Period, however, numerous well-dated sites and components provide abundant evidence for changes in the nature of local subsistence economies. The dominance of acorn nutshell in these sites is among the most compelling evidence for acorn intensification in central California. Bedrock milling fixtures are established across the landscape, near well-developed residential middens, and as isolated features both above and below the oak zone. Subsistence remains in foothill sites include many more spring and summer grass seeds, and fruits and berry pits than were present in Archaic deposits. This indicates that occupation occurred for a longer part of the year, or that sites below the snow line were more regularly used to store warm-season resources for winter use.

There also appears to have been greater settlement differentiation during the Recent Prehistoric II Period. Residential sites often include house-depressions and other structural remains. Special-use localities consisting simply of bedrock milling features also occur. Summer use of higher elevations is also apparent. Many sites from this time period are found in the Lower Montane Forest, often containing high proportions of summer-ripening plant foods.

Like the Archaic, large mammal remains continue to make up a substantial portion of faunal assemblages from both high- and low-elevation sites. Similarly, the distribution of different east- and west-side toolstones indicates that regions above 6,000 ft remained primarily within the seasonal round of east-side people, probably targeting sheep and deer which congregate at high elevations during the summer. Many more specialized technologies are associated with the Recent Prehistoric II Period than were evident during the Archaic, including stone drills and bone awls.

The Desert Side-notched arrow point was first introduced on the western slope at about 610 cal B.P., clearly borrowed from Great Basin peoples to the east. Circular, perforated stone shaft-straighteners are also common in these sites, consistent with use of the bow and arrow. Imported shell beads from coastal California first appear in appreciable amounts in Recent Prehistoric II village sites, as do other rare items such as shell ornaments and bone whistles.

3.11.1.3.3 Ethnohistory

Ethnographically, the Don Pedro Project area lies within Central Sierra Miwok territory, located in the Sierra Nevada foothills and mountains spanning the upper drainages of the Stanislaus and Tuolumne Rivers. The Central Sierra Miwok group is considered a member of the Eastern Miwok, one of the two major divisions of the Miwokan subgroup of the Utian language family (Levy 1978). The Eastern Miwok peoples belonged to five separate linguistic and cultural groups each of which had distinct language and cultural characteristics (Levy 1978). Anthropologists have categorized the Eastern Miwok into language areas according to geographical location, which consist of (1) the Bay Miwok that occupied the eastern area of the Contra Costa County extending from Walnut Creek eastward to the Sacramento-San Joaquin delta; (2) the Plains Miwok, which inhabited the lower reaches of the Mokelumne and Calaveras river drainages; (3) the Northern Sierra Miwok that occupied foothills and mountains of the Mokelumne and Calaveras river drainages; (4) the Southern Sierra Miwok, which inhabited the foothill and mountain portions of the Merced and Chowchilla drainages; and (5) the Central Sierra Miwok mentioned above (Levy 1978).

These five groups were further designated as three distinct groups based on their phonological history and structural and lexical similarity (Levy 1978). Plains and Bay Miwok are both members of a distinct group, while the other three groups comprise a Sierra Miwok language group (Levy 1978). It has been suggested that Plains Miwok separated from the Sierra Miwok languages around 2,000 years ago (Levy 1978). Lexicostatistical chronology and language classification suggests that ancestral Miwok occupation of the Sierra Nevada and its foothills is probably a much more recent event compared to the central California delta region, since Sierra Miwok internal time depth is estimated at around 800 years (Levy 1978).

The main political unit of the Miwok was the tribelet, which was an independent and sovereign nation that had a defined and bounded territory designating its zone of control over natural resources. Among the Sierra Miwok, tribelets included political lineage localities that made up the permanent settlements with an average population estimate of around 25 persons, as well as several semi-permanent settlements and numerous seasonally occupied campsites that were used at various times throughout the seasonal round of gathering, hunting, and fishing activities (Levy 1978). Ethnographic literature points to the presence of a chief or an assembly house in the community at the capital or principal settlement (Levy 1978). The dominant form of house was a conical structure of bark slabs, supported by posts or frameworks.

The main foci of subsistence were the gathering of wild plant foods, especially acorn, and the hunting of mammals. The Sierra Miwok traveled to higher or lower elevation levels during various seasons of the year to obtain subsistence resources unavailable in the vicinity of their permanent settlements. The inhabitants occupying the Transition Zone forest moved to higher elevations during the summer months in pursuit of deer. Those in the foothill areas would occasionally visit the plains of the central valley to hunt antelope and tule elk, which are unavailable in the mountains. Gathering of plant foods varied seasonally, as greens were gathered in the spring and were used to supplement the diet of acorns stored since the previous fall. Seeds were gathered from May to August. Pine nuts were collected after August, when the land was burned. In the late fall and early winter, acorns were gathered (Levy 1978). Meat consumption was its greatest in the winter months when plant resources were limited to stored foods (Levy 1978).

Technological skills included basket making and production of ground stone items, such as mortars and pestles used in acorn processing. Lithic technology consisted of projectile points, knives, scrapers, and expedient tools like hammer stones and choppers made from various materials, such as chert and obsidian (Levy 1978).

The Eastern Miwok in the Sacramento-San Joaquin Valley were first contacted by Spanish explorers in the second part of the eighteenth century (Levy 1978). Since then, dramatic cultural changes developed, including the transformation of previously independent tribelets into unified militias resisting forced labor, forced missionization, and displacement that was intensified by epidemics and targeted violence against the Miwok by the Spanish, which killed many thousands of Miwok persons in the first half of the nineteenth century (Levy 1978).

During the 1840s, fur trappers, gold miners, and settlers arrived in large numbers and often hostile relations arose between these newcomers and Sierra Miwok. For a brief time, Southern

Sierra Miwok supplied labor for J.D. Savage's gold mining operations in the Big Oak Flat district, but as the number of non-indigenous miners increased in the region, large mining operations were shut down, and Miwok participation decreased (Levy 1978). Records indicate that at least 200 Miwok were killed by the miners during the years 1847 to 1860 (Levy 1978).

A period of confiscation of Indian lands began with the annexation of California by the U.S. (Levy 1978). Although treaties were signed by several members of the tribelets, they were never ratified by the U.S. Senate (Levy 1978). A few groups of Sierra Miwok were removed to the Fresno area but most of the Sierra Miwok population remained in rancherias scattered throughout the Sierra Nevada foothills (Levy 1978). Reliance on wage labor steadily increased and dependence on gathering and hunting diminished throughout the end of the nineteenth century and early twentieth century. Federally recognized Sierra Miwok Tribes in the vicinity of the Don Pedro Project area include the Chicken Ranch Rancheria of Jamestown, California and the Tuolumne Band of Me-Wuk Indians of Tuolumne, California.

3.11.1.3.4 General Historical Themes

Regional Mining History

Like every other county along California's Mother Lode, reaching from Mariposa in the south to Auburn in the north (Clark 1970:15), intensive non-Native settlement in Tuolumne County began with gold mining operations.

County folklore credits the initial discovery of gold in Tuolumne County to James Savage and Benjamin Wood and company in July of 1848, on what is now Woods Creek near its crossing with the Stockton Road (State Route 108). Although it is not known who first mined for gold in the region, evidence points to people of Hispanic origin. The diaries of Americans who arrived in the area in 1848 provide accounts of Mexicans from Sonora, Mexico, working the flats and streams for gold. Extensive placer mining was carried out during the early years of the Gold Rush in nearly all of the ravines and gulches in present-day Tuolumne County, to be followed by hydraulic and hard-rock or quartz mining. The results of these activities can still be seen in the drainages and on the hillsides in and around the Don Pedro Project vicinity.

Placer Mining

The richest deposits of retrievable gold in California were found in the Sierra Nevada foothill region. How the gold came to the foothills is an involved story of geological processes. Basically, granitic rock, quartz lodes, and the contact zones were washed and eroded, and naturally milled by flowing water which concentrated the native gold in former and present streams and gravel beds. It was this "free" or placer gold which attracted the Gold Rush miners. Placer mining was the initial extraction method used in Tuolumne County, already familiar to miners from Mexico, Central America, and South America, where placer mining began in the 1500s.

Placer mining was the most common technique used in the APE and vicinity along the Tuolumne River and its drainages, from the earliest years of the Gold Rush through the Depression era.

Most of the successful placer mines are now located beneath the waters of Don Pedro Reservoir, although some activity was carried on in the Jacksonville area until the New Don Pedro Dam was built in the late 1960s. Although placer mining was carried on all along the river, the most successful mines were located near Jacksonville and on the river bars along its length. Major placer mining activities on Moccasin Creek, Woods Creek, Sullivan Creek, and Kanaka Creek were identified above the present water line and were recorded during the Historic Properties Study (CR-01), while smaller operations were noted on Mine Island and on many drainages and gulches in the area.

Hydraulic Mining

After placer mining declined in the 1860s, hydraulic and quartz lode mining gave the region a more permanently based mining economy, one which continued—with cycles of expansion and contraction—through the 1930s and in some areas until the 1950s. Invented in California, hydraulic mining began in the 1850s when Anthony Chabot attached a wooden nozzle to a canvas hose and washed ancient river gravels. Over the next 20 years, miners improved upon Chabot's design, developing "the Little Giant," used for more than 100 years thereafter. The Little Giant, or monitor, required vast amounts of gravity-fed water at high head to spray on the Tertiary river gravels. Torrents of water would melt away boulders, trees, gravel, and dirt, all mixed with gold.

Although a simple and economic way of recovering rich nuggets deep in the gravels, hydraulic mining had numerous adverse effects downstream, where thousands of cubic yards of dirt and rocks were sent into the Central Valley. The tons of waste that entered the valley rivers caused the water level to rise, resulting in floods that destroyed crops, agricultural fields, and buildings. Hydraulic mining effectively ended in 1884, when Judge Sawyer of the United States Circuit Court granted an injunction making it illegal to discharge mining residue into rivers and streams. The 1893 Caminetti Act permitted hydraulic mining if debris-impounding dams were constructed, but the construction and maintenance of such dams was generally too expensive and not very successful and so the method was not widely used in Tuolumne County; it was successfully employed for many years, however, in nearby La Grange in Stanislaus County.

Hydraulic mining, with its dramatic landscapes and large open pits, never took hold in the Southern Mines[36], including those in Tuolumne County, to the degree it did in the Northern Mines of Placer, Nevada, Amador, and El Dorado counties. A small hydraulic pit has been identified near Moccasin and hydraulic mining was conducted at Hawkins Bar.

Hard-Rock Mining

Hard-rock (or quartz) mining began in Tuolumne County in the 1850s. Some of the earlier quartz mines continued to operate for many years: Carlin, Cherokee, Buchanan, Confidence, App, Soulsby, Dutch, and the Trio/Whiskey Hill mines. Hard-rock mining is a method of

[36] The term "Southern Mines" is commonly used in Gold Rush related literature and refers to those mining areas at the southern end of the Mother Lode gold belt. Conversely, the term "Northern Mines" is commonly used in Gold Rush related literature and refers to those mining areas at the northern end of the Mother Lode gold belt.

exploration that is largely subsurface but that leaves many remains on the landscape, including shafts, adits, haul roads, waste rock, prospects, surface vein workings, and tunnels.

The advent of the hard-rock mining boom of the late 1880s, which continued until most of the mills were shut down for World War I, was induced by a combination of advanced mining and milling technologies, primarily the invention of dynamite and the development of square-set timbering in the Comstock lode, the chlorination and cyanide ore refining processes, water or steam power drills, and water pumps and air power. Along with investment of foreign capital, these technologies provided for the resurgence of the mining industry in Tuolumne County and the foothills.

With the advent of hard-rock mining, mines that had closed throughout Tuolumne County were reopened during the late 1880s, often with new names and under new ownership. The larger mines were owned by corporations with abundant capital to invest in the construction of modern and larger stamp mills and recovery systems. The Eagle-Shawmut near Jacksonville (now beneath the waters of Don Pedro Reservoir) and the Harvard Mine near Jamestown were the largest of these, although hundreds of small and medium-sized mines were developed at Confidence, Soulsbyville, Jamestown, Stent, Quartz, Carters, Big Oak Flat, Groveland, Tuttletown, Sonora, and other locations. This boom continued for two decades, and by 1915, mining was still the major industry in the county (Hamilton 1915:136-166). Physical remains from that era include shafts and adits, stamp mills, haul roads, abandoned equipment, leach fields, powder magazines, mill tailings, ponds, waste rock dumps, workers' and superintendents' housing, and company offices.

The Eagle-Shawmut Mine, the Orcutt, Harriman, Mammoth, Republican, Tarantula, Wheeler, and other mines on the Mother Lode vein near Jacksonville were inundated by the new Don Pedro Reservoir in the late 1960s. Other hard-rock mining activities in the area included surface vein workings, prospecting, coyoting, and small adits and "gyppo" (independent operator) mines, some of which are above the present water line of the reservoir and were recorded during the relicensing studies (49 Mine, McCormick/Tuolumne River Mine, coyoting on Kanaka Creek, the surface vein workings on the Penrose property near Jacksonville, and others).

Gold Dredging

Bucket-line and dragline dredges, which are based on the large-scale processing of low-grade placer-bearing gravel, became important producers of placer gold in the early 20th century. . Although introduced into California in 1897, dredging did not become a viable method of mining in Tuolumne County until the 1930s, when dredges worked on and in the Stanislaus and the Tuolumne rivers, Moccasin Creek, and at Montezuma. "Doodlebug" dredges were used on the hillsides below Jamestown during the 1940s. Both forms of dredging have left characteristic scars on the landscape, although many dredger gravel bars are now under reservoirs, including Don Pedro. Dredge tailings on the Ferretti/Sandner Ranch near Moccasin on Moccasin Creek are the most visible remnants of this activity in the APE. Tailings from the extensive dredge mining near La Grange were used in the construction of the new Don Pedro Dam.

Tuolumne County Agricultural Development

While gold mining drove the study area's economy, agriculture was a necessary industry to supply the miners with food. Close behind the prospectors and miners came the agriculturalists, families from the eastern states and Europe who saw opportunities for stock-raising and truck-garden operations on the open grasslands. Following the decline of placer deposits in the Mother Lode after c. 1860, ranching and farming became more important to the foothill economy. Settlers established farms in the area where they grew hay, alfalfa, and wheat, and planted orchards. Most families practiced a mixed agricultural economy, raising cattle, sheep, hogs, and poultry and maintained vegetable gardens and orchards. As the mining economy declined, farming gained importance as a family enterprise which helped to establish more permanence and stability in the local society.

In Tuolumne County, agricultural pursuits were always critical as a supporting service and at times were the most important source of income; even so, agricultural development was not as great as conditions warranted, since the interest in the county was so heavily centered on mining. In the early years when animals provided much of the labor, massive production of hay and grasses was necessary to feed the cattle, oxen, and horses. In 1909 about 18,000 ac were devoted to "hay" (wheat, barley, and oats), since these could be grown without water or much attention. County grasslands were used for stock grazing. Hogs were among the first animals to be raised in the county. Though few ranchers developed hog operations, other animals, such as goats, llamas, sheep, dairy cows, chickens, and other poultry were raised on county ranches and farms.

Livestock grazing was the primary agricultural industry in the vicinity of the APE, and in Tuolumne County as a whole. In 1909 more than half of the cattle ranches in the county were located in or near the Don Pedro area (*Union Democrat* 1909:63). When the first Don Pedro dam was constructed in the 1920s, lands that were to be inundated were purchased from ranchers, including Rosasco, Rushing Land & Cattle Company, Rydberg, Randall, Fleming, Hammond, Donahue, Hughes, Bartlett, Kassabaum, and others (Meikle 1927). As noted by Bill Welch, who was born and raised in the area: "When the dams were built the water backed up over many of the old ranches and the settlers moved out. There were big families here and I often wondered how they all made a living—they had nice homes and big barns and buildings" (Beard 1988:87). Additional lands were purchased in the 1960s when the new Don Pedro Dam was constructed. By that time, many of the ranchers no longer lived on their grazing lands full time, but resided in La Grange, Merced Falls, Empire, Jamestown, Chinese Camp, and other nearby communities.

Transportation Development

Most of the major highways and corridors in California follow the routes of Indian trails (Davis 1961). Such routes in Tuolumne County include State Route 49 and likely include portions of State Route 120. Within Tuolumne County, the pattern of roads generally led to river fords, which later became ferries crossings, and then successive bridge crossings, many of which persist to this day. Stevens Bar was bridged in 1859 and Ward's Ferry in 1879. Other crossings were made at Central Ferry (replaced by Central Bridge in the late 1850s), Jacksonville Ferry, McLeans Ferry, and more. Most physical remains are no longer extant or are underwater in reservoirs, but the names of those crossings survive today as road names: Parrotts Ferry, O'Byrnes Ferry, Reynolds Ferry, Ward's Ferry, and Don Pedro Bar. Numerous avenues between towns, camps, wood mills, mines, ranches, and all the other human additions to the landscape were developed, especially during the period 1849-1900. With the advent of the automobile and other gasoline-powered vehicles, there grew a state-wide interest in transportation development.

Early Wagon Roads

Several early roads and routes traversed the APE and are depicted on historical maps, including the late 19th century General Land Office (GLO) plat maps and historic USGS topographic maps. These include Coulterville Road, Merced and Coulterville Road, Sonora to Jacksonville Road, Sonora to Big Oak Flat Road, Don Pedro Road, Marsh Flat Road, Chinese Camp and Jacksonville Road, Moccasin Road, Ward's Ferry Road, Moffitts Road, Knights Ferry and Don Pedro Bar Road, Road to Crawford's Ranch, Salumbo and French Bar Road, Crimea House Road, Chinese Camp to Stevens Bar Road, Morgans Bar Road, Indian Bar Road, Hatch Creek Road, and other smaller routes between ranches and settlements. Most of them were established in the 1850s, first as public roads, then as county roads, and some later as state highways. The Sonora to Big Oak Flat Road was accepted into the state highway system and later named State Route 120, while the Sonora to Coulterville Road became part of State Route 49.

With the construction of the old and new Don Pedro dams and reservoirs, several roads were inundated and their names and destinations altered. Old Don Pedro Road became Don Pedro Bar Road, the Chinese Camp to Jacksonville Road (c. 1900) was changed to Shawmut Road, Jacksonville Road was moved to the east and Jacksonville-Stent Road was abandoned, the road from Priest Grade along the northeast side of Moccasin Creek was named Grizzly Road and on the south side was named Moccasin Road; and the old Coulterville Road from La Grange was rerouted to cross the New Don Pedro Dam and renamed Bonds Flat Road. Several early roads were truncated and new turnarounds constructed, as on Kanaka Creek Road, old Highway 49 near Moccasin, Grizzly Road, and others. The old road along the northwest side of the river above Stevens Bar was inundated and a new River Road constructed to serve the mines along its route (Rose c. 1970; TID 1975).

Railroads

Although the first common-carrier railroad in California was in place by 1852, and the transcontinental rails of the Central and Union Pacific were laid by 1869, it was not until the end of the 19th century that Tuolumne County began to consider building a railroad. The first one in the county, the Sierra Railway, was incorporated in 1897 as a standard gauge railroad between the cities of Oakdale (on the Southern Pacific line) and Angels Camp in Calaveras County (Coleman 1952:165). The railway was completed to Jamestown that year, financed by Thomas S. Bullock, W. H. Crocker, and Prince Andre Poniatowski. When the railroad to Tuolumne was completed in 1901 to serve the financiers' mill there, it penetrated farther into the Sierra Nevada than any other railroad in California except the Central Pacific (Deane 1960:318). Six branches and secondary railroads were built that linked directly with the Sierra Railway in subsequent years, including the Atlas Branch, the Don Pedro Branch (or spur), the Hetch Hetchy Railroad, the Melones Branch, the Yosemite Short Line Railroad, and the Angels Camp Branch (Tuolumne County Historical Society 2013). Of these, the Don Pedro Branch, the Hetch Hetchy Railroad and the Yosemite Short Line Railroad ran through the APE. Though the railway was built to service the lumber industries and gold fields in the Sierras, the Sierra Railway was instrumental in the construction of several dams, for which most of the spurs and secondary railroads were built. The railroad was used during the 1920s construction of the Don Pedro Dam, the Melones Dam, and the O'Shaughnessy Dam. It also supported the construction of the Tri-Dam Project. During the Great Depression the railway went into receivership and emerged in 1937 as the Sierra Railroad. The last passenger train ran in 1955, after which the train hauled freight exclusively. The train complex in Jamestown was sold in 1982 to the State of California Parks and Recreation Department and became Railtown 1897 State Historic Park. Today the train still runs and offers passenger excursion rides along a portion of the old route.

Water and Power Development[37]

The earliest efforts to control water in Tuolumne County (and elsewhere in the Mother Lode region) were the ditches and flumes constructed originally to provide water for the miners working the rich gold-bearing gravels in the gold diggings. By 1853, within five years of the initial gold discovery, most easily retrievable gold had been recovered. Decreasing quantities of placer gold and the need for vast quantities of water to mine in new ways and areas spurred the development of large-scale water storage and conveyance systems.

<u>Tuolumne County Water Company</u>

From its organization in 1851 to its purchase by Pacific Gas and Electric (PG&E) in 1927, the Tuolumne County Water Company (TCWC) constructed dams, reservoirs, ditches, flumes, and watercourses, purchasing virtually every other ditch and flume company within its sphere of operations. Starting with small ditches built only to serve Columbia, TCWC's system expanded to provide water to the entire area between the Tuolumne and Stanislaus rivers. Over the ensuing years, the use of water controlled by the company shifted from placer mining to hard-rock mining, then to agriculture, and finally to domestic use, reflecting the changing economic pattern of Tuolumne County and the entire foothill region. One important early ditch of the TCWC, the Algerine Ditch, ran close to the APE, near Sullivan and Curtis Creeks. An extension of the ditch appears to have extended into the APE.

<u>La Grange Hydraulic Mining Company</u>

The town of La Grange, also known as French Bar, was one of the important mining camps on the Tuolumne River, established by a group of Frenchmen in the early 1850s. The wealth of the area was based upon the rich gravel bars along the river and associated terraces. A townsite was laid out in 1852 and by 1856 mining had proved so successful that La Grange (French for "the farm") became the Stanislaus County seat. It held that honor until 1862, when the county seat was moved to Knights Ferry. After the county seat was moved and the mining excitement had

[37] Much of the Tuolumne County Water Company history and La Grange Hydraulic Mining Company history is provided from Marvin and Francis 2012.

subsided, the town lost its former prestige and began to show signs of decline (Branch 1881:114, 116).

To help counter this decline, the La Grange Ditch was constructed from 1871 to 1872 for the La Grange Hydraulic Mining Company, headed by San Francisco attorney Edmund Green. The ditch was built to bring water from the Tuolumne River to the company's hydraulic mining operations north of La Grange, where gold was found in the rich auriferous gravels in surface diggings and in an old river channel. By the late 1880s the ditch system had fallen into poor condition (JRP and Caltrans 2000:40, 41, 45, 46, and 50). In the early 20th century the ditch was used for dredging operations and later the water rights were used to supply water for the town of La Grange. However, by the 1920s, following the construction of the old Don Pedro Dam, the La Grange Ditch, portions of which were inundated by the newly formed Don Pedro Reservoir, was abandoned for good (TID vs. Allen Zanker et al. 2006).

Turlock Irrigation District

The first irrigation system to be completed under the Wright Act was by TID, which was also the first public irrigation district to be established in California and one of only four in California today to deliver retail electric power (TID 2013). Its history has been written at length elsewhere (Annear et al. 1950; Elias 1924; Hohenthal et al. 1972; Paterson 1989; Tinkham 1921) and is only briefly summarized here. Although impetus for the development of irrigation systems within Stanislaus County began in the early 1870s, only one canal, the San Joaquin and King's River Canal on the west side of the county, was constructed during that decade (Elias 1924:203–204). The following decade saw the submission of the first irrigation bills in the California legislature, but no action was taken until the late 1880s.

In 1886, Turlock and Ceres farmers began proposing the formation of irrigation districts for the farmers of their regions, stating that "a new water code for equal distribution of water and water rights, under strict regulations, with no chance of monopoly, should be drawn up" (Hohenthal et al. 1972:61). The answer to their demands was provided by a young Modesto attorney, C. C. Wright, who had recently been elected to the State Assembly and chosen "for the express purpose of advocating some measure providing for the municipal control of water for irrigation" (Paterson 1989:53). In the spring of 1887 Wright drafted the Irrigation Districts Act, based largely on the draft of a law prepared the previous year by William Hammond Hall, State Engineer of California.

The Wright Act, approved in March 1887, provided "for the organization and government of irrigation districts and…for the acquisition of water and other property and for the distribution of water thereby for irrigation purposes." The act was designed to give "highest legal sanction to the permanent union of land and water, but at the same time to recognize every other existing right and equity." Patterned on the government of California counties, the district was to have an elected board and powers to assess and collect funds, with all district lands to be taxed (Hohenthal et al. 1972:62).

Within three months of passage of the Wright Act, on June 6, 1887, TID was formed, boundaries were fixed and officers elected. Initially, 176,210 ac (over 275 mi^2) were included in the district, which was all the irrigable land between the Tuolumne and Merced Rivers, from the foothills on the east to the San Joaquin River on the west. The first members of the board, W. L. Fulkerth, E. V. Cogswell, R. M. Williams, J. T. Dunn, and E. B. Clark, met in June of 1887. The TID offices were established in Turlock.

The Board soon located a water right for 225,000 inches near Wheaton's Dam on the Tuolumne River close to La Grange. George Manuel of Fresno, who was hired as district engineer, surveyed the dam site and canal routes and estimated costs for the system at $467,544.62. The Board called for an election to authorize issuance of $600,000 in bonds. The election was held in October of 1887 and only 12 of 188 votes cast opposed the sale. The first sale occurred in November, when Robert McHenry purchased $50,000 in bonds. The first contracts for construction were let in 1890.

Concerned with the prospect of lawsuits against the Wright Act, the TID Board commenced a writ of mandate before the State Supreme Court to compel the secretary of TID to sign certain bonds, which the secretary had refused to sign on the grounds that the Wright Act was unconstitutional and void. The decision, handed down on May 31, 1888, upheld the Wright Act in all respects and ordered the secretary to sign the bonds. TID then set about construction of the La Grange Diversion Dam, located about one-and-one-half miles above La Grange, near the site of the 1870s Wheaton Dam. Built as a joint undertaking by MID and TID, under an agreement made in August of 1890, the water rights were divided in proportion to the number of acres in the respective districts, giving TID 68.46 percent of the total and MID 31.54 percent of the total. The dam was completed by the Pacific Bridge Company in 1893 at a cost of $543,164. At the time of its completion, La Grange Diversion Dam was the highest overflow dam in the country and one of the largest in the world. Most of the design was done by Luther Wagoner, Engineer for MID. E. H. Barton, TID Engineer, supervised the construction.

The years following construction of the La Grange Diversion Dam were characterized by lawsuits, difficulties in selling bonds and making payroll, and deterioration of the canal system during delays. Finally, by 1902 all of the main canals west and some east of the main line of the Southern Pacific Railroad, a total length of 10 miles, were completed. With the La Grange Reservoir and the system on line, TID began to look for storage reservoirs. In 1910, bonds were passed for the construction of reservoirs downstream from the La Grange Diversion Dam in order to store more water from the Tuolumne River for irrigation.

That same year, TID formally began to consider producing electric power, with the intention of building hydroelectric plants at La Grange Diversion Dam and the Hickman Drop. By 1913, 17 dams and one levee were nearly completed, including the Owens (Turlock) Reservoir on the bluff south of the Tuolumne River on the old Morley Ranch (Paterson 1989:158-159). In 1915, TID and MID agreed to build a water-storage dam at the Don Pedro site. The following year, TID Chief Engineer Roy V. Meikle revived a proposal to build a power plant at Hickman Drop, though this plan was later abandoned.

By 1923, the old Don Pedro Dam and Reservoir had been completed and more than 55 miles of main and lateral canals had been lined with concrete to reduce seepage and avoid washouts. A decade later, another 50 miles of concreting had been completed, contributing to a 30 percent increase in canal capacity and reducing the average interval between irrigations from 30 or 35 days to 10 or 15 days (Paterson 1989:258-259). Additional canal improvements and lining were accomplished during the mid-1930s when TID received funding from the Public Works Administration (PWA) (Paterson 1989:271). Over the ensuing years the canals have been periodically upgraded to modern construction standards. In the late 1960s the new Don Pedro Dam was built by TID and MID downstream of the old Don Pedro Dam. Following completion of the new Don Pedro Dam the old dam quickly became inundated by the new Don Pedro Reservoir, which at full capacity holds over 2,000,000 AF of water.

Modesto Irrigation District

Much of MID's history has been closely entwined with that of TID since 1890, when they reached an agreement to construct the La Grange Diversion Dam. MID's history has been written about at length elsewhere (Annear et al. 1950; Barnes 1987; Elias 1924; Hohenthal 1972; Tinkham 1921) and is summarized briefly herein.

Almost immediately after the signing of the Wright Act in March 1887, the organizers of MID circulated a petition calling for formation of the District, presenting it to the Board of Supervisors on April 25. However, the plan was petitioned against. Numerous challenges and court cases led by farmer Christopher Columbus Baker and harness-maker William Tregea delayed the formation of the District for several years. In November of 1889, however, Justice Minor ruled in favor of the District's organization. The decision was immediately appealed by Tregea but was upheld by the California Supreme Court in March of 1891 (Barnes 1987:31).

By early 1894, following completion of the La Grange Diversion Dam, MID had a means of diverting water from the Tuolumne River but no canals to carry it. In April 1890, work began on a gravity-flow main canal running 25 miles through the foothills to the district. The canal was damaged in the floods of 1892 but quickly repaired, and the rest of the main canal contracts were awarded that year. By 1893 all the main canals were finished, but headworks and gates at the dam and lateral canals were not yet complete. A portion of the canal below the dam was declared unsafe and had to be rebuilt. Almost nothing happened in the district from 1896 through 1900, except for the natural deterioration of the canals.

On February 2, 1901, control of MID's Board of Directors was wrested from the anti-irrigationists in an election made contentious by the Board's refusal to act. A bond election held in January of 1902 was overwhelmingly approved by the voters and, with the refinancing bonds approved, the Board set about to raise its $71,000 share of the construction money. The bonds, approved in 1895, were purchased by rancher and president of the First National Bank of Modesto, Oramil McHenry, and work commenced under the direction of Engineer R. H. Goodwin.

Water first flowed through the main canal from the La Grange Diversion Dam to the district boundary and into Dry Creek at 7 a.m. on April 3, 1903. Irrigation formally began in 1904 when Oramil McHenry, George Covell, and T. H. Kewin received the first "official" water.

Irrigation forever altered the early dry-land wheat farming and cattle grazing within the district, as the large grain farms were broken up into smaller parcels and alfalfa became the dominant crop. Dairying also became a major factor in the region's agricultural economy, with grapevines and orchards close behind. Canning and packing plants were established, and in 1907 and 1908 special rail coaches traveled throughout the nation displaying the fruits grown in the MID and TID areas and carrying real estate agents promoting small farm and residential developments. By 1913 more than half of the tillable land in the district was under irrigation, and the amount of land provided with water had increased by 160 percent. Stanislaus County had become the 27th largest producer of crops and livestock in the nation and was second only to Los Angeles County in the pace of agricultural growth. By the beginning of the 1920s, alfalfa had given way to fruit, nut, and vine crops.

As the demand for water storage grew, MID decided to provide its own storage along its main canal below La Grange Diversion Dam. MID enlarged the Dallas and Warner lakes near Waterford, to cover 2,800 ac with a capacity of 27,700 AF. Now known as Modesto Reservoir, the original Dallas-Warner Reservoir was completed in 1912.

Within a decade the wooden flumes and trestles of the irrigation canals began to deteriorate and were replaced with concrete. In March 1914, the voters approved, by a seven-to-one vote, two bond issues totaling $610,000 as part of a policy to expand the irrigating facilities and supersede the temporary early construction with concrete. New headgates, weirs, and diversion points were constructed, and existing canal facilities were replaced and improved (Barnes 1987:55–56).

Evaporation and seepage along MID's canals and ditches accounted for a loss of 30 percent of the water, while weeds and tules clogged the canals and ground squirrels dug holes in the structures and caused additional integrity problems. Accordingly, MID's most important long-range water management program after completion of the La Grange Diversion Dam was the concerted effort to line with concrete or divert into underground pipelines all of its main canal, laterals, and ditches. By 1921, only one mile of the main canal had been lined, and by 1933, less than 25 miles of canals had been piped or concreted. The Work Progress Administration (WPA) improved additional sections of the canal during the Great Depression (mid-1930s to early 1940s). After World War II, however, MID began a 20-year program to line or pipe all of its main canal and laterals. By 1955, 93.7 miles of the total network had been improved. By 1960, 81 percent of the work had been completed. The Don Pedro Project was finished in the mid-1960s. Today, all 288 miles of the main canal, laterals, and drains are piped or lined with concrete (Barnes 1987:118).

In addition to these important long-range management measures to improve the infrastructure of the canal system, MID's largest projects include construction of the original Don Pedro Dam and Reservoir in 1923 and the new Don Pedro Dam and Reservoir in the late 1960s. Including the new Don Pedro Dam and Reservoir, numerous new facilities and improvements were completed in the latter half of the twentieth century. Following the merger with the Waterford Irrigation District in 1978, MID completed the New Hogan hydroelectric plant and the Coldwater Creek geothermal plant (in 1986) and the Modesto Regional Water Treatment Plant (in 1994). In 1997 MID expanded electric service to Oakdale, Ripon, and Escalon.

The New Don Pedro Project

The 1940s through the 1960s proved to be a critical period for TID and MID, as the Districts often had to defend their Tuolumne River water rights. To ensure that water requirements for TID and MID would be met "for all time," the Districts began planning for the new Don Pedro Dam and Reservoir, which would require a Federal Power Commission (FPC) license (Barnes 1987:124).

The first official report of plans to construct a new dam and reservoir dates to 1931, when the California Department of Water Resources (CDWR) discussed the feasibility of such a development. By that time, farmers and officials of the Districts were aware of the need for additional storage, especially as there had been only one year of "normal" rainfall since completion of the first Don Pedro Dam. In addition, about a decade later the ACOE looked to the Tuolumne for additional flood control, and the City of San Francisco began pressing to develop resources based upon the Raker Act. An agreement to proceed with the new dam and reservoir was reached by the three local agencies in November of 1943, and three months later the COE recommended the construction to Congress. Congress concurred with the recommendation in December 1944, and the next year the California Legislature authorized construction of a 1,200,000 AF reservoir (increased to 2,030,000 AF after aerial mapping). The CDWR issued rights in 1953, and by 1955 five potential dam sites had been identified by geologist Roger Rhoades. Two years later, after additional mapping and boring studies, the present location was selected.

The construction site was located in a V-shaped gorge, where terrain was rugged, access was difficult, and the river was violent. Access to much of the river was achieved by filling the old La Grange Ditch (1871), perched on the side of the hill. Later, John Goodier, vice-president and chief engineer of the Atkinson Company, the company contracted to build the dam, noted that it had been an interesting job for a contractor, with two diversion tunnels, a shaft, a powerhouse, a switchyard, a dam, and a spillway—all in one job.

Atkinson established its construction camp at what is now the Blue Oaks Campground, managed by the DPRA. Irrigation engineer, Charles Crawford, a 39-year employee of MID, was named as coordinator. The first order of work was to build a diversion tunnel and clear the dam site. The tunnel was completed and the river diverted on September 7, 1967; nine days later the first loads of dredge tailings were delivered. Following the dam completion, the diversion tunnel became part of the outlet works, draining the downstream portal located south of the powerhouse. On February 27, 1969, the first of the dam's clay core (of silty sand mixed with clay found near La Grange) was placed. For the next 15 months the dam rose 18 inches a day, raised with tailings dumped by earth movers nicknamed "belly dumps." The rigs operated around the clock from 8 a.m. Mondays to 8 p.m. Saturdays, stopping only for a half-hour lunch period on each shift. Two years after construction began, 500 men were working on construction and the development was 53 percent complete.

The last load of material was delivered May 28, 1970, with TID Chief Engineer Roy Meikle riding in the passenger seat (Barnes 1987:140–143). The new dam began storing water in November 1970 (Barnes 1987:146). Formal dedication ceremonies were held May 22, 1971, where San Francisco mayor Joseph Alioto addressed an audience of 3,000. The total cost of the development was $115,697,000 (Barnes 1987:148–150).

Tourism/Recreation

Provisioned by the local agricultural and livestock industries, inns, boarding house, hostelries, and restaurants were established in virtually every community, at crossroads, and at stopping places along the major roads in Tuolumne County. Although tourism was an early activity in the county (Bower Cave, Hetch Hetchy, and Table Mountain all drew visitors), the railroad from Stockton to Milton, completed in May 1871 (originally part of the Stockton & Copperopolis Railroad), greatly increased tourism. After the completion of the Sierra Railway, many locations in the county became destinations for vacationers who came to admire its natural wonders and cooler temperatures.

During the Don Pedro Project FPC hearings in 1962, Tuolumne County lobbied the Districts to incorporate boating and camping facilities into the new Don Pedro Project. The county felt it would benefit financially from the recreation tourism at the reservoir. The Districts maintained they did not have to provide public recreation services and did not want to add this aspect to their management operations. The FPC disagreed and included a recreation requirement in the Don Pedro Project license (Paterson 1989:344). This resulted in the creation of the Don Pedro Recreation Area in 1970, which incorporated all lands and water available for recreation use within the federally licensed Don Pedro Project (FERC Project Number 2299). Subsequently, three formal recreation areas were built around the reservoir in the early 1970s. These areas, Fleming Meadows Recreation Area, Blue Oaks Recreation Area, and Moccasin Point Recreation Area, continue to be operated and maintained today much as they were in the 1970s.

Settlement

The vicinity of the APE includes the locations of several historic-era towns and mining camps, often located on bars of the Tuolumne River or along its larger tributaries. Fire and weather destroyed many of the earliest settlements, and others were later razed before reservoir inundation[38] or abandoned (such as Poverty Hill #1, Curtisville, and Blanket Creek). The following sections provide details of the communities located within the APE. Most of these communities initially sprang up as a result of the Gold Rush, and represented either mining camps or supply centers that supported the surrounding mining communities.

Jacksonville and Shawmut

Jacksonville, located on the Tuolumne River near its confluence with Woods Creek, was named for Colonel Aldan Apollo Moore Jackson, for whom the town of Jackson in Amador County is also named. Jackson is believed to have discovered gold here in 1849 and opened a trading post. Later that year it was reported that there were about 40 people engaged in mining and storekeeping. By April of 1851 the community boasted 252 inhabitants, with a post office

[38] Including dozens of camps such as Melones or Pine Log Crossing on the Stanislaus River, every major mining center on the Tuolumne River from Brazoria Bar to Jacksonville to Don Pedro’s Bar to Rodgers Bar, and Junction Camp and Dutch Bar on Woods Creek.

established that October. According to Heckendorn and Wilson, in 1855 the river was being successfully worked in the months of August through November, at its lowest stage (Heckendorn and Wilson 1856:85). The rich placer deposits in the district reportedly produced $9 million in gold, while hard-rock mining (beginning in the late 1850s) produced more than $7.5 million (Clark 1970:77).

Jacksonville's population waned with the depletion of the easy gold, and it slumbered until reawakened by the hard-rock mining boom of the late 1880s. In 1909, with its location on the Mother Lode Vein and with quartz and gravel mining continuing on an extensive scale, the town was still providing goods and services to the surrounding mines and farms, with a couple of stores, a hotel, and some small farms (*The Union Democrat* 1909:84). Jacksonville was registered as State Historic Landmark No. 419, but all buildings were removed and the townsite was inundated by the waters of Don Pedro Reservoir when the new dam was built in the late 1960s (Gudde 1975:174).

Shawmut, named for the Shawmut Mine on Woods Creek, was located about two miles northwest of Jacksonville. The mine was the most important reason for the town's existence. The first hard-rock mine in the area was the Eagle on Blue Gulch, which started in the 1860s with a 10-stamp mill. After changing hands several times, in the 1890s it was consolidated with the Shawmut claim as the Eagle-Shawmut Mine, the most important in the Jacksonville Mining District and the largest in Tuolumne County in the early 1900s. After being closed for a short time, the mine was reopened in 1897 with a 40-stamp mill (increased to 100 stamps in 1901), with a power plant driven by water purchased from the Sierra and San Francisco Power Company (Hamilton 1915:146). Numerous extensive improvements were made over the ensuing years to the mine and mill, surrounded by Shawmut, a company town with boarding houses and cottages for workers and their families (Wagner 1980:56). The mine continued to operate successfully until shut down by World War II in 1942, by which time it was noted as one of the major mines along the Mother Lode, having many miles of workings (3,550 ft below bedrock), and the producer of huge tonnages of low-grade ore. Most of the extensive workings had been driven after the turn of the 19th century, resulting in a production of approximately $7.5 million in gold (Jenkins 1948:48). For over 50 years the Eagle-Shawmut had been the lifeblood of the district, which never recovered after the mine closure at the start of World War II. Today, what remains of the mine and mill site are under the waters of the Woods Creek Arm of Don Pedro Reservoir, and surface only during times of extreme low water (personal communication with Dave Jigour of DPRA).

<u>Tuolumne River Bars</u>

Many other settlements, in addition to the larger, more permanent communities of Jacksonville and Shawmut, sprang up along the river bars. Heckendorn and Wilson (1856:89) provided this description of the smaller bars and settlements along the Tuolumne River in the mid-1850s:

> *Stevens', Red Mountain, Hawkins', Indian, Texas, Morgan's, Don Pedro's, Rodgers' and many other Bars on the Tuolumne river, are all in Tuolumne County, and are places of considerable note. In 1850 they were the largest camps in the county—thousands of miners were engaged in attempting to turn the river, the bed of which they imagined*

> *contained millions in treasure; but few companies succeeded in diverting the channel from its course, and what few did were disappointed in its supposed richness. Some few companies [have] done well, but as a general thing the river turning that year was a failure—since then the mode of operating has been very different, and the bed of the stream in a number of places has paid well for the expense of fluming, which is the only mode by which it can be successfully worked. The River will furnish profitable employment for many years to come.*

In 1850, the river camps along the Tuolumne were among the largest in the county; few, however, enjoyed any great prosperity and all of them had disappeared by the beginning of the 20th century. Only Don Pedro Bar, Indian Bar, and Red Mountain Bar continued to exist, and those only until the construction of the first Don Pedro Dam in the early 1920s. Not even the bars themselves remain, for the river has changed its course several times since the 1850s and the bars are now located beneath the waters of the reservoir (Hoover et al. 1990:519).

Demographic History of the APE and Vicinity

The cultural resources which remain today in Tuolumne County gain much of their importance from the people who lived and worked there, and from those who designed or built or used the resources. Tuolumne County's structures, sites, objects, and buildings often bear more meaning or significance because of their association with a particular ethnic, religious, or social group that constructed it, lived in it, or was otherwise associated with it. This section provides a brief demographic history of the APE and vicinity, focusing primarily on the ethnic background of the Tuolumne County population.

Although there were other ethnic groups present in California prior to the Gold Rush, particularly Hispanic and Russian peoples, very few made it into what is now Tuolumne County. In the middle of the 19th century, the area was inhabited by several different Indian groups, *Californios*, a handful of Americans, and others. The *Californios* (one of the names for the people of Iberian descent who lived in California before the Gold Rush) were born in California, usually of Spanish, Mexican, and/or Indian parents. Another early group was composed of the 500 men from the eastern United States who came to California in 1846 with Colonel Jonathan D. Stevenson to become the first American regiment in the state. The Mexican-American War had begun and Stevenson's regiment, fought in Baja California but otherwise saw no action in the war, spending its latter part on the Stanislaus River. By 1849 their military tasks were finished and many stayed to become craftsmen, miners, and merchants, and were among the first Americans to settle and mine for gold in California.

Many different groups have lived in Tuolumne County, some of which are still reflected in local place-names like Chinese Camp, Chili Camp, and Kanaka Creek. The Anglos, or people of British extraction, composed an early majority of inhabitants, including the Cornish, with their important hard-rock mining skills, as well as the English, Irish, Welsh, and Scots. Other Europeans were also important to the early development of the county, and many of them stayed when the placer gold was depleted.

The Chinese were a particularly important ethnic group in the history of the Gold Rush as they offered a large labor force. The Chinese Exclusion Act of 1882 essentially ended Chinese immigration and forced many to return to their native land.

3.11.1.4 Existing Information and Need for Additional Information

To gather existing, relevant, and reasonably available information regarding cultural resources in the Don Pedro Project APE and vicinity, the Districts performed a records search in July 2010 at the Central California Information Center (CCIC) of the California Historical Resources Information System at California State University (CSU), Stanislaus in Turlock. In addition to identifying cultural resources, this research also served to obtain background information pertinent to understanding the archaeology, history, and ethnohistory of the Don Pedro Project vicinity and APE. The data gathering area included the FERC Project Boundary, which is much larger than the APE, plus an additional 0.25-mile buffer beyond, to identify previously recorded cultural resources and previous cultural studies that may require consideration.

The records search included reviews of cultural resources records and site location maps, historic GLO plats, NRHP, California Register of Historic Resources, Office of Historic Preservation Historic Property Directory, *California State Historic Landmarks* (CDPR 1996), *California Inventory of Historic Resources* (CDPR 1976), historic topographic maps, and the Caltrans Bridge Inventory.

The records search indicates that the Project Boundary contains numerous prehistoric- and historic-era properties and that some areas have been subject to previous cultural surveys (see Section 5.8 in the PAD). However, the research also revealed that many areas within the APE have not yet been surveyed for cultural resources and a portion of previously surveyed areas should be reexamined to meet current professional standards for identifying historic properties. A comprehensive field survey of the APE was conducted to accomplish this.

3.11.1.4.1 <u>Summary of Record Search</u>

Previous Cultural Studies

The above-described records search identified 62 previous cultural resource investigations within 0.25 miles of the APE, of which 32 fall within the APE, and were conducted prior to a variety of different undertakings, to include proposed water control/treatment facilities, utilities, housing developments, mining activities, road/highway construction, recreation facilities, and grazing leases. Two of the previous investigations are comprised of articles from The Quarterly of the Tuolumne Historical Society, and one is comprised of documentation of monuments and plaques of the E Clampus Vitus organization.

The previous investigations covered roughly 20 percent of the APE, though many of these studies were not completed to current (2010) professional standards. One of the largest studies in the APE (Moratto 1971) did not include a map of the area surveyed, thus it is unclear exactly what locations within the APE were included in this study.

Previously Recorded Archaeological Sites

The records searches identified 160 known archaeological sites previously documented within 0.25 miles of the Don Pedro Project APE, of which 104 fall within the APE. Of the 160 sites within 0.25 miles of the APE, one is protohistoric, one includes both prehistoric and protohistoric components, 12 have both prehistoric and historic-era cultural remains, three did not have any information on file and therefore are unknown as to their age, 65 are prehistoric in age, and 78 contain historic-era resources. The prehistoric components typically include flaked stone with and without bedrock milling stations, with both short term and long term occupation sites represented. The historic components are predominantly represented by refuse scatters and/or remains of habitation structures/buildings, and also include a number of mining relates sites. According to the Office of Historic Preservation's Archaeological Determinations of Eligibility list and the Directory of Properties in the Historic Property Data File on file at the CCIC, of the 160 sites recorded in the vicinity of the Don Pedro Project APE, nine have been evaluated as eligible for inclusion on the NRHP. The remaining 151 resources remain unevaluated for the NRHP.

Potential Historic-Period Cultural Resources

Historic period USGS topographic quadrangles and GLO plats were reviewed during the records search to identify locations of potential historic-era sites and features within the APE and within 0.25 miles of the APE. This resulted in the identification of well over 50 locations where unrecorded historic period sites or features may be present within the APE. These sites and features include potential roads and trails, the town site of Jacksonville, buildings, mines, ditches, the Hetch Hetchy Railroad/Yosemite Short Line Railroad, the Hetch Hetchy Aqueduct, and other features.

Historic period maps often provide a general idea of where sites may be located but are not necessarily accurate. Today's maps and mapping standards are not always translatable to the past and plots cannot be taken as exact. Because of the disparity between historic-period maps and modern maps, it is not known if physical attributes associated with the potential sites and features are accessible, or if the remains are actually within the APE. As well, the presence of cultural features on an historic map does not confirm that the features still exist. Many historic features, such as town sites, mines, roads, etc., often have continued use into present times that may obliterate any historic remains. As well, historic features can also disappear over time through natural erosion or other weathering processes. Based on the inventory of previously recorded cultural resources in the APE and the 0.25 mile study area, it appears that many of the historic features identified on the historic maps of the Don Pedro Project area have not been formally recorded as archaeological sites.

3.11.1.5 Results of Relicensing Studies

To assist FERC in identifying historic properties that may be affected by continued operation and maintenance of the Don Pedro Project under the new FERC license, the Districts conducted two cultural resources studies: the Historic Properties Study (TID/MID 2014a) and the Native American Traditional Cultural Properties (TCP) Study (TID/MID 2014b). The results of each of these studies are provided in the following sections and summarized in the table below (Table 3.11-2).

Table 3.11-2. Summary of results for the cultural resources relicensing studies.

Resource Type	NRHP Evaluation			Totals
	Ineligible	Unevaluated	Eligible	
Historic Properties Study				
Isolated Find	127	0	0	**127**
Archaeological Site[1]	130	75	29	**234**
Built Environment Resource[2]	33	3	1	**37**
Native American TCP Study				
TCP[3]	0	0	1	**1**
Totals	**290**	**78**	**31**	**399**

[1] This count includes two historic districts and one prehistoric district, the primary components of which are archaeological. All three districts have been evaluated as eligible for the NRHP.
[2] This count includes two historic districts comprised of built environment resources. Both districts are currently ineligible for the NRHP.
[3] The TCP identified is represented by a district.

3.11.1.5.1 Historic Properties Study

The Historic Properties Study focused on identifying archaeological and built environment resources within the APE. It included conducting a comprehensive and intensive field survey of the APE, which was completed between January 2012 and September 2012 in accordance with the Secretary of Interior's Standards and Guidelines for Identification (NPS 1983) and the BLM's Class III/intensive standards, per the BLM's 8100 manual series. Tribal monitors from the Tuolumne Band of Me-Wuk Indians and the Southern Sierra Miwuk Nation accompanied the field crew during the field survey.

Archaeological Resources

A total of 361 archaeological resources were identified as a result of the Historic Properties Study, including 127 isolated finds and 234 archaeological sites. Each of these resource groups are described below, including their NRHP evaluations.

Isolated Finds

A total of 127 isolated finds were located and documented within the APE as a result of the Historic Properties Study (see Attachment A for an isolate location map). Of the 127 isolated finds, 85 are prehistoric in affiliation and 42 are historic-era isolates. The prehistoric isolated finds are predominantly comprised of isolated flakes and groundstone tools, but also include flaked stone tools, cores, core tools, possible charm stones or atlatl weights, a bowl mortar fragment, and one milling station that is no longer in situ. The historic isolated finds include isolated occurrences of mining activity and isolated cairns/cadastrals, concrete features, rock alignments, earthen dams (likely modern), glass fragments, ceramic fragments, an earthen structure pad, a brick feature, and a tire.

As is usual for isolated finds, all 127 of these resources were evaluated as ineligible for inclusion on the NRHP.

Archaeological Sites

A total of 234 archaeological sites were identified within the APE as a result of the Historic Properties Study, of which at least 22 were previously documented during prior investigations and 212 were newly identified (see Attachment B for an archaeological site location map). As summarized in Section 2.2.2, there are a total of 97 previously recorded cultural resources within the APE, of which 19 archaeological sites were revisited and updated during the present field investigation[39]. Of the remaining 78 previously recorded resources, one is a built environment resource that is discussed in the following section (P-55-3913, the Red Mountain Bar Siphon) and 77 were not located in the field as they were likely either miss-mapped and are actually outside the APE or were inundated by the reservoir. Many of the historical features identified on historic maps of the APE were also located in the field and documented as archaeological sites; conversely, many were also not relocated due to inundation and because they have either eroded away over time or have been removed/covered by modern development.

Of the 234 archaeological sites identified, 129 contain historic-era deposits and features (two of these represent the Woods Creek Mining Landscape and the Kanaka Creek Mining Landscape), 76 represent prehistoric or Native American use (one of these represents the Tuolumne River Prehistoric Archaeological District) and 29 represent both prehistoric and historic-era occupations. The types of prehistoric sites represented in the APE include occupation sites, lithic quarry sites, small temporary task locations (lithic retooling, lithic reduction, subsistence procurement and processing, and hunting-related locals), districts/landscapes, and possibly other types of prehistoric or ethnographic occupation that could not be distinguished. Based on the artifact assemblages recorded during the study, the prehistoric or Native American occupation of the area appears to be focused on the Middle to Late Archaic periods through to the ethnographic or contact period (from roughly 7000 to 100 cal B.P., as provided above in Section 3.11.1.3.2). The historic sites observed represent the remains of a variety of historic-era land uses, primarily consisting of extensive mining, including two historic mining landscapes, utilities, homesteads, ranching/farming, transportation (roads, railroads), water control and conveyance features, and other unassociated historical remains. The historic occupation dates to as early as the late 1840s and as late as the 1960s.

As summarized in Table 3.11-3 below, 159 of the 234 archaeological sites identified within the APE were evaluated for the NRHP during the Historic Properties Study; 130 have been evaluated ineligible for inclusion in the NRHP and 29 have been evaluated as eligible for inclusion in the NRHP. The remaining 75 sites are unevaluated for the NRHP pending further work.

The remainder of this section provides more details of the archaeological sites. It is organized by site age – prehistoric, historic, and multi-component.

[39] Two of these previously recorded archaeological sites (P-55-1920 and P-55-1921) were merged to create one site during the present survey. As well, four of the other sites updated during the present survey (P-55-110, P-55-3876, P-55-5231, and P-55-7353) are comprised of linear sites, of which the segments previously recorded were located outside of the APE. Accordingly, these four sites were not counted as part of the 97 previously recorded cultural resources within the APE.

Table 3.11-3. Summary of NRHP evaluations for archaeological sites identified within the APE.

Age	Ineligible	Unevaluated	Eligible	Totals
Historic	98	23	8	**129**
Prehistoric	27	37	12	**76**
Multi-component	5	15	9	**29**
Totals	**130**	**75**	**29**	**234**

Prehistoric Resources

Of the 76 prehistoric sites identified within the APE, 12 are evaluated as eligible for inclusion on the NRHP, while 27 are evaluated as ineligible and 37 remain unevaluated pending further investigations (Table 3.11-4). The prehistoric sites have been grouped according to the following types:

(1) Lithic Scatter (26)

(2) Short-Term Habitation (14)

(3) Quarry (13)

(4) Long-Term Habitation (12)

(5) Milling Feature (6)

(6) Rock Shelter (2)

(7) Other (2)

(8) District (1)

Those sites included under the lithic scatter type include flaked stone debitage and/or flaked stone tools and contain no groundstone, milling features, or habitation features that might suggest more long term activity or a multi-task site. The lithic scatter sites may represent secondary lithic reduction and/or retooling locations and also locations related to hunting activities. Those sites grouped under the short-term habitation type include flaked and groundstone tools and debris and may include non-extensive bedrock milling stations (<10 mortar cups). It is assumed that these sites represent small temporary campsites that are occupied longer than the lithic scatters and thus are more complex and may represent multiple kinds of tasks being undertaken at them. Long-term habitation sites include those sites with prominent midden deposits and/or housepits or extensive (>10 mortar cups) milling features. These sites represent village sites that were occupied for much longer time periods than the short-term habitation sites, and generally represent an even greater variety of tasks and activities, with greater complexity of features and artifact types. The quarry type represents those sites with small to extensive quarries, where the primary activity appears to be focused on tool stone acquisition and usually includes moderate to heavy primary lithic reduction debris. The milling feature type includes those sites with an isolated milling feature or containing a non-extensive (<10 mortar cups) milling feature(s) with minimal associated debris. The rock shelter type represents those sites that contain a prominent rock shelter. As rock shelters are important sites that usually offer a great deal of information potential, it was important to identify these sites separately from the other site types, even when they contained other prominent features. The other type includes two sites that do not conform to the other categories. One is a possible tool cache and/or procurement location and one is a possible hunting blind. Finally, the district type represents one archaeological district, the Tuolumne River Prehistoric Archaeological District.

Historic Resources

Of the 129 historic sites identified within the APE, eight have been evaluated as eligible for inclusion on the NRHP, while 98 have been evaluated as ineligible and 23 remain unevaluated pending further investigations (Table 3.11-5). The historic sites have been grouped according to the following types:

(1) Transportation (51)

(2) Mining (40)

(3) Water Control/Hydroelectric (WCH) (20)

(4) Other (8)

(5) Utilities (5)

(6) Habitation (3)

(7) Trash Scatter (2)

The sites that fall within the transportation type include roads and railroads. Those within the mining type include placer mining and lode mining complexes and sites comprised of prospect pits, tailings, waste rock, shafts/adits, or other mining-related features. Additionally, two of the resources included under the mining type are historic landscapes that incorporate several sites as elements of the landscapes: Kanaka Creek Mining Landscape and Woods Creek Mining Landscape. Sites included under the water control/hydroelectric type are ditches, dams, reservoirs, and other features directly associated with water control and hydroelectric-related facilities. The other type covers those sites that do not conform to any of the other types, or whose type is unknown. The utilities type covers sites related to power transmission/distribution and/or communication facilities (telephone/telegraph lines and one radio tower) and includes sites comprised of utility poles and transmission line or radio tower footings. Sites that fall under the habitation type include those sites that represent primary residential locations. Finally, sites that are within the trash scatter type include those sites that are refuse scatters and represent primary or secondary discard, but are not associated with a primary residential location and have no features that represent an activity that would suggest association with one of the other types.

It is important to note that even though all of the sites have been assigned to one type, several of them may contain features or components that represent another type. For example, a mining complex under the mining type may also incorporate a habitation feature, transportation feature, and/or a water control feature. These sites are assigned to a particular type based on the primary activity/focus of the site, as determined by the number and type of components contained within the site.

Table 3.11-4. Summary of prehistoric sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
1	FW-DP-003	--	Prehistoric	Lithic Scatter	Lithic Scatter. Age unknown.	TID/MID/ BLM	U	U
2	FW-DP-004	--	Prehistoric	Lithic Scatter	Lithic Scatter; three artifacts and ~20 flakes. Age unknown.	TID/MID/ BLM	U	U
3	FW-DP-005	--	Prehistoric	Lithic Scatter	Lithic Scatter: Small, moderately dense (up to three flakes per square meter) greenstone flake and artifact scatter of 23 items. Age unknown.	TID/MID/ BLM	U	U
4	FW-DP-006	--	Prehistoric	Lithic Scatter	Lithic Scatter small, sparse, greenstone flake scatter (eight flakes on the surface), shovel probe test uncovered four additional flakes. Age unknown.	TID/MID/ BLM	U	U
5	FW-DP-043	--	Prehistoric	Settlement	Habitation site; 40 cultural items were recorded and mapped. These consist of ten core tools, 14 handstones, two bifaces, one pestle, one perforator, two milling slabs, one cobble tool, one flake tool, two cores, and six flakes. Dates to Middle Archaic.	TID/MID	E	C
6	FW-DP-068	--	Prehistoric	Subsistence	BRM with one cup. Age unknown.	TID/MID/ BLM	I	NC
7	FW-DP-072	--	Prehistoric	Subsistence	Two BRMs ~50m apart. Age unknown.	TID/MID	I	NC
8	FW-DP-081	--	Prehistoric	Settlement	Occupation site with BRMs across from marina; eight bedrock milling features, a possible rockshelter, midden deposit, ground stone artifacts, and at least one flake. Age unknown.	TID/MID/ Private	E	C
9	FW-DP-086	--	Prehistoric	Short-term Habitation	Lithic scatter with three bifacial tools, two battered cobbles, one core, two handstones, one millingstone fragment, and one cobble tool. Age unknown.	TID/MID/ BLM	U	U
10	HDR-DP-001	--	Prehistoric	Milling Feature	A single milling station. Age unknown.	TID/MID	I	NC
11	HDR-DP-013	--	Prehistoric	Short-term Habitation	One milling station; lithic scatter (50+ flakes). Age unknown.	TID/MID	I	NC
12	HDR-DP-014	--	Prehistoric	Quarry	Lithic scatter (40+ flakes, one handstone, one biface); one quarry feature. Age unknown.	TID/MID	I	NC
13	HDR-DP-015	--	Prehistoric	Quarry	Quarry/assay location with lithic scatter (100+ flakes). Age unknown.	TID/MID	I	NC
14	HDR-DP-018	--	Prehistoric	Quarry	Quarry; lithic scatter (500+ flakes, one battered cobble, one scraper, and one milling slab); one milling station. Age unknown.	TID/MID	U	C
15	HDR-DP-021	--	Prehistoric	Quarry	Quarry/assay location; Lithic scatter (200+ flakes, 20+ assayed cobbles, one spokeshave). Age unknown.	TID/MID	I	NC
16	HDR-DP-024	--	Prehistoric	Long-term Habitation	Lithic scatter (65+ flakes, one core, one handstone, one abrader, one scraper, one chopper); three milling features with possible rock art; Looter's pile. Age unknown.	TID/MID	E	C
17	HDR-DP-026	--	Prehistoric	Long-term Habitation	Two loci: lithic scatter and tools (450+ flakes, 20+ FCR, five hanstones, three choppers, two Elko series projectile points, one modified flake, one scraper, one biface). Dates to Middle Archaic.	TID/MID	E	C
18	HDR-DP-027	--	Prehistoric	Other	Three features: two possible hunting blinds; one rock scatter. Age unknown.	TID/MID	U	U
19	HDR-DP-028	--	Prehistoric	Short-term Habitation	Three milling stations; lithic scatter (25+ flakes). Age unknown.	TID/MID	U	U
20	HDR-DP-032	--	Prehistoric	Short-term Habitation	Lithic scatter (300+ flakes, two handstones, one milling slab). Age unknown.	TID/MID	I	C
21	HDR-DP-033	--	Prehistoric	Lithic Scatter	Lithic scatter (10 flakes). Age unknown.	TID/MID	U	U
22	HDR-DP-034	--	Prehistoric	Short-term Habitation	Lithic scatter (30+ flakes and 1 handstone). Age unknown.	TID/MID	I	NC
23	HDR-DP-041	--	Prehistoric	Quarry	Quarry/assay location; Lithic scatter (100+ flakes, one core). Age unknown.	TID/MID	U	U
24	HDR-DP-043	--	Prehistoric	Lithic Scatter	Lithic scatter (12 flakes - two are utilized, one scraper, one core, one possible spokeshave). Age unknown.	TID/MID	U	U
25	HDR-DP-046	--	Prehistoric	Milling Feature	One milling station feature (four cups); lithic scatter (three flakes). Age unknown.	TID/MID	U	U
26	HDR-DP-047	--	Prehistoric	Milling Feature	One milling station feature (three cups); lithic scatter (two flakes). Age unknown.	TID/MID	U	U
27	HDR-DP-049	--	Prehistoric	Lithic Scatter	Lithic scatter (eight flakes, one core). Age unknown.	TID/MID	U	U
28	HDR-DP-050	--	Prehistoric	Quarry	One quarry feature; lithic scatter (500+ flakes). Age unknown.	TID/MID	I	NC

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
29	HDR-DP-054	--	Prehistoric	Quarry	One quarry feature; lithic scatter (27 flakes). Age unknown.	TID/MID	I	NC
30	HDR-DP-055	--	Prehistoric	Lithic Scatter	Lithic scatter (six flakes). Age unknown.	TID/MID	I	NC
31	HDR-DP-056	--	Prehistoric	Lithic Scatter	Lithic scatter (15 flakes). Age unknown.	TID/MID	I	NC
32	HDR-DP-057	--	Prehistoric	Quarry	One quarry feature; Lithic scatter (215+ flakes, one core). Age unknown.	TID/MID	I	NC
33	HDR-DP-058	--	Prehistoric	Lithic Scatter	Lithic scatter (50+ flakes). Age unknown.	TID/MID	U	U
34	HDR-DP-060	--	Prehistoric	Lithic Scatter	Lithic scatter (six flakes). Age unknown.	TID/MID	U	U
35	HDR-DP-061	--	Prehistoric	Long-term Habitation	Lithic scatter (two loci, 60+ flakes, one retouched flake, one scraper); midden; possible housepit. Age unknown.	TID/MID	U	U
36	HDR-DP-062	--	Prehistoric	Lithic Scatter	Lithic scatter (four flakes - one is a possible scrapper, one broken CCS cobble). Age unknown.	TID/MID	I	NC
37	HDR-DP-063	--	Prehistoric	Quarry	One milling station feature (three cups); quarried outcrop; lithic scatter (12 pieces of debitage). Age unknown.	TID/MID	U	U
38	HDR-DP-064	--	Prehistoric	Lithic Scatter	Lithic scatter (nine flakes). Age unknown.	TID/MID	I	NC
39	HDR-DP-065	--	Prehistoric	Lithic Scatter	Lithic scatter (100 flakes, one digging tool); a quarried CCS cobble with flake scars. Age unknown.	TID/MID	U	U
40	HDR-DP-066	--	Prehistoric	Short-term Habitation	Lithic scatter (25 flakes, two utilized flakes, two cores, one chopper, one scraper, two milling slabs, and two projectile points shown to the crew by local residents who collected them from the site the year before; Rosegate Series and Elko Series). Dates to Middle Archaic to Late Archaic.	TID/MID	U	C
41	HDR-DP-067	--	Prehistoric	Lithic Scatter	Lithic scatter (one flake, two assayed cobbles). Age unknown.	TID/MID	I	NC
42	HDR-DP-068	--	Prehistoric	Short-term Habitation	Lithic scatter (one portable mortar, three pieces of debitage). Age unknown.	TID/MID	I	NC
43	HDR-DP-069	--	Prehistoric	Quarry	Lithic scatter/assay location (four pieces of debitage). Age unknown.	TID/MID	I	NC
44	HDR-DP-071	--	Prehistoric	Lithic Scatter	Lithic scatter (one modified flake, one chopper, and two flakes). Age unknown.	TID/MID	I	NC
45	HDR-DP-073	--	Prehistoric	Lithic Scatter	Lithic scatter (one Elko Series projectile point, four cores, and seven flakes). Dates to Middle Archaic.	TID/MID	U	C
46	HDR-DP-074	--	Prehistoric	Long-term Habitation	Four bedrock milling station features; midden; lithic scatter (100+ flakes, three cores, three handstones, one milling slab, and one bifacially modified amethyst bottle glass fragment). Dates to Protohistoric age.	TID/MID	E	C
47	HDR-DP-075	--	Prehistoric	Lithic Scatter	Lithic scatter (two cores, one modified flake, and one biface). Age unknown.	TID/MID	I	NC
48	HDR-DP-076	--	Prehistoric	Quarry	Lithic scatter (100+ flakes, 50+ tools including choppers, hammerstones, edge modified cores, edge modified flakes, and cores); quarry (cobbles and outcrops across site). Age unknown.	TID/MID	E	C
49	HDR-DP-077	--	Prehistoric	Quarry	Lithic scatter (500+ flakes, 100+ tools, a sample was recorded including 25 edge modified flakes, nine bifaces, eight cores, five edge modified cores, four unifaces, three utilized flakes, four handstones, one scraper, one blade, one flake blank, and one chopper); quarry. Age unknown.	TID/MID	E	C
50	HDR-DP-095	--	Prehistoric	Long-term Habitation	One milling feature (12 cups); One handstone. Age unknown.	TID/MID	U	U
51	HDR-DP-106	--	Prehistoric	Long-term Habitation	Eight housepit features; nine milling station features; a possible water retention basin feature; a rock feature; a lithic scatter with four artifact scatters (100+ flakes, two edge modified flakes, one biface, one uniface, one cached pestle, several cores). Age unknown.	TID/MID	E	C
52	HDR-DP-107	--	Prehistoric	Lithic Scatter	Lithic scatter (150+, one biface). Age unknown.	TID/MID	I	NC
53	HDR-DP-109	--	Prehistoric	Short-term Habitation	Two milling station features (three cups total); lithic scatter (100+ flakes, one biface). Age unknown.	TID/MID	U	U
54	HDR-DP-110	--	Prehistoric	Lithic Scatter	Lithic scatter (14 flakes, one core/scraper). Age unknown.	TID/MID	I	NC
55	HDR-DP-112	--	Prehistoric	Lithic Scatter	Lithic scatter (two flakes, two modified flakes, one biface, one uniface). Age unknown..	TID/MID	I	NC
56	HDR-DP-113	--	Prehistoric	Long-term Habitation	Nine housepits with possible midden deposits; five milling stations; lithic scatter (50+ flakes, one uniface, one scraper, 100+ FCR, one bowl mortar fragment). Age unknown.	TID/MID	E	C
57	HDR-DP-115	--	Prehistoric	Quarry	Quarry feature; lithic scatter (200+ flakes, 30-60 cores). Age unknown.	TID/MID	I	C
58	HDR-DP-116	--	Prehistoric	Long-term Habitation	Five milling station features; lithic scatter (10+ flakes, one scraper). Age unknown.	TID/MID	U	U
59	HDR-DP-118	--	Prehistoric	Short-term Habitation	One milling station feature; lithic scatter (two loci, 190+ flakes, one biface). Age unknown.	TID/MID	U	U

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
60	HDR-DP-127	--	Prehistoric	Long-term Habitation	Lithic scatter with possible midden deposits (215+ flakes, two loci, one artifact concentration, six bifaces, four edge modified flakes, two unifaces, one handstone, one hammerstone, one core, and one flake blade. Age unknown.	TID/MID	U	C
61	HDR-DP-128	--	Prehistoric	Short-term Habitation	Two bedrock milling station features (nine cups total); lithic scatter (two flakes, one handstone). Age unknown.	TID/MID	U	U
62	HDR-DP-131	--	Prehistoric	Other	Ten+ possible atlatl weights, some are cached. Age unknown.	TID/MID	E	C
63	HDR-DP-135	--	Prehistoric	Short-term Habitation	Lithic scatter (two concentrations, eight flakes, one Elko Corner-notched projectile point, one bowl mortar fragment). Dates to Middle to Late Archaic age.	TID/MID	U	C
64	HDR-DP-137	--	Prehistoric	Lithic Scatter	Lithic scatter (5 flakes). Age unknown.	TID/MID	I	NC
65	HDR-DP-140	P-55-1331/ CA-TUO-306	Prehistoric	Long-term Habitation	Eight bedrock milling stations. Age unknown.	TID/MID	U	C
66	HDR-DP-141	--	Prehistoric	Lithic Scatter	Lithic scatter (eight flakes). Age unknown.	TID/MID	U	U
67	HDR-DP-145	--	Prehistoric	Lithic Scatter	Lithic scatter (70+ flakes, two bifaces, one flake tool, and one Elko Corner-notched point). Dates to Middle Archaic age.	TID/MID	U	C
68	HDR-DP-147	--	Prehistoric	Lithic Scatter	Lithic scatter (four flakes). Age unknown.	TID/MID	U	U
69	HDR-DP-151	--	Prehistoric	Long-term Habitation	Three milling station features; lithic scatter (100+ flakes, two handstones, one biface, two cores, two cached pestles, two cobble tools, one flake tool). Age unknown.	TID/MID	U	C
70	HDR-DP-155	--	Prehistoric	Short-term Habitation	Lithic scatter (four flakes, four handstones). Age unknown.	TID/MID	U	U
71	HDR-DP-158	--	Prehistoric	Short-term Habitation	Three groundstone artifacts and one flake tool. Age unknown.	TID/MID	I	NC
72	HDR-DP-164	P-55-1925/ CA-TUO-915	Prehistoric	Lithic Scatter	Lithic scatter (two flakes, one core). Previously identified milling station with 14+ mortar cups was not observed and likely inundated during current recordation. Age unknown.	TID/MID	U	U
73	HDR-DP-186	--	Prehistoric	Short-term Habitation	Lithic scatter (three handstones, two pestles, one millings slab, one flake). Age unknown.	TID/MID	U	U
74	HDR-DP-192	P-55-1363/ CA-TUO-340	Prehistoric	Rock Shelter	One rock shelter, midden, two bedrock milling stations; Lithic scatter (30+ flakes, 60+ cobble tools, 40+ groundstone tools). Age unknown.	TID/MID	E	C
75	HDR-DP-195	--	Prehistoric	Milling Feature	One milling station feature (one mortar cup) and one handstone. Age unknown.	TID/MID	U	U
76	HDR-DP-196	--	Prehistoric	District	Tuolumne River Prehistoric Archaeological District. Elements of the district are comprised of all prehistoric archaeological site components documented in the APE. Dates from 11,500 cal B.P. to the mid-19th Century.	TID/MID/ BLM	E	N/A

[1] NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; C = Contributing Element; NC = Non-Contributing Element; N/A = Not Applicable (this resource is the Tuolumne River Prehistoric Archaeological District and is not an element of the district).

Table 3.11-5. Summary of historic sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]: Individual Eligibility	NRHP Eligibility[2]: NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility[2]: NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
1	FW-DP-002/25/79	--	Historic	Utilities	Remnants of a former above-ground utility line. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
2	FW-DP-010	--	Historic	WCH	Ditch near Taco House site, two segments. Dates to c. 1850s-1950s.	TID/MID/BLM	I	N/A	N/A
3	FW-DP-011/012	--	Historic	WCH	Two parallel square-shaped ditches on Raggio parcel. Dates to c. 1930s.	TID/MID/BLM	I	N/A	N/A
4	FW-DP-013	--	Historic	Transportation	Road to Ferretti property near Moccasin Creek. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
5	FW-DP-016	--	Historic	Transportation	Old Sonora to Big Oak Flat Road; 690 feet road segment. Dates to c. 1850s-1970s.	TID/MID/BLM	I	N/A	N/A
6	FW-DP-020	--	Historic	WCH	Placer mining ditch with stacked rock support along Moccasin Creek. Dates to c. 1850s to early 20th century.	TID/MID/BLM	I	N/A	N/A
7	FW-DP-021	--	Historic	Mining	Temporary camp with three features: square rock alignment, fire ring, prospect pit. Historic age unknown.	TID/MID/BLM	U	N/A	N/A
8	FW-DP-022	--	Historic	Mining	Mining - Dredge Area with several tailings piles. Dates to c. 1935-1942.	TID/MID/BLM	I	N/A	N/A
9	FW-DP-024	--	Historic	Transportation	Jacksonville to Big Oak Flat Road. Dates to c. 1850s-1930s.	TID/MID/BLM	I	N/A	N/A
10	FW-DP-026	--	Historic	WCH	Ditch West of Steven's Bar, approximately 150 in length. Dates to c. 1850s-early 20th century.	TID/MID	I	N/A	N/A
11	FW-DP-030/031	--	Historic	Mining	Hard rock mining complex, two loci with four collapsed adits each, four features. Dates to c. 1850s-early 20th century.	TID/MID/BLM	U	N/A	N/A
12	FW-DP-032	--	Historic	Other	Bulldozed structure and leveled area (possible structure location), no artifacts/features. Dates to c. 1960s-1970s or later.	TID/MID/BLM	I	N/A	N/A
13	FW-DP-033	--	Historic	WCH	Ditch, ~470 feet long, near Jacksonville. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
14	FW-DP-034/035/036/063	--	Historic	Transportation	Jacksonville area roads: three road segments, one trail; one rock wall. Dates to c. late-19th /early-20th century.	TID/MID/BLM	I	N/A	N/A
15	FW-DP-037/038	--	Historic	Transportation	Don Pedro and Indian Bar Road. Dates to c. 1850s-1970.	TID/MID/BLM	I	N/A	N/A
16	FW-DP-039	--	Historic	Transportation	Road, 290 feet long. Unknown Historic age (pre-1971).	TID/MID	I	N/A	N/A
17	FW-DP-040	--	Historic	Transportation	Road, 360 feet long. Unknown historic age (pre-1971).	TID/MID/BLM	I	N/A	N/A
18	FW-DP-041	--	Historic	Transportation	Road; two segments, 210 and 2,495 feet long. Unknown historic age (pre-1971).	TID/MID/BLM	I	N/A	N/A
19	FW-DP-042	--	Historic	WCH	Ditch (Brown Adit area). Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
20	FW-DP-046	P-55-3227/ CA-TUO-2253H	Historic	WCH	Brown Adit site, originally recorded in 1989 by Napton and Greathouse, four new features (adit, shop building foundations, concrete platform, waste rock pile). Dates to c. 1920s-1945.	TID/MID/BLM	E	N/A	N/A
21	FW-DP-047/048/051/052	--	Historic	Transportation	Road (Railroad Canyon); four segments. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
22	FW-DP-050	--	Historic	Mining	Clio Mine; 14 features. Dates to c. 1870s-c. 1942.	TID/MID/BLM/Private	E	N/A	N/A
23	FW-DP-053	--	Historic	Mining	Kanaka Creek mining landscape (District); several features including roads, ditches, coyote holes (adits), numerous randomly stacked tailings piles, pits, and channels in Kanaka Creek. There are sixe elements (FW-DP-54, FW-DP-57, FW-DP-58, FW-DP-59, FW-DP-80, FW-DP-99); Dates to c. 1850s- c. 1930s. A prehistoric component within the District is not considered an element of the District as it is not affiliated with the time period or theme of the District.	TID/MID/BLM/Private	E	N/A	N/A
24	FW-DP-054	--	Historic	WCH	Ditch above Kanaka Creek Cabin, 195 feet long. Dates to c. 1850s-c. 1930s.	TID/MID/Private	I	NC	N/A
25	FW-DP-055	--	Historic	Mining	Hard Rock mining site; four features (one pit, three linear prospects). Dates to c. 1880-post 1945.	TID/MID/BLM	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
26	FW-DP-056	--	Historic	WCH	Ditch (west of Stevens Bar) ~60 feet long, four features. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
27	FW-DP-058	--	Historic	WCH	Two ditches with reservoir in Kanaka Creek Landscape; five features - ditch segment, earthen berm, ditch, dam breach, linear rock pile. Dates to c. 1850s to c. 1930s.	TID/MID/BLM	I	C	N/A
28	FW-DP-059	--	Historic	Transportation	470 foot earthen road (along Kanaka Creek). Dates to c. 1850s to c. 1930s.	TID/MID/BLM	I	NC	N/A
29	FW-DP-061	--	Historic	WCH	Two Ditch segments, 90 feet and 106 feet. Dates to c. 1850s to c. 1880s.	TID/MID/BLM	I	N/A	N/A
30	FW-DP-064	--	Historic	WCH	Ditch 1,366 feet long. Dates to c. 1869.	TID/MID/BLM	I	N/A	N/A
31	FW-DP-065	--	Historic	Mining	Woods Creek placering mining complex with habitation area; seven features: hand stacked rock wall, linear stacked rock wall, tailings piles, placer mining gulch, tailings piles, hand-stacked waste rock, tailing piles. Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
32	FW-DP-066	--	Historic	WCH	One Ditch (above FW-DP-65) 970-feet, six features incl. stacked rock feature. Dates to c. 1850-1880s.	TID/MID/BLM	I	N/A	C
33	FW-DP-069	--	Historic	Mining	Placering area at mouth of Sullivan Creek; six features (channel, pit, tailings, mining cuts with associated tailings, channel, and fire ring). Dates to c. 1848-1880s.	TID/MID/BLM	U	N/A	N/A
34	FW-DP-070/071	--	Historic	Mining	Woods Creek Mining Landscape (includes FW-DP-65; FW-DP-66; FW-DP-87; FW-DP-88; FW-DP-89; FW-DP-91; FW-DP-94; FW-DP-95; FW-DP-96; FW-DP-97; FW-DP-98; ISO-FW-DP-09; ISO-FW-DP-13; ISO-FW-DP-33). Dates to c. 1850-1880s.	TID/MID/BLM/Private	E	N/A	N/A
35	FW-DP-073	P-55-3877/ CA-TUO-2893H	Historic	Transportation	Ward's Ferry Road; two segments and three new features (stacked rock retaining wall, two board-formed reinforced concrete abutments) recorded as part of this update. The stone bridge abutments of old Ward's Ferry Bridge were recorded as a separate site. Dates to c. 1875-1930s.	TID/MID/BLM	U	N/A	N/A
36	FW-DP-074	--	Historic	Transportation	Ward's Ferry Bridge Abutments (two stone abutments on either side of the Tuolumne River). Dates to c. 1875.	TID/MID	I	N/A	N/A
37	FW-DP-075	--	Historic	Transportation	Old River Road, 1,935 feet long, one stacked rock feature. Dates to c. 1914.	TID/MID/BLM	I	N/A	N/A
38	FW-DP-076	--	Historic	Mining	McCormick River Mine; five features: stacked rock walls, collapsed adit, drainage pipe, gate post, wooden lean-to (possibly modern). Dates to post 1914 to c. 1930s.	TID/MID/BLM/Private	U	N/A	N/A
39	FW-DP-077	--	Historic	Transportation	Road, inaccessible by foot; 0.5 miles long. Age unknown.	TID/MID/Private	I	N/A	N/A
40	FW-DP-080	--	Historic	Transportation	Road adjacent to Cabin near Kanaka Creek (FW-DP-57); 150 foot segment in the APE. Dates to late-19th to early-20th century.	TID/MID/Private	I	NC	N/A
41	FW-DP-082	--	Historic	Transportation	Earthen road on Mine Island; approximately 150 feet in length. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
42	FW-DP-083	--	Historic	WCH	Earthen bermed ditch on Mine Island. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
43	FW-DP-084	--	Historic	Transportation	Earthen road on Mine Island, approximately 1,882 feet in length. Unknown Historic age.	TID/MID/BLM	I	N/A	N/A
44	FW-DP-087	--	Historic	WCH	Ditch with rock-work along Woods Creek, two linear segments. Dates to c. 1850s to 1880s.	TID/MID	I	N/A	C
45	FW-DP-088	--	Historic	WCH	Earthen bermed ditch along Woods Creek. Dates to c. 1850s to 1880s.	TID/MID	I	N/A	C
46	FW-DP-089	--	Historic	Transportation	Road above Woods and Slate creeks. Dates to c. 1850s-early 20th century.	TID/MID/Private	I	N/A	C
47	FW-DP-091	--	Historic	WCH	Ditch along Woods Creek; two discontinuous segments (A and B), segment A contains a stacked-rock retaining wall (Feature 1). Dates to c. 1850s-1880s.	TID/MID	I	N/A	C
48	FW-DP-092	--	Historic	Habitation	Raggio Parcel across from Taco House; rectangular rock foundation, concrete structure pads, a cased well, and two ditches (FW-DP-11/12). Dates to c. late 19th-century to c. 1930s.	TID/MID/BLM	U	N/A	N/A
49	FW-DP-093	--	Historic	Transportation	Earlier alignment of Grizzly Road/Highway 120; paved and measures approximately 25 feet wide and 1,710 feet long. Dates between c. 1934 and c. late 1960s/early 1970s.	TID/MID/Private	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2] Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
50	FW-DP-094	--	Historic	Mining	Woods Creek placer mining complex; three distinct areas of mining resources (loci H, I, and J) that include placer tailings piles, mining cuts, and a mining claim. Dates to c. 1850s-1880s.	TID/MID/BLM/Private	U	N/A	C
51	FW-DP-095	--	Historic	Mining	Woods Creek placer mining complex with habitation areas, three loci (F, G, and K), 13 features recorded (more located). Dates to c. 1850s-1880s.	TID/MID/Private	E	N/A	C
52	FW-DP-096	--	Historic	Mining	Woods Creek placer mining complex, remnants of placer mining activities along a terrace above Woods Creek; three loci (C, D, and E) and three hand-stacked waste rock features (feature 1a, 1b and 2); single "black" glass bottle base fragment Dates to c. 1850s-1880s.	TID/MID/Private	U	N/A	C
53	FW-DP-097	--	Historic	Mining	Woods Creek placer mining complex including hand-stacked rock walls and placering piles; three loci (L, M, and N), three features (dry-stacked rock wall dam, hand-stacked waste rock feature, prospect pit), no artifacts. Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
54	FW-DP-098	--	Historic	Mining	Woods Creek placer mining complex with possible structure flat/tent pad (feature 1). Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
55	FW-DP-100	--	Historic	Transportation	Road segment along Willow Creek. Dates to c. pre-1944.	TID/MID/BLM	U	N/A	N/A
56	FW-DP-109	P-55-3876/ CA-TUO-2892H	Historic	Transportation	Pedestrian/animal trail with rock retaining walls. Dates to 1851.	BLM	U	N/A	N/A
57	HDR-DP-002	--	Historic	Transportation	A historic road segment. Dates between the late 19th century and the 1960s.	TID/MID	I	N/A	N/A
58	HDR-DP-004	--	Historic	Transportation	Four historic dirt road segments. Dates to pre-1944.	TID/MID	I	N/A	N/A
59	HDR-DP-005	--	Historic	Mining	Two tailings piles; A pile of waste rock; Two features comprised of multiple placer scrapes; Artifact Concentration of historic metal. Dates to after the turn of the century.	TID/MID	I	N/A	N/A
60	HDR-DP-007	--	Historic	Other	Two features: a concrete pad; wooden beam; debris scatter. Dates to the early modern period (c. late 1960s or later).	TID/MID	I	N/A	N/A
61	HDR-DP-012	--	Historic	Transportation	Two historic road segments; two metal items; two quartz crystals (natural). Dates to c. 1890s.	TID/MID	I	N/A	N/A
62	HDR-DP-016	--	Historic	Mining	Nine mining features: four back dirt/tailings piles; three placer scar features; two ditches. Dates to post 1930.	TID/MID	I	N/A	N/A
63	HDR-DP-017	--	Historic	Mining	Two features: Three-four bulldozer scrapes, and backdirt pile. Age unknown.	TID/MID	I	N/A	N/A
64	HDR-DP-020	--	Historic	Mining	One feature comprised of about four tailings piles. Age unknown.	TID/MID	I	N/A	N/A
65	HDR-DP-022	--	Historic	Other	Two concrete foundations. Dates to c. late 1960s.	TID/MID	I	N/A	N/A
66	HDR-DP-023	--	Historic	Other	Nine features: one feature of concrete footings, three bulldozer scrapers, two rock cairns, two prospect pits, a benchmark. Dates to c. late 1960s.	TID/MID	I	N/A	N/A
67	HDR-DP-025	--	Historic	Transportation	A historic road segment. Dates to c. 1940 - 1960s	TID/MID	I	N/A	N/A
68	HDR-DP-030	--	Historic	Transportation	Old Highway 132. Two segments of a historic road; four features: a borrow scrape, two culvert, and earthen dam. Dates between the 1870s and early 1970s.	TID/MID	I	N/A	N/A
69	HDR-DP-035	--	Historic	Habitation	Historic homestead site of the Haskell family: two pits (possible cellar features), a rock alignment, and sparse trash scatter. Dates between 1880s and 1910s.	TID/MID	U	N/A	N/A
70	HDR-DP-051	--	Historic	Other	Windmill remains. Dates to c. 1960.	TID/MID	I	N/A	N/A
71	HDR-DP-052	--	Historic	Other	Windmill/well remains. Dates to c. 1960.	TID/MID	I	N/A	N/A
72	HDR-DP-072	--	Historic	Transportation	Road segment. Dates to c. 1960.	TID/MID	I	N/A	N/A
73	HDR-DP-079	--	Historic	Utilities	A segment of a utility pole line, with 17 pole remnants. Age unknown.	TID/MID	I	N/A	N/A
74	HDR-DP-081	--	Historic	Mining	Three features: a road/ditch, a placer scrape, an earthen dam. Age unknown.	TID/MID	I	N/A	N/A
75	HDR-DP-083	--	Historic	Transportation	Ten segments of an old alignment of Highway 49; five features: three flattened terraces, a debris pile, a stacked rock wall; one glass fragment and a few ceramic fragments. Dates between the 1850s and 1970s.	TID/MID/ BLM	I	N/A	N/A

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76	HDR-DP-084	--	Historic	Mining	Five waste rock/tailings piles. Age unknown.	TID/MID	I	N/A	N/A
77	HDR-DP-085	--	Historic	Mining	Mining complex with eight features (rock piles, a large pit with a rock alignment, placer scars), a metal pipe and tin can fragment. Age unknown.	TID/MID	I	N/A	N/A
78	HDR-DP-086	--	Historic	Mining	20 features: nine scrapes (possible tent platforms), three ditch segments, three pits, two features comprised of pipes sticking out of the ground, one road segment, one excavated area, and one rock pile; waste rock/placer tailings; limited associated debris. Dates between the late 19th Century and 1940.	TID/MID	E	N/A	N/A
79	HDR-DP-087	P-55-1913/ CA-TUO-903H	Historic	Habitation	Ten features: a dug-out house structure, a modern landmark shrine, one rock wall, one rock alignment, a structural foundation, remnants of a corral, an improved spring, a structural depression, a spring box, and a ditch segment; moderate trash scatter. Dates from 1870s to 1930s-1940s.	TID/MID	E	N/A	N/A
80	HDR-DP-090	--	Historic	Other	Two metal pipes. Dates to the late 1960s.	TID/MID	I	N/A	N/A
81	HDR-DP-094	--	Historic	Transportation	Don Pedro Road with two culverts, rock retaining wall; concrete pad; post; bulldozer scrape. Dates to early 1900s.	TID/MID	I	N/A	N/A
82	HDR-DP-096	--	Historic	Utilities	One feature: radio tower foundation. Dates to c. 1960.	TID/MID	I	N/A	N/A
83	HDR-DP-100	--	Historic	Mining	Six tailings/waste rock piles and a rock cairn. Dates to c. 1880s - 1890s	TID/MID	I	N/A	N/A
84	HDR-DP-101	P-55-1346/ CA-TUO-321H	Historic	Mining	Mining complex with waste rock/tailings, two level areas, a trench, a depression, a road trace, a standing stone structure, and three pieces of metal. Dates between the 1880s and 1890s.	TID/MID	U	N/A	N/A
85	HDR-DP-102	--	Historic	Mining	Four waste rock/tailings concentrations; one metal artifact; two historic fence posts. Dates between 1880s and 1940s.	TID/MID	I	N/A	N/A
86	HDR-DP-103	P-55-110/ CA-TUO-2007H	Historic	Transportation	Four segments of the Hetch Hetchy Railroad; three features (two culverts, one road), two railroad ties. Dates between 1916/1917 and 1949.	TID/MID	I	N/A	N/A
87	HDR-DP-104	--	Historic	Mining	Six distinct concentrations of waste rock, a cut utility pole and two beer cans. Dates to c. 1900.	TID/MID	I	N/A	N/A
88	HDR-DP-108	--	Historic	Mining	Four features: one hearth, one cairn, two waste rock/tailings concentrations. Age unknown.	TID/MID	I	N/A	N/A
89	HDR-DP-111	--	Historic	Transportation	One historic road segment. Dates to c. 1940 - 1960s	TID/MID	I	N/A	N/A
90	HDR-DP-114	P-55-7353/ CA-TUO-4795H	Historic	Transportation	Segment of the Don Pedro Spur of the Sierra Railway (one railroad spike, no features or other artifacts). Dates to c. 1921-1923.	TID/MID	I	N/A	N/A
91	HDR-DP-117	P-55-5231	Historic	Transportation	One historic road segment. Dates from the mid-1800s.	TID/MID/BLM	I	N/A	N/A
92	HDR-DP-120	--	Historic	Transportation	Three historic road segments. Dates from the mid-1800s.	TID/MID	I	N/A	N/A
93	HDR-DP-122	--	Historic	Mining	Four features: one earthen dam with rock retaining wall, one prospect pit, one rock alignment, two prospect trenches; trash scatter. Dates from the mid-1800s to the early 1900s.	TID/MID	U	N/A	N/A
94	HDR-DP-124	--	Historic	Mining	Six prospect pits; one water control feature; waste rock. Age unknown.	TID/MID	I	N/A	N/A
95	HDR-DP-125	--	Historic	Transportation	One historic road segment, "road to coulterville". Dates to pre-1875 through late 1870s.	TID/MID	I	N/A	N/A
96	HDR-DP-126	--	Historic	Mining	Three prospect trench features, one prospect pit; waste rock. Age unknown.	TID/MID	U	N/A	N/A
97	HDR-DP-129	--	Historic	Transportation	Two segments of Morgan's Bar Road. Dates to mid to late 1800s.	TID/MID	I	N/A	N/A
98	HDR-DP-133	--	Historic	Mining	Nine tailings piles. Age unknown.	TID/MID	U	N/A	N/A
99	HDR-DP-136	--	Historic	Transportation	One historic road segment with bulldozer scrapes/push piles. Age unknown.	TID/MID	I	N/A	N/A
100	HDR-DP-138	--	Historic	Transportation	Two historic road segments. Age unknown.	TID/MID	I	N/A	N/A
101	HDR-DP-143	--	Historic	Transportation	One historic road segment. Dates from the mid to late 1800s.	TID/MID	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
102	HDR-DP-144	P-55-3175/ CA-TUO-2201H	Historic	WCH	A historic pipeline with 13 access point features. Dates between the 1870s to the present.	TID/MID	I	N/A	N/A
103	HDR-DP-146	--	Historic	Transportation	One road segment. Dates to late 1960s/early 1970s.	TID/MID	I	N/A	N/A
104	HDR-DP-148	--	Historic	Trash Scatter	Three can dumps (over 1,500 tin cans and other refuse) associated with the construction of the Hetch Hetchy Project. Dates between the late 1920s and early 1930s.	TID/MID	U	N/A	N/A
105	HDR-DP-149	P-55-1887/ CA-TUO-877H	Historic	Mining	Three mine shafts, one pit, and one linear cut. Age unknown.	TID/MID	I	N/A	N/A
106	HDR-DP-150	--	Historic	Transportation	Two segments of a historic road. Dates to c. 1850 - 1920s	TID/MID	I	N/A	N/A
107	HDR-DP-152	--	Historic	Utilities	Seven cut utility poles. Dates from 1923-early 1960s.	TID/MID/BLM	I	N/A	N/A
108	HDR-DP-153	--	Historic	Transportation	One historic road segment; three railroad ties and a metal can. Dates to the mid-1920s to the 1930s.	TID/MID	I	N/A	N/A
109	HDR-DP-154	--	Historic	Transportation	Two segments of a historic road; likely remnants of the Brown Adit Tramway. May date to mid 1870s, certainly 1920s-1960s.	TID/MID/BLM	I	N/A	N/A
110	HDR-DP-156	--	Historic	Transportation	One historic road segment. May be associated with HDR-DP-154 and date to c. 1920s.	TID/MID	I	N/A	N/A
111	HDR-DP-157	--	Historic	Trash Scatter	Possible remnants of a tramway associated with the construction of the Red Mountain Bar Siphon. One feature: an iron wheel encased in concrete; metal debris. Dates between the late 1920s and early 1930s.	TID/MID	I	N/A	N/A
112	HDR-DP-160	--	Historic	Transportation	One historic road alignment. Age unknown.	TID/MID	I	N/A	N/A
113	HDR-DP-161	--	Historic	Transportation	Seven segments of an historic road. Dates to c. 1890s	TID/MID	I	N/A	N/A
114	HDR-DP-165	--	Historic	Transportation	One historic road segment. Dates to c. 1905	TID/MID	I	N/A	N/A
115	HDR-DP-170	--	Historic	Other	One historic rock wall. Age unknown.	TID/MID	U	N/A	N/A
116	HDR-DP-171	--	Historic	Mining	A collapsed mine entrance; an adit; two concrete structures; trash scatter. Dates to the 1880s through the mid 1940s.	TID/MID	U	N/A	N/A
117	HDR-DP-173	--	Historic	Mining	Two features: one prospect pit, one prospect trench. Age unknown.	TID/MID	I	N/A	N/A
118	HDR-DP-174	--	Historic	WCH	One segment of a historic ditch. Age unknown.	TID/MID	I	N/A	N/A
119	HDR-DP-175	--	Historic	Transportation	One historic road segment, a metal pipe and a railroad spike. Dates to c. 1900 - c. 1942.	TID/MID	I	N/A	N/A
120	HDR-DP-178	--	Historic	Utilities	Four utility pole posts. Age unknown.	TID/MID	I	N/A	N/A
121	HDR-DP-179	--	Historic	Mining	One concrete foundation; one quartz tailing pile, one road segment, one adit. Dates from the 1880s to 1947.	TID/MID	U	N/A	N/A
122	HDR-DP-180	--	Historic	Mining	One historic road segment; three prospect trenches, three mine shafts/adits. Age unknown.	TID/MID	I	N/A	N/A
123	HDR-DP-181	--	Historic	Transportation	Two segments of a historic road, two rock features, and a railroad tie timber. Dates to c. 1895 - 1905.	TID/MID	I	N/A	N/A
124	HDR-DP-182	--	Historic	Transportation	Three historic road segments; dumped car. Dates to c. 1905 and c. 1970.	TID/MID	I	N/A	N/A
125	HDR-DP-183	--	Historic	Mining	13 mining-related features. Age unknown.	TID/MID	I	N/A	N/A
126	HDR-DP-187	--	Historic	Mining	One mining trench; one tailings pile. Age unknown.	TID/MID	I	N/A	N/A
127	HDR-DP-188	--	Historic	Mining	Two features: one trench, one tailings pile. Age unknown.	TID/MID	I	N/A	N/A
128	HDR-DP-193	--	Historic	WCH	Pedro Adit - portal for the Foothill Tunnel of the Hetch Hetchy Project. Remains include concrete foundations, waste rock pile, adit entrance, two road segments, utility pole stub, possible tent platform, trench, possible powder house, and limited debris. Dates between the 1920s and 1930s.	TID/MID	E	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
129	HDR-DP-197	--	Historic	Transportation	Gravel access road that was used during the construction of the Foothill Tunnel of the Hetch Hetchy Project. The road is now used as access for maintenance and inspections of the Foothill Tunnel, Pedro Adit, the Red Mountain Bar Syphon, and a transmission line. Dates from the 1920s to the 1930s.	TID/MID	U	N/A	N/A

[1] Types: WCH = Water Control / Hydroelectric.
[2] NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; C = Contributing Element; NC = Non-Contributing Element; N/A = Not Applicable (i.e., not an element of the landscape).
[3] In addition to those resources identified herein as elements to this landscape, the following resources are also elements of this landscape: FW-DP-57, a standing cabin (recorded as a built environment resource), FW-DP-99, a multi-component site addressed below, and ISO-FW-DP-9, ISO-FW-DP-13, and ISO-FW-DP-33 (recorded as isolated finds).

Multi-Component Resources

Of the 29 multi-component sites identified within the APE, nine have been evaluated as eligible for inclusion on the NRHP, while five have been evaluated as ineligible and 15 remain unevaluated pending further investigations (Table 3.11-6). The 29 prehistoric and historic components represented by the multi-component sites fall within the following historic and prehistoric types, which are the same as those described in the above sections, with the exception of the farming/ranching type that represents those historic components associated with farming/ranch activities:

Historic Types:

(1) Transportation (2)

(2) Mining (9)

(3) WCH (1)

(4) Utilities (3)

(5) Other (3)

(6) Habitation (8)

(7) Trash Scatter (1)

(8) Farming/Ranching (2)

Prehistoric Types:

(1) Lithic Scatter (4)

(2) Short-Term Habitation (9)

(3) Long-Term Habitation (10)

(4) Quarry (1)

(5) Milling Feature (3)

(6) Other (2)

Built Environment Resources

A total of 37 built environment resources were identified and recorded within the APE as a result of the Historic Properties Study (Table 3.11-7). These resources have been grouped into eight categories[40]:

(1) Don Pedro Project Dam System Resources (15)

(2) TID and MID Transmission Lines (2)

(3) Don Pedro Project Dam Construction-Related Resources (1)

(4) Don Pedro Project Operations Support Resources (8)

(5) Don Pedro Project Recreation-Related Resources (4)

(6) Don Pedro Project Historic District (1)

(7) Don Pedro Recreation Agency Historic District (1)

(8) Other Non-Don Pedro Project resources (5)

[40] The resources within the following categories are Don Pedro Project-related facilities, the operations and maintenance of which is licensed by FERC: Don Pedro Project Dam System Resources, Don Pedro Project Dam Construction-Related Resources, Don Pedro Project Operations Support Resources, Don Pedro Project Recreation-Related Resources, Don Pedro Project Historic District, and Don Pedro Recreation Agency Historic District. The resources in the other built environment categories are non-Don Pedro Project related resources, thus the operation and maintenance of these facilities does not fall under the Don Pedro Project FERC license.

Table 3.11-6. Summary of multi-component sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
1	FW-DP-017	P-55-6021	Multi-component	P: Long-term Habitation H: Habitation	Habitation site - Taco House Site with Human remains; eight features: two possible house pit features associated with the prehistoric/protohistoric component, and six features associated with the historic-era component. Historic dates to c. 1930s. Age unknown. However, glass beads indicate a protohistoric component.	TID/MID/BLM	E	C
2	FW-DP-018	--	Multi-component	P: Long-term Habitation H: Mining	Habitation site with human remains and a historic artifact scatter; two loci, two features, ~three BRMs, 22 artifacts; previously recorded but no trinomial. Age unknown. Historic dates to late 19th to mid-20th century.	TID/MID/BLM	E	C
3	FW-DP-078	P-55-1351/ CA-TUO-326	Multi-component	P: Long-term Habitation H: Habitation	Habitation site excavated by Moratto; Feature 1 is a quartz bedrock outcrop with three cupules, 12 artifacts. Dates to Protohistoric. Historic age dates to c. 1848 to c. 1914.	TID/MID/BLM	E	C
4	FW-DP-085	--	Multi-component	P: Short-term Habitation H: Mining	Multi-component site on Mine Island; Historic: (nine features) collection of mining-related archaeological resources: tailings piles, prospecting pits, surface vein workings, an adit, and a stock dam; Prehistoric: scatter of flaked and ground stone artifacts and debitage. Historic age dates to late 19th-early 20th century. Age unknown.	TID/MID/BLM	U	U
5	FW-DP-099	--	Multi-component	P: Milling Station H: Mining	Kanaka Creek placer and hard rock mining complex; BRMs with groundstone; two loci - A:linear tailings piles, sluicing channels, drainage trenches, pits, and randomly stacked tailings piles; B:two mortar cups; additional features 1-4; (three adits, one cut); no historic artifacts; three prehistoric artifacts (pestle, handstone end frag, pestle). Age unknown. Historic age dates to c. 1880s-1930s.	TID/MID/BLM	U	N/A
6	HDR-DP-006	P-55-1902/ CA-TUO-892	Multi-component	P: Quarry H: Habitation	Historic habitation location with two structural remnants (structure pads) and associated refuse (glass, ceramics, metal, one cut animal bone); a placer mining complex (two prospect pits, one area of placer scrapes, one ditch, and one excavated area) with limited debris (two pieces of metal and one piece of animal bone); an extensive lithic scatter with two quarry features (1,500+ flakes, one concentration, four scrapers, two bifaces, two cores, one quartz crystal, one milling slab, one utilized flake). Age unknown. Historic age dates between 1850 and 1960 and may represent either multiple periods of occupation of consistent occupation.	TID/MID	U	C
7	HDR-DP-009	--	Multi-component	P: Other H: Other	Two historic rock features; single prehistoric lithic flake. Prehistoric age unknown. Historic c. late 19th/early 20th century	TID/MID	I	NC
8	HDR-DP-019	--	Multi-component	P: Short-term Habitation H: Mining	Historic: 11 mining features and two metal artifacts. Prehistoric: milling station; lithic scatter (270+ flakes, one pestle, one core, one handstone). Prehistoric age unknown. Historic component dates to c. late 19th/early 20th Century.	TID/MID	U	U
9	HDR-DP-029	P-55-1920, P-55-1921, CA-TUO-910/H, CA-TUO-911/H	Multi-component	P: Long-term Habitation H: Habitation	Two loci; two features: a historic rock alignment and prehistoric milling station, seven depressions that are previous archaeological excavation units, historic refuse scatter including residential discard and structural debris (two historic artifact concentrations), lithic scatter (700+ flakes, 40+ lithic tools, 50-100 fire cracked rock). Prehistoric component dates to Late Archaic period based on previously identified point types (Desert Side-notched and Rosegate Series) and historic age dates to c. 1870 to c. 1900s.	TID/MID	E	C
10	HDR-DP-031	P-55-1923/ CA-TUO-913	Multi-component	P: Short-term Habitation H: Other	Five features: three modern depressions with backdirt piles, two historic bulldozer scrapes; lithic scatter (300+ flakes, two handstones). Prehistoric age is between 550 A.D. (1400 BP) and 1450 A.D. (500 BP) and historic age dates to between the 1930s and 1950s.	TID/MID	I	NC
11	HDR-DP-039	--	Multi-component	P: Short-term Habitation H: Habitation	Prehistoric lithic scatter (two flakes, one scraper) and milling station and four historic features (rock foundations for a residential structure and three rock alignments) and historic refuse. Age unknown. Historic component dates to late 19th Century/early 20th Century.	TID/MID	U	U
12	HDR-DP-042	--	Multi-component	P: Lithic Scatter H: Habitation	Five historic features: three pits and two rock foundations, limited historic trash scatter, lithic scatter (<ten flakes, four cores, one spokeshave, one gouge, two possible digging tools, one hammerstone). Unknown Prehistoric age and historic age c. 1890s to c. 1900s.	TID/MID	U	U
13	HDR-DP-045	--	Multi-component	P: Lithic ScatterH: Utilities	Lithic scatter (250+ flakes, two choppers, one modified flake, one utilized flake); transmission line tower foundations. Unknown Prehistoric age and historic age 1921-1923.	TID/MID	U	U

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
14	HDR-DP-053	--	Multi-component	P: Short-term Habitation H: Utilities	Transmission tower foundation; Lithic scatter (one pestle, one retouched flake, and three flakes). Unknown Prehistoric age and historic age 1921-1923.	TID/MID	U	U
15	HDR-DP-070	--	Multi-component	P: Short-term Habitation H: Mining	Historic component: three bulldozer scars, one bulldozer mound, one rock pile. Prehistoric component: lithic scatter (two flakes, two chunks of CCS with flake scars, one milling slab). Unknown Prehistoric and Historic age.	TID/MID	I	NC
16	HDR-DP-078	--	Multi-component	P: Lithic Scatter H: Transportation	Historic road segment; Lithic scatter (10+ flakes, one modified flake). Age unknown. Historic age between 1944 and 1962.	TID/MID	I	NC
17	HDR-DP-092	--	Multi-component	P: Long-term Habitation H: Utilities	15 prehistoric housepits; eight milling stations; three possible midden areas; lithic scatter (one artifact concentration, 350+ flakes, four bifaces, three modified flakes, one handstone, one uniface); one historic transmission line tower; limited historic trash scatter. Unknown Prehistoric age and historic age 1921-1923.	TID/MID	E	C
18	HDR-DP-093	--	Multi-component	P: Other H: Other	One feature with prehistoric and historic petroglyphs (three panels). Age unknown. Historic component dates to 1887.	TID/MID	I	NC
19	HDR-DP-098	--	Multi-component	P: Long-term Habitation H: Transportation	One segment of a historic road and four metal pipe fragments; one milling station (12 cups and two possible cups), two flakes, one possible handstone. Age unknown. Historic component dates between the 1920s and 1950s.	TID/MID	U	U
20	HDR-DP-099	--	Multi-component	P: Long-term Habitation H: Ranching / Farming	Two historic features: a concrete trough, one historic road segment, two prehistoric milling station features; three historic metal artifacts; lithic scatter (16 flakes, one core, one uniface). Unknown Prehistoric age and historic age possibly as early as the 1890s with continued use through the present.	TID/MID	U	U
21	HDR-DP-119	P-55-1360/ CA-TUO-336/H	Multi-component	P: Long-term Habitation H: Habitation	Prehistoric component: thousands of flakes, thousands of fire cracked rocks (FCR), several milling stations, midden deposits, numerous lithic tools, possible hearth features, possible remnant housepits, a cluster of quartz boulders that may represent a grave marker, and human remains. Historic component: sparsely scattered refuse (ceramics, metal, and glass), two rock alignments that appear to be property boundaries, and a depression of unknown function. Prehistoric component dates from the Middle to Late Archaic and ethnographic periods. Historic component dates to late 19th Century/early 20th Century.	TID/MID/ BLM	E	C
22	HDR-DP-130	--	Multi-component	P: Long-term Habitation H: Mining	One bedrock milling station feature; three prospect trenches; sparse trash scatter (glass, metal, ceramics); lithic scatter (six flakes, one handstone); one historic road segment. Age unknown. Historic component dates to the 1890s.	TID/MID	U	U
23	HDR-DP-134	--	Multi-component	P: Short-term Habitation H: Mining	One earthen dam feature; one dug-out feature; one ditch; one rock wall; one ditch/trail; three placer mining areas; lithic scatter (50+ flakes, one core, one flake tool, one handstone, one concentration). Unknown Prehistoric and Historic ages.	TID/MID	U	U
24	HDR-DP-139	--	Multi-component	P: Lithic Scatter H: Trash Scatter	Lithic scatter (10+ flakes, one core, one biface, one handstone); historic trash scatter (bottle glass, ceramics, and a nail). Age unknown.. Historic component dates to late 19th Century/early 20th Century.	TID/MID	U	U
25	HDR-DP-142	P-55-1384/ CA-TUO-361	Multi-component	P: Milling Feature H: Ranching / Farming	One historic fence segment; two milling stations (five cups) and three pestles. Unknown Prehistoric and Historic ages.	TID/MID	U	U
26	HDR-DP-162	P-55-1927/ CA-TUO-917	Multi-component	P: Short-term Habitation H: WCH	Two milling station features; two concrete footings; lithic scatter (25+ flakes, two cobble tools, one Elko Corner-notched point; historic trash scatter (bottle glass, a ceramic, and a square metal nut). Prehistoric component dates to Middle Archaic in age. Historic component dates to 1860s-1950s.	TID/MID	U	C
27	HDR-DP-189	--	Multi-component	P: Long-term Habitation H: Mining	Seven bedrock milling stations; Lithic scatter (two concentrations, 150+ groundstone tools - mostly fragmented, one battered cobble, and one core); Historic adit and two rock piles. Prehistoric age unknown. Historic age 1902.	TID/MID	E	C

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
28	HDR-DP-198	P-55-1928/ CA-TUO-918/H	Multi-component	P: Short-term Habitation H: Habitation	Only part of the historic component was observed and recorded during the present survey. This part included a fenceline, one piece of glass, a modern water system, an orchard area, and a few other fruit/nut trees. Previous recordation noted the following: A prehistoric lithic scatter with six+ flakes and one handstone; a historic ranching complex with 12 standing structures, two wells and associated water systems, a former structure location, a recent trash pit, many exotic fruit, nut, and other trees and vegetation, roads, fences, ranching machinery, and other associated remains. Prehistoric age unknown. Historic component dates from the 1860s to the present.	TID/MID	E	U
29	HDR-DP-250	--	Multi-component	P: Millling Feature H: Mining	Extensive placer mining area with 17 historic features (four trenches or sluicing channels, two structural depressions, one stone foundation, one stone oven, one road trace, one culvert, one rock pile/cairn, one rock alignment, a waste rock pile, a collapsed adit, one stacked rock pile, a reservoir, and one feature comprised of rock dams) and limited associated trash (one automobile and automobile parts date to a later period than the rest of the historic component). The prehistoric component is an isolated milling station (three mortar cups). Historic component dates to two periods: 1848 to 1850s and 1950s to 1960s. Prehistoric age is unknown.	TID/MID/ BLM	E	NC

1 Types: P = Prehistoric; H = Historic; WCH = Water Control / Hydroelectric.
2 NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; Only the prehistoric components of these multi-component sites are considered district elements.

Of the 37 built environment resources documented within the APE, all but four are less than 50 years of age. Of these four resources that are older than 50, one has been evaluated as eligible for inclusion on the NRHP and three remain unevaluated regarding their eligibility for inclusion on the NRHP pending further work (one of these is also an element to a NRHP eligible historic landscape that is discussed with the archaeological resources above). Of the remaining 33 built environment resources, all were constructed less than 50 years ago, e.g., 1968–1972. None of these 33 resources are considered to be exceptionally significant (NRHP Criterion Consideration G), as would be required of resources less than 50 years of age to be considered eligible for inclusion on the NRHP. Subsequently, these 33 resources are evaluated as not eligible for listing on the NRHP. However, when these resources do become 50 years of age, reassessment of their eligibility for inclusion on the NRHP will likely find several of these resources eligible for inclusion on the NRHP (Table 3.11-8), assuming their current level of integrity remains intact. Table 3.11-8 provides a summary of all 37 built environment resources, their NRHP eligibility evaluations, and potential future NRHP eligibility evaluations, if applicable. As two of the resources not yet 50 years of age are historic districts that incorporate several of the other resources as elements, the table below also identifies which elements of the two districts will potentially be evaluated in the future as contributing and non-contributing elements to the districts once the districts reach 50 years of age.

Table 3.11-7. Summary of built environment resources identified within the APE.

Building/Structure (Field Designation)	Date	Engineering Style/Type	Designer
Don Pedro Project Dam System Resources			
Don Pedro Dam (FR-1)	1970	Earth and Rock Fill	Bechtel
Gated Dam Spillway (HDR-1a)	1969	None	Bechtel
Un-gated Dam Spillway (HDR-1b)	1969	None	Bechtel
Dike A (HDR-2a)	1969-1970	Earth and cobble fill	Bechtel
Dike B (HDR-2b)	1969-1970	Earth and cobble fill	Bechtel
Dike C (HDR-2c)	1969-1970	Earth and cobble fill	Bechtel
Gasburg Creek Dike (HDR-2d)	1970	Earth and cobble fill	Bechtel
Powerhouse (FR-2)	1968-1970	Industrial	Bechtel
Switchyard (FR-3a)	1971	Industrial	Bechtel
Power Intake and Tunnel (FR-4)	1968-1970	None	Bechtel
Outlet Works/Diversion Tunnel (FR-5)	1968	None	Bechtel
Unit 1 Substation (HDR-3)	1970	None	Bechtel
Unit 2 Substation (HDR-4)	Circa 1972	None	Bechtel
Cable Hoist Building/Inclined Gate Track (HDR-5)	1969-1971	Utilitarian	Bechtel
Reservoir (FR-6)	1970	None	Bechtel
TID and MID Transmission Lines			
TID (east) Transmission Line (FR-3b)	1970 to 1971	Steel lattice towers	Bechtel
MID (west) Transmission Line (FR-3c)	1970 to 1971	Steel lattice towers	Bechtel
Don Pedro Project Dam Construction-Related Resources			
Guy F. Atkinson Company construction camp powder house (HDR-6)	1967-1968	Utilitarian	Bechtel
Don Pedro Project Operations Support Resources			
Dam Storage Yard Warehouse (HDR-8)	1971	Butler style building	Bechtel
Riley Ridge Microwave Building and Tower (1 building and attached tower), and second tower built in 1986 (HDR-9)	1970–1971; 1986	Contemporary	Unknown; Possibly James W.B. Shade-Turlock
Riley Ridge Employee Housing House 1 (HDR-10a)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 2 (HDR-10b)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 3 (HDR-10c)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 4 (HDR-10d)	1972	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 5 (HDR-10e)	1972	Contemporary	James W.B. Shade-Turlock
Riley Ridge Water Tank (HDR-11)	1971	Utilitarian	National Tank Manufacturing Company of Los Angeles

Building/Structure (Field Designation)	Date	Engineering Style/Type	Designer
Don Pedro Project Recreation-Related Resources			
Headquarters and Visitor Center (HDR-12)	1972	Pole	Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Moccasin Point Recreation Area (HDR 13)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Blue Oaks Recreation Area (HDR-14)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Fleming Meadows Recreation Area (HDR 15)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Don Pedro Project Historic District			
Don Pedro Project Historic District	1968-1972	Industrial/Utilitarian/ Contemporary	Bechtel, James W.B. Shade, and National Tank Manufacturing Company
Don Pedro Recreation Agency Historic District			
Don Pedro Recreation Agency Historic District	1971-1972	Pole/Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Other Non-Don Pedro Project resources			
Kanaka Creek cabin (FW-DP-57)	1930s-1950s	Vernacular	Unknown
La Grange Ditch (FW-DP-08)	1872	Vernacular water conveyance structure	Augustus Bowie
Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928H)	1923	Engineered water conveyance structure	Marsden Manson and Michael Maurice O'Shaughnessy
Moccasin Creek stone building (HDR-DP-101/P-55-1346/CA-TUO-321H)	1890s	Vernacular rubble construction	Unknown
Hetch Hetchy Moccasin-Newark Transmission Line (HDR-16)	1969	Steel lattice towers	Unknown

Table 3.11-8. Summary of NRHP evaluations for built environment resources identified within the APE. [1]

Building/Structure (Field Designation)	NRHP Eligibility	Potential Future NRHP Eligibility of Resources Not Yet 50 Years of Age	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Project Historic District	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Recreation Agency Historic District
Don Pedro Project Dam System Resources				
Don Pedro Dam (FR-1)	Ineligible	Eligible	Contributing Element	N/A
Gated Dam Spillway (HDR-1a)	Ineligible	Eligible	Contributing Element	N/A
Un-gated Dam Spillway (HDR-1b)	Ineligible	Eligible	Contributing Element	N/A

Building/Structure (Field Designation)	NRHP Eligibility	Potential Future NRHP Eligibility of Resources Not Yet 50 Years of Age	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Project Historic District	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Recreation Agency Historic District
Dike A (HDR-2a)	Ineligible	Ineligible	Contributing Element	N/A
Dike B (HDR-2b)	Ineligible	Ineligible	Contributing Element	N/A
Dike C (HDR-2c)	Ineligible	Ineligible	Contributing Element	N/A
Gasburg Creek Dike (HDR-2d)	Ineligible	Ineligible	Contributing Element	N/A
Powerhouse (FR-2)	Ineligible	Eligible	Contributing Element	N/A
Switchyard (FR-3a)	Ineligible	Ineligible	Contributing Element	N/A
Power Tunnel (FR-4)	Ineligible	Eligible	Contributing Element	N/A
Outlet Works/Diversion Tunnel (FR-5)	Ineligible	Eligible	Contributing Element	N/A
Unit 1 Substation (HDR-3)	Ineligible	Ineligible	Non-Contributing Element	N/A
Unit 2 Substation (HDR-4)	Ineligible	Ineligible	Non-Contributing Element	N/A
Cable Hoist/Incline Track (HDR-5)	Ineligible	Eligible	Contributing Element	N/A
Don Pedro Reservoir (FR-6)	Ineligible	Ineligible	Contributing Element	N/A
TID and MID Transmission Lines				
TID (east) Transmission Line (FR-3b)	Ineligible	Ineligible	N/A	N/A
MID (west) Transmission Line (FR-3c)	Ineligible	Ineligible	N/A	N/A
Don Pedro Dam Construction-Related Resources				
Guy F. Atkinson Company construction camp powder house (Blue Oaks Campground) (HDR-6)	Ineligible	Ineligible	N/A	N/A
Don Pedro Project Operations Support Resources				
Dam Storage Yard Warehouse (HDR-8)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Microwave Building and two towers (HDR-9)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 1 (HDR-10a)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 2 (HDR-10b)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 3 (HDR-10c)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 4 (HDR-10d)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 5 (HDR-10e)	Ineligible	Ineligible	Non-Contributing Element	N/A

Building/Structure (Field Designation)	NRHP Eligibility	Potential Future NRHP Eligibility of Resources Not Yet 50 Years of Age	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Project Historic District	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Recreation Agency Historic District
Riley Ridge Water Tank (HDR-11)	Ineligible	Ineligible	Non-Contributing Element	N/A
Don Pedro Project Recreation-Related Resources				
Headquarters and Visitor Center (HDR-12)	Ineligible	Eligible	N/A	Contributing Element
Moccasin Point Recreation Area (HDR 13)	Ineligible	Eligible	N/A	Contributing Element
Blue Oaks Recreation Area (HDR-14)	Ineligible	Eligible	N/A	Contributing Element
Fleming Meadows Recreation Area (HDR 15)	Ineligible	Eligible	N/A	Contributing Element
Historic Districts				
Don Pedro Project Historic District	Ineligible	Eligible	N/A	N/A
Don Pedro Recreation Agency Historic District	Ineligible	Eligible	N/A	N/A
Other Non-Don Pedro Project Resources				
Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928H)	Unevaluated	N/A	N/A	N/A
La Grange Ditch (FW-DP-08)	Eligible	N/A	N/A	N/A
Kanaka Creek Cabin (FW-DP-57)[2]	Unevaluated	N/A	N/A	N/A
Hetch Hetchy Moccasin-Newark Transmission Line (HDR-16)	Ineligible	Ineligible	N/A	N/A
Moccasin Creek Stone Building (HDR-DP-101/P-55-1346/CA-TUO-321H)[3]	Unevaluated	N/A	N/A	N/A
Totals	**Ineligible = 33 Eligible = 1 Unevaluated = 3 Total = 37**	**Eligible = 13 Ineligible = 20 N/A = 4 Total = 37**	**Contributing = 13 Non-Contributing = 10 Total Elements = 23 N/A = 14**	**Contributing = 4 Non-Contributing = 0 Total Elements = 4 N/A = 33**

[1] N/A = Not Applicable.

[2] The Kanaka Creek Cabin (FW-DP-57) is also a contributing element to the Kanaka Creek Mining Landscape (FW-DP-53), which is discussed in the archaeological discussion above and has been evaluated as eligible for inclusion on the NRHP.

[3] The Moccasin Creek Stone Building (HDR-DP-101) is a feature of an archaeological site (site HDR-DP-101) also addressed in the archaeological discussion above. The entire site remains unevaluated regarding its eligibility for inclusion on the NRHP.

3.11.1.5.2 Native American Traditional Cultural Properties Study

The primary goal of this study was to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Don Pedro Project would have an adverse effect on eligible TCPs. The objective of this particular study was to identify TCPs that may potentially be affected by O&M, evaluate their eligibility to the NRHP, and identify Don Pedro Project-related activities that may affect eligible TCPs, and/or locations of ethnographic use.

To be considered a historic property, a TCP must have integrity and meet at least one of the NRHP criteria. When a place of traditional practices is evaluated as eligible for listing on the NRHP, it is termed a TCP. A TCP is defined as any property that is "…eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" [NR Bulletin 38 (Parker and King 1998:1)].

TCPs are further defined in National Register Bulletin 38 (Parker and King 1998:1) as:

(1) Locations associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.

(2) A rural community, whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents.

(3) An urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices.

(4) Locations where Native American religious practitioners have historically gone and are known or thought to go to today, to perform ceremonial cultural rules of practice.

The Districts contracted Dr. Michael Moratto in early 2012 to complete the Native American TCP Study. Dr. Moratto is a Senior Cultural Resources Specialist with Applied EarthWorks, Inc. and has over 40 years of experience in cultural studies throughout California.

The study included completing archival research focusing on locations used by or important to local Native Americans. The study also included outreach to both recognized and non-recognized Tribes and tribal members that may have interests in the Don Pedro Project location and may be able to offer intellectual knowledge of places important to local Native American groups. As part of this effort, Dr. Moratto conducted close to 20 face-to-face and telephone interviews with Tribal representatives (both individually and in groups) from three groups (the Tuolumne Band of Me-wuk Indians, the Southern Sierra Miwuk Nation, and the Chicken Ranch Rancheria) and one unaffiliated Yokuts/Miwuk individual that lives in Chinese Camp, California near the Don Pedro Project. Two field visits with Tribal representatives and Tribal elders to archaeological sites and other locations of importance to Tribal participants were also conducted. These investigations showed that certain traditional cultural activities—harvesting plants for use as foods, medicines, and basketry materials, the redistribution of harvested plants, fishing, and panning for gold—are still practiced today by residents of foothill Me-wuk communities.

As a result of the Native American TCP Study, eight cultural properties were identified as possible TCPs:

(1) the lower Kanaka Creek native plant gathering area;

(2) lower Moccasin Creek cultural area, encompassing a native plant harvesting area and archaeological sites 4-Tuo-307, 4-Tuo-313, 4-Tuo-314, 4-Tuo-318, FW-DP-81, and HDR-DP-192;

(3) auriferous streams;

(4) archaeological site HDR-DP-92;

(5) archaeological site HDR-DP-106;

(6) archaeological site HDR-DP-113;

(7) archaeological site HDR-DP-119; and

(8) a spring with associated native plants in the Blue Oaks Recreation Area.

Each of these properties was evaluated in terms of the significance and integrity criteria for the NRHP (36 CFR 60.4) as well as the additional qualifications for TCP status (Parker and King 1998). As a result of this evaluation process, one property—the Lower Kanaka Creek Traditional Native Plant Gathering District—was evaluated as NRHP-eligible under NRHP Criterion A (i.e., 36 CFR 60.4(a)) as a TCP and thus is a historic property that must be managed in accordance with Section 106 of the NHPA and its implementing regulations, 36 CFR 800 (see Attachment D for location map of the TCP). The archaeological resources investigated as potential TCPs were also assessed for the NRHP separately during the Historic Properties Study, for their archaeological attributes, the results of which are summarized in Section 3.11.2.1.1, above.

The diverse natural vegetation along lower Kanaka Creek has been viewed by generations of Indians as a source of traditional foods, medicines, and materials for making baskets and ceremonial regalia. Plants are still harvested in this locality today, and their availability contributes importantly to the maintenance of the foothill Me-wuk community's cultural traditions and identity. The plant-gathering area along lower Kanaka Creek is deemed to be a NRHP-eligible district significant under Criterion A because of its association with a "pattern of events or a historic trend that made a significant contribution to the development of a community, a State, or the nation" (NPS 1995:12), and specifically because of its association with cultural practices of a living community.

3.11.2 Resource Effects

Continued operation and maintenance of the Don Pedro Project may affect cultural resources that are listed on or eligible for listing on the NRHP (i.e., historic properties). The effect may be direct (e.g., result of ground disturbing activities), indirect (e.g., public access to recreation areas), or cumulative (e.g., caused by a Don Pedro Project activity in combination with other non-Don Pedro Project activities). Certain O&M activities may affect historic properties within the Project Boundary or outside the Project Boundary.

Adverse effects are activities that may alter those characteristics of an historic property that contribute to its NRHP eligibility in a manner diminishing the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Examples of adverse effects would include road maintenance that affects a previously undisturbed archaeological deposit, or a facilities upgrade that removes the windows or doors of an historic powerhouse and does not replace them in kind, with new windows and doors of a similar style and material. There are a number of such activities that could potentially affect historic properties within the APE, including use and maintenance of Don Pedro Project facilities and roads, maintenance to historic buildings or other structures, vegetation management activities, recreational site use, issuance of grazing leases, emergency actions, looting/vandalism, and erosion caused by wave action and fluctuating water levels of the reservoir. In addition, certain kinds of Don Pedro Project-related activities may not have a direct impact on historic properties, but may create the conditions by which damage occurs. For example, a Don Pedro Project road may not directly impact historic properties, but may enable public access to areas that do contain historic properties.

By contrast, there are Don Pedro Project O&M activities that may not have an adverse effect on historic properties and there may also be historic properties within the APE that are not subject to O&M activities. For example, the continued use of a paved access road that is closed to the public and travels through an historic property that is an archaeological site, will likely not be considered an adverse effect. As well, a historic property comprised of a recreation facility will likely not be adversely affected by continued use and maintenance of the facility, if the facility is used as it has been in the past and any maintenance activities maintain the existing integrity of the facility. Furthermore, there may be historic properties located within the APE that are substantially above the high waterline of the Don Pedro Reservoir and nowhere near any other Don Pedro Project facility or within the vicinity of O&M activities. Subsequently, O&M activities may not adversely affect these historic properties.

3.11.2.1 Types and Causes of Effects

The following sections describe in more detail some of the activities in the APE that may affect historic properties. Section 3.11.2.2, which follows, provides an assessment of Don Pedro Project-related effects on historic properties and resources not yet evaluated for the NRHP, as identified during relicensing studies within the APE.

3.11.2.1.1 Routine Operation and Maintenance of Buildings and Structures

The Don Pedro Project’s hydroelectric operating system includes dams, powerhouses, penstocks, etc., and associated features. As well, a few additional buildings, associated with other historic activities not directly related to the hydroelectric system, were also identified within the APE. As these facilities age, they may require maintenance to maintain operational efficiency or usefulness as a storage or residential facility. Maintenance can affect the character-defining features of a building or structure that contribute to its significance. Future activities might include structural, mechanical or electrical upgrades of these facilities, maintenance or repair of buildings and other structures, replacement of windows, doors, roofing, or other building components; expansion or improvement of parking and storage area; and similar activities. Moreover, above ground resources (i.e. buildings and structures) often require consideration of the integrity of their viewscape as an important factor. Viewscapes can contribute to a resource's significance and eligibility to the NRHP, and to the integrity of setting, association, and feeling of a resource. Planned and unplanned O&M tasks associated with structures and buildings, including repairs, upgrades, or viewscape changes, could result in negative or adverse effects on those built or engineered resources that are considered eligible for listing on the NRHP and must be considered.

3.11.2.1.2 Reservoir Inundation and Fluctuation[41]

Historic properties within a reservoir basin may be consistently inundated by water or subject to wet and dry cycles and wave action associated with annual fluctuations in reservoir water level. Research indicates that the effects of these actions may include erosion, deflation, hydrologic sorting or displacement of artifacts, and are primarily dependent on where within the reservoir basin a site is located (Lenihan et al. 1981). Inundated sites are subject to less impact than sites within the annual fluctuation zone.

Several studies have been conducted on the effects of reservoir inundation to archaeological sites in California and elsewhere (Foster et al. 1977; Foster and Bingham 1978; Henn and Sundahl 1986; Lenihan et al. 1981; Stoddard and Fredrickson 1978; Ware 1989). These studies show that the nature and extent of the effects are dependent on several factors, most notably the location of a cultural resource within the reservoir basin. Sites within the zone of seasonal fluctuation or drawdown suffer the greatest impacts, primarily in the form of erosion/scouring, deflation, hydrologic sorting, and artifact displacement caused by waves and currents. Sites located lower in the reservoir are more likely to be covered with silt, sometimes forming a protective cap, but burrowing clams and crayfish have been known to rework these sediments too. Finally, it should be emphasized that resources lying deep within the reservoir pool are also subject to erosion when major drawdown and refilling events occur (e.g., during major droughts or periodic maintenance activities).

3.11.2.1.3 Vegetation Management

In addition, DPRA complies with the CPRC section 4291 that requires maintenance of vegetation within 30 to 100 feet of a structure (defensible space). Additionally, DPRA maintains vegetation around developed campsites and other DPRA improvements to protect life and property from fire and other injury that could be caused by low hanging branches. The vegetation maintenance includes removal of all grassy vegetation in a 30 foot perimeter around structures and campsite furnishings, along road edges, and then the mowing of grassy vegetation for an additional 70 feet beyond the 30 foot cleared areas. Pruning of trees and shrubs is done

[41] The Proposed Action covered in the application for a new FERC license is the Districts' proposal to continue hydroelectric generation at the Don Pedro Project. While reservoir fluctuations have the potential to affect historic properties, the fluctuations of the Don Pedro Reservoir are due to operations for the purposes of water supply and flood control. Hydroelectric project operations are dependent upon water released for these purposes; therefore, reservoir fluctuations are not the result of hydroelectric operations. The effect of the Proposed Action has no measureable impact on reservoir fluctuations. During relicensing of the hydroelectric project, the Districts undertook comprehensive investigations of the cultural resources associated with the Don Pedro Project within the APE identified in the study plan. These cultural resource investigations considered the effects of all Don Pedro Project operations. The Districts intend to address the effects of all Don Pedro Project operations within the Historic Properties Management Plan.

around structures and furnishings to remove ladder fuels that are subject to spreading fire up into the trees and into structures, and to eliminate low branches that could injure passing humans.

3.11.2.1.4 Grazing Leases

Issuing grazing leases for lands within the Project Boundary may result in moderate to heavy cattle grazing/trampling which can cause both direct and indirect effects to historic properties. Direct effects result from cattle trampling which can impact the surface of an historic property. Indirect effects can result from both grazing and trampling. Grazing reduces vegetation coverage and can increase erosion. Cattle trampling around historic resources can also increase erosion, which can affect the integrity of historic resources.

3.11.2.1.5 Road Maintenance, Construction and Use

Numerous road maintenance and construction activities have the potential to affect historic properties. Dirt access roads within the Project Boundary are maintained by grading, which can affect historic properties that may lie buried beneath them. In addition, ditches excavated for roadway drainage may cause further impacts to archaeological sites. Vehicular traffic on dirt roadways can also damage historic properties by traveling through or over, depending on the condition of the road, the season of use, and the types of vehicles that travel the roads. Roads also make historic properties more accessible to the public, in some cases increasing their vulnerability to looting and vandalism.

3.11.2.1.6 Recreation

Common recreational activities include boating, fishing, hiking, picnicking, and camping. These activities can expose historic properties to public use and can lead to disturbance of intact cultural deposits, increased erosion or deterioration of sites, unauthorized artifact collection, or more severe vandalism and looting. Ongoing maintenance at recreational facilities, formal and informal improvements, and infrastructure development can also affect significant cultural values. The more accessible historic properties are to public traffic, the more likely they are to be affected by recreational activities.

3.11.2.1.7 Emergency Repairs

Emergency repairs to facilities, including dams, penstocks, powerhouses, etc., may be necessary in response to serious threats life, property, or the safe operation of Licensee’s hydroelectric facilities. Such actions, however, have the potential to affect historic properties. For example, an historic dam may require repair not in keeping with its original materials, or the creation of a fire break could affect a lithic scatter.

3.11.2.1.8 Artifact Collection/Vandalism

Vandalism and looting pose potential threats to historic properties within the APE. Looting includes the casual collection of surface artifacts as well as deliberate unauthorized digging and theft of cultural resources. Vandalism is the destruction or defacement of cultural resources.

Looting is one form of vandalism, as it contributes to the destruction of a cultural resource, but vandalism can also include acts that don't necessarily result in the removal of materials, but certainly contribute to the defacement or physical destruction of a resource. A prehistoric rock art site can be vandalized by modern graffiti added to rock art panels or the removal of a panel. An historic structure can be vandalized by shooting holes through the windows or walls.

The more accessible historic properties are to public traffic, such as resources in close proximity to public roads and recreation areas, the more likely they are to be affected by vandalism. As well, reservoir drawdowns can expose artifacts and sites within the fluctuation zone to looting. Additionally, archaeological sites that have been impacted by looting in the past are prone to additional looting.

3.11.2.2 Assessment of Ongoing Don Pedro Project-Related Effects

This section presents an assessment of ongoing Don Pedro Project-related effects on historic properties and resources not yet evaluated for the NRHP, as identified during relicensing studies within the APE. The Districts have identified a total of 234 archaeological sites, 127 isolated finds, 37 built resources, and one TCP within the APE. Of the 234 archaeological sites identified within the APE, 130 have been evaluated as ineligible for the NRHP, 75 are unevaluated with regards to their eligibility for inclusion in the NRHP, and 29 have been evaluated as eligible for the NRHP. All 127 of the isolated finds are ineligible for listing on the NRHP. Of the 37 built resources, 33 have been evaluated as ineligible, three are unevaluated, and one is eligible for listing on the NRHP. The TCP identified within the APE has been evaluated as eligible for the NRHP.

The resources that have been evaluated as ineligible for the NRHP are not historic properties and are therefore not further assessed with regards to ongoing Don Pedro Project-related effects. The unevaluated and eligible resources are addressed below.

3.11.2.2.1 Ongoing Don Pedro Project-Related Effects on Archaeological Sites[42]

Of the 234 archaeological sites identified within the APE, 130 have been evaluated as ineligible for the NRHP, 75 are unevaluated with regards to their eligibility for inclusion in the NRHP, and 29 have been evaluated as eligible for the NRHP. Of the 29 eligible resources, 8 are historic, 12 are prehistoric, and 9 are of multi-component affiliation. Of the 75 unevaluated resources, 23 are historic, 37 are prehistoric, and 15 are of multi-component affiliation. As summarized in Table 3.11-9, below, there are a total of 26 eligible archaeological sites and 64 unevaluated archaeological sites experiencing ongoing Don Pedro Project-related effects.

[42] Note that archaeological isolated finds are not addressed as all of these finds have been determined to be ineligible for inclusion on the NRHP and, therefore, are not historic properties that require an assessment of Don Pedro Project-related effects.

Table 3.11-9. Summary of ongoing Don Pedro Project-related effects assessments for eligible and unevaluated archaeological sites.

Experiencing Ongoing Don Pedro Project-Related Effects	Age			
	Historic	Prehistoric	Multi-Component	Total
Eligible Archaeological Sites				
Yes	7	12	7	**26**
No	1	0	2	**3**
Total	**8**	**12**	**9**	**29**
Unevaluated Archaeological Sites				
Yes	17	34	13	**64**
No	6	3	2	**11**
Total	**23**	**37**	**15**	**75**

Of the 90 eligible and unevaluated archaeological sites experiencing ongoing Don Pedro Project-related effects, eight are experiencing effects from cattle grazing only; 47 are experiencing effects from fluctuating water levels only; 24 are experiencing effects from fluctuating water levels and recreation; one site is affected by fluctuating water levels and cattle grazing; one site is affected by fluctuating water levels, cattle grazing, and looting; one site is affected by fluctuating water levels, cattle grazing, looting, and recreation; one site is affected by fluctuating water levels, cattle grazing, and recreation; two sites are being affected by fluctuating water levels and looting; two sites are being affected by fluctuating water levels, looting, and recreation; and three sites are affected by recreation only. Table 3.11-10, below, lists all 104 unevaluated and eligible archaeological sites identified within the APE, and identifies which have been determined to be impacted by ongoing Don Pedro Project-related effects and which have not.

Table 3.11-10. Ongoing Don Pedro Project-related effects assessment for eligible and unevaluated archaeological sites.

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
FW-DP-003	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-004	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-005	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-006	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-017	P-55-6021	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	No	N/A
FW-DP-018	--	Multi-component	P: Long-term Habitation H: Mining	E	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-021	--	Historic	Mining	U	TID/MID/ BLM	No	N/A
FW-DP-030/031	--	Historic	Mining	U	TID/MID/ BLM	No	N/A
FW-DP-043	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
FW-DP-046	P-55-3227 CA-TUO-2253H	Historic	WCH	E	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-050	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels
FW-DP-053	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels
FW-DP-065	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-069	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-070/071	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels, recreation
FW-DP-073	P-55-3877 CA-TUO-2893H	Historic	Transportation	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility [2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
FW-DP-076	--	Historic	Mining	U	TID/MID/ BLM/Private	Yes	Recreation
FW-DP-078	P-55-1351 CA-TUO-326	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-081	--	Prehistoric	Rock Shelter	E	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-085	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-086	--	Prehistoric	Short-term Habitation	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-092	--	Historic	Habitation	U	TID/MID/ BLM	No	N/A
FW-DP-094	--	Historic	Mining	U	TID/MID/ BLM/Private	Yes	Fluctuating water levels, recreation
FW-DP-095	--	Historic	Mining	E	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-096	--	Historic	Mining	U	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-097	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-098	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-099	--	Multi-component	P: Milling Station H: Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-100	--	Historic	Transportation	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-109	P-55-3876 CA-TUO-2892H	Historic	Transportation	U	BLM	Yes	Fluctuating water levels
HDR-DP-006	P-55-1902 CA-TUO-892	Multi-component	P: Quarry H: Habitation	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Looting; Recreation
HDR-DP-018	--	Prehistoric	Quarry	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Looting

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-019	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing
HDR-DP-024	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Recreation
HDR-DP-026	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-027	--	Prehistoric	Other	U	TID/MID	No	N/A
HDR-DP-028	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-029	P-55-1920, P-55-1921, CA-TUO-910/H, CA-TUO-911/H	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-033	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-035	--	Historic	Habitation	U	TID/MID	No	N/A
HDR-DP-039	--	Multi-component	P: Short-term Habitation H: Habitation	U	TID/MID	No	N/A
HDR-DP-041	--	Prehistoric	Quarry	U	TID/MID	Yes	Cattle grazing
HDR-DP-042	--	Multi-component	P: Lithic Scatter H: Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-043	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Cattle grazing
HDR-DP-045	--	Multi-component	P: Lithic Scatter H: Utilities	U	TID/MID	Yes	Cattle grazing
HDR-DP-046	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-047	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Cattle grazing
HDR-DP-049	--	Prehistoric	Lithic Scatter	U	TID/MID	No	N/A
HDR-DP-053	--	Multi-component	P: Short-term Habitation H: Utilities	U	TID/MID	Yes	Recreation
HDR-DP-058	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Recreation
HDR-DP-060	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Cattle grazing

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-061	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Cattle grazing
HDR-DP-063	--	Prehistoric	Quarry	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-065	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-066	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-073	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-074	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-076	--	Prehistoric	Quarry	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-077	--	Prehistoric	Quarry	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-086	--	Historic	Mining	E	TID/MID	Yes	Fluctuating water levels; Recreation; Looting;
HDR-DP-087	P-55-1913, CA-TUO-903H	Historic	Habitation	E	TID/MID	Yes	Fluctuating water levels; Looting
HDR-DP-092	--	Multi-component	P: Long-term Habitation H: Utilities	E	TID/MID	Yes	Cattle grazing
HDR-DP-095	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Cattle grazing
HDR-DP-098	--	Multi-component	P: Long-term Habitation H: Transportation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-099	--	Multi-component	P: Long-term Habitation H: Ranching / Farming	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-101	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-106	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-109	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-113	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-116	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-118	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-119	P-55-1360 CA-TUO-336/H	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation
HDR-DP-122	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-126	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-127	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-128	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-130	--	Multi-component	P: Long-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-131	--	Prehistoric	Other	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-133	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-134	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-135	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-139	--	Multi-component	P: Lithic Scatter H: Trash Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-140	P-55-1331 CA-TUO-306	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-141	--	Prehistoric	Lithic Scatter	U	TID/MID	No	N/A
HDR-DP-142	P-55-1384 CA-TUO-361	Multi-component	P: Milling Feature H: Ranching / Farming	U	TID/MID	No	N/A
HDR-DP-145	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-147	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-148	--	Historic	Trash Scatter	U	TID/MID	No	N/A

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-151	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-155	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-162	P-55-1927 CA-TUO-917	Multi-component	P: Short-term Habitation H: WCH	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-164	P-55-1925 CA-TUO-915	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-170	--	Historic	Other	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-171	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-179	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-186	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-189	--	Multi-component	P: Long-term Habitation H: Mining	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-192	P-55-1363 CA-TUO-340	Prehistoric	Rock Shelter	E	TID/MID	Yes	Fluctuating water levels; Looting
HDR-DP-193	--	Historic	WCH	E	TID/MID	No	N/A
HDR-DP-195	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-196	--	Prehistoric	District	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation
HDR-DP-197	--	Historic	Transportation	U	TID/MID	No	N/A
HDR-DP-198	P-55-1928 CA-TUO-918/H	Multi-component	P: Short-term Habitation H: Habitation	E	TID/MID	No	N/A
HDR-DP-250	--	Multi-component	P: Millling Feature H: Mining	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation; Looting

[1] H: Historic; P: Prehistoric.
[2] E: Eligible; U: Unevaluated.

3.11.2.2.2 Ongoing Don Pedro Project-Related Effects on Built Environment Resources

There are 37 built environment resources identified within the APE. Of these, 33 have been determined ineligible, three are unevaluated, and one is eligible for inclusion in the NRHP. The three unevaluated resources are Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928), Kanaka Creek Cabin (FW-DP-57), and Moccasin Creek Stone Building (HDR-DP-101). The Red Mountain Bar Siphon is an inverted siphon constructed by the City and County of San Francisco in 1923 to carry the Hetch Hetchy Aqueduct under the Tuolumne River (later Don Pedro Reservoir). Though running under water, beneath the reservoir, the siphon is functioning as intended and is not being impacted by O&M. The Kanaka Creek Cabin (FW-DP-57) is also a contributing element to the Kanaka Creek Mining Landscape (FW-DP-53), which is documented with the archaeological resources above. The Moccasin Creek Stone Building (HDR-DP-101) is within a larger archaeological site and thus is also part of an archaeological site (site HDR-DP-101) discussed above. Both the cabin and stone building are in rather secluded areas and are above the high waterline of the reservoir and are not being impacted by any identified Don Pedro Project-related activity. The La Grange Ditch (FW-DP-08) is the NRHP eligible built environment resource. It is located on a steep canyon wall and is also not impacted by Don Pedro Project-related effects.

3.11.2.2.3 Ongoing Don Pedro Project-Related Effects on TCPs

Only one TCP was identified in the APE: Lower Kanaka Creek Native Plant Gathering Area. This is an area along lower Kanaka Creek, extending 100 meters (330 feet) on both sides of the stream and one kilometer (0.6 mile) upstream from the edge of Don Pedro Reservoir. It has been viewed by generations of Indians as a source of traditional foods, medicines, and materials for making baskets and ceremonial regalia. Plants are still harvested in this locality today, and their availability contributes importantly to the maintenance of the Tuolumne Me-wuk community's cultural traditions and identity (see Chapters 6 and 8 of the TCP Study Report, Moratto et al. 2014). This TCP is located predominately above the high waterline of the reservoir and is accessible by Tribal members from Jacksonville Road. While the Don Pedro Reservoir appears to inundate a small portion of the TCP, this does not appear to be adversely affecting the resource. No other potential Don Pedro Project-related effects to this resource were identified and it has been determined that there are no ongoing adverse effects to the TCP (TID/MID 2014b).

3.11.3 Proposed Resource Measures

The Districts have developed a draft HPMP to manage potential effects on historic properties throughout the term of any new license. The draft HPMP is Appendix E-4 of this Exhibit E (being filed as PRIVILEGED) and will be provided to the Tribes, BLM, and SHPO for review and comment. FERC typically completes Section 106 by entering into a Programmatic Agreement (PA) or Memorandum of Agreement (MOA) with the licensee, the ACHP, if they choose to participate, and the SHPO that requires the licensee to develop and implement an HPMP. Additionally, FERC requires the licensee to consult with various federal, state, tribal, and non-government parties in the development of any HPMP.

The purpose of an HPMP is to outline actions and processes to manage historic properties within the APE under the new license. It is intended to serve as a guide for the licensee's operating personnel when performing necessary O&M activities and identify resource treatments designed to address potential ongoing and future effects to historic properties. An HPMP should also describe a process of consultation with appropriate state and federal agencies, as well as with Native Americans who may have interests in historic properties within the APE. Following the Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects issued by FERC and ACHP in 2002 (FERC and ACHP 2002), an HPMP should include: management measures; training for all O&M staff; mechanisms for providing the public interpretive information on cultural resources; and periodic review and revision of the HPMP.

3.11.4 Unavoidable Adverse Impacts

Adverse impacts to historic properties are discussed above in Section 3.11.2. The HPMP describes those adverse impacts that cannot be avoided. The HPMP also provides a schedule and plan for managing adverse effects to historic properties caused by Don Pedro Project O&M. The draft HPMP is included herein as Appendix E-4 to this Exhibit E and is being filed with FERC as PRIVILEGED.

3.12 Socioeconomic Resources

The Don Pedro Project is essential to the economic welfare of the central San Joaquin Valley. The Don Pedro Project provides irrigation water to more than 200,000 ac of highly productive farmland, drinking water to residential and business customers, flood flow management, hydropower generation, recreation, and flows for the protection of aquatic resources. The Don Pedro Project also provides important benefits to the Bay Area by virtue of the 570,000 acre-foot "water bank" CCSF acquired by its financial contribution to the construction of the Don Pedro Project. As a part of the relicensing process, the Districts conducted a thorough analysis of the socioeconomic effects of the Don Pedro Project (TID/MID 2014). The primary goals of the Socioeconomics Study were to quantify the baseline economic values and socioeconomic effects of current Don Pedro Project operations. Because the primary purpose of Don Pedro Project is to supply water for regional agriculture, municipal, and industrial water users, any changes in operations may have broad socioeconomic effects well beyond changes to hydropower generation. Information from this analysis is summarized below, and more detailed information is available in the Socioeconomic Study Report (TID/MID 2014).

3.12.1 Existing Environment

The Don Pedro Project has many positive direct and indirect economic effects on the entire regional economy within Stanislaus, Merced, and Tuolumne counties. By providing reliable irrigation water supplies, it directly supports the vibrant agricultural sector which has evolved in the Districts' service areas. And by extension, it indirectly supports the large agribusiness complex that has developed around crop and dairy farm production, including input suppliers, dairy plants, food processing businesses, and many others. The Don Pedro Project also provides reliable M&I water supplies that are essential to meet population and business growth in the area.

The Districts' study of socioeconomics demonstrates the economic strength of the area, including the many people and industries which are directly and indirectly affected by the Don Pedro Project. The Don Pedro Project is shown to be a major economic factor in the region by supporting agriculture and many other industries which provide thousands of jobs and millions of dollars of output and income in the central San Joaquin Valley.

Table 3.12-1 presents a summary of the regional economic effects of the Don Pedro Project. Accounting for both directly supported activities and other forward-linked sectors, it is estimated that the Don Pedro Project supports approximately 18,900 total jobs and $734.8 million in total annual labor income.

Table 3.12-1. Regional economic benefits – summary ($millions per year).[1,2]

Activity	Output ($millions)		Labor Income ($millions)		Employment (Full and Part-Time Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Directly-Supported Activities						
Crop Production	$527.9	$854.2	$171.7	$278.1	4,340	7,270
Recreation Spending	$6.2	$9.7	$1.9	$2.9	80	100
Hydropower	$24.7	$31.2	$7.5	$9.5	30	90
Directly-Supported Sub-total	*$558.9*	*$859.1*	*$181.1*	*$290.5*	*4,400*	*7,500*
Forward Linkages						
Crop Processing	$569.1	$854.9	$87.0	$165.8	1,050	3,020
Crop Processing Subtotal[3]	*$512.6*	*$854.9*	*$87.0*	*$173.4*	*1,050*	*2,870*
Dairy Production	$537.4	$816.7	$23.6	75	2,270	3,630
Dairy Processing	$787.6	$1,143.1	$71.8	156	1,060	3,040
Dairy Subtotal[3]	*$922.1*	*$1,959.8*	*$95.4*	*$231.6*	*3,330*	*6,670*
Cattle Production	$128.1	$233.0	$7.2	23	620	1,220
Cattle Processing	$119.8	$166.0	$11.8	24	270	630
Cattle Subtotal[3]	*$172.9*	*$399.0*	*$19.0*	*$46.9*	*890*	*1,850*
Forward-Linkage Sub-Total	*$1,607.6*	*$3,213.7*	*$201.4*	*$444.3*	*5,300*	*11,400*
Total Economic Benefits						
Total	**$2,166.4**	**$4,108.8**	**$382.5**	**$734.8**	**9,700**	**18,900**

Source: Cardno ENTRIX (based on IMPLAN modeling)

1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI)

2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties)

3 Forward linkage direct output values are adjusted to avoid double counting of crop, dairy, and cattle output that become inputs into a processing sectors (where their value is included in the processing sector output value). For example, $56.5 million of crop output is estimated to be processed in the food and beverage processing sectors, and is included in the $569.1 direct processing output value. The direct additional output due to crop processing is thus $512.6 million ($569.1 million less the $56.5.0 million of crop input.)

3.12.1.1 Agriculture

Agriculture has been, and remains, a very important industry, particularly in Merced and Stanislaus counties. Agriculture has been a foundation industry of the San Joaquin Valley for more than 150 years. Development of surface water supplies encouraged additional land cultivation and helped offset the groundwater overdraft problems that resulted from widespread pumping in many parts of the Valley.

Water supply reliability has been a critical issue for agriculture in the San Joaquin Valley. In this respect, the Don Pedro Project has been crucial to the development, directly, of crop and dairy production in the MID and TID service areas. Water supply reliability has been one of the most important factors supporting the large investments made by farmers in such permanent crops as almonds, peaches, and grapes; and in the dairies which rely on the associated production of corn silage, alfalfa, and other forage crops used in those operations.

Today, crop and livestock operations in the Districts' service areas represent a cornerstone in the regional economy of Stanislaus and Merced counties. In revenue alone, farmers in the Districts' service areas contribute an estimated $1.2 billion annually directly into the local economy, including $527.9 million from crop production and $665.5 million from livestock operation. In addition to supporting about 7,230 on-farm (direct) full and part-time jobs generating an estimated $202.5 million in labor income.

The estimated $1.2 billion in annual gross agricultural production (e.g. crops, dairy and cattle) supported by crops grown with Don Pedro Project water supports an additional $2.9 billion in annual output, taking into account both the industries which support and which are supported by production agriculture. These industries create another 11,670 jobs generating $532.3 million in labor income. Among major employers in Stanislaus and Merced counties, half are directly related to agriculture.

Neither Stanislaus County nor Merced County would have the agricultural strength they have absent the reliable irrigation water supply provided by the Don Pedro Project. Neither county is capable of being served by the SWP or CVP, and groundwater availability and quality are not sufficient to independently support the large, highly productive agricultural land base in the area. Thus, Tuolumne River water provided by the Don Pedro Project has been critical to the success of agriculture.

In 2011, Merced and Stanislaus counties were the fifth and sixth largest counties in California as measured by gross value of agricultural production (Table 3.12-2).[43] Together, they contributed $6.5 billion in gross value, 12.3 percent of total gross value for the state, with a significant portion of this production coming from land irrigated with water supplies provided by MID and TID.

The Districts have key roles in the agricultural economies of Stanislaus and Merced counties and the entire San Joaquin Valley. Through the Don Pedro Project, the Districts have provided

[43] Gross value represents the product of price and quantity for farm products as they leave the farms where they are produced. It does not represent net income, which incorporates farm expenses.

highly reliable water supplies to their customers. With these reliable supplies, growers and producers have invested heavily in high-value perennial crops, such as almonds and peaches, as well as dairy production. The consistent, high value of agricultural output has, in turn, resulted in a large complex of agricultural support industries being developed in the area. With those supplies, the two counties are regularly among the top 10 most productive agricultural counties in California.

3.12.1.2 Municipal and Industrial Use

In addition to agriculture, the Don Pedro Project supplies water to M&I users in both Districts. M&I water demands trace directly to the economic development and job creation characterizing the area. In addition to those presently served, several municipalities within Stanislaus County are seeking Don Pedro Project water as a substitute for groundwater supplies. In addition, the CCSF, through its water bank credits in the Don Pedro Reservoir, is able to reliably deliver Hetch Hetchy water supplies to 26 water agencies in the Bay Area, serving 2.6 million customers.

The value of M&I water supplies is less easily estimated than that for agriculture. Farm profit is the difference between gross production value and costs, aggregated over all crops. The value of M&I supplies is not directly measurable and such measurement instead requires estimates of the costs of alternative supplies. Those alternatives may include groundwater, desalination, recycling, or transfers from other areas. Based on those alternatives, Don Pedro M&I water values range from $143 per AF (for groundwater pumping[44]) to $700 per AF, reflecting the estimated willingness to pay by the SFPUC for municipal water supplies.

3.12.1.3 Recreation

In addition to consumptive agricultural and M&I water uses, the Don Pedro Reservoir provides unique recreational opportunities in designated recreation areas managed by DPRA. Annual visitation to the reservoir is in the hundreds of thousands, whose expenditures benefit the entire regional economy. At current estimates of 378,000 visitor days per year, the economic value of recreation to participants is between $19.8 million and $25.4 million per year. Table 3.12-2 lists visitor use of the Don Pedro Reservoir for 2010–2012.

Table 3.12-2 presents the regional economic benefits generated by recreation spending by visitors to Don Pedro Reservoir. The approximate $10 million in recreation spending is estimated to generate about $6.2 million in direct output at local businesses and $9.7 million in total output across all industries on an annual basis. In addition, total labor income and jobs supported by recreation spending totals about $2.9 million per year and 100 total full and part-time jobs.

Table 3.12-2. Regional economic benefits – recreation visitation at DPRA ($millions).[1,2]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$6.2	$1.8	$1.7	$9.7

[44] Includes both fixed (capital) and variable (operating) costs associated with groundwater pumping.

Metric	Direct	Indirect	Induced	Total
Labor Income ($millions)	$1.9	$0.5	$0.5	$2.9
Employment (full and part-time jobs)	80	10	10	100

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent regional effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
Source: TID/MID 2014 (based on IMPLAN modeling).

3.12.1.4 Hydropower Generation

Another of the important benefits which the Don Pedro Project provides is hydroelectric generation. Since 1997, the facility has provided an average of 622,440 MWh of clean, low cost energy per year (1997-2012). It is used by MID and TID to serve 21 communities in their combined service areas. About 80 percent of the electrical accounts are residential or commercial and industrial, with agriculture, municipal, and street lighting, and other types making up the remainder.

MID provides electrical service to seven communities in Stanislaus and San Joaquin counties, comprising about 114,000 accounts in a service territory of 560 mi^2. The composition of those accounts is shown in Table 3.12-3.

Table 3.12-3. MID customer accounts, by type of account.

Type of Account	No. of Accounts	Percent of Accounts
Residential	94,119	82.6%
Commercial	12,265	10.8%
Industrial	157	0.1%
Agricultural	1,819	1.6%
Other	5,571	4.9%
Total	113,931	100.0%

Source: MID 2013.

TID serves 100,345 accounts across 14 communities in a service area of 662 mi^2 in Stanislaus, Merced, Tuolumne, and Mariposa counties. The communities served include Ballico, Ceres, Crows Landing, Delhi, Denair, Diablo Grande, Hickman, Hilmar, Hughson, Keyes, La Grange, Patterson, South Modesto, and Turlock. The composition of those accounts is shown in Table 3.12-4.

Table 3.12-4. TID customer accounts, by type of account.

Type of Account	No. of Accounts	Percent of Accounts
Residential	72,033	72%
Municipal/street lighting	16,367	16%
Commercial	6,983	7%
Agricultural	2,508	2%
Other	1,656	2%
Industrial	798	1%
Total	**100,345**	**100%**

Source: TID 2013.

The output and price data used to estimate hydropower output values are shown in Table 3.12-5. As shown, output varied considerably over the five years from 2008 to 2012, with peak production in 2012 at more than 1.0 billion kilowatt-hour (kWh); and the minimum in 2009, at about 340 million kWh. Over the same period, electricity prices varied from a peak of $0.085 per kWh in 2008 to a minimum of $0.032 per kWh in 2012, with an average price of $0.047 per kWh (in 2012 dollars). As shown, the five-year average value of hydropower generation supported by the Don Pedro Project is approximately $26.9 million annually.

Table 3.12-5. Value of hydropower generation, Don Pedro Hydroelectric Plant, 2008–2012.[1]

Year	Output (kWh)	Price/Value ($/kWh)[2]	Total Value
2008	399,858,940	$0.085	$33,947,361
2009	339,501,259	$0.042	$14,174,961
2010	364,964,701	$0.042	$15,352,087
2011	715,749,872	$0.037	$26,220,584
2012	1,013,360,425	$0.032	$32,447,801
Average (5 Year)	**556,687,039**	**$0.047**	**$26,902,782**

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Prices are annual average day ahead on-peak prices.
Sources: TID/MID 2013, FERC 2013.

3.12.1.5 Land Values

Land values, particularly agricultural land values, are affected by the availability and reliability of affordable water and electricity from the Don Pedro Project. Irrigators who have access to reliable water supplies, other factors equal, will be more profitable than those who do not have such access. The availability of reliable water supplies at reasonable cost is capitalized into land values because those values frequently reflect the stream of net income available from the land; and because net income is higher, other factors being equal, with lower water prices.

Land values in the Districts' service areas have been relatively stable despite the economic recession, the effects of which have been offset by high crop prices, low interest rates, and available water supplies. Currently, cropland in the Districts' service areas is valued from 30 to 50 percent higher than similar cropland in other districts served by both surface water and groundwater. The land valuation is important in supporting the decisions by irrigators to invest in permanent and other high value crops that account for such a large part of overall agricultural value in the area.

Overall, there appears to be a clear premium on land values in the Districts' service areas compared to other nearby regions with access to surface or groundwater supplies. The land value differential is more dramatic when compared to rangeland without water supplies. Irrigated land values in the Districts' service areas are five to 15 times greater than rangeland values, demonstrating the value added by reliable water supplies for agricultural production. However, there are likely a number of factors other than water supplies that also drive land values in the region, such as soil quality and proximity to urban centers and infrastructure. Therefore, it is not reasonable to attribute the land value premium solely to water supplies. However, it is clear that high quality, reliable surface water supplies provided by the Don Pedro Project have a positive influence on land values. Table 3.12-6 shows regional land values from 2007 to 2011.

Table 3.12-6. Regional land values, 2007–2011.[1]

Region/Land Use	Land Value ($/acre)		
	Low	High	Average
Merced County			
Cropland: TID	**$15,870**	**$22,410**	**$19,140**
Cropland: Well Water (ENID & CWD)	$5,290	$10,580	$7,930
Cropland: Merced ID	$10,170	$19,290	$14,730
Cropland: Westside, Exchange Contractors	$5,700	$10,300	$8,000
Cropland: Westside, Federal and Other	$3,700	$5,820	$4,760
Permanent Cropland: Almonds	$12,690	$22,430	$17,560
Permanent Cropland: Walnuts	$12,450	$21,320	$16,880
Rangeland: West County	$530	$1,270	$900
Rangeland: East County and Mariposa County	$740	$1,670	$1,210
Stanislaus County			
Cropland: MID and TID	**$16,500**	**$26,040**	**$21,270**
Cropland: Non-Federal Water (Westside, incl. Gustine)	$10,000	$15,000	$12,500
Cropland: Well Water and Federal (Westside)	$8,170	$12,910	$10,540
Cropland: Well and OID (Eastside)	$10,370	$17,350	$13,860
Permanent Cropland: Almonds (MID and TID)	**$17,760**	**$28,160**	**$22,960**
Permanent Cropland: Almonds (Minor Irrigation Districts and Wells)	$15,020	$20,500	$17,760
Permanent Cropland: Walnuts	$14,560	$24,530	$19,540
Permanent Cropland: Cling Peaches	$15,230	$23,080	$19,160
Permanent Cropland: Wine Grapes (District 12)	$13,990	$20,980	$17,480
Rangeland: Westside	$1,060	$1,900	$1,480
Rangeland: Eastside and Tuolumne County	$1,940	$4,570	$3,250

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
ENID = El Nido Irrigation District
CWD = Chowchilla Water District
OID = Oakdale Irrigation District
Source: California Chapter of the American Society of Farm Managers and Rural Appraisers, 2012.

3.12.2 Resource Effects

Page 38 of FERC's SD2 identifies the following issues associated with socioeconomic resources:

- *The socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests.*
- *Water supply effects on San Francisco Public Utility Commission retail and wholesale customers that would result if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation.*

Several resources studies are not yet complete; analysis of proposed measures will be completed when all relevant data, reports, and models are available. The socioeconomic resources of the Bay Area are not analyzed as a part of this Exhibit.[45]

[45] CCSF prepared an independent study on the potential socioeconomic effects of potential changes in Don Pedro Project operations entitled *Socioeconomic Impacts of Water Shortages within the Hetch Hetchy Regional Water System Service Area.*

3.12.3 Proposed Resource Measures

No measures that specifically address socioeconomic resources are proposed.

3.12.4 Unavoidable Adverse Impacts

The Don Pedro Project has no known unavoidable adverse effects on socioeconomic resources.

4.0 CUMULATIVE EFFECTS OF THE PROPOSED ACTION

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) (50 CFR §1508.7), cumulative effects on a resource are the result of the combined influence of past, present, and reasonably foreseeable future actions within a specified geographical range (FERC 2008), regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative effects may be beneficial or adverse.

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

Based on scoping meetings, comments FERC received during scoping, and information in the PAD, FERC identified the resources having the potential to be cumulatively affected by the Proposed Action: (1) geomorphology, (2) water resources, (3) aquatic resources including anadromous fish and habitat, and (4) socioeconomic resources. For water resources, aquatic resources, anadromous fish and their essential habitat, and socioeconomics, FERC defined the geographic scope as extending from Hetch Hetchy Reservoir to San Francisco Bay. For geomorphology, the geographic scope extends only to the confluence of the Tuolumne and San Joaquin rivers. The temporal scope includes past and present actions and reasonably foreseeable actions that could occur over the next 30 to 50 years. Actions potentially contributing to cumulative effects to the identified resources are described in Section 4.1, and the cumulative effects of these actions are addressed, by resource, in sections 4.2 through 4.5 below.

The Don Pedro Project provides water storage for irrigation and municipal and industrial (M&I) use, flood control, hydroelectric generation, recreation, and natural resource protection (hereinafter, the “Don Pedro Project”). The environmental analysis contained in this Exhibit E considers all the components, facilities, operations, and maintenance that make up the Don Pedro Project. The Don Pedro Project was constructed for the following primary purposes: (1) to provide water supply for the co-licensees, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts), for irrigation of over 200,000 acres (ac) of Central Valley farmland and for M&I use, (2) to provide flood control benefits along the Tuolumne and San Joaquin rivers, and (3) to provide a water banking arrangement for the benefit of the City and County of San Francisco (CCSF) and its 2.6 million Bay Area water customers. The original license was issued in 1966. In 1995, the Districts entered into an agreement with a number of parties which resulted in greater flows to the lower Tuolumne River for the protection of aquatic resources.

Hydroelectric generation is a secondary purpose of the Don Pedro Project. Hereinafter, the hydroelectric generation facilities and operations will be referred to as the “Don Pedro Hydroelectric Project”, or the “Project”. With this license application to FERC, the Districts are seeking a new license to continue generating hydroelectric power. Based on the information contained in this application, and other sources of information on the record, FERC will consider whether, and under what conditions, to issue a new license for the continued generation of hydropower at the Districts' Don Pedro Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the Don Pedro hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of the hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project will aid in defining the scope and substance of reasonable protection, mitigation, and enhancement (PM&E) alternatives to be considered in relicensing. As FERC states in Scoping Document 2 in a discussion related to alternative project operation scenarios: "…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water are…alternative mitigation strategies that could not replace the Don Pedro *hydroelectric* project [emphasis added]. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the Proposed Action and are not reasonable alternatives for the NEPA analysis."

4.1 Actions In and Outside of the Tuolumne River Basin

4.1.1 Summary of Chronology of In-Basin and Out-of-Basin Actions

In accordance with the requirements of cumulative effects assessments provided under NEPA, the initial step of performing the analysis is to identify significant past, present, and foreseeable future actions that potentially contribute to cumulative effects to the target resources. The Tuolumne and San Joaquin river basins have been affected by substantial resource management and land and water use activities over the past 150-years. Table 4-1.1 summarizes a chronology of the in-basin and out-of-basin actions that are likely to contribute to cumulative effects to the four resource areas identified in FERC's SD2. The information available to describe and address each of these actions varies greatly, ranging from very little (e.g., commercial and sport salmonid harvest in the early to mid 1900s) to volumes of studies (e.g., recent studies of salmonid juvenile and smolt survival studies in the Delta). A map of the San Joaquin River basin and Delta is provided in Figure 4.1-1.

Table 4.1-1. Chronology of actions in the San Joaquin River Basin and Delta contributing to cumulative effects.

Action	Date
Dams, Diversions, Flow Regulation	
Tuolumne River Basin	
Wheaton Dam	1871
La Grange Mining Ditch (Indian Bar Diversion)	1871
Phoenix Dam	1880
La Grange Diversion Dam	1893
Modesto Reservoir	1911
Turlock Lake	1914
Eleanor Dam	1918

Action	Date
Old Don Pedro Dam	1923
O'Shaughnessy Dam (Hetch Hetchy)	1923
Priest Dam	1923
Early Intake	1924
Dennett Dam	1933
Hetch Hetchy Aqueduct completed; exports to San Francisco begin	1934
O'Shaughnessy Dam raised	1938
Cherry Lake	1956
Pine Mountain Dam	1969
New Don Pedro Dam	1971
Riparian water diversions along the Lower Tuolumne River	1870s – present
San Joaquin River Basin and Delta (excluding Tuolumne River)	
Central Valley Project	
Friant Dam	1942
Madera Canal	1945
Friant-Kern Canal	1951
Jones Pumping Plant	1951
Delta-Mendota Canal	1951
Delta Cross-Channel	1951
Hidden and Buchanan Projects	1962
Los Banos Detention Dam	1965
Little Panoche Detention Dam	1966
B.F. Sisk Dam	1967
O'Neill Pumping Plant	1967
William R. Gianelli Pumping-Generating Plant	1967
San Luis Drain	Halted in 1975
New Melones Dam	1983
San Felipe Division	1964 – 1987
State Water Project	
Harvey O. Banks Pumping Plant	1968
Edmonston Pumping Plant	1971
Pyramid Dam	1973
Castaic Dam	1973
Warne Powerplant	1982
Alamo Powerplant	1986
Coastal Branch Aqueduct	1997
Upper San Joaquin River	
Mendota Dam	1871
Sack Dam	Seasonal 1870s – 1946
Merced River Basin	
Robla Canal Company begin diverting Merced River	1870
Merced Canal and Irrigation Company forms	1883
Merced Falls Diversion Dam	1901
Crocker-Huffman Dam	1910
Exchequer Dam	1926
New Exchequer Dam	1967
Stanislaus River Basin	
Big Dam	1856
Herring Creek, Upper Strawberry, and Lower Strawberry reservoirs	1856
Lyons Reservoir	1898
Sand Bar Diversion Dam	1908
OID/SJID purchase Tulloch water rights/distribution system	1910

Action	Date
Relief Dam	1910
Goodwin Dam	1913
Philadelphia Diversion Dam	1916
Lower Strawberry Reservoir	1917
Old Melones Dam	1926
Spicer Meadow Dam	1929
Lyons Reservoir enlarged	1930
Tri-Dam Project (Donnells, Beardsley, and Tulloch dams)	1958
New Melones Dam (also in CVP section)	1983
New Spicer Dam	1989
In-Channel and Floodplain Mining	
Tuolumne River Basin	
Placer mining	1848 – 1890
Hydraulic mining (La Grange)	1871 - c.1900
Dredge mining of the Lower Tuolumne River (gold)	1908-1942, 1945-1951
Gravel and aggregate mining of the Lower Tuolumne River	1940s to present
San Joaquin River Basin and Delta (excluding Tuolumne River)	
Sand and gravel mining from Bay floor shoals begins	1915
Channel Alteration	
Begin large-scale construction of levees in San Joaquin River basin and Delta	1850s
Stockton Deep Water Ship Channel	1930s
San Joaquin River and Tributaries Project (> 100 miles of levees and bypasses)	1950s - 1960s
Non-Native Fish Species	
18 fish species introduced in Tuolumne River basin by state/federal agencies	1874 – 1954
4 additional fish species introduced in Tuolumne River basin	After 1954
Hatchery Practices	
CDFW begins stocking fish in the inland waters of California	Late 1800s
CDFW begins large-scale supplementation of anadromous fish stocks	1945
California's hatcheries at times use out-of-basin broodstocks/move fry to other basins	Before 1980s
Salmon from Central Valley hatcheries released in San Francisco Bay	Ongoing
Commercial and Sport Harvest	
Commercial salmon fishing begins in California	Early 1850s
Gill net salmon fisheries well established in lower San Joaquin River	1860
Well developed canning industry (20 canneries)	1880
12 million pounds of salmon landed and processed	1882
Ocean troll fishery dominates harvest	1917
Last inland cannery shutdown due to decline of inland fishery	1919
Last commercial river salmon fishery closed in Sacramento-San Joaquin basin	1957
Agriculture, Livestock, and Timber Harvest	
Timber operations begin in upper watersheds	Mid 1800s to present
Large-scale agriculture and livestock grazing begins in region	Mid 1800s to present
Urban Development	
Within Tuolumne River watershed and downstream	Mid 1800s to present
San Francisco Bay Area (Hetch Hetchy diversions)	1934 to present
MID M&I diversions	1995 to present
Climate Change	
Changes in global climate and weather patterns	

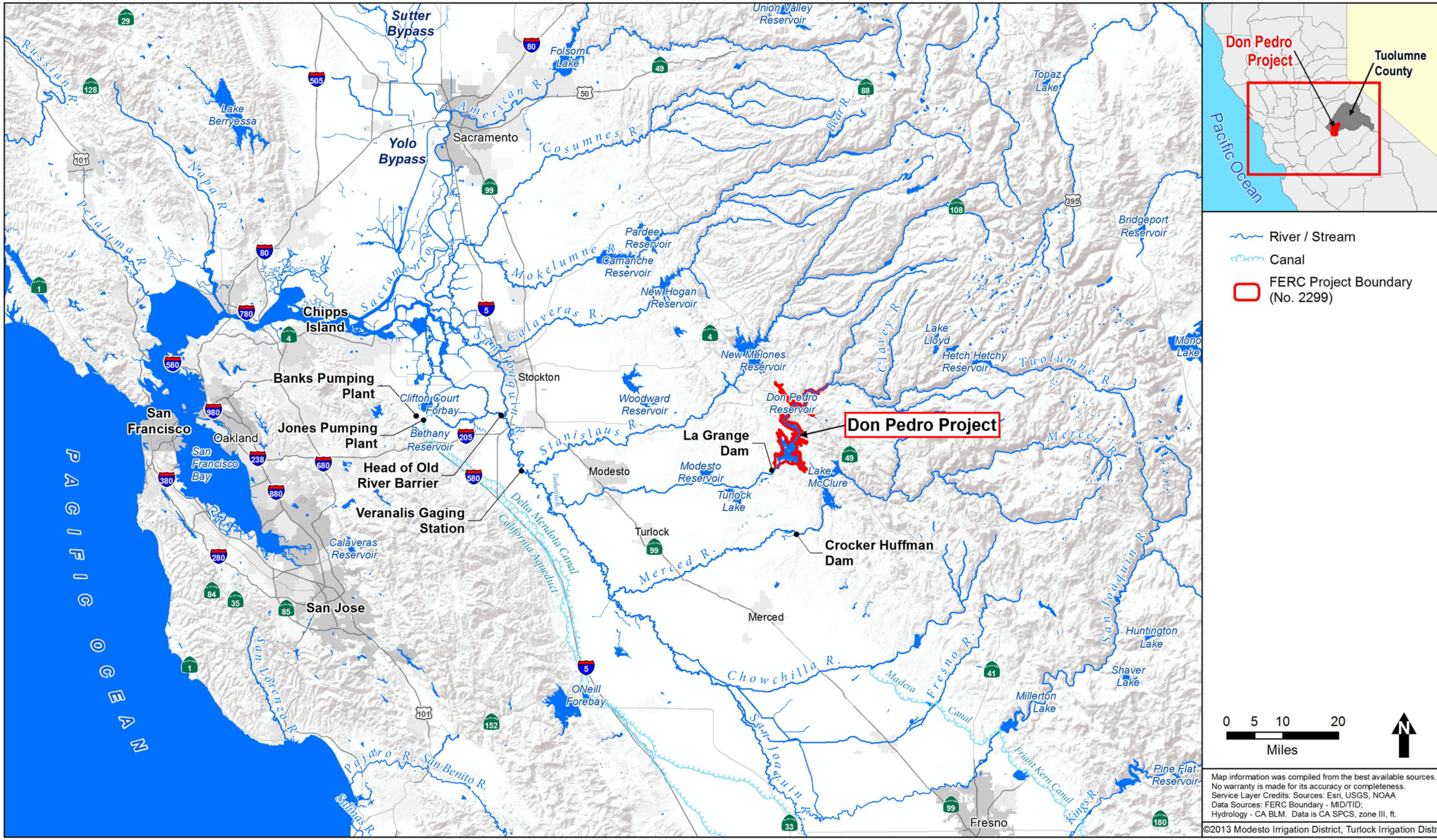

Figure 4.1-1. Map of the San Joaquin River basin and Delta.

4.1.2 Don Pedro Hydroelectric Project

4.1.2.1 Proposed Action

The Proposed Action under review by FERC is the issuance of a new license to the Districts to authorize the continued generation of hydroelectric power at Don Pedro Dam. As such, and as described in FERC's Scoping Document 2 (SD2) issued on July 25, 2011, any measures proposed to mitigate the Project's effects must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydroelectric power generation at the Don Pedro Project.

Flow releases through the powerhouse from Don Pedro Reservoir are scheduled based on requirements for (1) flood flow management, including pre-releases in advance of anticipated high flows during wet years, (2) the Districts' irrigation and M&I demands, including flows to maintain water storage in Turlock Lake and Modesto Reservoir, and (3) protection of aquatic resources in the lower Tuolumne River in accordance with the terms of the FERC license. Once the weekly and daily flow schedules are established based on these demands, outflows from the Don Pedro powerhouse are scheduled to deliver these flows. During periods of on-peak electrical demand, daily outflows may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule and the physical constraints of the Districts' irrigation systems. In accordance with the Districts' "water-first" policy, flow releases are scheduled around the three requirements listed above, then delivered via the generation units up to their capacity and availability. Hydroelectric generation at the Don Pedro Project is a secondary consideration with respect to flow scheduling.

Issuance of a new FERC license will allow the Districts to continue generating electricity at the Project for the term of the new license, producing low-cost electric power from a non-polluting, renewable resource. Clean, renewable hydropower generation is a valuable benefit of the Project. The average annual generation from the Project from 1997 to 2012 was 622 million kilowatt hours (kWh) of electricity. The current maximum hydraulic capacity of the four turbines is approximately 5,500 cfs, and the current FERC-authorized capacity is 168 MW.

The electricity generated at the Project is important to the State of California. The California Energy Commission (CEC) issued an Updated California Energy Demand Forecast 2011–2022 in May 2011. The report presented an update to the 2009 California Energy Demand electricity forecast adopted for the 2009 Integrated Energy Policy Report in December 2009. The updated forecast was meant to provide the CEC's best estimate of the effect of economic conditions on energy demand since the 2009 forecast was published. The updated forecast presents low, mid, and high forecasts for the state; average annual growth rates for consumption for 2010–2022 are 1.13 percent, 1.28 percent, and 1.53 percent, respectively (CEC 2011).

4.1.2.2 Independent Primary Purposes of the Don Pedro Project

Water storage and releases for the Don Pedro Project's primary purposes, i.e., irrigation, M&I uses, the City and County of San Francisco's (CCSF) water bank, and flood control in cooperation with the ACOE, are not dependent on the issuance of a FERC license for the Project, and would occur with or without the licensing of the Proposed Action. As such, these uses are not interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are seeking a license to permit the Proposed Action, and power would be generated as it has been historically (i.e., the Proposed Action would be equivalent to the environmental baseline as defined by FERC, and there would be no effects on the lower Tuolumne River, as explained below), the non-hydropower water uses are independent actions. These independent actions contribute to cumulative effects in the Tuolumne and San Joaquin river basins but do not constitute direct or indirect effects associated with the Proposed Action.

4.1.2.3 Don Pedro Dam and Reservoir

Don Pedro Dam is a 1,900-foot-long and 580-foot-high, zoned earth and rockfill structure. The top of the dam is at 855 ft (NGVD 29). Don Pedro Reservoir extends upstream for approximately 24 miles at its normal maximum water surface elevation of 830 ft. The tailwater elevation at the outlet works tunnel is approximately 300 ft. Under normal operations of the hydroelectric units, the powerhouse tailwater elevation varies from about 300 ft to about 305 ft. Water levels in Don Pedro Reservoir have exceeded the normal maximum water level of 830 ft only once since Don Pedro Project construction, in early January 1997.

4.1.2.4 Timing and Magnitude of Flow Releases

As noted above, water is generally provided from Don Pedro Reservoir for only three reasons: (1) to provide water needed to meet the Districts' irrigation and M&I demands, (2) for flood management purposes, and (3) to provide flows required by the Project license for the benefit of aquatic resources in the lower Tuolumne River. In general, reservoir operations follow a relatively consistent annual cycle of water management for flood control, capturing runoff from snowmelt and seasonal rainfall, and delivery of water to serve the purposes identified above. Don Pedro Project operations must consider potential water availability over the course of multiple years, so that even in drier years the reservoir can retain a water supply to provide for consumptive use and resource protection.

Flows released at Don Pedro Dam to meet the Districts' irrigation and M&I water demands are all diverted from the Tuolumne River at La Grange Diversion Dam to the TID and MID canal systems. The Districts possess senior water rights in the Tuolumne River. Diversions for irrigation purposes can occur year-round, but generally occur from late February to early November. From 1971 to 2012, the average annual water diversion at La Grange Diversion Dam to the Districts' canals was approximately 900,000 AF for irrigation and M&I purposes.

ACOE guidelines call for making 340,000 AF of storage available in Don Pedro Reservoir for management of high-flow conditions. ACOE contributed financially to the construction of Don Pedro Dam to acquire this flood reservation. Flows released at Don Pedro Dam to comply with the ACOE flood management guidelines consist of both pre-releases in anticipation of high runoff and releases during periods of high runoff. Both of these release scenarios occur to balance reservoir levels, forecasted runoff, and downstream flows. "High" river flows can be defined as any flows released that are greater than those needed for irrigation and M&I purposes and protection of aquatic resources. Flow releases for high-flow management may occur from November to July, and from February to July these releases must also consider water supply needs for consumptive use purposes. High flows in the Tuolumne River upstream of the Don Pedro Project are affected by operation of CCSF's Hetch Hetchy system.

The resulting water elevations and water velocities in the lower Tuolumne River during high-flow releases are affected by past and present in-channel and floodplain mining, levee construction and maintenance, agricultural development on the floodplain, and urban development and encroachment, particularly in the Modesto area.

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

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

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

The FPC's 1964 decision set normal-year flow releases of 123,210 AF from the Don Pedro Project for fish protection during the first 20 years of the Don Pedro Project's existence. The decision also required the Districts to conduct studies that could be used to develop future fisheries requirements. FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of the lower Tuolumne River minimum flow provisions contained in the 1995 Settlement Agreement between the Districts, CCSF, resource agencies, and environmental groups. The revised minimum flows in the lower Tuolumne River vary from 50 to 300 cfs depending on water year hydrology and time of year. The water year classifications are re-calculated each year to maintain approximately the same frequency distribution of water year types.

The settlement agreement and license order also specify certain pulse flows for the benefit of upstream migrating adult salmon and downstream migrating juveniles, the amount of which also varies with water year type. The downstream flow schedule provided for by the settlement agreement and subsequent FERC order is shown in Table 4.1.-2. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project.

4.1.2.5 Hydroelectric Power Production

As noted in Section 4.1.2.1, electric power is generated at the Don Pedro Project using flows released to satisfy the Don Pedro Project's independent, primary purposes (i.e., irrigation and M&I releases and flood management) and to provide flows to the lower Tuolumne River for the benefit of aquatic resources. Water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflows and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is shaped, consistent with water supply requirements and physical constraints of the Districts' irrigations systems, to release flows with a preference for on-peak rather than off-peak hours during periods of high electrical demand.

4.1.2.6 Other Don Pedro Project-Related Actions

4.1.1.1.1 Recreation and Shoreline Protection at Don Pedro Reservoir

Don Pedro Reservoir is a popular recreation location providing about 400,000 user-days of recreation each year to mostly local and regional users. Recreation at the Don Pedro Project is well-managed and limited to the reservoir proper. The Districts' land use policy, implemented through the DPRA, prohibits shoreline disturbances such as dredging, docks, moorings, piers, or developed improvements of any kind. DPRA rules prohibit all off-road vehicle use on Don Pedro Project lands and restrict motorized boat access to designated boat launches. These and other rules ensure that over 90 percent of the reservoir shoreline remains in its natural condition. Recreational activities and facilities associated with the Don Pedro Project are independent of the Proposed Action, i.e., they would occur even in the absence of hydroelectric generation.

4.1.1.1.2 Herbicide and Pesticide Applications near Don Pedro Reservoir

The DPRA applies herbicides to certain areas in the Don Pedro Project area. Pre- and post-emergent herbicides are used to treat invasive plants at campsite pads and road edges. Other areas treated with herbicides include locations surrounding wastewater treatment facilities, wastewater ponds, shoreline trails and firebreaks, immediate areas around DPRA structures, immediate areas around shoreline restrooms, and semi-developed dispersed camping pads. Although rarely used, DPRA sometimes apply a rodenticide in early spring or late fall to control ground squirrels around developed recreation facilities. Application of these herbicides and rodenticide is independent of the Proposed Action, i.e., it would occur even in the absence of hydroelectric generation.

Table 4.1-2. Schedule of flow releases from the Don Pedro Project to the lower Tuolumne River by water year type contained in FERC's 1996 order.

Schedule	Units	# of Days	Critical and Below	Median Critical[1]	Interm. CD	Median Dry	Interm. D-BN	Median Below Normal	Interm. BN-AN[1]	Median Above Normal	Interm. AN-W	Median Wet/Max
Occurrence	%		6.4%	8.0%	6.1%	10.8%	9.1%	10.3%	15.5%	5.1%	15.4%	13.3%
October 1-15	cfs	15	100	100	150	150	180	200	300	300	300	300
	AF		2,975	2,975	4,463	4,463	5,355	5,950	8,926	8,926	8,926	8,926
Attraction Pulse	AF		none	none	None	none	1,676	1,736	5,950	5,950	5,950	5,950
October 16-May 31	cfs	228	150	150	150	150	180	175	300	300	300	300
	AF		67,835	67,835	67,835	67,835	81,402	79,140	135,669	135,669	135,669	135,669
Outmigration Pulse Flow	AF		11,091	20,091	32,619	37,060	35,920	60,027	89,882	89,882	89,882	898
June 1-Sept 30	cfs	122	50	50	50	75	75	75	250	250	250	250
	AF		12,099	12,099	12,099	18,149	18,149	18,149	60,496	60,496	60,496	60,496
Volume (total)	AF	365	94,000	103,000	117,016	127,507	142,502	165,003	300,923	300,923	300,923	300,923

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

Source: FERC 1996.

4.1.3 Non-Don Pedro Project In-Basin Actions

The first dam built on the Tuolumne River, Wheaton Dam, was constructed in 1871 near the current location of La Grange Diversion Dam at approximately RM 52.2. There are currently a number of dams in the mainstem Tuolumne River and its tributaries, some of which are used for storage and others that are primarily diversion dams. Table 4.1-3 lists the owners of the dams in the Tuolumne River basin and the capacities of their associated impoundments, if known. Table 4.1-4 provides information on known hydropower facilities in the Tuolumne River basin, including both small and conventional hydroelectric generation facilities. Completion dates for select impoundments are also provided in Table 4.1-3.

Table 4.1-3. Owners and capacities of dams or diversion facilities and their associated reservoirs in the Tuolumne River basin.

Owner	FERC Project No.	Stream	Dam or Diversion Dam	Reservoir or Impoundment Name (date completed)	Capacity (AF)
CCSF	None	Tuolumne River	O'Shaughnessy Dam / diversion to Mountain Tunnel	Hetch Hetchy Reservoir (1923)	360,360 (USGS 1999)
CCSF	None	Eleanor Creek	Eleanor Dam	Lake Eleanor (1918)	26,146 (USGS 1999)
CCSF	None	Cherry Creek	Cherry Dam	Cherry Lake (1956)	274,2520 (USGS 1999)
CCSF	None	Tuolumne River	Early Intake (facility only used by CCSF for infrequent diversion from Cherry watershed)	n/a (1924)	<100
CCSF	None	Off-stream	Priest Dam	Priest Forebay (1923)	1,500
CCSF	None	Off-stream (Moccasin Creek and all local runoff diverted under or around impoundment)	Moccasin Dam	Moccasin Afterbay	Approx. 500
Private	None	Big Creek	Pine Mountain Dam	Pine Mountain Lake (1969)	7,700 (USGS 1999)
Private	None	Sullivan Creek (receives diversion from SF Stanislaus River)	Phoenix Dam	Phoenix Lake (1880)	612 (USGS 1999)
TID MID	2299	Tuolumne River	Don Pedro Dam	Don Pedro Reservoir	2,033,000
TID MID	None	Tuolumne River	La Grange Diversion Dam	La Grange Pool	100
MID	None	Off-stream	Modesto Reservoir Dam	Modesto Reservoir (1911)	28,000
TID	None	Off-stream	Turlock Lake Dam	Turlock Lake (1914)	48,000
TID	None	Off-stream	Dawson Dam	Dawson Lake	Unknown

Source: USGS 1999; CCSF 2006.

Table 4.1-4. Hydropower generation facilities in the Tuolumne River watershed.

Owner	FERC Project No.	Powerhouse	Location / Description
CCSF	None	Robert C. Kirkwood Powerplant	124 MW; Completed 1967; water diverted from Hetch Hetchy Reservoir to powerhouse via Canyon Tunnel (CCSF 2006)
CCSF	None	Dion R Holm Powerplant	169 MW; Completed 1960; water diverted from Lake Lloyd via Cherry Power Tunnel (CCSF 2006)
CCSF	None	Moccasin Powerhouse (off-stream)	110 MW; water diverted to powerhouse via CCSF Mountain Tunnel by way of Priest Forebay (CCSF 2006)
MID TID	2299	Don Pedro Powerhouse	Immediately downstream of Don Pedro Dam; 4 units, authorized capacity 168 MW.
TID	None	La Grange Powerhouse	4.5 MW Powerhouse; water source is TID Upper Main Canal.
TID	4450	Dawson Power Plant (off-stream)	5.5 MW; Small hydro located on TID Upper Main Canal between La Grange Diversion Dam and Turlock Lake
TID	3261	Turlock Lake (off-stream)	3.3 MW; Small hydro located at the outflow of TID's Turlock Lake
MID	290	Stone Drop (off stream)	230 kW; small hydro located on the MID main canal just below Modesto Reservoir
TID	1000	Hickman (off stream)	1,100 kW, first built 1979 on the TID Main Canal

4.1.3.1 Dam and Reservoir Operations Upstream of the Don Pedro Project

CCSF's Hetch Hetchy Water and Power Division maintains and operates several reservoirs in the middle-elevation band of the Tuolumne River watershed upstream of the Don Pedro Project, including CCSF's Cherry Lake (elevation 4,700 ft), Lake Eleanor (elevation 4,660 ft), and Hetch Hetchy Reservoir (elevation 3,800 ft) (CCSF 2006). These projects provide storage for water supply and also generate hydroelectric energy. CCSF stores and diverts water from the upper Tuolumne River for use outside the Tuolumne River basin. CCSF provides potable water to approximately 2.6 million Bay Area residents and serves much of the Bay Area's commercial, manufacturing, and industrial enterprises. The Hetch Hetchy system includes the San Joaquin Pipeline, which transports about 85 percent of CCSF's total water supply. The Hetch Hetchy system is an indispensable component of the welfare and economy of the Bay Area. The Hetch Hetchy system also produces about 1,700,000 MWh of renewable hydroelectric energy in an average year. The maximum rate of diversion from the upper Tuolumne River to the San Francisco Bay Area is about 465 cfs. The historical average annual diversion is about 250,000 AF, or about 13 percent of the average annual runoff.[1]

Another user of water in the upper Tuolumne River is CDFW, which operates the Moccasin Fish Hatchery below CCSF's Moccasin Reservoir, a 505-AF water supply reservoir. Flow to the hatchery is estimated to be about 15 million gallons per day (23 cfs) or about 11,000 AF per year. Water from the hatchery is discharged into Moccasin Creek, which flows into Don Pedro Reservoir. Water from Moccasin Reservoir also feeds CCSF's Foothill Tunnel, which delivers water to the San Joaquin Pipelines.

[1] For the period 1987 - 2012.

4.1.3.2 Dam and Reservoir Operations Downstream of the Don Pedro Project

Water released through the Don Pedro powerhouse or outlet works discharge into the Tuolumne River and about one mile downstream enters the La Grange pool. At La Grange Diversion Dam, an irrigation diversion dam owned by the Districts, water is diverted into MID's canal system on the north side of the Tuolumne River and into TID's canal system on the south side of the river. Flows greater than the Districts' irrigation and M&I needs continue on to the lower Tuolumne River by passing over the dam's spillway, through TID's La Grange powerhouse located off the TID main canal, or through sluice gates associated with the La Grange facilities.

La Grange Diversion Dam is located near the border of Stanislaus and Tuolumne counties at RM 52.2. Originally constructed by TID and MID between 1891 and 1893, the primary purpose of the dam is to raise the level of the Tuolumne River to permit diversion of water, by means of gravity, into the Districts' canal systems. La Grange Diversion Dam, which replaced Wheaton Dam (built by other parties in the early 1870s), was constructed at the downstream end of a narrow, steep-sided canyon. Operation of La Grange Diversion Dam results in very little fluctuation of water surface elevation in the La Grange pool. When not in spill mode (i.e., above elevation 296.5 ft, which occurs about 30 percent of the time), the pool operates between elevation 296 ft and 294 ft about 90 percent of the time. The volume of storage in this 2-ft operating band is less than 100 AF. La Grange Diversion Dam is the most downstream dam on the Tuolumne River. Flows in the lower Tuolumne River are recorded at the USGS' La Grange gage located about 0.3 miles below La Grange Diversion Dam.

4.1.3.3 Diversions Downstream of Don Pedro Project

There are 26 points of unscreened pumping diversions along the lower Tuolumne River between La Grange Diversion Dam and the San Joaquin River (with an estimated total combined withdrawal capacity of 76.6 cfs [CDWR 2013]), and four unscreened diversions along Dry Creek (Figure 4.1-2). There are numerous diversions and water exports along the San Joaquin River and in the Delta. The diversions along the lower Tuolumne River typically occur during irrigation season.

4.1.3.4 Accretion Flows

Runoff from Dry Creek, agricultural return flows, groundwater seepage, and operational spills from irrigation canals all enter the lower portion of the Tuolumne River. Average monthly accretion flows in the lower Tuolumne River range from 40 cfs to 200 cfs, with an estimated annual average accretion from water year 1970-2010 of 152 cfs (TID/MID 2013a, Attachment A).

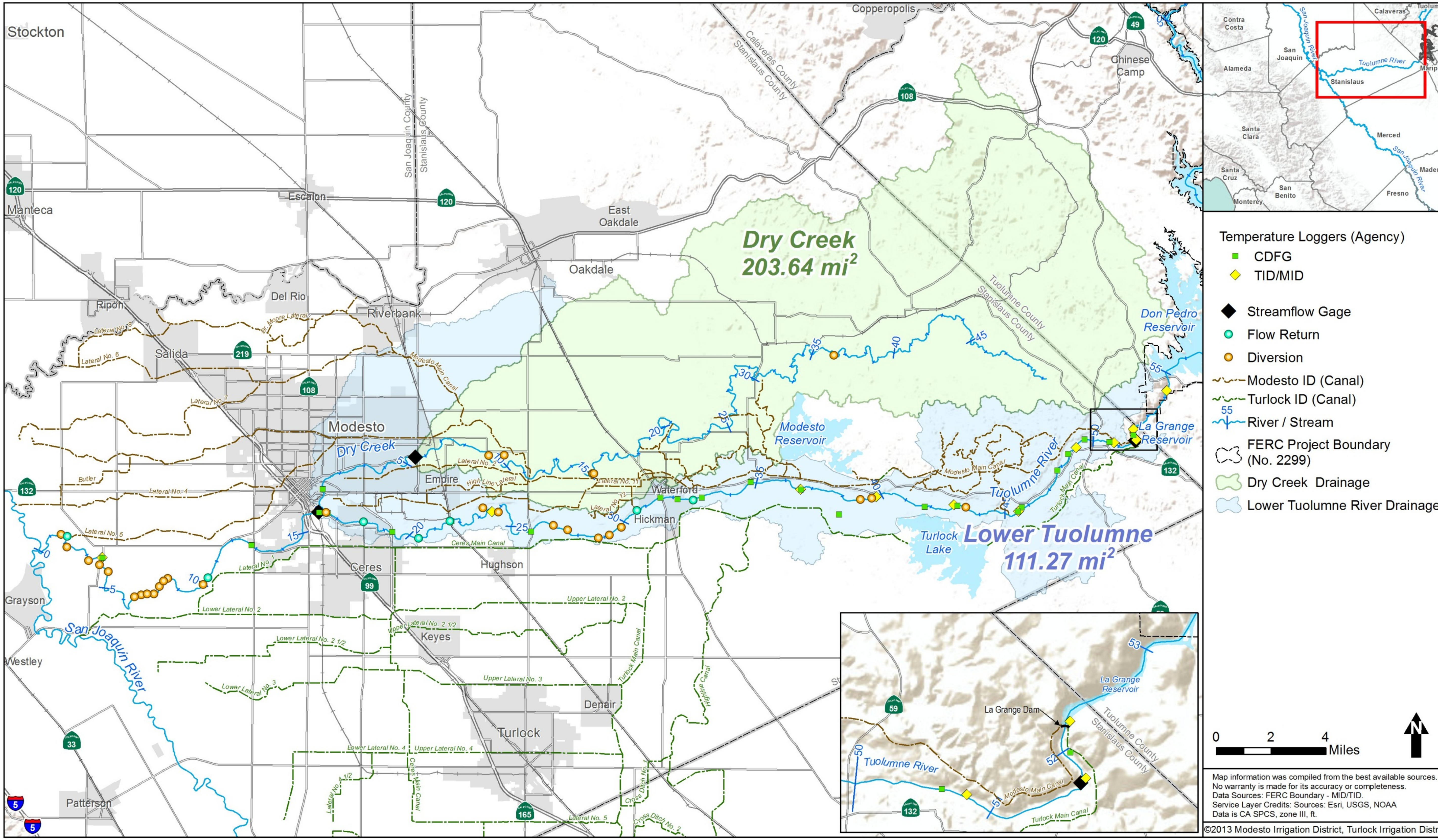

Figure 4.1-2. **Locations of diversions along the lower Tuolumne River and Dry Creek.**

4.1.3.5 Resource Extraction, Land Development, and Land Use Practices along the Tuolumne River

4.1.1.1.3 In-Channel and Floodplain Mining

Mining-related impacts in and along the mainstem Tuolumne River began with the California Gold Rush in 1848. The major mining camps of Sonora, Columbia, and Jacksonville were founded in 1848 and 1849. A historical timeline of mining activities in the San Joaquin River's tributaries, including the Tuolumne River, includes placer mining (1848–1880), hydraulic mining in the La Grange vicinity (1871 to about 1900), dredge mining (1908-1942, 1945-1951), and gravel and aggregate mining (1940s to present) (McBain & Trush 2000). Decades of dredge mining in the main channel of the Tuolumne River resulted in the excavation of channel and floodplain sediments, which has left a legacy of significant Tuolumne River channel modifications and dredger tailing deposits between RM 50.5 and 38.0. Gravel and aggregate mining, with their attendant floodplain modifications, continue to be conducted alongside the river corridor.

The chief mining commodities in the vicinity of the Don Pedro Project are gold and gravel. The Columbia and Springfield placer mining operations northwest of the Don Pedro Project produced approximately $55 million in gold prior to 1899 (TID/MID 2011). The pocket mines of Sonora and Bald Mountain, as well as others in their vicinity, have been highly productive and long-lived. Marble and limestone products have been second in value to gold. The Columbia marble beds northwest of the Don Pedro Project had a long history of production prior to 1941, and two plants are currently processing stone from these deposits (TID/MID 2011). From the 1860s to the 1940s, roughly 10,000 tons of chromite ore and several hundred tons of crude magnesite ore were mined in the Don Pedro Project vicinity (TID/MID 2011). Most of the chromite came from the McCormick Mine, located northwest of the Project Boundary. All magnesite production in Tuolumne County occurred in the 1920s and came from two sites in the northern portion of the Red Hills located northwest of the Don Pedro Project (TID/MID 2011).

Gold mined in Stanislaus County has come predominantly from placers. Quaternary gravels of the Tertiary lower Tuolumne River channel near Waterford were among the most productive (TID/MID 2011). In the early 1900s, large-scale dredging of Quaternary gravels began along the Tuolumne River between La Grange and Waterford, and most of the gold produced in Stanislaus County from 1932 through 1959 came from this area. In the late 1940s, gold mining declined sharply (Koschmann and Bergendahl 1968).

On the other hand, California leads the United States in aggregate production, and virtually all aggregate is removed from alluvial deposits (Kondolf 1995). As of 1994, sand and gravel mining exceeded the economic importance of gold mining in the state. Large-scale, in-channel aggregate mining began in the Tuolumne River corridor in the 1940s, when aggregate mines extracted sand and gravel directly from large pits excavated in the active river channel. Off-channel and floodplain aggregate mining along the Tuolumne River has also been extensive. Aggregate in Stanislaus County is currently classified as Aggregate Resources (potentially useable aggregate that may be mined in the future but for which no mining permit has been granted) and Aggregate Reserves (aggregate resources for which mining and processing permits have been granted) (Higgins and Dupras 1993).

An estimated 540 million tons (338 million yd^3) of aggregate resources are located in six different geographic areas of Stanislaus County (Higgins and Dupras 1993). The lower Tuolumne River corridor is the largest of the six areas and contains an estimated 217 million tons (135 million yd^3) in its channel and terraces (Higgins and Dupras 1993). The Gravel Mining Reach of the lower Tuolumne (RM 34.2 to 40.3) is currently the focus of development by commercial aggregate producers.

Much of the residual dredger tailings upstream of RM 45 were removed from the floodplain downstream of La Grange Diversion Dam as part of the construction of the new Don Pedro Dam in the 1960s. Reaches of the Tuolumne River between RM 47 and 50 that had been affected by gold dredger mining in the early 1900s were reconfigured following removal of the dredger tailings.

4.1.1.1.4 Agriculture, Livestock Grazing, and Timber Harvest

After the Gold Rush there was a substantial increase in crop production and ranching in the Central Valley (TID/MID 2013b). During this period, woody vegetation along the Tuolumne River was cleared to allow for crop production in the rich alluvial soils of the bottomlands. Levees were constructed to protect the new farmlands from flooding in spring, and irrigation canals were constructed to provide water during the growing season (Thompson 1961, Katibah 1984). Of the estimated 4 million acres of wetland that occurred historically in the Central Valley, only about 300,000 acres remained in 1990. The conversion of wetlands to agricultural uses accounts for much of this reduction in wetland area.

Land in the lower Tuolumne River watershed is primarily privately owned, including that used for agriculture and livestock grazing (Stanislaus County 2006). Primary agricultural land uses along the gravel-bedded reach include orchards, row crops (RM 24.0 - 40), and livestock grazing (RM 40 - 51) (McBain & Trush 2000).

Timber operations existed throughout the Sierra Nevada since the mid-1800s. However, the subsequent Gold Rush of 1849 fueled a human migration into California that resulted in dramatic increases in the demand for timber. The indirect effects of gold mining included steamship transportation along the major rivers of the Central Valley, which was fueled by cordwood harvested from adjacent lands, which likely resulted in the first wave of riparian forest clearing in some areas of the Tuolumne River basin (Rose 2000, as cited in McBain & Trush 2002).

In recent times, timber harvest in the Tuolumne River watershed has typically been limited to lands in the upper basin. The Yosemite Stanislaus Solutions (YSS) collaborative group was formed in December 2010 to assist the Stanislaus National Forest in developing restoration plans across the landscape regardless of ownership patterns, in the southern part of the Forest (USFS 2013). One critical area within the YSS collaborative is Hetch Hetchy Reservoir. Approximately one third of the land within the YSS boundary burned in 1987 and succeeding years. After 1987, the majority of this land was successfully reforested. The 2013 Rim Fire (which burned from August 17, 2013 through September 20, 2013) burned a total of 253,360 acres (USFS 2013); much of the burn occurred in the Tuolumne River watershed.

4.1.1.1.5 Industrial, Urban and Residential Development

Privately owned land in the lower Tuolumne River watershed is also used for rural residential purposes or for denser residential, municipal, and industrial purposes in communities such as Waterford and Modesto (Stanislaus County 2006). Many miles of river bank have been leveed and stabilized with riprap by agencies or landowners. Levees and bank revetment extend along portions of the river bank from near Modesto (RM 16) downstream to the San Joaquin River. Following the 1997 flood, some subdivisions that had been inundated in the Modesto area were found to have been constructed within the Federal Emergency Management Agency floodplain area designated prior to 1997 (TID/MID 2013b).

Four wastewater treatment plants (WWTPs), i.e., Tuolumne County Water District #1, Jamestown, Sonora, and Tuolumne contribute a little over 19 percent of the total phosphorus to the Don Pedro Reservoir. Urban runoff to the lower Tuolumne River from the Modesto area has been shown to contain pesticides (Dubrovsky et al. 1998). Fifteen pesticides were detected, and chlorpyrifos, diazinon, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998).

The CVRWQCB has issued various Cleanup and Abatement Orders for the Tuolumne River and its tributaries (TID/MID 2011). For example, in 2004, the CVRWQCB issued Order No. R5-2004-0718 for a discharger within the City of Hickman because a water retention pond at a nursery failed and caused 2,000 cubic yards of sediment and rock to enter the Tuolumne River. In 2008, the CVRWQCB issued Order No. R5-2008-0701 because two dischargers graded over 1,000 acres of land and caused significant discharges (11,200 NTU) of sediment into Peaslee Creek and the Tuolumne River. In 2009, the CVRWQCB issued Order No. R5-2009-0707 because a discharger graded over 76 acres of land and caused significant discharges of sediment into Peaslee Creek and one of its unnamed tributaries.

4.1.3.6 Fish Hatchery Practices

The following paragraphs relate to fish hatchery practices as they pertain specifically to the Tuolumne River and Don Pedro Reservoir. For a more in-depth discussion of hatchery practices in the State of California, see Section 4.1.4.8, Hatchery Practices of Exhibit E in this FLA.

Fall-run Chinook salmon are raised at five major Central Valley hatcheries, which release more than 32 million smolts each year. Due to concerns over population size and hatchery influence, the Central Valley fall/late fall-run Chinook salmon is a Species of Concern under the federal Endangered Species Act. Hatchery-origin fish contribute disproportionately to the salmon runs of the Central Valley (Barnett-Johnson et al. 2007, Johnson et al. 2011), and adipose-fin-clipped fish from hatcheries have been found in high percentages in Tuolumne River carcass surveys in some years (e.g., TID/MID 2005; TID/MID 2012, Report 2011-8). Recent studies have provided local evidence of high rates of straying into the Tuolumne River resulting from off-site hatchery releases by the Merced River Fish Facility and Mokelumne River Hatchery (Mesick 2001; ICF Jones & Stokes 2010).

CDFW manages the Don Pedro Reservoir fishery as a put-and-grow resource with substantial stocking and appropriate fishing regulations. As part of its Inland Salmon Program, CDFW generally plants rainbow trout (*O. mykiss*), kokanee (*O. nerka*), and land-locked Chinook salmon in Don Pedro Reservoir annually. Don Pedro Reservoir is also managed by CDFW as a year-round fishery for black bass. No known fish stocking has occurred in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam (TID/MID 2013d).

4.1.3.7 Freshwater Salmonid Harvest

CDFW implemented sport catch limits on salmon in the early 2000s within a portion of the Tuolumne River. Salmon fishing is currently banned in the lower Tuolumne River and San Joaquin River upstream of the Delta. No estimate of salmon lost to poaching is available (TID/MID 2013c). However, poaching of Chinook salmon, to the extent that it occurs, would likely only take place during the adult upstream migration period. No data are available that address the extent of *O. mykiss* poaching.

4.1.3.8 Non-Native Fish Species

Of the 23 non-native fish species documented in the lower Tuolumne River, 19 were introduced by state or federal agencies (CDFW, NMFS, USFWS, and the State Board of Human Health) between 1874 and 1954, and one was introduced with permission from CDFW in 1967 (Dill and Cordone 1997; Moyle 2002). The remaining three species were introduced by aquarists, catfish farms, or private individuals (Dill and Cordone 1997). Sixteen of the fish species released by state or federal agencies were introduced intentionally for sport or commercial fisheries, as a prey base for sport fish, or for mosquito control; two were introduced incidentally with shipments of sport fish (Dill and Cordone 1997). The most abundant and widespread non-native fish species in the lower Tuolumne River–bluegill, redear sunfish, and green sunfish–were first released in California between 1891 and 1954. Other introduced fish species in the lower Tuolumne River include threadfin shad, black and brown bullhead, white and channel catfish, common carp, fathead minnow, red shiner, golden shiner, goldfish, striped bass, largemouth bass, smallmouth bass, spotted bass, black and white crappie, warmouth, bigscale logperch, western mosquitofish, and inland silversides.

4.1.1.1.6 <u>Black Bass and Striped Bass</u>

Largemouth, smallmouth, and spotted bass (collectively black bass) were all introduced into California waters by CDFW and are now actively managed by CDFW in many locations. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992, and spotted bass were introduced in 1976. According to CDFW (2014), "Bass angling provides recreation and economic value to the state of California." Also according to CDFW (2014), "…California has been the center of attention for producing trophy-sized black bass. In a list of the top 25 largest largemouth bass caught in the U.S., 21 of the bass are from California waters." The California state record smallmouth bass is 9 pounds 13 ounces (CDFW 2014). Angler catches of Alabama spotted bass over six pounds have been verified by CDFW biologists for many California water bodies, including one spotted bass that weighed 10 pounds 4 ounces (CDFW 2014). All three species of black bass can be highly piscivorous and prey heavily on salmonids and other fish species (see below).

In 1990, largemouth bass abundance estimated for the lower Tuolumne River (RM 0.0 to RM 52.0) based on shoreline lengths was 11,074 individuals (TID/MID 1992). During 2012, the abundance of largemouth bass from RM 0.0 to RM 39.4 was estimated to be 3,323 based on shoreline length, and 3,891 based on habitat area (TID/MID 2013g). However differences in study methods between the 1990 and 2012 sampling years preclude comparison of these estimates. For largemouth bass, site-specific density estimates ranged from 0 to 218 fish per mile (collected in 1998, 1999, and 2003) (McBain & Trush and Stillwater Sciences 2006) and 4 to 196 per mile in 2012.

Smallmouth bass density estimates for the lower Tuolumne River (converted to fish per mile) from McBain & Trush and Stillwater Sciences (2006) (collected in 1998, 1999, and 2003) ranged from 2 to 97 fish per mile. In 2012, site-specific density estimates of smallmouth bass ranged from 0 to 251 fish per mile (TID/MID 2013g).

The Districts' 2012 Predation Study represented the first year that abundance estimates were produced by the Districts for smallmouth bass, largemouth bass, and striped bass, because only the abundance of largemouth bass was estimated during the 1990 study. Additional years of study are likely necessary to understand the population dynamics of these species in relation to river conditions.

There is limited information regarding the abundance of striped bass in the Tuolumne River. However, there is anecdotal evidence of large numbers of striped bass being found in the Tuolumne River as far back as 1903 (State Board of Fish Commissioners 1904). Striped bass were captured by electrofishing in the lower Tuolumne River in 1989 (TID/MID 1992) and during predator surveys in 1998, 1999, and 2003 (McBain & Trush and Stillwater Sciences 2006). The Districts' 2012 Predation Study estimated striped bass abundance in the lower river to be in the range of 500-750 individuals during summer 2012.

Average consumption rates of juvenile Chinook salmon (i.e., number of Chinook salmon per predator) by largemouth and smallmouth bass in the lower Tuolumne River (not scaled by gastric evacuation rates) ranged from 0–0.20 during the 2012 predation study (TID/MID 2013g) and from 0–1.7 in an earlier study conducted by the Districts (TID/MID 1992). In 2012, predation rates averaged for all habitat types and sampling events were 0.07 Chinook salmon per largemouth bass per day and 0.09 per smallmouth bass per day. Striped bass predation rates in the lower river were generally higher than those of smallmouth bass and largemouth bass (TID/MID 2013g). In 2012, predation rate averaged for all habitat types and sampling events was 0.68 Chinook salmon per striped bass per day.

Largemouth bass and smallmouth bass were estimated to have consumed about 37 percent and 49 percent, respectively, of the total potential juvenile Chinook salmon consumed by the three primary non-native predator species (i.e., largemouth bass, smallmouth bass, and striped bass).

Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to have consumed nearly 15 percent of the total potential juvenile Chinook salmon consumed by the three predator species. There was no evidence of consumption of Chinook salmon by Sacramento pikeminnow during either the 2012 study or the Districts' previous study (TID/MID 1992).

A conservative estimate of the total consumption of juvenile Chinook salmon by striped, largemouth, and smallmouth bass is about 42,000 during March 1-May 31, 2012 based on observed predation rates and estimated predator abundance. This suggests that nearly all juvenile Chinook salmon may be consumed by introduced predators between the Waterford and Grayson rotary screw traps. Only 2,268 Chinook salmon were estimated to have survived migration through the 25 miles between the screw-trapping sites (Robichaud and English 2013) during January through mid-June, making it plausible that most losses of juvenile Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 can be attributed to predation by non-native piscivorous fish species.

4.1.3.9 Tuolumne River Fisheries Management and Recovery Activities

4.1.1.1.7 Native Salmonid Management and Recovery Programs

The Ecosystem Restoration Program[2] is designed to improve the ecological health of the Bay-Delta watershed through restoring and protecting habitats, ecosystem functions, and native species. The Watershed Program Element specifically works in tandem with the Ecosystem Restoration Program Element to ensure that the ecological health of the Delta is restored and that water management is improved by working with communities at the watershed level.

The draft Central Valley Salmon and Steelhead Recovery Plan (NMFS 2009) addresses the Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), the Central Valley spring-run Chinook salmon ESU, and the Distinct Population Segment (DPS) of Central Valley steelhead. The draft plan describes recovery strategies, lists recovery goals, objectives, and criteria, and proposes recovery scenarios and numerous recovery actions throughout the Central Valley (see Section 4.1.4.11 of Exhibit E for greater detail regarding the plan).

The California Advisory Committee on Salmon and Steelhead Trout was established by California legislation in 1983 to develop a strategy for the conservation and restoration of salmon and steelhead in California. The committee's recommendations were advanced and discussed in the related publications described in the following four paragraphs.

The Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990) was intended to outline CDFW's restoration and enhancement goals for salmon and steelhead resources of the Sacramento River and San Joaquin River systems and to provide direction for various CDFW programs and activities.

[2] (http://www.dfg.ca.gov/ERP)

The Restoring Central Valley Streams (CDFG 1993) plan identifies the following goals to benefit anadromous fish: restore and protect California's aquatic ecosystems that support fish and wildlife, protect threatened and endangered species, and incorporate the state legislature's mandate and policy to double the size of populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

The Steelhead Restoration and Management Plan for California (CDFG 1996) focuses on restoration of native and naturally produced (wild) fish stocks because they have the greatest value for maintaining genetic and biological diversity. Goals for steelhead restoration and management are: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses.

The Final Restoration Plan for Anadromous Fish Restoration Program (USFWS 2001) identifies restoration actions that may increase natural production of anadromous fish in the Central Valley of California. This plan is divided to address different watersheds within the Central Valley, and restoration actions are identified for each watershed. It also includes the involved parties, tools, priority rating, and evaluation of each restoration action. The plan addresses only Central Valley waters accessible to anadromous fish.

4.1.1.1.8 Habitat Protection, Restoration, and Enhancement Projects

The USFS Tuolumne Wild and Scenic River Management Plan was approved in 1986 and revised in 1988 (NPS 2006). The purpose of the plan is to provide "direction for managing the federal lands within the boundaries of the designated corridor." The plan addresses portions of the Tuolumne Wild and Scenic River (29 miles) outside of Yosemite National Park.

As directed under the 1995 Settlement Agreement, the TRTAC developed the following 10 top priority habitat restoration projects aimed at improving geomorphic and biological elements of the lower Tuolumne River corridor (completion status in parentheses):

- Channel and Riparian Restoration Projects (RM 34.3–RM 40.3):
- Gravel Mining Reach Phase I (Completed in 2003),
- Gravel Mining Reach Phase II (Not completed),
- Gravel Mining Reach Phase III (Not completed), and
- Gravel Mining Reach Phase IV (Not completed).
- Predator Isolation Projects:
- Special Run-Pool (SRP) 9 (RM 25.7–25.9) (Completed in 2001), and
- Special Run-Pool (SRP) 10 (RM 25.5) (Not completed).
- Sediment Management Projects (RM 47.5–RM 51.8):

- Riffle Cleaning (Fine sediment) (Not completed),
- Gasburg Creek basin (Fine sediment) (Completed prior to 2008),
- Gravel Augmentation (Coarse sediment) (Not completed), and
- River Mile 43 (Coarse sediment) (Completed in 2005).

Other restoration efforts have been implemented in the lower Tuolumne River corridor by various groups, including FOT, TRT, NRCS, ESRCD, USFWS, CDFW, Stanislaus County, and the cities of Waterford, Ceres, and Modesto. Habitat restoration projects are discussed in detail in Section 5.3.2.2 of the Districts' PAD (TID/MID 2011).

To improve salmonid spawning and rearing conditions in the lower Tuolumne River, several coarse sediment augmentation and habitat restoration projects have been completed (TID/MID 2005, from TID/MID 2013c). CDFW placed approximately 27,000 cubic yards of gravel in the river near Old La Grange Bridge (RM 50.5) from 1999 to 2003 (TID/MID 2007, Report 2006-10). Riffle and floodplain reconstruction projects have also been completed at Bobcat Flat (RM 43.5), near the site of 7/11 Materials (RM 40.3–37.7), and at Special Run Pools (SRPs) 9 and 10 (≈ RM 25.7), with designs and preliminary permitting completed for additional gravel augmentation projects at upstream locations (TID/MID 2007, Report 2006-8).

Riparian restoration projects along the Tuolumne River include Grayson River Ranch, Big Bend, SRP 9, 7/11 Mining Reach Segment #1, and River Mile 43 at Bobcat Flat. Floodplain restoration was conducted at Grayson River Ranch (located approximately 4 miles upstream of the San Joaquin River confluence) by The Friends of the Tuolumne in 2000. Anecdotal evidence indicates some recovery of riparian vegetation has occurred on the floodplain and along newly constructed sloughs. The Tuolumne River Trust and other partners acquired approximately 250 acres on both sides of the Tuolumne River at Big Bend (RM 5.8 to 7.4). Restoration was completed in 2005, and monitoring results suggest that planting to reestablish native, woody riparian species was effective. In 2001, restoration of river and floodplain habitat was completed at SRP 9 (RM 25.7 to 25.9). A brief survey conducted in 2002 indicated that tree survival typically exceeded 60 percent for most species one year after planting. In 2003, restoration of river and floodplain habitat was completed at the 7/11 site (RM 40.3 to 34.4). Post-project monitoring has been limited to quantifying survival of planted vegetation and replacing plants as stipulated in the construction contract. The Bobcat Flat restoration site includes 303 acres of riparian and instream habitat owned by Friends of the Tuolumne. Restoration was conducted in 2005–2006, and anecdotal evidence, including some site photos, indicates some success in restoration of riparian vegetation at the site.

The AMF was initiated in 2001 to review designs for restoration projects in Central Valley rivers and assist resource agencies and tributary restoration teams. The AMF panel of technical experts reviewed and made recommendations on tributary restoration projects, incorporating adaptive management into projects, and maximizing restoration success (Adaptive Management Forum Scientific and Technical Panel and Information Center for the Environment 2004).

As noted above, The Ecosystem Restoration Program[3] is designed to improve the ecological health of the Bay-Delta watershed through restoring and protecting habitats and ecosystem functions.

4.1.4 Non-Don Pedro Project Out-of-Basin Actions

The San Joaquin River originates in the high Sierra Nevada range, flows northward, and enters the legally-defined Delta near the USGS Vernalis gaging station (RM 73) (see Figure 4.1-1). The drainage area of the San Joaquin River above the Vernalis gage is 13,539 mi^2. The average annual flow at Vernalis was 3.26 million AF from WY 1924 through WY 2012 (3.19 million AF for WY 1971–WY 2012). The three main tributaries to the San Joaquin River above Vernalis are the Merced (drainage area 1,726 mi^2), Tuolumne (drainage area 1,960 mi^2), and Stanislaus (drainage area 1,075 mi^2) rivers.

The Sacramento and San Joaquin rivers meet at the western boundary of the Sacramento-San Joaquin Delta. Freshwater from the rivers mingles with saltwater from the Pacific Ocean, creating the West Coast's largest estuary. Under historical conditions, the south Delta and lower San Joaquin River were composed of tidal wetlands merging southward into floodplain wetlands interspersed with complex side-channel habitats, lakes, and ponds, with seasonal wetlands bordering upland habitats (Whipple et al. 2012). As summarized by Lund et al. (2007), the present day Delta encompasses about 60,000 acres of open water (exclusive of Suisun Bay), 520,000 acres of agricultural lands, 64,000 acres of towns and cities, and 75,000 acres of undeveloped areas.

For the purposes of documenting out-of-basin actions within the FERC-defined geographical scope for cumulative effects assessment, the following sections focus on water management and other past, present, and reasonably foreseeable actions in the lower San Joaquin River basin, including the mainstem San Joaquin River below Friant Dam, two of the three major San Joaquin River tributaries, i.e., the Merced and Stanislaus rivers (actions on the Tuolumne River have been discussed previously in sections 4.1.2 and 4.1.3), and the Delta.

4.1.4.1 CCSF Regional Water System

The CCSF, through the SFPUC, owns and operates a regional water system that extends from the Sierra Nevada to San Francisco and serves retail and wholesale customers in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne Counties. The regional water system consists of water conveyance, treatment, and distribution facilities. The regional system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, five pump stations, and two water treatment plants. The source of the water supply is a combination of local supplies from streamflow and runoff in the Alameda Creek watershed and in the San Mateo Creek and Pilarcitos Creek watersheds (referred to together as the Peninsula watersheds), along with imported supplies from the Tuolumne River watershed. Local watersheds provide about 15 percent of total supplies, with the Tuolumne River providing the remaining 85 percent.

3 (http://www.dfg.ca.gov/ERP)

The SFPUC serves about one-third of its water supplies directly to retail customers, primarily in San Francisco, and about two-thirds of its water supplies to wholesale customers by contractual agreement. The wholesale customers are largely represented by the Bay Area Water Supply and Conservation Agency (BAWSCA), which consists of 26 member agencies in Alameda, San Mateo, and Santa Clara Counties. Some of these wholesale customers have other sources of water in addition to what they receive from the SFPUC, while others rely completely on the SFPUC for supply.

4.1.4.2 Central Valley Project and State Water Project

The development and management of California's surface water is a process that has spanned decades and has involved the participation of private companies and local, state, and federal agencies (CDWR et al. 2013). Irrigated agriculture in the San Joaquin Valley proliferated after the Gold Rush and again in 1857, when the California State Legislature passed an act to promote the drainage and reclamation of floodplains (Galloway and Riley 1999). By 1900, much of the flow of the Kern River and all flow from the Kings River were diverted and routed through canals and ditches to irrigate fields in the southern part of the San Joaquin Valley (Nady and Laragueta 1983, as cited in Galloway and Riley 1999). Because early diversions did not have associated storage facilities, agricultural water supply was limited by low summer flows.

By 1910, almost all available surface water in the San Joaquin Valley was diverted, which led to the development of groundwater for irrigation (Galloway and Riley 1999). The first groundwater development took place in areas where shallow groundwater was abundant, particularly in the central part of the valley where flowing wells were common. When the output from the flowing wells declined, pumps were installed to maintain flows. Around 1930, the development of an improved deep-well turbine pump, along with a reliable electrical supply in rural areas, allowed for further groundwater development.

The cities of Los Angeles and San Francisco began to have water shortages early in the 1900s. They recognized the need to augment local water supplies and were the first to develop distant water sources for this purpose. As California's population grew, existing projects could not meet the demand for water. As a result, the federal CVP and the California SWP were initiated in 1937 and 1957, respectively (CDWR et al. 2013). These two major statewide projects were developed to serve agricultural, environmental, and municipal water users throughout California.

The SWP and CVP water infrastructure is operated in a coordinated manner, with joint points of diversion that allow one project to use the other's diversion facility under certain conditions (CDWR et al. 2013). To some degree, both the SWP and CVP systems rely on runoff and upstream reservoir releases from the Sacramento and San Joaquin River basins to deliver contracted water via the Sacramento and San Joaquin Delta export pumps located in the south Delta to deliver water to project customers. The CDWR exports water through the Harvey O. Banks Pumping Plant (Banks pumping plant, completed in 1968), which supplies the California Aqueduct. The USBR exports water into the Delta-Mendota Canal (completed in 1951) through the C. W. "Bill" Jones Pumping Plant (Jones pumping plant, completed in 1951). The history and structure of the CVP and SWP facilities are described in the following subsections.

4.1.1.1.9 Central Valley Project

The CVP is the largest water supply project in the United States. It includes 18 reservoirs with a combined storage capacity of more than 11 million AF, 11 hydroelectric power plants, and more than 500 miles of major canals and aqueducts (CDWR et al. 2013). The USBR operates and maintains the CVP as an integrated project and coordinates operations with the SWP. Authorized project purposes include flood management; navigation; water supply for irrigation and domestic uses; fish and wildlife protection, restoration and enhancement; and power generation. However, not all facilities are operated to meet each of these purposes. The USBR has entered into approximately 250 long-term contracts with water districts, irrigation districts, and others for delivery of CVP water. Currently, there are eight divisions of the project and 10 corresponding units. Of the contracted water supply, approximately 70 percent goes to agricultural users, almost 20 percent is dedicated to fish and wildlife habitat, and nearly 10 percent is allocated to M&I water users (USBR 2011). In addition to water storage and regulation, the system has a hydroelectric capacity of over 2,000 MW, provides recreation, and enables flood control with its dams and reservoirs.

There are five CVP divisions/units south of the Delta in the San Joaquin River basin: Friant Division, New Melones Unit, San Luis Unit, San Felipe Division, and Hidden Unit on the Chowchilla and Fresno rivers (described below).

Friant Division[4]

The Friant Division transports surplus water from northern California through the southern part of the Central Valley. The major facilities of this division are Friant Dam, Friant-Kern Canal, and Madera Canal, all constructed and operated by the USBR.

Friant Dam, located on the San Joaquin River 25 miles northeast of Fresno, was completed in 1942. The dam is a concrete gravity structure, 319 feet high, with a crest length of 3,488 ft. The dam controls San Joaquin River flows, provides downstream releases to meet water requirements above Mendota Pool, provides flood control and conservation storage, provides diversion into the Madera and Friant-Kern Canals; prevents saltwater from degrading thousands of acres of lands in the Delta, and delivers water to 1 million acres of agricultural lands in Fresno, Kern, Madera, and Tulare Counties. The reservoir, Millerton Lake, which first stored water in 1944, has a total capacity of approximately 520,500 AF, a surface area of 4,900 acres, and an approximate length of 15 miles.

Friant Dam`s spillway was designed to pass flood water into Millerton Lake. However, due to frequent drought cycles in central California over the past 50 years, water has seldom spilled at Friant Dam. The outlet works consist of four steel pipes through Friant Dam that are controlled by four hollow-jet valves at the outlet ends. The capacity of the jet valves is 16,400 cfs; but flow through the valves rarely exceeds 100 cfs. Small releases are made to the river through two pipes branching from Penstocks 3 and 4.

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[4] Source: http://www.usbr.gov/projects/Project.jsp?proj_Name=Central+Valley+Project

Construction of the Friant-Kern Canal began in 1945 and was completed in 1951. The canal has an initial capacity of 5,000 cfs that gradually decreases to 2,000 cfs at its endpoint in the Kern River. The canal outlet works consist of a stilling basin and four steel pipes through the dam. The canal carries water 151.8 miles from Millerton Lake to the Kern River, 4 miles west of Bakersfield. Along a 113-mile reach between Friant Dam and the White River, the canal has more than 500 different structures, including overchutes, drainage inlets, irrigation crossings, and turnouts. The water is used for supplemental and new irrigation supplies in Fresno, Tulare, and Kern Counties.

The 35.9-mile-long Madera Canal carries water north from Millerton Lake to lands in Madera County to provide supplemental and new irrigation supply. The canal, which was completed in 1945, has an initial capacity of 1,250 cfs, which decreases to 625 cfs at the Chowchilla River. The outlet works consists of two pipes that discharge into a stilling basin at the upstream end of the Madera Canal. Water ran for the first time through the canal's entire length on June 10, 1945. The John A. Franchi Diversion Dam, formerly the Madera Diversion Dam, on the Fresno River, is operated by the Madera Irrigation District. Built by the USBR, the facility was completed in 1964.

In 1947, riparian landowners sued the United States government under the California Fish and Game Code, stating that Friant Dam deprived them of commercial and recreational uses related to salmon fishing. The State Attorney General concluded the United States was not required by California law to discharge water to preserve fisheries downstream of the dam. In 1988, when first contracts for the Friant Division came up for renewal, 15 environmental groups sued the federal government, maintaining that contract renewals should be subject to environmental review under NEPA and the ESA. The lawsuit culminated in the signing of the San Joaquin River Restoration Settlement Act and development of the associated San Joaquin River Restoration Program (see Section 4.1.4.11).

Hidden and Buchanan Units

The Hidden and Buchanan Units, located on the Chowchilla and Fresno Rivers, provide flood control and water supply to the Chowchilla and Madera irrigation districts. The Hidden Unit provides 24,000 AF annually from Hensley Lake to the Madera Irrigation District, and the Buchanan Unit provides 24,000 AF annually from Eastman Lake to the Chowchilla Water District.

New Melones Unit[5]

The New Melones Dam and Power Plant are located on the Stanislaus River, about 60 miles upstream of its confluence with the San Joaquin River. The dam is a 625-foot-high earth and rockfill structure that impounds New Melones Lake, which has a capacity of 2.4 million AF at a pool elevation of 1,088.0 ft. Construction of the New Melones Dam project began in 1966, about 0.75 miles downstream of the original Melones Dam, which was built by the Oakdale and South San Joaquin Irrigation Districts in 1926. Construction of the diversion tunnel was

[5] Source: http://www.water.ca.gov/swp/swptoday.cfm

completed in 1973. Construction of the main dam began in 1974, and initial filling of the reservoir took place in 1983.

The outlet works consist of a 3,774-foot-long, 23-foot-diameter tunnel and two conduits for emergency releases. Releases for flood control and irrigation are made through a branch of the multipurpose tunnel. The outlet works have a capacity of 8,300 cfs. The spillway has an uncontrolled concrete crest, with a capacity 112,600 cfs. The New Melones Power Plant, located immediately downstream of the dam, has a dependable capacity of about 279 MW, producing about 455 million KWh of energy annually. The New Melones Unit was officially transferred to the USBR in 1979 for integrated operation as part of the CVP.

An original purpose of the New Melones Dam was flood control. New Melones Lake includes a flood control reservation of 450,000 AF. Under flood control conditions, release operations are designed not to exceed a flow of 8,000 cfs (channel capacity) in the Lower Stanislaus River from Goodwin Dam downstream to the San Joaquin River. Unit operations provide releases for downstream fisheries requirements, water quality, water rights, and a water supply yield estimated at about 180,000 AF to meet present and projected agricultural and M&I needs in the service area.

Water availability for the New Melones Project has proven to be significantly different from what had originally been expected. The USBR found that previous modeled estimates of drought and demand were significantly inaccurate. As a result, contracts negotiated with the Stockton East Water District and the Central San Joaquin Water Conservation District have not always been met during drought years, and the USBR has had to purchase water from the Tri-Dam Project to meet the release requirements for the fall Chinook salmon run.

When the lake levels are lower, the old Melones Dam, which is now submerged, prevents cold water at the bottom of the lake from reaching the outlet works of the new dam, resulting in temperatures that are too high for salmonids downstream of the dam. The situation becomes most critical when the volume of the lake drops below 350,000 AF.

San Luis Unit[6]

Authorized in 1960, the San Luis Unit was constructed by the USBR and the State of California. It is now jointly operated by the USBR and State of California, with some facilities operated by Westlands Water District (see below).

The joint-use facilities of the San Luis Unit include O'Neill Dam and Forebay, B.F. Sisk San Luis Dam and Reservoir, William R. Gianelli Pumping-Generating Plant, Dos Amigos Pumping Plant, Los Banos and Little Panoche reservoirs, and San Luis Canal from O'Neill Forebay to Kettleman City, together with the associated switchyard facilities. The federal/private facilities include the O`Neill Pumping Plant and Intake Canal, Coalinga Canal, Pleasant Valley Pumping Plant, and the San Luis Drain.

[6] Source: http://www.water.ca.gov/swp/swptoday.cfm

Los Banos (completed in 1965) and Little Panoche (completed in 1966) detention dams are located southwest of the town of Los Banos on Los Banos and Little Panoche Creeks, respectively. B.F. Sisk Dam and Reservoir, a 382-foot-tall zoned earthfill structure located on San Luis Creek near Los Banos, were completed in 1967. The reservoir has a capacity of 2,041,000 AF. O'Neill Dam, an 87-foot-high zoned earthfill structure located on San Luis Creek about 2.5 miles downstream of San Luis Dam, was completed in 1967. The O'Neill Pumping Plant was also completed in 1967. The William R. Gianelli Pumping-Generating Plant, located at San Luis Dam, was completed in 1967. The San Luis Canal, the largest earth-moving project in USBR history, extends 102.5 miles from the O'Neill Forebay to a location west of Kettleman City. Water was first released into the canal in 1967. The Dos Amigos Pumping Plant is located 17 miles south of the O'Neill Forebay.

The Pleasant Valley Pumping Plant, operated by Westlands Water District, lifts water at an intake channel leading from the San Luis Canal at mile 74. Coalinga Canal, also operated in part by Westlands Water District, extends from the turnout structure on the San Luis Canal to the Coalinga area in Fresno County. Construction of the San Luis Drain, designed to convey and dispose of subsurface irrigation return flows from the San Luis service area, began in April 1968. Construction was halted in 1975 because of high costs and concerns about the quality of the agricultural drainage that would enter the Delta.

San Luis Reservoir serves as the primary storage reservoir, and O'Neill Forebay serves as an equalizing basin for the pumping-generating plant. Pumps at the base of O'Neill Dam take water from the Delta-Mendota Canal through an intake channel and release it into the O'Neill Forebay. The California Aqueduct flows directly into O'Neill Forebay. The pumping-generating units take water from the O'Neill Forebay and discharge it into the main reservoir. When not pumping, the units generate electric power by reversing flow through the turbines. Water used for irrigation is discharged into the San Luis Canal and flows via gravity to Dos Amigos Pumping Plant, where it is elevated to allow for gravity flow to its terminus at Kettleman City.
A state canal system extends to southern coastal areas. During the irrigation season, water from the California Aqueduct flows through O'Neill Forebay into San Luis Canal rather than being pumped into San Luis Reservoir. Two reservoirs, Los Banos and Little Panoche, are used to control cross drainage along the San Luis Canal and also provide flood control benefits. B.F. Sisk Reservoir is used to store surplus water of the Sacramento-San Joaquin Delta. A hydraulic junction for federal and state waters, B. F. Sisk Reservoir acts as a forebay for the Gianelli Pumping-Generating Plant. The primary purpose of the federal portion of the San Luis Unit facilities is to furnish approximately 1.25 million AF of water to supplement irrigation supply to approximately 600,000 acres in western Fresno, Kings, and Merced counties.

San Felipe Division[7]

Initial authorization for construction of elements of the San Felipe Division occurred in 1960, and the division was fully authorized in 1967. Construction began in 1964 and was completed in 1987. The division consists of the Pacheco Tunnel, 48.5 miles of closed conduits, the Pacheco and Coyote pumping plants, San Justo Dam and Reservoir, and two associated switchyards. The

[7] Source: http://www.water.ca.gov/swp/swptoday.cfm

Santa Clara Valley Water District (SCVWD) manages the Santa Clara Tunnel and Conduit, Pacheco Tunnel and Conduit, and Pacheco and Coyote Pumping Plants. The Western Area Power Administration (WAPA) manages Pacheco Switchyard, and San Benito County Water District (SBCWD) manages San Justo Dam and Reservoir and Hollister Conduit.

Water from the Delta is transported through the Delta-Mendota Canal to O'Neill Forebay (see San Luis Unit, above), pumped into San Luis Reservoir, and then diverted through the Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. At the pumping plant, water is lifted to the Pacheco Tunnel Reach 2. The water flows through the tunnel and the 7.92-mile-long Pacheco Conduit, which extends to the bifurcation of the Santa Clara and Hollister conduits. The 22-mile-long Santa Clara Tunnel and Conduit convey water from the Pacheco conduit to the Coyote Pumping Plant, which is located at the end of the Santa Clara Conduit, near Anderson Dam. The 19.5-mile-long Hollister Conduit extends from the Pacheco Conduit to San Justo Reservoir. San Justo Dam, located about 3 miles southwest of Hollister, is a 151-foot-high earthfill structure that impounds a reservoir with a capacity of 9,785 AF.

The primary recipients of water from the San Felipe Division are municipal and industrial users. The San Felipe Division provides supplemental irrigation to 63,500 acres and about 132,400 AF of water annually for municipal and industrial uses.

4.1.1.1.10 State Water Project

The SWP is a complex system composed of pumping plants, hydroelectric power plants, water storage facilities with a combined capacity of approximately 5.8 million AF, and approximately 700 miles of pipelines and canals (CDWR et al. 2013). It is the largest state-built water storage and conveyance project in the United States. The CDWR operates and maintains the SWP, which delivers water to 29 agricultural and municipal and industrial contractors in northern California, the San Joaquin Valley, the Bay Area, the Central Coast, and southern California.

SWP facilities south of the Delta in the San Joaquin River basin include the following: (1) the San Luis Area, which includes the Gianelli Pumping-Generating Plant and the Dos Amigos Pumping Plant, (2) the Coastal Branch Area, which consists of the Devil's Den, Bluestone, and Polonio Pass pumping plants and the Las Perillas and Badger Hill pumping plants, (3) the South San Joaquin Area, which includes the Buena Vista, Teerink and Chrisman, and Edmonston pumping plants, (4) the West Branch Area, which includes the Oso and Alamo pumping plants and the Warne and Castaic power plants, and (5) the East Branch Area, which includes Lake Perris, the Pearblossom Pumping Plants, and the Mojave and Devil Canyon power plants. The Gianelli Pumping-Generating Plant and Dos Amigos Pumping Plant are joint-use facilities, described above in the context of the CVP (see preceding section). The remaining facilities are described below.[8]

As noted above, water is pumped into the California Aqueduct at the Banks Pumping Plant and flows south by gravity to the San Luis Joint-Use Complex. After leaving the San Luis Joint-Use Complex, water travels through the California Aqueduct in the central San Joaquin Valley, until

[8] Source: http://www.water.ca.gov/swp/swptoday.cfm

it reaches the bifurcation near Kettleman City, which conveys a portion of the water into the Coastal Branch Aqueduct (completed in 1997) to serve San Luis Obispo and Santa Barbara counties. The water remaining in the mainstem of the California Aqueduct is pumped uphill by the Buena Vista, Teerink, and Chrisman pumping plants until it reaches Edmonston Pumping Plant (operational beginning in 1971), the SWP's largest pumping facility and the world's largest water lift. The Edmonston Plant pumps water nearly 2,000 feet up and over the Tehachapi Mountains through approximately 10 miles of tunnels. In so doing, it consumes 40 percent of the electricity used by the SWP.

As the water reaches the bottom of the mountain, it bifurcates into the West Branch and the East Branch aqueducts (the latter is the mainstem). Water in the West Branch is pumped by the Oso Pumping Plant into Quail Lake, from where it enters a pipeline leading into Warne Powerplant (operating since 1982). Water is then discharged into Pyramid Lake (Pyramid Dam was completed in 1973) and through Angeles Tunnel to the Castaic Powerplant (the latter two facilities are jointly operated by CDWR and the Los Angeles Department of Water and Power, which owns the facilities). At the end of the West Branch is Castaic Lake (Castaic Dam was completed in 1973) and Castaic Lagoon.

Water flowing down the East Branch generates power at Alamo Powerplant (completed in 1986) and is then pumped uphill by the Pearblossom Plant, from where it flows downhill through an open aqueduct, linked at its end to four underground pipelines that carry the water into the Mojave Siphon Powerplant, which discharges the water into Lake Silverwood. When water is needed, it is discharged into Devil Canyon Powerplant and its two afterbays. The 28-mile-long Santa Ana Pipeline then conveys the water underground to Lake Perris, the southernmost SWP facility.

The SWP's most recently constructed facility, the East Branch Extension, conveys water from Devil Canyon Powerplant's afterbay to Yucaipa Valley and the San Gorgonio Pass area in San Bernardino and Riverside counties. The project, which consists of 13 miles of buried pipeline, three pump stations, and a 90 AF regulatory reservoir, is expected to meet the region's water needs for 40 years. SWP water will be used to recharge groundwater basins and allow greater flexibility for local water systems. The extension, completed in 2003, is a cooperative project between CDWR, the San Bernardino Valley Municipal Water District, and the San Gorgonio Pass Water Agency.

SWP deliveries provide water to 25 million Californians and about 750,000 ac of irrigated farmland. Other project functions include flood management, water quality maintenance, power generation, recreation, and fish and wildlife enhancement. The SWP operates under long-term contracts with public water agencies throughout California from counties north of the Delta to southern California. These public water agencies in turn deliver water to wholesalers or retailers or deliver it directly to agricultural and M&I water users (USBR and CDWR 2005). Of the contracted water supply, approximately 75 percent goes to M&I users and 25 percent to agricultural users.

4.1.4.3 Water Management in the San Joaquin, Merced, and Stanislaus Rivers

There are currently more than 80 dams on the San Joaquin, Merced, Tuolumne, and Stanislaus rivers, with a total storage capacity of over 7.7 million AF. Combined, these facilities have the capacity to capture and control the entire average annual yield of the rivers they dam for the primary purposes of water supply, flood control, and hydroelectric power generation. The relatively large flows from the eastside tributaries, i.e., the Merced, Tuolumne, and Stanislaus rivers, strongly influence flow and water quality in the mainstem San Joaquin River. The westside tributaries are ephemeral, so water entering the San Joaquin River from the west side of the basin consists largely of agricultural return flows, which strongly influences the quality of water in the river.

4.1.1.1.11 San Joaquin River Mainstem

The flow regime downstream of Friant Dam (described as part of the Friant Division) has been managed since the implementation of the CVP (Cain et al. 2003). Friant Dam and its associated infrastructure irrigate approximately 1 million acres of agricultural land along the San Joaquin Valley's east side (Cain et al. 2003). In most years, these diversions take 95 percent of the river's average annual yield. A small fraction of the water is released according to a 1957 legal settlement to maintain flows (typically 250 cfs or less) during the irrigation season to support agricultural diversions by riparian water rights holders in the 36-mile reach between Friant Dam and the Gravelly Ford Canal. As a result, this reach of the river is wetted all year.

Below the Gravelly Ford Canal, the river channel is underlain by highly permeable bed material, and there are high rates of flow losses to infiltration. This reach has been allowed to go dry to avoid losing valuable surface water to groundwater infiltration (Cain et al. 2003). Riparian water rights holders downstream of Gravelly Ford have been served by the Delta-Mendota Canal, which delivers water from the Delta to the San Joaquin River at Mendota Pool. Mendota Pool is formed behind Mendota Dam and was originally constructed in the 1800s to divert irrigation water from the San Joaquin River to several irrigation districts now known as the San Joaquin River Exchange Contractors (Exchange Contractors). The Exchange Contractors agreed not to exercise their historic rights to the San Joaquin River's water in exchange for Delta water delivered via the Delta- Mendota Canal. Today, Mendota Pool has a storage capacity of 3,000 AF and distributes Delta water into a system of irrigation canals. Some water is released downstream of Mendota Pool into the historical channel of the San Joaquin River for subsequent diversion into Arroyo Canal at Sack Dam, 22 miles downstream of the Mendota Pool. Below Sack Dam, the river is often dry for several miles except during flood events.

The San Joaquin River between Gravelly Ford and the Merced River has an unusually complex system of flood bypasses, which route most flood flows around the historical river channel and flood basin of the San Joaquin River (Cain et al. 2003). Authorized by the Flood Control Act of 1944, the San Joaquin River and Tributaries Project was constructed in the 1950s and 1960s and includes over 100 miles of levees and bypasses. Starting 35 miles downstream of Friant Dam, a levee-confined floodway between Gravelly Ford and the Chowchilla bypass is designed to convey 12,000 cfs, but due to channel aggradation and levee instability may only be able to safely convey 8,000 cfs. Approximately 45 miles downstream of Friant, large flood releases are diverted into the Chowchilla and Eastside Flood bypass systems, which route most of the river's floodwaters around the historical flood basin downstream of Mendota Pool.

There are hundreds of entities with rights to divert water from the San Joaquin River between the mouth of the Merced River and the Delta. Many of these are small, unscreened private irrigation diversions. Some diversions, such as those of the Patterson Irrigation District (at which a new fish screening facility was constructed in 2011) and the West Stanislaus Irrigation District, are capable of diverting hundreds of cfs of water.

The median annual unimpaired flow in the San Joaquin River at Vernalis from WY 1930 through 2008 was reportedly 5.9 million AF (Cain et al. 2003). The median annual actual flow was reportedly 1.9 million AF, or 32 percent of the median annual unimpaired flow. This reduction in actual flow compared to unimpaired flow is attributable to exports of water to locations outside the basin and consumptive use of water within the basin. Unimpaired flow in the San Joaquin River at Vernalis is primarily attributable to flow from the Stanislaus, Tuolumne, and Merced rivers, and during wetter water years, the upper San Joaquin River. In flood years, water from the Kings River also contributes to the flow in the San Joaquin River.

The San Joaquin River Restoration Program (see Section 4.1.4.11 for a description of the Program), includes flow releases at Friant Dam to restore and maintain fish populations in good condition in the mainstem San Joaquin River. Interim flows were first released from Friant Dam on October 1, 2009. In 2013, interim flows between 350 and 400 cfs were released from Friant Dam to maintain the flow target at Gravelly Ford.[9] Up to 1,060 cfs was released from Friant Dam in 2013 as part of spring pulse flows. On January 2, 2014, flows released from Friant Dam were increased to 475 cfs to maintain the flow target at Gravelly Ford. However, beginning in February 2014, flows released from Friant Dam were decreased to 360 cfs to begin ceasing restoration flows because of drought conditions (i.e., a critical low-water year beginning March 1, 2014). Flows were reduced in 50-cfs increments until all restoration flows were discontinued. If drought conditions persist, restoration flows are unlikely to resume before March 2015.

4.1.1.1.12 Merced River

In about 1870, the Robla Canal Company, a private water company, began diverting water from the Merced River to eastern Merced County (Merced Irrigation District 2012). The Robla Canal Company was succeeded by the Farmers Canal Company, which was acquired by the Merced Canal and Irrigation Company in 1883 (Merced Irrigation District 2012).

Currently, four dams control the majority of flow in the Merced River: Merced Falls Diversion Dam, New Exchequer Dam, McSwain Dam, and Crocker-Huffman Dam (Cain et al. 2003). Merced Falls Diversion Dam (RM 55.0), constructed in 1901 by Pacific Gas and Electric Company (PG&E), generates hydroelectric power and diverts flow into the Merced Irrigation District (Merced ID) Northside Canal, which has a capacity of 90 cfs. In 1910, the Merced ID constructed Crocker-Huffman Dam (RM 52.0), which diverts flow into the Main Canal. The Main Canal has a capacity of 1,900 cfs and delivers water to lands south of the Merced River.

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[9] Source: http://restoresjr.net/activities/if/index.html

Exchequer Dam, the first major storage facility on the Merced River, was constructed in 1926 by the Merced ID. It stored flows during the high spring run-off period and released them during the irrigation season into the North and Main Canals at Merced Falls and at the Crocker-Huffman Diversion Dam. Due to its limited capacity of 281,000 AF, Exchequer Dam did not capture all spring run-off and therefore did not allow for inter-annual water storage. Exchequer Dam, now known as Old Exchequer Dam, was inundated in 1967 by Lake McClure, when the Merced ID constructed New Exchequer Dam immediately downstream of the old dam (RM 62.5).

New Exchequer Dam and its downstream counterpart, McSwain Dam (RM 56.0), are the primary components of the Merced River Development Project, which is owned by the Merced ID and licensed by FERC. Lake McClure, the reservoir created by New Exchequer Dam, has a storage capacity of 1.03 million AF and enables the Merced ID to store water in wet years for use during subsequent dry years. Lake McSwain, located 6.5 miles downstream of New Exchequer Dam, has a capacity of 9,730 AF and is operated as a re-regulation reservoir and hydroelectric facility. Together, the New Exchequer and McSwain projects have a combined storage capacity of 1.04 million AF, which amounts to 102 percent of the average annual runoff from the Merced River watershed. The Merced River Development Project provides agricultural water supply, hydroelectric power, flood control, recreation, and some water to maintain minimum instream flows for fish in the Merced River.

The ACOE regulates flood control operations on the New Exchequer Dam and Reservoir. According to the ACOE Water Control Manual, which dictates operations of the dam for flood control, a maximum of 400,000 AF of space is dedicated to flood control during the winter runoff season, i.e., November 1 through March 15 (Stillwater Sciences 2001). The ACOE limits maximum reservoir releases to 6,000 cfs, measured at Stevinson gage near the confluence with the San Joaquin River. The maximum physical release from the New Exchequer outlet structure is 12,400 cfs. A flood reservation storage capacity of 350,000 AF is maintained for the rain flood pool between October 31 and March 15, and an additional 50,000 AF is reserved for the forecasted spring snowmelt after March 1.

The Merced River between Crocker-Huffman Dam (RM 52.0) and Shaffer Bridge (RM 32.5) has been extensively affected by alteration of the flow regime, water withdrawals, agricultural water returns, and land use activities (Stillwater Sciences 2001). The major water withdrawals are associated with the Cowell Agreement water users and riparian water users. These water users have maintained seven main channel diversions in this reach since the mid 1800s and have the right to divert annually up to approximately 94,000 AF of water. The users divert water to private canals via small wing dams constructed in the channel each year with rock and gravel excavated from the river. Most of these diversions are unscreened. There are numerous agricultural water returns in this section of river as well. Downstream of Shaffer Bridge, CDFW identified 238 diversions, generally small pumps that deliver water for agricultural purposes (Stillwater Sciences 2001).

4.1.1.1.13 Stanislaus River

There are more than 30 dams in the Stanislaus River watershed, with a combined storage capacity of approximately 2.7 million AF, more than 220 percent of the river basin's average annual runoff (Cain et al. 2003). Development of dams and diversions for both mining and irrigation began soon after the Gold Rush. Beginning in 1856, a series of water and power companies constructed several water supply and power facilities in the Stanislaus River Watershed. On the South Fork Stanislaus River, Big Dam and Herring Creek, Upper Strawberry, and Lower Strawberry reservoirs were constructed in 1856, Lyons Reservoir was constructed in 1898, and Philadelphia Diversion Dam (11-ft-high concrete face rock masonry overflow spillway dam) in 1916. The Oakdale Irrigation District and San Joaquin Irrigation District were formed in 1909 and bought the Tulloch water rights and physical distribution system in 1910. The Sand Bar Diversion Dam (24-ft-high timber crib overflow spillway dam) and the Stanislaus Forebay (60-ft-high shotcrete face earthfill compacted rock overlay dam) were constructed on the Middle Fork Stanislaus River in 1908, and Relief Dam (144.5-foot-high concrete face rock masonry dam) in 1910. In 1917, Lower Strawberry Reservoir was enlarged from 1,190 AF to 17,900 AF (Strawberry Dam is a 133-ft-high concrete face rock masonry dam).

The Oakdale and San Joaquin irrigation districts built the original 80-foot Goodwin Dam in 1913 to divert water into the Oakdale and South San Joaquin Irrigation Canals. Despite its height, Goodwin Diversion Dam provided no usable storage. Oakdale Canal, with a capacity of 560 cfs, diverts water to the south, and the South San Joaquin Canal diverts up to 1,320 cfs to the north. The height of Goodwin Dam was increased in the late 1950s to create a re-regulating reservoir for the New Tulloch Dam.

In 1926, Oakland Irrigation District and San Joaquin Irrigation District constructed Melones Dam and its associated 112,500 AF reservoir 15 miles upstream of Goodwin Dam to store spring runoff and release it downstream for diversion at Goodwin Dam (Cain et al. 2003). In 1929, Spicer Meadow Dam (with a reservoir capacity of 4,060 AF) was completed on the North Fork Stanislaus River, and in 1930, Lyons Reservoir was enlarged from 839 to 5,508 AF.

In 1948, the Oakdale and San Joaquin irrigation districts agreed to investigate the cost and feasibility of constructing additional dams to increase water supply and provide power production, and in 1955 the districts agreed to construct the Tri-Dam Project, including the Donnells Dam (483 ft high) and Reservoir (64,325 AF) and Beardsley Dam (280 ft high) and Reservoir (97,802 AF) on the Middle Fork Stanislaus River upstream of Melones Dam, and the Tulloch Dam (205 ft high) and Reservoir (66,968 AF) downstream of Melones Dam. Construction of the three facilities was completed in 1957 and the facilities became operational in 1958. As part of the construction of the Tri-Dam Project, the height of Goodwin Diversion Dam was increased to 87 ft to create an afterbay to regulate discharge from Tulloch Dam. From 1985–1990, the Calaveras County Water District constructed the North Fork Stanislaus Hydroelectric Project, which included the construction of New Spicer Dam (265 ft high) and Reservoir (189,000 AF) in 1989.

Melones Dam, now known as Old Melones Dam, was replaced and inundated in 1979 when the ACOE constructed New Melones Dam. New Melones Dam is the largest reservoir in the San

Joaquin River Basin, with a storage capacity of 2.4 million AF or 2.4 times the Stanislaus River's average annual runoff. New Melones Dam is operated and maintained by the USBR for flood control, to provide water for CVP contractors in the watershed, and to maintain water quality in the Stanislaus River and Delta.

4.1.4.4 Stockton Deep Water Ship Channel

The lower San Joaquin River flows north past the City of Stockton and into the Delta. The river connects the global economy to the Port of Stockton (Port) through a 78-mile-long Deep Water Ship Channel (DWSC) (Newcomb and Pierce 2010). The DWSC, which was first dredged in the 1930s, terminates at the Deep Water Turning Basin adjacent to the Port. The channel serves as a shipping corridor for cargo ships traveling from San Francisco Bay to the Stockton Port.

Periods of low dissolved oxygen (DO) concentrations have historically been observed in the DWSC; the majority of these low DO periods have occurred during summer and fall upstream of Turner Cut. In January 1998, the State Water Resources Control Board (SWRCB) adopted the CWA Section 303(d) list that identified this DO impairment, and the CVRWQCB initiated development of a TMDL to identify factors contributing to the DO impairment and assign responsibility for correcting the low DO problem (ICF International 2010).

Since the approval of the San Joaquin River DO TMDL Basin Plan Amendment in 2005, two actions have been implemented to alleviate low DO conditions in the DWSC: (1) the City of Stockton added engineered wetlands and two nitrifying bio-towers to the Stockton Regional Wastewater Control Facility to reduce ammonia discharges to the San Joaquin River and (2) the CDWR constructed the Demonstration Dissolved Oxygen Aeration Facility (Aeration Facility) at Rough and Ready Island to evaluate its applicability for improving DO conditions in the DWSC (ICF International 2010).

A full-scale aerator was constructed (using public grant funds) in the Stockton DWSC by CDWR and was operated by CDFW until 2011. In 2011, CDWR deeded the aerator to the Port of Stockton, which now owns and operates the facility. The annual cost of operating the aerator is the subject of a multi-party agreement. Twenty five percent of the cost is provided by the San Joaquin Tributaries Authority and San Joaquin River Group Authority, a joint powers authority that includes the Districts. The other cost-share partners in the operating agreement, and their cost-share percentages, are the CDWR jointly with the State Water Contractors (17%), the San Luis Delta Mendota Water Authority (12.5%), the San Joaquin Valley Drainage Authority (12.5%), and the Port of Stockton (33%). Upon completion of the operation agreement, the Port of Stockton will continue to own and operate the aerator.

4.1.4.5 Delta Water Management and Diversions

The Delta's boundaries are defined in Water Code § 12220, and encompass a roughly triangular area extending from Chipps Island near Pittsburg on the west, to the City of Sacramento on the Sacramento River on the north, and to the Vernalis gaging station on the San Joaquin River on the south. With the construction of the CVP and SWP, the Delta became a critical link in California's complex water distribution system (CDWR et al. 2013). Delta channels transport water mostly from upstream Sacramento Valley reservoirs to the South Delta, where the Banks and Jones pumping plants divert water into the California Aqueduct and the Delta Mendota Canal, respectively. The Delta is currently a conduit for water that is used for a wide range of instream, riparian, and other beneficial uses, including critical habitat for several native aquatic and terrestrial species, drinking water for more than 25 million people, and irrigation water for 4 million acres of farmland throughout the Delta and San Joaquin Valley.

The water balance in the Delta—i.e., total inflow versus total outflow—is controlled by supply from the Sacramento and San Joaquin rivers, eastside tributary rivers and streams, contributions from Coast Range watersheds, upstream diversions, demand from in-Delta water users, outflows from the Delta to the San Francisco Bay and Pacific Ocean, and exports to agricultural and M&I users outside the Delta (CDWR et al. 2013). Precipitation in the Delta region and small tributary inflows provide some water to the Delta, but these are minor compared to the flow contributions of the large rivers. The largest volume of water exiting the Delta is outflow, which is the water that travels through the Delta, contributes to in-channel and wetland coverage, and exits through the San Francisco Bay to the Pacific Ocean. Exports of water through the SWP and the CVP, followed by in-Delta use and local diversions, constitute the next largest volumes of water exiting the Delta.

There are over 3,000 diversions that remove water from upstream and in-Delta waterways for agriculture and M&I use (CDWR et al. 2013). Of these, 722 are located in the mainstem San Joaquin and Sacramento rivers, and 2,209 diversions are in the Delta (Herren and Kawasaki 2001). Of the 2,209 diversions in the Delta, most are unscreened and used for in-Delta agricultural irrigation (Herren and Kawasaki 2001). There are also numerous water management activities and diversions in eastside rivers that affect inflows to the Delta (e.g., to support M&I uses, hydroelectric generation, agriculture, and flood control in the Calaveras and Mokelumne river watersheds).

4.1.1.1.14 Population Growth and Water Demand

In the past decade, California's population has increased by 25 percent, double the national average (CDWR et al. 2013). The California Department of Finance estimates that the current population of 37 million will exceed 52 million by 2030 and reach nearly 60 million by 2050. In its 2009 update of the California Water Plan, CDWR used three possible future scenarios to forecast water demands up to the year 2050. It is estimated that water demands will be as high as 10 million AF per year. In addition to the increased demand for Delta water resulting from population growth, established flow release requirements and restrictions on project operations for the protection of certain fish and wildlife species with critical life stages that depend on freshwater flows are expected to increase in the future. These current and projected future requirements all increase the competition for water supplies in the State of California.

With forecasts of reduced precipitation, shifts in timing of peak flow and runoff periods, reductions in snowpack, and impacts from a rising sea level resulting from global climate change, the struggle to meet the divergent demands for water will increase in the future. Nevertheless, the Delta will remain the center of California's water system, because the economies of major regions of the state depend on the water flowing through the Delta.

4.1.4.6 San Joaquin River and Delta Levee Construction and Maintenance

Beginning in the 1850s, the construction of levees around the San Joaquin River and Delta facilitated the conversion of lands to agricultural and other human uses. Combined with the straightening, widening, and dredging of channels, levee construction increased shipping access to the Central Valley and increased the ability to control water conveyance and prevent flooding (CDWR et al. 2013). Currently, the Delta is a highly engineered environment, composed of 57 leveed island tracts and 700 miles of sloughs and winding channels. Over 1,100 miles of levees protect 738,000 acres of Delta islands, tracts, and population centers from flooding and safeguard a large portion of California's water supply (CDWR et al. 2013). The extensive levee system supports widespread farming throughout the Delta. This has allowed farmers to drain and farm a large portion of the Delta, which in its natural state was a tidal marsh.

Most of the levees protecting the Delta (approximately 65%) are not part of the federal/state Sacramento Flood Control Project system and were constructed and now maintained by island landowners or local reclamation districts (CDWR et al. 2013). These levees are generally built to an agricultural standard and may be less stable than those constructed and maintained to protect urban areas. Improvement and maintenance of these "non-project" levees can be challenging; the peat deposits that made the Delta a fertile farming location make poor materials for constructing levees and/or their foundations. Oxidization of these peat soils has led to island and levee subsidence, which has increased the burden on the levee system. Another way that the Delta levees are distinguished from levees along rivers such as the Sacramento and San Joaquin rivers is that they are constantly exposed to water, so they often act more as dams than levees, although they are not constructed or regulated to the same engineering standards as dams.

Currently, California has several programs in place to help manage risk and improve the environment in the Delta (CDWR et al. 2013). Local reclamation districts are responsible for maintaining their levees but may be reimbursed for a portion of the cost of maintenance under the State's Delta Levees Subvention Program, which was established in 1973. The Delta Flood Protection Fund Act of 1988 and the Delta Levee's Special Project program also provide financial assistance to local levee maintenance programs.

4.1.4.7 Land Use

4.1.1.1.15 <u>Mining</u>

Known mineral resources in the western Delta are primarily sand and gravel deposits that are valuable as construction aggregate or as construction fill material (CSLC 2012). Since 1915, millions of cubic yards of sand and gravel have been mined from Bay floor shoals. Sand mining in recent decades has been conducted under mining leases granted by the California State Lands Commission (CSLC).

Based on the 2006 CGS study of aggregate availability, estimates of demand for construction aggregate in California over the next 50 years will total approximately 13.5 billion tons (Kohler 2006), not including increased demand following major bond initiatives (e.g., for public infrastructure projects, reconstruction following a major earthquake, etc.). Under the latest mining leases, for the years 1998 through 2007, an average of approximately 135,700 cubic yards per year were mined from the Delta and Carquinez Strait lease areas. Recently proposed 10-year mineral extraction leases that would enable continuation of dredge mining in the western Delta have been reviewed and approved by the CSLC.

4.1.1.1.16 Agriculture and Livestock Grazing

Agriculture is the primary land use along the lower San Joaquin River from its confluence with the Tuolumne River to Vernalis, with uses including fruit and nut orchards, field crops, vegetables, seed and other row crops, vineyards, and pastures (Mintier Harnish et al. 2009). The Delta's combination of highly productive soils, a climate conducive to agriculture, and readily available high quality irrigation water support a broad range of agriculture, including high value crops (CDWR et al. 2013). According to the Farmland Mapping and Monitoring Program classifications, Delta land used for agricultural purposes totals more than 575,000 acres, including approximately 395,000 acres of Prime Farmland, 33,000 acres of Farmland of Statewide Importance, 41,000 acres of Unique Farmland, 44,000 acres of Farmland of Local Importance (including locally-designated Farmland of Local Potential), and 63,000 acres of Grazing land (CDWR et al. 2013).

Over 30 types of crops are grown in the Delta region, including alfalfa, almonds, apples, apricots, asparagus, cherries, corn, squashes and melons, dry beans, grain and hay, wine and table grapes, miscellaneous truck crops, olives, peaches and nectarines, pears, rice, safflower, subtropical trees, Sudan grass, sugar beets, sunflowers, tomatoes, turf, and walnuts (CDWR et al. 2013). Areas with less productive soils such as hard pan or areas with high water tables or poor drainage are often used as pasture.

Delta agricultural production relies heavily on irrigation because there is low rainfall during the majority of the growing season (CDWR et al. 2013). Irrigation and drainage practices vary depending on the kind of crop being irrigated. Methods include drip, sprinkler, furrow, flood, border strip, basin, sub-irrigation, or a combination of these. Most crops produced in the Delta require weekly or biweekly irrigation throughout the growing season until a few weeks before harvest. In-season irrigation quantities depend on crop type, stage of crop growth, soil moisture profile, management of plant pests and diseases, and weather conditions. Generally, irrigation water is diverted directly from Delta waterways and transported to agricultural lands via canals. In some cases water is pumped directly into field furrows. Irrigation and drainage canals are operated and maintained in the Delta by reclamation districts, irrigation districts, and water agencies. Some of the agricultural surface water diversions are screened to protect fish, but many are not (CDWR et al. 2013).

Fertilizers, pesticides, and herbicides are commonly used to maximize yields and protect crops (CDWR et al. 2013). Fertilizers are used to replenish soil nutrients and may be composed of natural and/or synthetic materials with varying concentrations of plant nutrients. Although pesticides are designed to break down after a period of time, spray drift and groundwater contamination are common problems associated with applied pesticides (CDWR et al. 2013). Application methods for fertilizers, pesticides, and herbicides vary by crop and chemical type and include: chemigation (i.e., application through the irrigation system), orchard spray rigs, spray booms, brush brooms, broadcast spreaders, chemically coated seeds, and aerial applicators (crop dusters). The California Department of Pesticide Regulation (CDPR) has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of California's Central Valley and Delta (Werner et al. 2008).

Delta agricultural runoff percolates into the water table or is discharged into Delta waterways (CDWR et al. 2013). Within the Delta, reclamation district canals and ditches frequently function as both water supply and drainage conveyance facilities, and they are typically kept at low water levels during the drainage season and pumped out by the reclamation districts to remove drainage and stormwater. During the crop irrigation season in subsurface irrigated areas, water is diverted from the Delta into these same ditches. Agricultural drainage water is captured in the canals and ditches and reused in subsequent irrigation. Most reclamation district drainage discharged into Delta waterways is for stormwater and flood management (CDWR et al. 2013).

4.1.1.1.17 Industrial and Residential Development

There are no incorporated cities along the lower San Joaquin River from its confluence with the Merced River to Vernalis. Rural residential use is typically the only type of development, and much of the population resides in surrounding cities (Mintier Harnish et al. 2009).

California is presently losing agricultural land at a rate of 49,700 ac annually, due in part to urban development fueled by population growth, housing prices, and commuting patterns (Kuminoff and Sumner 2001) as well as drainage problems, loss of reliable or affordable water supply, and conversion to wildlife habitat. These circumstances suggest that the existing land use patterns in the Delta and surrounding areas (including the lower San Joaquin River watershed) may experience continuing changes in the future, with a shift to more industrial, commercial, and residential land uses. Currently, there are 64,000 ac in the Delta that support urban and commercial land uses, although this is expected to increase due to population growth and the concomitant conversion of agricultural land to urban and residential uses.

There is little infrastructure along the lower San Joaquin River aside from that which supports agriculture and rural residential development. The Delta, on the other hand, contains much infrastructure of statewide importance, including transportation facilities and power generation and transmission facilities (Mintier Harnish et al. 2009). Three interstate highways (I-5, I-80, and I-580) pass along the periphery of the Delta; Interstate-5 is one of the most important north-south transportation routes on the west coast, running from the Mexican border to the Canadian border. It also runs along the entire eastern edge of the Delta. On an average day, the segments of I-5 that pass through Stockton carry approximately 130,000 vehicles.

Ship traffic in the Delta supports interstate and international commerce. More than 300 ships and barges used the Stockton DWSC in 2005.

Electricity, gasoline, and other energy supplies for the region are provided by pipelines and transmission facilities that cross the Delta, and in 2004, there were approximately 240 operating natural gas wells in the Delta (Mintier Harnish et al. 2009). In addition, a large PG&E gas storage facility is located under McDonald Island within the San Joaquin County portion of the

Delta (Mintier Harnish et al. 2009). More than 500 miles of electrical transmission lines run through the Delta, portions of which carry power to other parts of the western United States. The petroleum pipelines that cross the Delta provide approximately 50 percent of the transportation fuel used in Northern California and Nevada (Mintier Harnish et al. 2009).

4.1.1.1.18 Recreation

Recreational use is a critical asset to the San Joaquin River watershed and Delta region. Visitors include local residents, residents from nearby communities, and many visitors from the Bay Area and other parts of the state (CDWR et al. 2013). Along the San Joaquin River and Delta waterways and on Delta islands, activities include picnicking, swimming, fishing, boating, waterskiing, nature study, sightseeing, horseback riding, tent and RV camping, biking, hunting, and hiking. Although these recreational activities contribute to local economies, they also increase pressure on an already fragile environment.

To support the high levels and diversity of recreational use, an extensive infrastructure of public (county, state, and federal) and private providers has been established within the region (CDWR et al. 2013). Tent and RV camping sites are located throughout the area. Most of the camping areas are privately owned at marinas around the Delta. There are, however, publicly owned camping sites such as Dos Reis Park on the San Joaquin River and Caswell Memorial State Park on the Lower Stanislaus River (near its confluence with the San Joaquin River). Public picnic areas along Delta waterways can be found at Buckley Cove Park (on the DWSC), Dos Reis Park, Mossdale Crossing (on the San Joaquin River), and at Westgate Landing (on the Mokelumne River).

Habitat preserves and state and county parks (Dos Reis and Mossdale Crossing regional parks and Durham Ferry State Recreation Area) along the San Joaquin River provide recreational access (CDWR et al. 2013). The 7,000-ac San Joaquin River National Wildlife Refuge supports a mix of habitats that provide excellent conditions for wildlife and plant diversity. Visitor activities at the refuge include wildlife viewing, interpretation and environmental education, and photography. Formal fishing access and hunting opportunities are generally available in publicly owned parks or wildlife areas. Along some waterways, particularly along the DWSC, there are sandy beaches which are heavily used by boaters. Public boat launch facilities are available throughout the Delta, but a significant number of launches are associated with private marinas.

4.1.1.1.19 Changes in Land Use

With population growth in California above the national average, i.e., 2.1 percent versus 1.7 percent between 2010 and 2012,[10] changes in land use in the lower San Joaquin and Delta area are likely, but the nature and extent of those changes are uncertain. Urban development to accommodate population growth continues to occur in the counties of the Delta (CDWR et al. 2013). Limited housing supply and high home prices in the Bay Area have induced many Bay Area residents to relocate to Delta counties and commute long distances to work. As an example, since 1992, cities in San Joaquin County have annexed 27,769 acres, or 3 percent of the

[10] http://quickfacts.census.gov/qfd/states/06000.html

total area for urban development (CDWR et al. 2013). Additionally, population growth within and outside the Delta region will inevitably increase the amount of infrastructure that is required to support increases in residential, commercial, and industrial land development. Much of the land that will support this development will be acquired by conversion of agricultural lands.

California's focus on climate change and greenhouse gas reduction could also dramatically change the form of land use in the future (CDWR et al. 2013). Adopted on September 30, 2008, Senate Bill (SB) 375 is the State's first attempt to control greenhouse gas emissions by reducing urban sprawl. SB 375 links land use and transportation planning and encourages more compact, higher-density development through various incentives, including transportation funding and streamlined California Environmental Quality Act (CEQA) review. The bill has the potential to significantly change land use planning and growth patterns in and around the Delta region.

Increasing environmental management and recovery activities in the San Joaquin and Sacramento river basins and in the Delta region (e.g., related to water management, water quality, conservation/recovery of rare, threatened, and endangered or commercially-viable species, etc.) may also impact patterns of land use change (CDWR et al. 2013) (see Section 4.1.4.11, San Joaquin and Delta Aquatic Resources Management and Recovery Activities).

4.1.4.8 Fish Hatchery Practices

CDFW is the principal agency responsible for managing and conserving fisheries and aquatic resources in California. As part of its responsibility, CDFW operates a statewide system of fish hatcheries that rear and subsequently release millions of trout, salmon, and steelhead of various age and size classes into state waters. These fish are reared and released for recreational fishing and commercial harvest, conservation and restoration of native fish species, mitigation for habitat losses caused by development, and mitigation for fish lost at pumping facilities in the Delta.

Anadromous fish hatcheries have been present in California since the first one was established by the United States Commission of Fish and Fisheries on the McCloud River in 1872 (JHRC 2001). In the early 1900s, CDFW assumed responsibility for stocking hatchery trout into state lakes and rivers. Since 1945, CDFW has reared inland and anadromous fish species at 21 hatcheries throughout California. CDFW currently stocks trout in high mountain lakes, low elevation reservoirs, and various streams and creeks. Salmon have been stocked primarily in rivers and direct tributaries to the Pacific Ocean, with the exception of kokanee, Coho, and Chinook salmon planted in reservoirs for sport fishing. Currently, California operates both trout (14) and salmon and steelhead (10) hatcheries throughout the state (ICF Jones & Stokes 2010). In addition to anadromous fish releases in the San Joaquin River basin, discussed below, fish are released from CDFW facilities in the Sacramento River basin, including fall-run Chinook salmon produced at the Nimbus Hatchery.

In the 1970s CDFW began stocking Chinook salmon in some California lakes and reservoirs (JHRC 2001). Initially, out-of-state sources of eggs were used, but subsequently, because none of these sources could provide disease-free eggs, eggs that were in excess of CDFW hatcheries' needs were used (JHRC 2001). Salmon, often from out-of-basin stocks, may have escaped downstream from the lakes and reservoirs in which they were planted and later returned as adults to that stream, possibly interbreeding with wild adult salmon from that stream (JHRC 2001). Until the early 1980s, California's hatcheries occasionally used broodstock from other basins or moved fry to other basins (JHRC 2001). This practice could have affected the genetics of fish naturally occurring in the receiving basins or resulted in the transfer of diseases from the hatchery to the wild populations (JHRC 2001).

Significant numbers of salmon from Central Valley hatcheries have been transported by truck to San Francisco Bay and released (JHRC 2001). For example, in 1999 the following releases of fall Chinook smolts were made downstream of the Delta: 5.88 million from the Feather River Hatchery; 3.8 million from the Nimbus Hatchery, and 1.72 million from the Mokelumne River Hatchery (JHRC 2001). Also in 1999, the Feather River Hatchery released 2.12 million of its spring Chinook smolts in San Pablo Bay (JHRC 2001). Releasing hatchery salmon downstream of the Delta improves their survival and contribution to fisheries and reduces the potential for competition of hatchery smolts with naturally produced fish (JHRC 2001). However, off-site releases may also increase the straying rate of returning adult salmon. Dettman and Kelley (1987) (as cited in JHRC 2001) estimated that 46 percent of Feather River Hatchery fish released in the Delta returned to rivers other than the Feather River. Releases that substantially increase the rate of straying fish, and likely increase interbreeding between natural and hatchery populations of different watersheds, are inconsistent with the CDFW and NMFS goal of maintaining the genetic integrity of wild salmon stocks (JHRC 2001).

The Merced River Fish Hatchery, located just downstream of the Crocker-Huffman Diversion Dam and operated by CDFW, began production in 1970 (Merced Irrigation District 2012). The hatchery rears fall-run Chinook salmon and follows an integrated broodstock strategy. Broodstock consists of unsegregated, natural and hatchery-produced Chinook salmon that volitionally enter the hatchery's facilities. Average annual production (from 2004–2008) was 972,344 fish, with most fish stocked as smolts. Most Merced River Hatchery fish are released from the hatchery from April through June, at 70 to 90 fish per pound. A Hatchery Genetic Management Plan (HGMP) has not been prepared for the Merced River Fish Hatchery, and until a HGMP is completed, the hatchery will continue to operate according to the existing hatchery and stocking plan.

Chinook salmon produced at the Merced River Fish Hatchery are routinely used for investigations in the San Joaquin River watershed, such as the previously conducted VAMP smolt survival evaluations, and have been stocked in the Stanislaus and Tuolumne rivers. The Merced Irrigation District and others voluntarily fund the coded-wire tagging of smolts produced at the hatchery.

The Mokelumne River Fish Hatchery was built in 1963 by the East Bay Municipal District (and is operated by CDFW) to offset impacts to fisheries due to construction of Camanche Dam (ICF Jones & Stokes 2010). The hatchery is located on the south bank of the Mokelumne River immediately downstream of Camanche Dam and raises fall-run Chinook salmon and steelhead with water from Camanche Reservoir. In addition to mitigation responsibilities, the Mokelumne River Hatchery has an enhancement program supported by commercial salmon trollers. The Mokelumne River Hatchery receives its steelhead broodstock from the Feather River Hatchery or from adults returning to the hatchery, and has received broodstock fish from the American River, and Battle Creek (CDFW 2012). The Chinook salmon broodstock is of Central Valley origin. Average annual fish production at the Mokelumne River Hatchery from 2004 through 2008 was 5,351,901 fish. The normal Mokelumne River Hatchery release schedule is as follows: (1) fall-run Chinook salmon smolts are released from May through July into San Pablo Bay at 40–60 fish per pound and (2) steelhead yearlings are released from January through February into the lower Mokelumne River at four fish per pound.

4.1.4.9 Freshwater Salmonid Harvest

Commercial salmon fishing in California began in the early 1850s, coinciding with the influx of miners associated with the Gold Rush. By 1860, gill net salmon fisheries were well established in the lower San Joaquin River. Growth of this fishery was enhanced by the canning industry (CDFW 2013), and by 1880 there were 20 salmon canneries operating in the Sacramento and San Joaquin rivers, which increased fishing effort to maintain the supply of salmon. The salmon fishery reached its peak in 1882 when about 12 million pounds were landed and processed. Shortly thereafter, the fishery collapsed due to a sudden decline in salmon stocks caused by the pollution and degradation of rivers from mining, agriculture, and timber operations, combined with excessive fishing pressure. By 1919, the last inland salmon cannery had shutdown, and in 1957, the last remaining commercial river fishery closed in the Sacramento-San Joaquin basin (CDFW 2013).

In past years, sport fishing for trout, steelhead, and salmon was closed from the I-5 bridge at Mossdale upstream on the San Joaquin River (CDFG 2011). However, 2013–2014 regulations allow two hatchery trout or hatchery steelhead (four total possession limit) to be taken year round (CDFW 2013). Salmon fishing remains closed in the San Joaquin River, although some sport harvest takes place in the Delta.

4.1.4.10 Non-Native Species

Non-native species enter a region's aquatic systems in a variety of ways, most prominently through historical stocking by state resource management agencies, illegal introductions by anglers, ballast water discharged from ships, and boating activities. Introduction of non-native species has resulted in large changes in the fish community structure of the Central Valley (Moyle 2002). Non-native fish introductions in California date back to European settlement, and current fish communities in the lower reaches of the San Joaquin River tributaries and Delta are dominated by non-native taxa. Over 200 non-native species have been introduced in the Delta and become naturalized (Cohen and Carlton 1995), including many fish (e.g., smallmouth bass, largemouth bass, and striped bass) that prey on juvenile salmonids.

CDFW continues to manage some non-native fish species for recreational angling, such as black bass (open year round in the Delta with a five fish daily bag limit), striped bass (open year round in the Delta and lower San Joaquin River with a two fish limit), sunfish and crappie (open year round in the Delta with no size limit and a combined bag limit of 25), and catfish and bullhead (open year round in the Delta with no size or catch limit) (CDFG 2011).

The Delta, particularly the San Joaquin River between the Antioch Bridge and the mouth of Middle River and other channels in this area, are important spawning grounds for striped bass (CDFW 2014). Another important spawning area is the Sacramento River between Sacramento and Princeton (CDFW 2014). Sublegal striped bass, under 18 inches long, are found all year in large numbers upstream of San Francisco Bay, but their migratory patterns are poorly understood. After spawning, most adult striped bass move out of the rivers and into brackish and salt water for the summer and fall. However, some adult fish remain in freshwater during summer, and many anglers have caught striped bass at unexpected times and places (CDFW 2014).

4.1.4.11 San Joaquin River and Delta Aquatic Resources Management and Recovery Activities

There are numerous programs and efforts in the San Joaquin River Basin and Delta that have been completed, are currently underway, or are planned for the foreseeable future. These programs are likely to result in the establishment of new environmental mandates such as streamflow requirements, aquatic habitat restoration measures, and fish protection and recovery objectives. Cumulatively, these requirements could have effects on aquatic resources and threatened and endangered species in the lower San Joaquin River and the Delta.

4.1.1.1.20 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead

In 2009, NMFS issued a Public Draft Recovery Plan (NMFS 2009 for several ESA listed anadromous salmonids in the Sacramento River and Central Valley: the endangered Sacramento River winter-run Chinook salmon ESU, threatened Central Valley spring-run Chinook salmon ESU, and threatened Central Valley steelhead DPS. Implementation of the recovery plan is intended to improve the viability of these species so they can be removed from federal protection under the ESA. The recovery plan describes the steps, strategies, and actions projected to return the three species to viable status in the Central Valley, thereby ensuring their long-term (i.e., greater than 100 years) persistence and evolutionary potential.

The recovery plan establishes watershed- and site-specific recovery actions. Watershed-specific actions address threats occurring in each of the rivers or creeks that support spawning populations of the ESUs and/or DPS. Site-specific actions address threats to these species occurring within a migration corridor (e.g., the Delta). Recovery actions were identified using two recovery planning public workshops and a number of ecosystem and/or anadromous fish enhancement plans. Recovery actions that have been identified in the Delta include development of alternative water diversion operations and conveyance systems, large-scale habitat restoration, integration of existing restoration programs, non-native predatory fish control, Yolo Bypass floodplain and fish passage enhancements, modifications to long-term operations of the CVP and SWP, and new stream flow requirements. Recovery actions that have been identified in the mainstem San Joaquin River include restoring floodplain habitat, implementing ecological flow schedules, reducing contaminants and improving water quality, and improving juvenile outmigration for steelhead and future spring-run Chinook salmon at CVP and SWP facilities.

4.1.1.1.21 San Joaquin River Restoration Settlement Act

The San Joaquin River Restoration Program (SJRRP) is a direct result of a settlement reached in September 2006 to provide sufficient fish habitat in the San Joaquin River below Friant Dam. Parties to the Settlement include the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council (NRDC), and the Friant Water Users Authority (FWUA). The settlement received Federal court approval in October 2006. Federal legislation was passed in March 2009 authorizing Federal agencies to implement the settlement.

The settlement is based on two goals: (1) to restore and maintain fish populations in "good condition" in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish, and (2) to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that could result from the interim flows and restoration flows provided for in the settlement.

The SJRRP outlines a comprehensive long-term effort to provide flows in the San Joaquin River from Friant Dam to the confluence of the Merced River to restore a self-sustaining spring-run Chinook salmon fishery while reducing or avoiding adverse water supply impacts. The program calls for full restoration flows beginning in 2014.

Implementation of the 2009 San Joaquin River Restoration Settlement Act and SJRRP has had significant effects on stream flows in the basin.[11] Annual restoration flows in the San Joaquin River vary between 0 AF in dry years to more than 550,000 AF in wet years. Combined with other flows in the watershed upstream of the Merced River confluence, these restoration flows are anticipated to provide 275,000 to 750,000 AF of water in the San Joaquin River as measured at the confluence with the Merced River, depending on hydrologic conditions. The flow schedule is designed to support spring-run Chinook salmon reintroduction and may not be compatible with efforts to improve conditions for other salmonid species in the Merced River and other tributaries in the San Joaquin River basin.

The first interim water releases from Friant Dam in support of the SJRRP began on October 1, 2009. In 2013, interim flows between 350 and 400 cfs were released from Friant Dam to maintain the flow target at Gravelly Ford.[12] Up to 1,060 cfs was released from Friant Dam in 2013 as part of spring pulse flows. On January 2, 2014, flows released from Friant Dam were increased to 475 cfs to maintain the flow target at Gravelly Ford. However, beginning in February 2014, flows released from Friant Dam were decreased to 360 cfs to begin ceasing restoration flows because of drought conditions (i.e., a critical low-water year beginning March 1, 2014). Flows were reduced in 50-cfs increments until all restoration flows were discontinued. If drought conditions persist, restoration flows are unlikely to resume before March 2015.

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[11] Source: www.restoresjr.net
[12] Source: http://restoresjr.net/activities/if/index.html

4.1.1.1.22 Delta Water Quality Control Planning

Recognizing that many water issues in California involved both water quantity and quality, the California Assembly Committee on Water Pollution proposed a coordinated water regulatory program.[13] Concomitant statutory changes enacted in 1967 merged the State Water Quality Control Board and State Water Rights Board to form the SWRCB. In 1969, the California State Legislature enacted the Porter-Cologne Water Quality Control Act, which is the basis of current water protection efforts in California. In 1972, the State assumed responsibility for enforcing the federal CWA, which involved blending state and federal processes to regulate activities such as setting water quality standards and issuing discharge permits.

On August 16, 1978, the SWRCB adopted the 1978 Delta Plan and Decision 1485 (D-1485). The 1978 Delta Plan included water quality objectives intended to protect M&I, agricultural, and fish and wildlife beneficial uses in the Delta, and fish and wildlife beneficial uses in Suisun Marsh. The 1978 Delta Plan and D-1485 standards were based on the principle that Delta water quality should be at least as good as it would have been had the state and federal water projects not been constructed. The fish and wildlife standards in the 1978 Delta Plan and D-1485 were based on an agreement developed by CDWR, CDFW (then CDFG), the USBR, and USFWS. It was acknowledged that these standards did not afford a “without-project” level of protection for salmon, but the level of protection was believed to be reasonable until determinations regarding Delta mitigation measures were finalized.

D-1485 added conditions to the CVP’s and the SWP’s operating permits requiring that the projects meet applicable water quality objectives. In all SWP and CVP permits affecting the Delta, the SWRCB reserved jurisdiction to formulate or revise terms and conditions for salinity control and fish and wildlife protection, and to coordinate the terms and conditions between the two projects.

In 1985, some D-1485 standards were amended to modify or omit some monitoring stations in Suisun Marsh and to revise the schedule for implementation of salinity objectives. In May 1991, the SWRCB adopted the 1991 Bay-Delta Plan, which superseded water quality objectives in the 1978 Delta Plan and the San Francisco Bay and the Sacramento-San Joaquin Delta regional water quality control plans in instances where the existing plans conflicted with the 1991 Bay-Delta Plan. The 1991 Bay-Delta Plan contained a range of water quality objectives aimed at protecting beneficial uses. These objectives addressed (1) salinity levels for municipal and industrial intakes, Delta agriculture, water export agriculture, and estuarine fish and wildlife resources, (2) an expanded period of protection for striped bass spawning, and (3) temperature and DO levels for Delta fisheries. The 1991 Bay-Delta Plan did not include Delta outflow objectives and operational constraints. The flow and operational objectives in the 1978 Delta Plan remained in effect, implemented via D-1485. Beneficial uses and water quality objectives in the 1991 Bay-Delta Plan were submitted to EPA, which approved the objectives for M&I uses, agricultural uses, and DO for Fish and Wildlife in the San Joaquin River. However, all other fish and wildlife objectives were not approved by EPA, so relevant standards in D-1485 remained in effect.

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[13] Source: http://www.swrcb.ca.gov/about_us/water_boards_structure/history_water_policy.shtml

In May 1995, the SWRCB adopted the 1995 Bay-Delta Plan, which was superseded by the 2006 Bay-Delta Plan, in instances where the 1995 plan conflicted with the 2006 plan. The 2006 Bay-Delta Plan included updates to address emerging issues that, because of changing circumstances or increases in scientific understanding, were either unregulated or not fully regulated by preceding plans. These issues included pelagic organism decline (pelagic fishes in the Delta Estuary and Suisun Bay), climate change, Delta and Central Valley salinity, and San Joaquin River flows. The 2006 Bay-Delta Plan included specific objectives related to the following variables: Delta outflow, flows in the Sacramento River at Rio Vista, flows in the San Joaquin River at Vernalis, export limits, Delta cross channel gates operation, and salinity.

Beginning on February 13, 2009, the SWRCB began updating and implementing the 2006 San Francisco Bay/Sacramento-San Joaquin Delta Estuary Plan (Bay-Delta Plan), particularly with regard to water quality and flow objectives and changes to water rights and water quality regulation consistent with the program of implementation. A technical report on the first phase of the project, Southern Delta Salinity and San Joaquin River flow objectives, was peer reviewed, and a final report was scheduled for release in early 2012. On January 24, 2012, the SWRCB issued a notice requesting additional information for the review of the Bay-Delta Plan.

The Bay-Delta Plan identifies beneficial uses of the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives. The SWRCB recognizes that changing conditions may alter the flows needed to protect beneficial uses in the Bay-Delta. Changes in conditions that could affect flow needs include, but are not limited to, reduced reverse flows in Delta channels, increased tidal habitat, improved water quality, reduced competition from invasive species, changes in the points of diversion of the SWP and CVP, and climate change. The SWRCB will consider whether certain water quality objectives should be phased in over time and under what conditions that phasing should occur, in addition to what type of contingencies should be provided in the program if expected habitat improvements do not occur or if actions do not produce the expected results.

4.1.1.1.23 San Joaquin River TMDL Plans

Adoption of TMDLs required under the CWA § 303(d) has the potential to affect stream flows in the San Joaquin River. The SWRCB has initiated a comprehensive effort to address salinity and nitrate problems in the Central Valley and to adopt long-term solutions that will lead to enhanced water quality and economic sustainability. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) effort is a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management program.

Additional San Joaquin River flows are being targeted to help dilute saline agricultural return waters and naturally occurring saline waters, pesticides, and other potentially toxic compounds and to reduce temperatures throughout the watershed. A partial list of TMDLs that may directly or indirectly affect flows and water quality in the San Joaquin River is shown below (SWRCB 2010):

- Completed:

- San Joaquin River diazinon and chlorpyrifos,
- San Joaquin River salt/boron at Vernalis, and
- San Joaquin River DO at Stockton.
- ▪ To be completed:
- San Joaquin River salt/boron upstream of Vernalis,
- San Joaquin River unknown toxicity, and
- San Joaquin River temperature.

4.1.1.1.24 Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) is expected to provide for water supply reliability and recovery of listed species through a Habitat Conservation Plan (HCP) under federal law and a Natural Community Conservation Plan (NCCP) under state law. The BDCP will include a wide range of actions related to habitat restoration, protection, and enhancement; water conveyance facilities; water operations and management; monitoring, assessment, and adaptive management; costs and funding; and governance structure and decision-making.

The BDCP is being developed to address ecological needs of at-risk Delta species, primarily fish, while improving and securing a reliable water supply. The BDCP will be structured to improve the health of the system as a whole by implementing a comprehensive restoration program for the Delta. The plan includes a suite of conservation measures designed to improve the state of natural communities and in so doing improve the overall health of the Delta ecosystem. The BDCP attempts to balance species conservation with a variety of other important uses in the Delta. A joint EIS/EIR, to be prepared by state and federal agencies, will include an analysis of the environmental impacts of improved water conveyance infrastructure and habitat conservation measures. Implementation of the BDCP will likely require changes to the Bay-Delta Plan (see Section 4.1.4.11.3).

Implementation of the BDCP will occur over a 50-year timeframe and be conducted by a number of agencies and organizations with specific roles and responsibilities as prescribed by the BDCP. A major part of implementation will be monitoring conservation measures to evaluate their effectiveness and revising actions through adaptive management.

4.1.1.1.25 Delta Stewardship Council

In November 2009, the Sacramento-San Joaquin Delta Reform Act was passed by the California Legislature and signed by the governor. It established a State policy of coequal goals (i.e., providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem) for the Delta and created the Delta Stewardship Council as a new, independent agency to determine how goals would be met through development and implementation of the Delta Plan. The BDCP (see preceding section) is to be included in the Delta Plan providing it is approved by state regulatory agencies and meets certain additional criteria. Because the Delta is linked to many statewide issues, the Plan will address decisions pertaining to statewide water use, flood management, and the Delta watershed.

4.1.1.1.26 Biological and Conference Opinion on the Long-Term Operation of the CVP and SWP

On June 4, 2009, NMFS released the Biological and Conference Opinion on the Long-Term Operation of the CVP and SWP. The opinion included a series of alternatives to avoid jeopardy of the continued existence of Central Valley steelhead, among other species, and adverse modification of its designated critical habitat. Among the alternatives identified are significantly higher instream flows in the Stanislaus River, San Joaquin River minimum flow requirements at Vernalis, and Delta export limitations to protect out-migrating anadromous salmonids.

Although the opinion addressed only the combined CVP and SWP operations, it concluded that "the long-term viability of this diversity group [steelhead] will depend not only on implementation of this reasonable and prudent alternative (RPA), but also on actions outside this consultation, most significantly increasing flows in the Tuolumne and Merced rivers." On September 20, 2011, the U. S. District Court invalidated the Biological and Conference Opinion and remanded it to NMFS for further consideration in accordance with the court's decision and the requirements of law. The decision has been appealed.

4.1.1.1.27 The Central Valley Project Improvement Act

As noted previously, the Ecosystem Restoration Program[14] has funded projects involving habitat restoration, floodplain restoration and/or protection, instream habitat restoration, riparian habitat restoration and protection, fish screening and passage projects, research on and eradication of non-native species and contaminants, research on and monitoring of fisheries, and watershed stewardship and outreach. An Environmental Water Account is used to offset losses of juvenile fish at the Delta pumps, and to provide higher instream flows in the Yuba, Stanislaus, American, and Merced rivers to benefit salmonids.

The Central Valley Project Improvement Act (CVPIA) added the purposes of fish and wildlife protection, restoration, and mitigation to the original CVP purposes of irrigation, domestic water use, fish and wildlife enhancement, and power augmentation. As part of the CVPIA, the following actions have been implemented: modifications of CVP operations, management and acquisition of water for fish and wildlife needs, flow management for fish migration and passage, increased flows, replenishment of spawning gravels, restoration of riparian habitats, screening of water diversions, and habitat restoration.

4.1.1.1.28 The Delta Pumping Plant Fish Protection Agreement and Tracy Fish Collection Mitigation Agreement

The Delta Pumping Plant Fish Protection Agreement and Tracy Fish Collection Mitigation Agreement mitigate for SWP pumping plant impacts by screening water diversions, enhancing

[14] http://www.dfg.ca.gov/ERP

law enforcement efforts to reduce illegal fish harvest, installing seasonal barriers to guide fish away from undesirable spawning habitat or migration corridors, and restoring salmon habitat. Mitigation has also included the removal of four dams to improve Chinook and steelhead passage on Butte Creek. Approximately one-third of the approved funding for salmonid projects specifically targets spring-run Chinook salmon and steelhead in upper Sacramento River tributaries.

4.1.1.1.29 CCSF Water System Improvement Program

On October 30, 2008, the SFPUC adopted a system-wide program, the Water System Improvement Program (WSIP, also known as the "Phased WSIP Variant") (SFPUC Resolution No. 08-200). The WSIP is a comprehensive program designed to improve the regional system with respect to water quality, seismic response, and water delivery based on a planning horizon through the year 2030. The WSIP also aims to improve the regional system with respect to water supply to meet water delivery needs in the service area through the year 2018.

The overall goals of the WSIP are to: maintain high-quality water, reduce vulnerability to earthquakes, increase delivery reliability and improve the ability to maintain the system, meet customer water supply needs, enhance sustainability in all system activities, and achieve a cost effective, fully operational system. To further these program goals, the WSIP also includes objectives that address system performance in the areas of water quality, seismic reliability, delivery reliability, and water supply.

Under the WSIP, the SFPUC established the year 2018 as an interim mid-term planning horizon for its water supply strategy. Thus, the SFPUC made a decision about a water supply strategy to serve its customers through 2018, and is deferring a decision regarding long-term water supply after 2018 and through 2030 until it undertakes further water supply planning and demand analysis.

The WSIP includes the following key program elements:

- Full implementation of all 17 proposed WSIP facility improvement projects described in the Program Environmental Impact Report (PEIR).
- Water supply delivery of 265 million gallons per day (mgd) (average annual target delivery) to regional water system customers through 2018, with water supplies originating from the Tuolumne, Alameda, and Peninsula watersheds. This includes 184 mgd for wholesale customers (including 9 mgd for the cities of San Jose and Santa Clara) and 81 mgd for retail customers.
- Development of 20 mgd of conservation, recycled water, and groundwater within the SFPUC service area (10 mgd in the retail service area and 10 mgd in the wholesale service area).
- Dry-year transfer from the Modesto and/or Turlock Irrigation Districts of about 2 mgd coupled with the a conjunctive-use project to meet the drought year goal of limiting rationing to no more than 20 percent on a system-wide basis.

- Reevaluation of 2030 demand projections, potential regional water system purchase requests, and water supply options by 2018, as well as a separate SFPUC decision in 2018 regarding regional system water deliveries after 2018.

Under the WSIP, the SFPUC will deliver to customers up to 265 mgd from the SFPUC watersheds on an average annual basis. While average annual deliveries from the SFPUC watersheds would be limited to 265 mgd, such that there would be no increase in diversions from the Tuolumne River to serve additional demand, there would be a small increase in average annual Tuolumne River diversions of about 2 mgd over existing conditions to meet delivery and drought reliability goals through 2018.

Day-to-day operation of the regional water system under the WSIP would be similar to existing operations, but would provide for additional facility maintenance activities and improved emergency preparedness. This would allow the SFPUC to meet its WSIP objectives and provide for increased system reliability and additional flexibility for scheduling repairs and maintenance. The proposed operations strategy would also include a multistage drought response program. Under the WSIP, regional water system operations would continue to comply with all applicable institutional and planning requirements, including complying with all water quality, environmental and public safety regulations; maximizing the use of water from local watersheds; assigning a higher priority to water delivery over hydropower generation; and meeting all downstream flow requirements.

4.2 Geomorphology

Geomorphology in the Tuolumne River is cumulatively affected by a variety of anthropogenic actions within the Tuolumne River watershed (see Section 4.1 of Exhibit E for a discussion of in-basin actions), including in-channel and floodplain mining, hydrologic alteration resulting from water management activities associated with multiple dams, and sediment retention in reservoirs. Because the Proposed Action would have no influence on flows downstream of La Grange Diversion Dam, and Don Pedro Reservoir would exist and continue to exist in the absence of hydroelectric generation, the Proposed Action would not contribute to cumulative effects on geomorphology in the lower Tuolumne River. The Don Pedro Project's primary purposes (water storage and supply for irrigation and M&I uses and flood control) contribute to these cumulative effects, but these effects diminish relative to other impacts, mainly those associated with aggregate mining, with increasing distance downstream of La Grange Diversion Dam. As a result, with greater distance downstream of the Don Pedro Project, it becomes increasingly difficult to isolate the effects of the Don Pedro Project's primary purposes on geomorphologic conditions in the river channel.

FERC's SD2 (page 35) identifies the following potential Don Pedro Project effects related to geomorphology in the Tuolumne River:

- *Effects of project operation and maintenance on soil erosion and shoreline erosion at the project reservoir and stream reaches.*
- *Potential effects of any project-related changes in streamflow and sediment delivery to project stream reaches on stream geomorphic processes or reservoir bathymetry.*

- *Potential effects of project operations on large woody debris distribution and recruitment.*

FERC's SD2 defines the geographic scope for geomorphology as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to the confluence of the Tuolumne and San Joaquin rivers. The temporal scope of the cumulative effects analysis includes past, present, and reasonably foreseeable future actions. FERC stated in it SD2 that based on the potential term of a new license, the temporal scope for analysis is to extend 30 to 50 years into the future, with concentration on resource effects resulting from reasonably foreseeable future actions. FERC notes that the historical discussion of cumulative effects is limited to the amount of available information for a given resource.

4.2.1 Effects of Mining, Hydrologic Alteration, and Sediment Retention on Tuolumne River Geomorphology

Prior to widespread European settlement, the channel form of the lower Tuolumne River consisted of a combination of single-thread and split channels that migrated and avulsed (McBain & Trush 2000). Variation in hydrologic and geological controls, primarily valley width and the location and elevation of underlying bedrock, resulted in variable and complex localized channel morphologies (McBain & Trush 2000). The riparian corridor was miles wide in places where the river lacked confinement (McBain & Trush 2000).

More than a century of anthropogenic impacts have altered the alluvial dynamics of the Tuolumne River. The cumulative effects of gold and aggregate mining, agricultural and urban encroachment, and a reduction in coarse sediment supply and high flows, have resulted in a relatively static channel within a floodway confined by dikes and agricultural uses.

4.2.1.1 In-Channel and Floodplain Mining

Prior to the construction of the major dams in the Tuolumne River basin, geomorphic conditions in the Tuolumne River were adversely affected by gravel and gold mining (TID/MID 2005) (see Section 4.1 for a summary of the chronology of historic and current actions within the defined geographic scope for cumulative effects).

Hydraulic mining, dredging, lode mining, and ore processing have left visible scars along the Tuolumne River and its tributaries upstream of Don Pedro Dam. Adverse impacts from acid mine drainage and ore processing have left trace metals, arsenic, iron, and mercury (Mount and Purdy 2010) at various locations in the watershed upstream of, and in the reach now impounded by, the Don Pedro Project.

In the lower Tuolumne River, stored bed material was excavated for gold and aggregate to depths below the river thalweg, resulting in sediment imbalances in the lower Tuolumne River channel, eliminating active floodplains and terraces, and creating large in-channel and off-channel pits (McBain & Trush 2000). By the end of the gold mining era, 12.5 miles of river channel and floodplain from RM 50.5 to RM 38 were dredged and converted to tailings piles, and much of the gravel-bedded zone (RM 52–24) of the river was converted to long, deep pools.

More recently, in-channel excavation of sand and gravel created large, in-channel pits now referred to as Special Run Pools (SRPs). These SRPs are as much as 400 ft wide and 35 ft deep, occupying 32 percent of the channel length in the gravel-bedded zone.

Mining, in combination with other actions (addressed below), has resulted in a channel downstream of La Grange Diversion Dam that is characterized by downcutting, widening, armoring, and depletion of sediment storage features (e.g., lateral bars and riffles) (CDWR 1994; McBain & Trush 2004). Sequences of historical photos show that channel corridor width has been progressively reduced by mining and other land uses (McBain & Trush 2000), and channel migration has been substantially curtailed. Floodplain and terrace pits in the lower river are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. The January 1997 flood caused extensive damage to dikes that separated deep gravel mining pits from the river, breaching or overtopping nearly every dike along an approximately 6-mile-long reach from RM 34.2 to RM 40.3 (TID/MID 2011).

4.2.1.2 Alteration of Hydrologic Conditions and Sediment Dynamics

Over the past 120 years, each increment of flow regulation (Wheaton, La Grange, O'Shaughnessy, old Don Pedro, and new Don Pedro dams along the mainstem and dams constructed along tributaries below O'Shaughnessy Dam, including Cherry and Eleanor Creeks) has modified the Tuolumne River's flow regime. Historically, Wheaton Dam and the present day La Grange Diversion Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain & Trush 2000). CCSF's Hetch Hetchy Project, the Districts' New Don Pedro Dam, and CCSF's Cherry Lake combined to reduce the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River downstream of La Grange Diversion Dam.

Analyses of streamflow records from the USGS gaging station at La Grange (Station 11-289650) reveal the following alterations of hydrologic conditions: (1) annual water yield to the lower Tuolumne River below La Grange Diversion Dam has been reduced from an average unimpaired yield of 1,906,000 AF to 772,000 AF, a 60 percent reduction in volume; (2) the magnitude and variability of summer and winter baseflows, fall and winter storms, and spring snowmelt runoff have been reduced; and (3) the magnitude, duration, and frequency of winter floods have been reduced (McBain & Trush 2000). Following completion of the New Don Pedro Dam in 1971, compliance with ACOE flood control and other flow requirements reduced the estimated average annual flood (based on annual maximum series) from 18,400 cfs to 6,400 cfs. The 1.5-year recurrence event (approximately bankfull discharge) was reduced from 8,400 cfs to 2,600 cfs (McBain & Trush 2000). The reductions in flood frequency attest to the success of the Don Pedro Project's flood control purpose. At the same time, these changes in hydrology have had impacts on sediment supply and transport and, as a result, channel morphology

Flow regulation associated with upstream dams may also affect riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian plants (TID/MID 2013b) As noted above, each increment of flow regulation (La Grange Diversion Dam, O'Shaughnessy Dam, Old Don Pedro Dam, New Don Pedro Dam) successively reduced the magnitude, duration, and frequency of flood flows, and removed key mortality agents, including scour, channel migration, flood-induced toppling, and inundation (McBain & Trush 2000). Reduced flood scour resulting from the flood control purposes of the Don Pedro Project allowed riparian vegetation to initiate along the low water channel, where historically vegetation would have been absent, increasing sediment stability along the channel margin and influencing sediment dynamics in the channel as a whole.

Together, the dams on the Tuolumne River trap all coarse sediment and woody debris that would otherwise pass downstream to the lower Tuolumne River. Brown and Thorp (1947) estimated that 4,734 AF (7,637,520 yd^3) of sediment accumulated in Don Pedro Reservoir behind Old Don Pedro Dam during the 23-year period from 1923 to 1946 (McBain & Trush 2004). This estimated annual volume equates to an average total sediment and coarse-grained sediment deposition of approximately 431,601 tons/year and 43,160 tons/year, respectively. These estimates assume 100 percent trap efficiency, an average sediment density of 1.30 tons/yd^3, and an average coarse-to-total sediment ratio of 0.10 (Reid and Dunne 1996, Snyder et al. 2004). Sediment yield to Don Pedro Reservoir based on improved accuracies of measuring reservoir bathymetry conducted in 2011 is discussed in Section 4.2.2. Small tributaries downstream of La Grange Diversion Dam do not supply significant quantities of coarse sediment (McBain & Trush 2004).

Fine (predominantly <2 mm) bed material (FBM) is supplied to the lower Tuolumne River primarily by three tributaries downstream of La Grange Diversion Dam (Gasburg, Dominici, and Peaslee Creeks) and by bank and floodplain erosion. Gasburg Creek (RM 50.3) and Peaslee Creek (RM 45.5) have relatively large input potential, and Lower Dominici Creek (RM 47.8) has moderate input potential (McBain & Trush 2000). These assessments were based in part on the size of deltas observed at each of the tributary mouths, believed to have been deposited on the receding limb of the January 1997 flood.

The January 1997 flood eroded approximately 500,000 yd^3 of sediment from the spillway channel at Don Pedro Dam, depositing sediment behind La Grange Diversion Dam and a large volume of fine sediment in downstream reaches of the Tuolumne River (McBain & Trush 2000, 2004). In June 2001, discrete fine sediment deposits in the channel were mapped from the USGS gauging station near La Grange Diversion Dam (RM 52.1) downstream to Roberts Ferry Bridge (RM 39.6) (Stillwater Sciences 2002). The results of the survey were used to estimate fine sediment storage in pools and other discrete deposits and estimate the relative contribution of fine sediment from tributaries. Survey results indicate that fine sediment constituted a large fraction of the channel bed surface. Discrete fine sediment deposits were more common in pools from Basso Bridge (RM 47.5) to Peaslee Creek (RM 45.5) than in upstream reaches, and the largest volumes of fine sediment were observed from Peaslee Creek to Roberts Ferry Bridge (RM 39.5). Gasburg Creek and Peaslee Creek appeared to be the largest contributors of fine sediment in the surveyed reach.

Sediment source analyses conducted for the Gasburg Creek watershed in 2003 and 2004 indicated that the tributary supplied approximately 1,203 yd^3 of fine sediment annually to the Tuolumne River (Stillwater Sciences 2004, PWA 2004). The Gasburg Creek Fine Sediment Reduction Project was implemented in 2007 to reduce fine sediment delivery from a deeply incised gully (the dominant erosion feature identified in the watershed) and to modify the Gasburg Creek floodway extending from the MID canal culvert downstream to approximately Old LaGrange Road (Laird 2005, McBain & Trush 2007). Beginning on January 6, 2008, the lower Tuolumne River experienced several episodes of high turbidity resulting from fine sediment input from the Peasley Creek watershed. Following the event, the Districts conducted turbidity monitoring, bulk sediment sampling, photo-monitoring, and benthic invertebrate sampling in the Tuolumne River in the vicinities of the Peasley Creek confluence and Bobcat Flat (located approximately 2 miles downstream of the Peasley Creek confluence) to document any effects related to the increased fine sediment supply (McBain & Trush 2008). In addition to the episodes of elevated fine sediment delivery from Peaslee Creek, several small dams that impounded fine sediment in Lower Dominici Creek failed in February 2006, releasing fine sediment to downstream reaches (CRWQCB 2006 as cited in Stillwater Sciences 2006).

Most woody debris captured in Don Pedro Reservoir is small, and it appears that the majority of it would pass through the lower river during higher flows if it were not trapped in the reservoir (TID/MID 2013e). The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 feet, and woody debris would have a limited effect on channel morphology in this reach (TID/MID 2013e). It is unknown, however, to what extent smaller pieces of wood might add to existing wood accumulations or initiate small jams in the lower river, thereby possibly influencing channel sediment dynamics.

4.2.2 2012 Spawning Gravel Study in the Lower Tuolumne River

To assess the contribution of the overall Don Pedro Project's continued presence and operation to cumulative effects to the supply, transport, and storage of coarse and fine sediment downstream of La Grange Diversion Dam, the Districts conducted a study in 2012 of spawning gravel in the lower Tuolumne River (TID/MID 2013f). Results of this study update information from prior studies to address the following objectives:

- Estimate average annual sediment yield to Don Pedro Reservoir based on reservoir sedimentation,
- Estimate changes in the volume of coarse (> 2 mm) bed material stored in the lower Tuolumne River channel over the 2005–2012 period,
- Map current FBM (predominantly < 2 mm) in the lower Tuolumne River channel and compare results to those of surveys conducted in 2001 (Stillwater Sciences 2002), and
- Develop a reach-specific coarse sediment budget to determine any cumulative effects of the Don Pedro Project on Don Pedro Project-affected reaches of the lower Tuolumne River.

In addition, the Districts conducted the Don Pedro Reservoir Bathymetric Study (HDR 2012) to develop an accurate geometry of Don Pedro Reservoir and update the reservoir's elevation-storage curve.

The results of the Districts' 2012 Spawning Gravel in the Lower Tuolumne River study (TID/MID 2013f) and bathymetric study are provided in the following subsections.

4.2.2.1 Average Annual Sediment Yield to Don Pedro Reservoir

Comparison of storage capacity curves for Don Pedro Reservoir in 1971 and 2011 indicates that there has been 15,694 AF (25,319,653 yd^3) of storage loss due to sedimentation since closure of the Don Pedro Dam, which represents less than 1 percent of the original storage capacity of Don Pedro Reservoir in 1971 (HDR 2012; TID/MID 2013f). Average annual total and coarse (>2 mm) sediment yields to the reservoir, calculated over the 1923–2011 period, are approximately 373,966 tons/year and 37,397 tons/year, respectively. These estimates are within 13 percent of estimates based on reservoir storage capacity changes during the period 1923–1946 reported by Brown and Thorp (1947) and are comparable to sediment yields estimated for other reservoirs on the western slope of the Sierra Nevada.

4.2.2.2 Changes in Volume of Bed Material Stored in the Lower Tuolumne River, 2005–2012

Previous studies have estimated the minimum threshold for significant bed mobility in the lower Tuolumne River to be 5,400–6,880 cfs (McBain & Trush 2000, 2004), with an average annual bedload transport rate of 1,930 tons/year based on an empirically derived bedload rating curve (McBain & Trush 2004). Sediment transport modeling has estimated a similar average annual bedload transport rate of 1,412 tons/year (McBain & Trush 2004). The following indicators suggest a deficit in coarse sediment supply relative to bedload transport downstream of La Grange Diversion Dam (CDWR 1994, McBain & Trush 2004):

- Channel cross section surveys indicate that the channel is wider than expected in many reaches, lacks bankfull channel confinement, and has cross sectional dimensions that are not adjusted to the contemporary flow regime.
- SRPs deprive downstream reaches of sediment by trapping all particles larger than coarse sand (4 mm), provide little or no high quality salmonid habitat, and provide suitable habitat for non-native piscivores that prey on juvenile salmonids (McBain & Trush 2000).

The coarse sediment budget developed through sediment transport modeling and analysis of changes in bed topography (TID/MID 2013f) indicates that without gravel augmentation, the channel in the first 12.4 miles downstream of La Grange Diversion Dam would be slowly degrading in response to a reduction in coarse sediment supply by upstream dams. Between 2005 and 2012, approximately 5,913–8,720 tons of coarse (>2 mm) bed material was lost from storage between RM 45.8 and 52.1, an area that encompasses the Dominant Salmon Spawning Reach (i.e., RM 46.6–RM 52.1) (TID/MID 2013f). Gravel augmentation has helped increase coarse sediment storage in the reach, and 94 percent of the coarse sediment added through augmentation has been retained within that reach.

Differencing of channel topography surveyed in 2005 and 2012 shows that little change in storage occurred during this period at the reach scale, but that high-flow events in WY 2006 and WY 2011 locally scoured the bed and redistributed coarse and fine sediment deposits (TID/MID 2013f). Pools commonly scoured 3 to 5 feet, mobilizing finer sediment to depositional areas in channel margins and coarser sediment to pool tails and riffles, where 1 to 3 feet of aggradation is commonly observed. The total estimated volume lost from storage in the reach that extends from RM 45.8 and 52.1 is comparable in magnitude to the quantity of coarse sediment added during any one of the augmentation projects (approximately 7,000–14,000 tons) that have occurred since 2002.

The results of sediment transport modeling and topographic differencing suggest that augmentation material is being mobilized short distances during infrequent high-flow events (e.g., during WY 2006 and WY 2011), but that routing is slow due to low bedload transport capacity. Prolonged retention of augmented coarse sediment may allow the gravel framework to fill with fine sediment.

4.2.2.3 Fine Bed Material Deposits in the Lower Tuolumne River

The total volume of discrete FBM (predominantly <2 mm) deposits in the reach from La Grange Diversion Dam (RM 52.1) to Roberts Ferry Bridge (RM 39.6) decreased by 48 percent from 2001 (Stillwater Sciences 2002) to 2012. Discrete FBM deposits mapped in 2012 were distributed nearly equally among pool margins, channel margins, and alcoves and backwaters but were more frequent and larger immediately downstream of Gasburg and Peaslee creeks, suggesting that supply from these tributaries continues to be an important source of fine sediment to the lower Tuolumne River channel (TID/MID 2013f).

4.2.2.4 Riffle Area in the Lower Tuolumne River

A total of 3,527,200 ft^2 of riffle mesohabitat was mapped from RM 52.1 to RM 23 in 2012, of which 2,967,500 ft^2 (84%) was occupied by spawning gravel (TID/MID 2013f). The particle size distribution of spawning gravel deposits was relatively uniform, with an average estimated D50 of 51 mm. Comparing the results of riffle surveys conducted in 1988 and 2012 suggests that riffle area increased by 606,200 ft^2 (21%). However, comparing the 2001 and 2012 surveys suggests a more significant increase of 709,500 ft^2 (54%). Increases in riffle area from 2001 to 2012 are largely attributed to differences in the methods used to map riffles over time (e.g., variability in the discharge and wetted channel area in aerial photographs used in desktop mapping and during field surveys, mapping criteria based on flow depth and gravel substrate, and accuracy and precision of riffle delineation [see Section 5.4.1 of TID/MID 2013f]). Although differences in riffle area are likely attributed to methodological differences, pool scour and associated deposition of coarse sediment in pool tails and riffles during high flow events in WY 2006 and WY 2011 increased the size and modified the distribution of riffle mesohabitats.

4.3 Water Resources

FERC's SD2 (page 35) identifies the following potential Don Pedro Project effects related to water resources in the Tuolumne River:

- *Effects of project operation on the quantity and timing of streamflow in the project-affected downstream reach, including water storage, peaking operations, and ramping rates*
- *Potential effects of project operation and maintenance on water quality, water temperature, and water quantity in the project reservoir and the project-affected downstream reach*

For water resources, FERC defines the geographic scope of cumulative effects as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. FERC noted that based on the potential term of a new license, the temporal scope should include reasonably foreseeable actions extending 30 to 50 years into the future. Assessment of past actions that have contributed to cumulative effects on water resources is necessarily limited by the availability of information.

Water quantity and water quality within the geographic scope of the cumulative effects analysis are affected by a myriad of actions within and outside the Tuolumne River basin (see Section 4.1 of Exhibit E for a discussion of these actions), including in-channel and floodplain mining; water storage and diversion at numerous dams; and a variety of land uses, including agriculture and industrial development. Because the Proposed Action would have no influence on flows downstream of the Don Pedro Project or water surface elevations in Don Pedro Reservoir, and the reservoir would exist and continue to exist in the absence of hydroelectric generation, the Proposed Action would not contribute to cumulative effects on water resources within the geographic scope defined by FERC. The Don Pedro Project's primary purposes (water storage and supply for irrigation and M&I uses and water management for flood control) do contribute to cumulative effects, but these effects diminish relative to other impacts, such as those associated with other water management projects and land uses in the San Joaquin basin, with increasing distance downstream of the Don Pedro Project. As a result, with greater distance downstream of the Don Pedro Project, it becomes increasingly difficult to isolate the effects of the Don Pedro Project's primary purposes of water supply and flood control on water resources.

Within the geographic scope identified by FERC, major actions (in addition to the existing Don Pedro Project) that contribute or have contributed to cumulative effects on water quantity and/or water quality are listed below (descriptions of the history and nature of these actions are provided in Section 4.1 of Exhibit E):

- CCSF's Hetch Hetchy water system (1923–present) on the upper Tuolumne River, which is used for water supply and hydroelectric generation, including construction of the San Joaquin Pipeline with a capacity to deliver up to 484 cfs, or 313 mgd, to CCSF's Bay Area customers,

- The Districts' original Don Pedro Project (1923–1971), which had about 300,000 AF of water storage for irrigation,
- Construction and operation of the Districts' La Grange Diversion Dam (1893–present) located about 2 miles downstream of Don Pedro Dam. The purpose of the diversion dam is to raise the level of the Tuolumne River to enable diversion of water into TID's and MID's canal systems, which provide water for irrigation and M&I uses,
- Flood control operations by the ACOE or under ACOE guidelines on the San Joaquin River and its tributaries,
- In-channel river dredging and modification of the Tuolumne River's floodplain for gold mining and aggregate extraction (1850–present),
- Operational spills from irrigation systems and runoff from farms into the Tuolumne River, Dry Creek, and the San Joaquin River (1890s–present),
- Diversion and pumping of water by riparian water users along the lower Tuolumne River (1880s–present),
- Groundwater accretion/depletion along the Tuolumne River (1880–present),
- Riparian diversions along the San Joaquin River and in the Delta (1880–present),
- Construction and operation of major storage reservoirs in the San Joaquin, Merced, Stanislaus, and Mokelumne river basins (1920s–present),
- Construction and operation of major water diversions, pumping, and canal delivery systems in the San Joaquin River and Delta (1940s–present), including the California Aqueduct, Friant Kern system, and Delta Mendota Canal,
- Development and operation of the Stockton Deep Water Ship Channel on the San Joaquin River (1930–present),
- Urbanization and its resulting pollution along the San Joaquin River and its tributaries and within the Delta,
- Use of pesticides, herbicides, and fertilizers to support agriculture,
- Development and expansion of wastewater systems to support urban development, and
- Climate change.

In addition to the actions listed above, there are numerous minor actions (e.g., levees for flood control, water withdrawals and wastewater discharges for industrial use) that also contribute to cumulative effects on water resources. The complexity and co-occurrence of past, present, and potential future actions in the San Joaquin River, it tributaries, and the Delta make it very difficult, and in many instances impossible, to isolate specific contributions, particularly quantitatively, to cumulative effects on water resources associated with individual actions.

4.3.1 Water Quantity

Major factors contributing to cumulative effects on the hydrology of the Tuolumne River include the operation of CCSF's Hetch Hetchy system, the operation of the Don Pedro Project for water storage and flood control, the diversion of water at La Grange Diversion Dam to the Districts' irrigation systems for irrigation and M&I uses, irrigation return flows in Dry Creek and along the lower Tuolumne River, and riparian water withdrawals along the lower Tuolumne River.

CCSF's diversion of 250,000 AF of water from the watershed affects both the quantity of water available in the watershed and the timing of flows in the Tuolumne River. CCSF's dams and reservoirs regulate approximately 50 percent of the Tuolumne River's flows above Don Pedro Reservoir. CCSF's regulation can affect Tuolumne River flows during low, normal, and moderately high-flow conditions. CCSF's historical average diversion is about 12 percent of the total average unimpaired flow of the Tuolumne River at La Grange Diversion Dam. During drought years, if CCSF uses credits available to it in the water bank, the only inflow to Don Pedro Reservoir can be that originating in the unregulated portion of the Tuolumne River along with minimum flow releases made by CCSF.

Based on data from the Tuolumne River Operations Model, the operation of the Districts' Don Pedro Reservoir primarily affects the timing of flows in the lower Tuolumne River below Don Pedro Dam (Figure 4.3-1). Reservoir inflows can be less than 100 cfs, but outflows are very seldom less than 200 cfs. A primary function of Don Pedro Reservoir is to store water during higher flows for later release during the irrigation season, with the highest releases for consumptive use purposes occurring in July and August, when the median reservoir inflow is about 500 to 600 cfs and the median outflow is about 2,700 cfs. As Figure 4.3-1 indicates, inflows can exceed 4,000 cfs about 20 percent of the time, whereas outflows exceed 4,000 cfs about 14 percent of the time. Operation of the Don Pedro Project results primarily in seasonal differences between inflows and outflows due to monthly and annual storage carryover in the reservoir, but except for evaporation losses, long-term inflow must equal long-term outflow. These seasonal differences are illustrated by the examples shown in Figures 4.3-2 and 4.3-3, which depict the February and August flow magnitudes and frequencies of reservoir inflows and outflows.

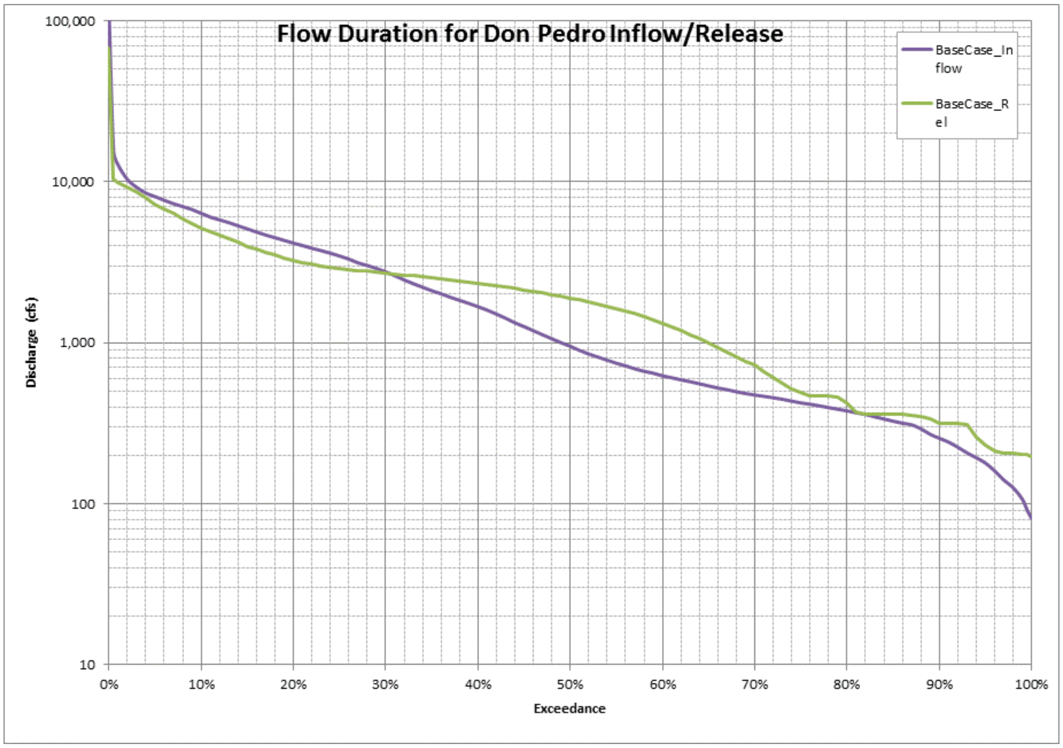

Figure 4.3-1. Don Pedro Reservoir annual inflow and outflow, 1971–2012.

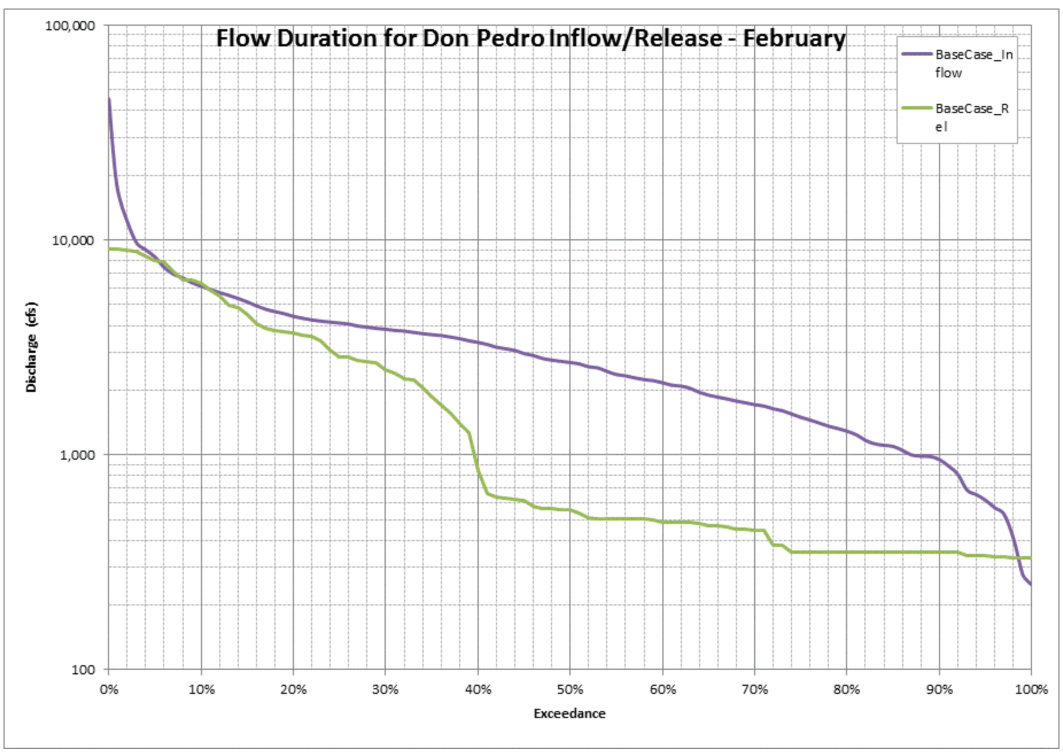

Figure 4.3-2. Don Pedro Reservoir February inflow and outflow, 1971–2012.

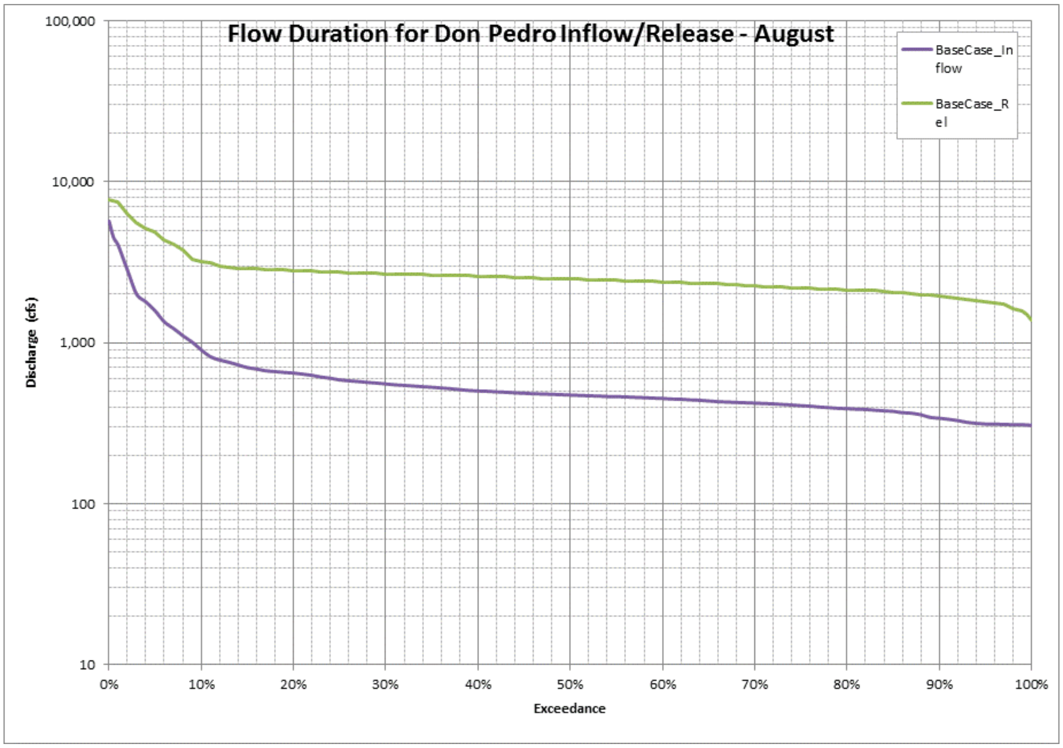

Figure 4.3-3. Don Pedro Reservoir August inflow and outflow, 1971–2012.

It is the operation of the Districts' 120-year-old La Grange Diversion Dam that has the most pronounced effects on water quantity in the lower Tuolumne River from RM 52.2 to the confluence with the San Joaquin River. This can be shown by the differences in flows released at the Don Pedro Project and those recorded at the USGS gage at La Grange. Figure 4.3-1 shows the median annual outflow from Don Pedro to be approximately 1,900 cfs. The median flow recorded at the USGS La Grange gage using 1997–2012 gage data is 325 cfs (Figure 4.3-4). The release from Don Pedro exceeds 300 cfs approximately 93 percent of the time, while the flows at the La Grange gage exceed 300 cfs 55 percent of the time (Figure 4.3-4). Inflows to Don Pedro Reservoir exceed 4,000 cfs about 20 percent of the time. Flows greater than 4,000 cfs are released from Don Pedro about 14 percent of the time, whereas flows greater than 4,000 cfs occur at the La Grange gage about 10 percent of the time.

The 1913 Raker Act required CCSF to recognize the prior water rights of the Districts. The Act requires that CCSF release 2,350 cfs or the unimpaired flow, whichever is less, year round, and up to 4,000 cfs for 60 days beginning April 15, whenever such water may be beneficially used. The Fourth Agreement requires CCSF to recognize an additional water right of 66 cfs, which is additive to the Districts' Raker Act entitlements. The Districts divert the flows they are entitled to under their water rights at La Grange Diversion Dam into the MID and TID canal systems. Therefore, absent the Don Pedro Project, the Districts are entitled to divert at La Grange Diversion Dam 100 percent of the unimpaired flow of the river, up to the capacity of their water rights. Diversions by the Districts' full water right entitlement at La Grange Diversion Dam would, absent Don Pedro Dam, leave the lower Tuolumne River without water during a substantial portion of the year (Figure 4.3-5).

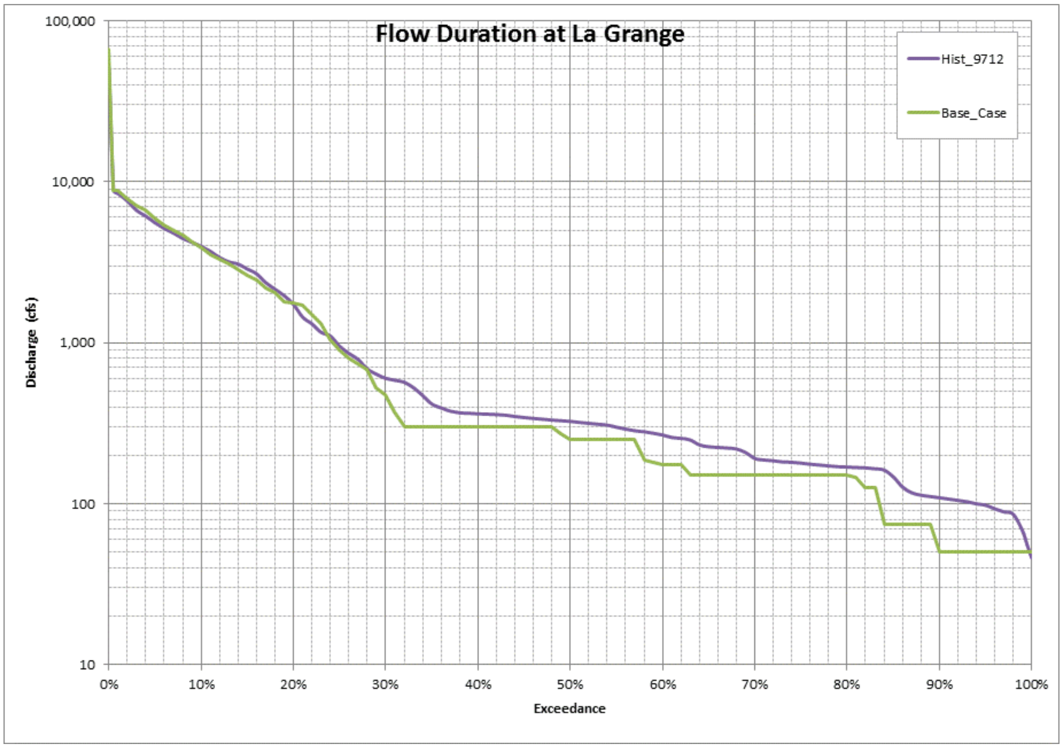

Figure 4.3-4. Historical (1997–2012) and modeled Base Case (1971–2012) flows at the USGS La Grange gage.

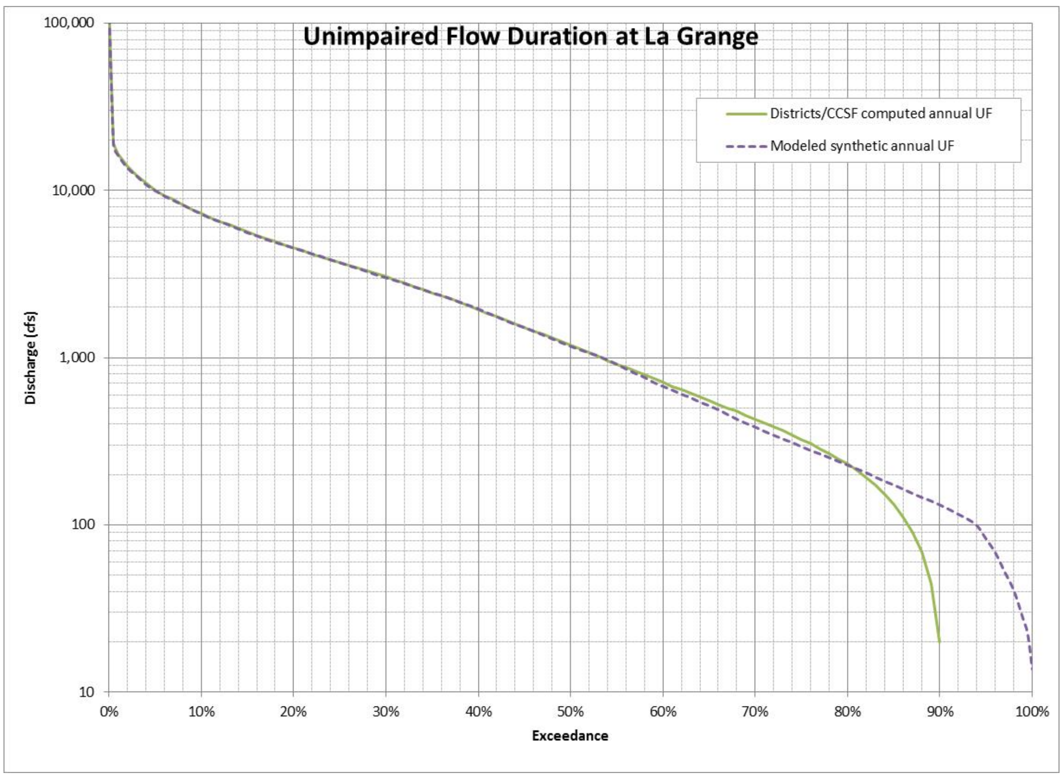

Figure 4.3-5. Estimates of unimpaired flow at USGS La Grange gage, 1971—2012.

The Don Pedro Project is required under its FERC license to provide flows to the lower Tuolumne River, measured by the USGS gage at La Grange, which vary with water year type from an annual minimum of 94,000 AF up to 300,923 AF. By percentage, the annual minimum release of 94,000 AF to the lower Tuolumne River occurs over the long term in just 6.4 percent of the years, and the annual maximum occurs approximately 50 percent of the years. The FERC-required minimum continuous flow is 50 cfs, although flows this low have occurred less than one percent of the time since 1997. In fact, a flow greater than 100 cfs has occurred 99 percent of the time since 1997. Therefore, the Don Pedro Project currently contributes positively to cumulative effects on water quantity in the lower Tuolumne River whenever the unimpaired flow would have been less than the Districts' water rights.

Water storage in Don Pedro Reservoir for flood control and irrigation and M&I uses reduces the occurrence of higher flows in the lower Tuolumne River. Don Pedro Reservoir inflow, for the period 1971 to 2012, exceeded 5,000 cfs approximately 15 percent of the time (Figure 4.3-1), and flows at the USGS La Grange gage since 1997 (post-FERC amendment to flows) exceeded 5,000 cfs 10 percent of the time (Figure 4.3-4).

Flows in the lower Tuolumne River are increased by occasional operational spills from the Districts' irrigation system, farm runoff, and groundwater accretion, and flows are decreased by riparian pumping. Quantitative values for these factors are generally unavailable, but direct accretion measurements made by the Districts as part of relicensing studies show that the lower Tuolumne River is generally a gaining river. However, riparian diversions, acting together, can contribute to significant loss of flow. There are 26 known riparian diversions with an estimated total combined withdrawal capacity of 76.6 cfs (CDWR 2013).

Factors contributing to cumulative effects on water quantity in the San Joaquin River and the Delta are numerous and are not all well quantified. Major factors include water development and diversion of flows on the San Joaquin River at Friant Dam to the Friant-Kern and Madera canals and associated facilities serving over 1 million acres of irrigated farmland. Friant Dam was constructed in 1942 and materially changed the flow regime of the San Joaquin River. In many years mean annual flows below Friant Dam are less than 200 cfs (SJRRP 2011). Construction of other major water storage and diversion projects on the Merced, Stanislaus, and Mokelumne rivers, as well as the Tuolumne River, all contribute to cumulative effects on water quantity in the San Joaquin River and Delta systems.

The total drainage area of the San Joaquin River is 31,800 mi^2, and at its entrance to the Delta (i.e., at Vernalis) the drainage area is 13,539 mi^2. The Tuolumne River has a drainage area of approximately 1,960 mi^2, or 14 percent of the San Joaquin River watershed at Vernalis and 6 percent of the total San Joaquin watershed area. In addition to water development projects associated with the SWP and CVP, numerous riparian diversions also occur along the San Joaquin River and its tributaries and throughout the Delta. Except for the State and Federal pumping plants, the total quantity of water historically diverted and pumped by these diversions is not well known.

4.3.2 Water Quality

Many of the factors listed above in Section 4.3 also contribute to cumulative effects on water quality in the Tuolumne and San Joaquin rivers and in the Delta. A study performed as part of relicensing (TID/MID 2013h) indicates that water quality in Don Pedro Reservoir and in the Tuolumne River immediately downstream of Don Pedro Dam meets California's water quality standards. Section 3.4 of Exhibit E describes sampling results for a range of water quality variables including, DO, pH, biostimulatory substances, turbidity, select pesticides, toxicity, mercury/methylmercury, bacteria, oil and grease, sediment, and taste and odor. Based on these results, it is apparent that the Don Pedro Project's presence and primary purposes of water supply and flood control do not contribute to adverse cumulative effects related to any of these variables. Because the Proposed Action does not influence overall storage and flow release schedule, it cannot, by definition, contribute to cumulative effects on any water quality variables, including temperature.

The lower Tuolumne River accumulates pollution loadings from pesticides and wastewater discharge as it travels downstream. The section of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River is included on the State of California's CWA § 303(d) list in relation to the non-point discharge of some agricultural pesticides (SWRCB 2010). Agricultural chemicals on the 303(d) list are chlorpyrifos, diazinon, and the Group A Pesticides: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene. This reach of the Tuolumne River is also 303(d) listed for mercury, a legacy contaminant of the gold mining era (SWRCB 2010).

Six pesticides were detected in runoff from agricultural and urban areas during a study conducted in the lower Tuolumne River, and chlorpyrifos, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998). Peak diazinon concentrations measured in the lower Tuolumne River have frequently exceeded levels that can be acutely toxic to some aquatic organisms (Dubrovsky et al. 1998).

The presence of the Don Pedro Project and its operation to satisfy the primary purposes of water supply and flood control do not contribute to cumulative adverse effects associated with agricultural pesticides or mercury downstream of the Don Pedro Project. Herbicides applied for control of invasive plants at some reservoir shoreline facilities are applied in such small amounts that their contribution to levels of chemical constituents in the Tuolumne River basin is negligible. For the same reason, rodenticides applied rarely to control ground squirrels near certain recreational facilities adjacent to Don Pedro Reservoir, are used in such small amounts that their effects are also considered insignificant.

4.3.2.1 Water Temperature

The section of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River is also included in the State of California's CWA § 303(d) list in relation to water temperature. In addition to the natural climate characteristics of the Central Valley, factors contributing to the thermal conditions in the lower Tuolumne River include (among others) water storage in Don Pedro Reservoir; water diversions at the Hetch Hetchy Project and at La Grange Diversion Dam;

substantial in-channel and floodplain habitat modifications, including removal of riparian vegetation; return flow from irrigation operations and alteration of groundwater accretion; riparian diversions; Dry Creek inflows; and wastewater discharges. As explained previously, the Proposed Action would not contribute to cumulative effects on water temperature in the Tuolumne River basin, because it would have no significant effect on water management, i.e., storage and diversion. However, the Don Pedro Project's primary purposes have a localized effect on temperature, as explained below, which is attenuated with increasing distance downstream.

4.1.1.1.30 Water Temperature Effects of Don Pedro Reservoir Operations

At over 400-feet deep, the Don Pedro Reservoir is a large reservoir which goes through a well-established annual cycle of temperature stratification and destratification. Temperature stratification begins to be established by early April, is well established by June, and remains until turnover in late October/early November or later. The effect of thermal stratification within Don Pedro Reservoir is to enable it to support both a robust cold-water and warm-water fishery.

The best indicator of the overall effects of the Don Pedro Reservoir on water temperatures is to compare the differences between the reservoir inflow and outflow temperatures. Figure 4.3-6 displays actual mean daily reservoir inflow and outflow temperatures recorded over the period of October 2010 through December 2012. The figure demonstrates the effects of the Don Pedro Reservoir on Tuolumne River temperatures. While reservoir inflow temperatures vary considerably due to local meteorological and geophysical conditions, outflow temperatures vary only slightly. Outflow temperatures are generally slightly higher than inflow temperatures from November to early April when inflow temperature ranged from 3 to 10°C and outflow temperatures were relatively steady at 10 to 11°C. Outflow temperatures were cooler than inflow temperatures from early April through early October when outflow temperatures are relatively steady at 11 to 12°C and inflow temperatures ranged from 12 to 22°C. In 2011, from mid-June to mid-September, daily average inflow temperatures ranged from 19 to 23°C. Reservoir inflow and outflow temperatures are relatively equal during the April through mid-May time frame and the mid-October to mid-November time at about 10 to 11°C.

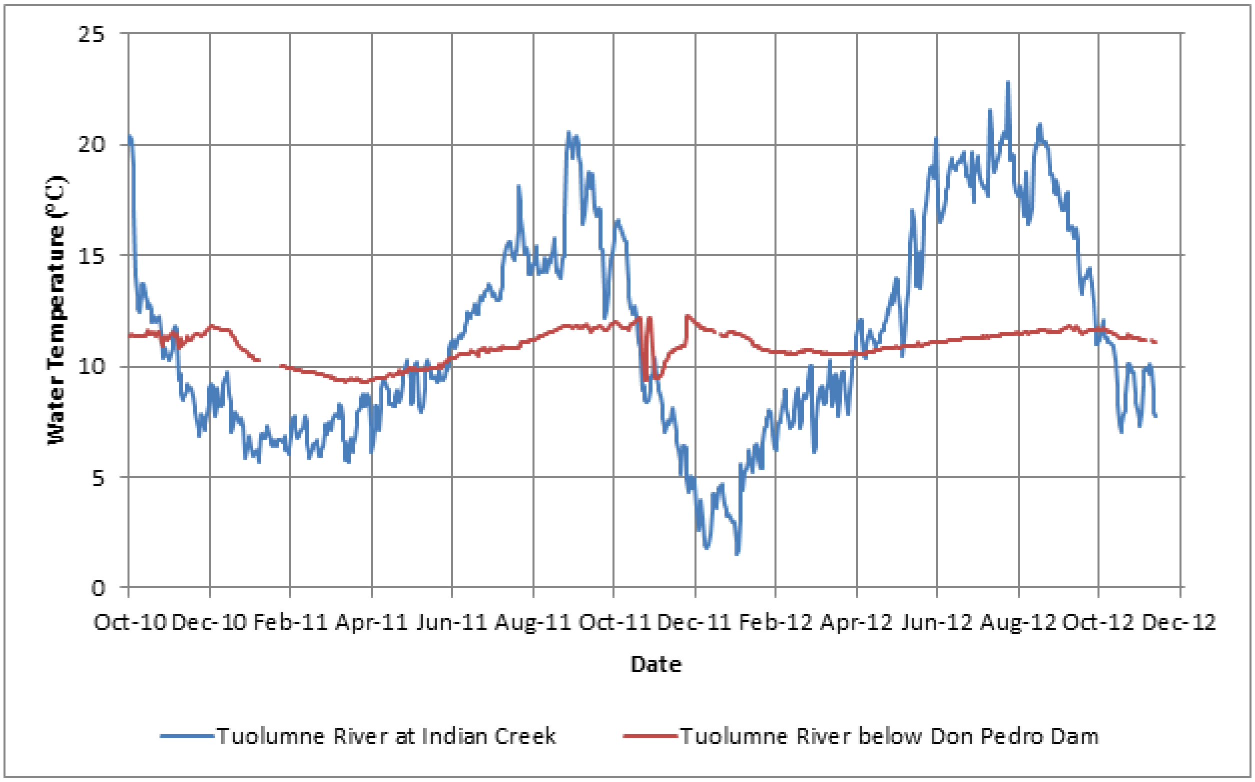

Figure 4.3-6. **Don Pedro Reservoir inflow and outflow temperature.**

These temperature patterns show very little change through the La Grange pool and just below La Grange Diversion dam. La Grange pool is shallow and short and is more riverine than lacustrine from a temperature perspective. La Grange pool does not stratify due to its shallowness and the flow-through is large relative to its volume, especially during summer months when releases for irrigation are at their highest. The contribution of the Don Pedro Project to cumulative effects to river temperature in the lower Tuolumne River would be consistent with its overall effects on water temperature; that is, Don Pedro Project operations tend to provide an initial cooling effect to temperatures in the river from June to early October, have no significant cumulative effect during the early April to mid-May and mid-October to mid-November time frames, and tend to provide a slight initial warming during the November to early April period.

The above findings of the cooling effects of Don Pedro Reservoir from the June through early October period applies only so long as the thermal stratification of the reservoir is intact. Modeling studies conducted during the development of the Don Pedro Reservoir 3-D temperature model indicate that once reservoir levels reach about elevation 625 to 650 ft, the reservoir temperatures become uniform and the thermal stratification breaks down. If these reservoir levels are reached during warmer periods (May-September), outflow temperatures can be expected to rise sharply.

4.1.1.1.31 With- and Without-Dams Project Temperature Comparisons

As explained previously, the Districts have developed a computer simulation of the temperature regime of the Tuolumne River without dams. The focus of the Tuolumne River Flow and Water Temperature Model: Without Dams Assessment (Jayasundara et al. 2014) was to develop a flow and water temperature model to simulate water temperatures in the Tuolumne River without the existing Hetch Hetchy (which includes Cherry and Eleanor reservoirs), Don Pedro, and La Grange projects. The model was developed to complement detailed models developed for Don Pedro and La Grange Reservoirs (TID/MID 2013i) and the lower Tuolumne River (TID/MID 2013j). Supporting data included the development of long-term flow and meteorological conditions to assess flow and water temperatures over a multi-decade period, i.e., 1970–2012. The following text and plots provide a characterization of with- and without-dam conditions to demonstrate the impoundments' contribution to cumulative effects on water temperatures in the Tuolumne River basin, in particular the reach between Don Pedro Dam and the San Joaquin River.

Figures 4.3-7–4.3-16 provide a comparison of simulated without-dams 7DADM temperatures to simulated (below the Don Pedro Project) and empirically derived (above the Don Pedro Project) with-dams temperatures at the following locations: (1) below the South Fork Tuolumne River (≈ RM 98), (2) the Tuolumne River below Indian Creek (≈ RM 88), (3) immediately below Don Pedro Dam (≈ RM 54), (4) RM 51.5, 46, 40, 34, and 24 in the lower Tuolumne River above Dry Creek (5) and RM 10 and RM 1 on the lower Tuolumne River below Dry Creek.

Comparison of 7DADM water temperatures under with- and without-dams conditions upstream of the Don Pedro Project indicates that during summer, water would be substantially warmer in the absence of the upstream impoundments than it is under existing conditions, particularly at RM 98 (Figures 4.3-7 and 4.3-8). With-dams temperatures are slightly warmer than without-dams temperatures during the November through February period by from 1 to 3°C at times (Figures 4.3-7 and 4.3-8). As noted in the figure captions, plots for RM 98 and RM 88 compare simulated without-dams temperatures to empirically derived with-dams temperatures.

The without-dams simulation reveals that average water temperatures in the Tuolumne River mainstem, in the absence of impoundments, would approach thermal equilibrium well upstream of the current location of the Don Pedro Project, i.e., the without-dams temperature regime at RMs 88 and 98 are very close to each other. Moreover, the highest without-dams 7DADM temperatures at RMs 88 and 98 (≈ 24 °C) are similar to the highest without-dams temperatures in the lower river (≈ 25 °C).

Immediately below Don Pedro Dam, with-dams 7DADM temperatures are relatively cool year-round, with little variability (Figure 4.3-9), because water is released from the reservoir's hypolimnion. Because of the thermal mass of the reservoir, water at depth is to a large degree buffered from the influence of seasonal and diel variability in air temperature and other climatic factors. With-dams 7DADM temperatures are much cooler than without-dams temperatures in summer but are slightly warmer by 1 to 5°C from about November through February.

With-dams 7DADM temperatures during summer rise rapidly with increasing distance downstream of the Don Pedro Dam, and by RM 46 temperatures during July reach 20 °C (Figure 4.3-11), while without-dams 7DADM temperatures reach 24°C. By approximately RM 34, thermal equilibrium has largely been restored under with-dams conditions, and with-dams and without-dams thermal regimes are closely matched. This condition persists from this point to the above Dry Creek. With-dams summer 7DADM temperatures are 2 to 5°C warmer below Dry Creek from mid-May to mid-September (Figures 4.3-15 – 4.3-16). Also, at all locations in the lower river, except immediately below Don Pedro Dam, there is a decrease in daily average water temperatures from mid-April to mid-May under the with-dams base case condition, which is the result of pulse flow releases scheduled to benefit fish downstream of La Grange Diversion Dam.

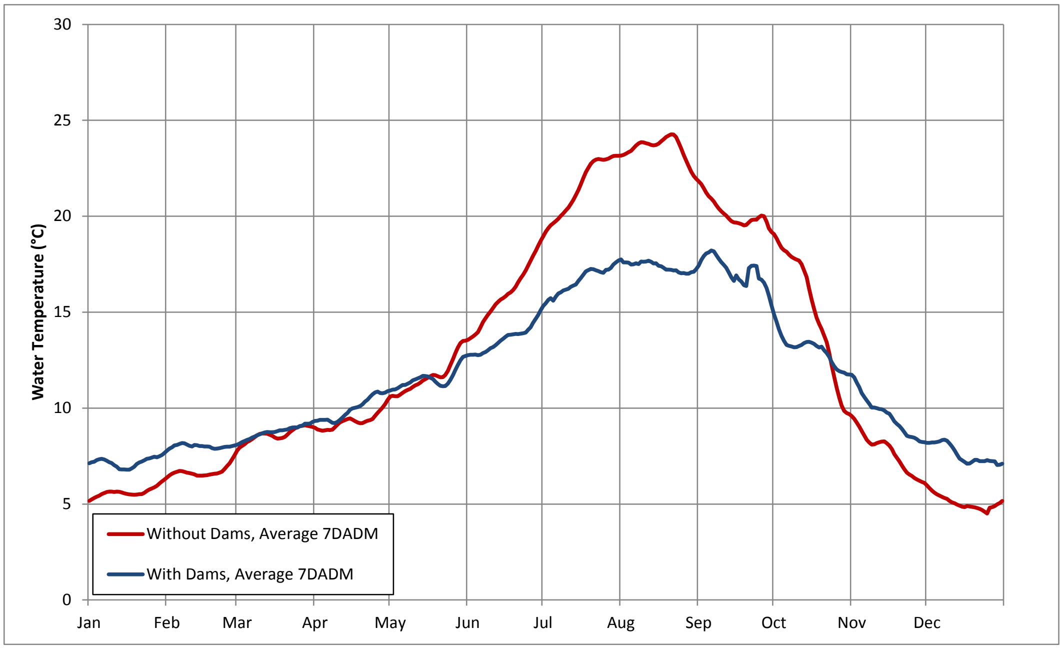

Figure 4.3-7. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below the South Fork Tuolumne River (≈RM 98). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 2014), and with-dams temperatures are based on data collected by temperature loggers from 2005 - 2012.

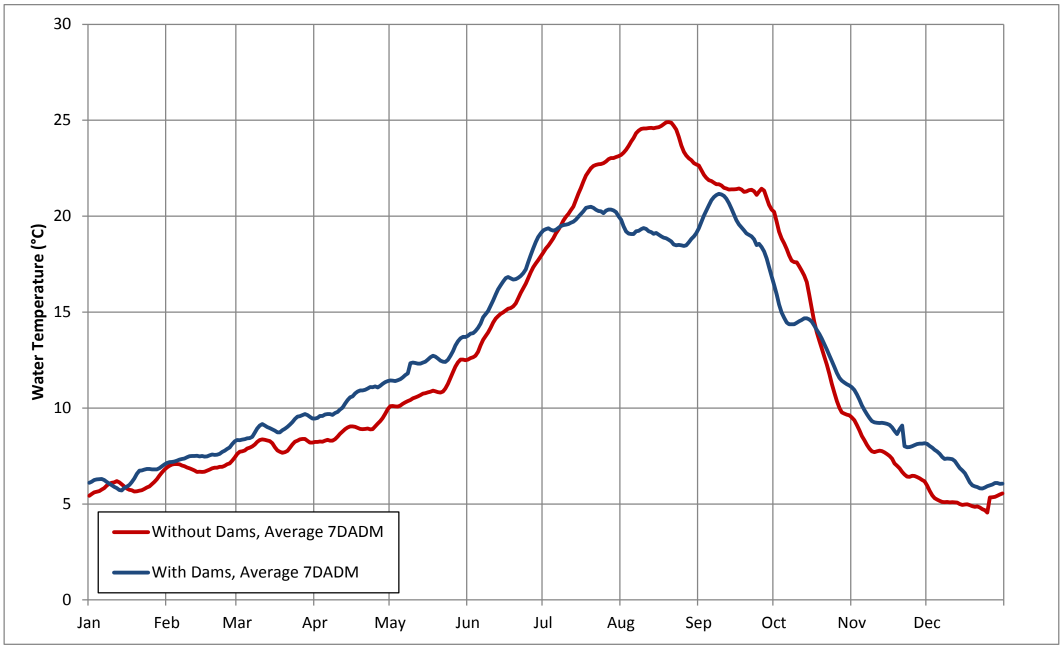

Figure 4.3-8. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Indian Creek (≈RM 88). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 2014), and with-dams temperatures are based on data collected by temperature loggers from 2009 – 2012.

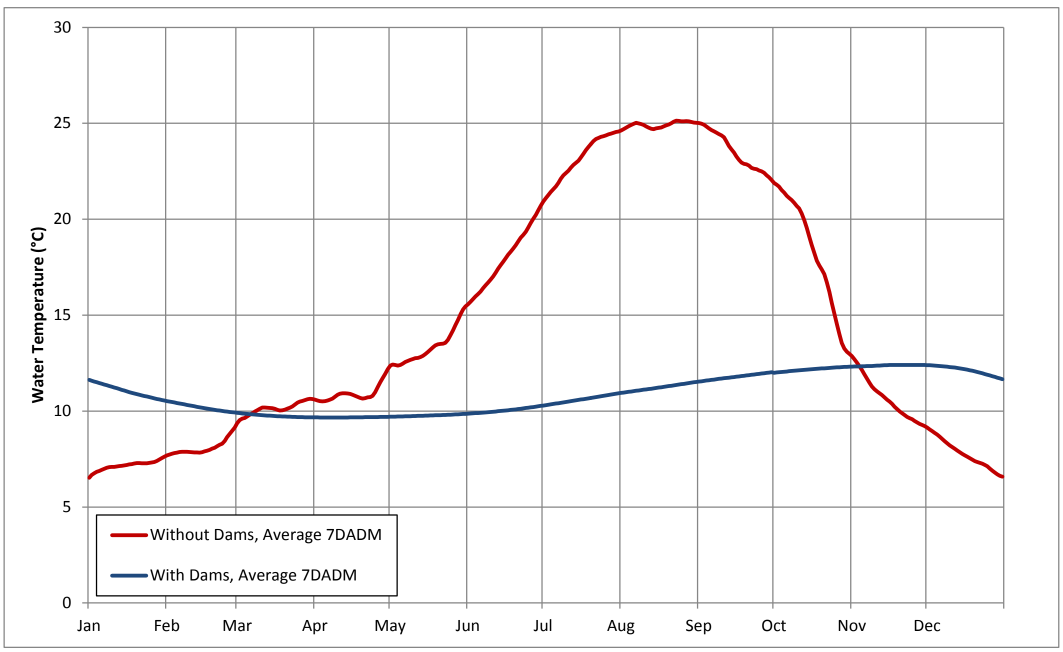

Figure 4.3-9. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Don Pedro Dam (≈RM 54). Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

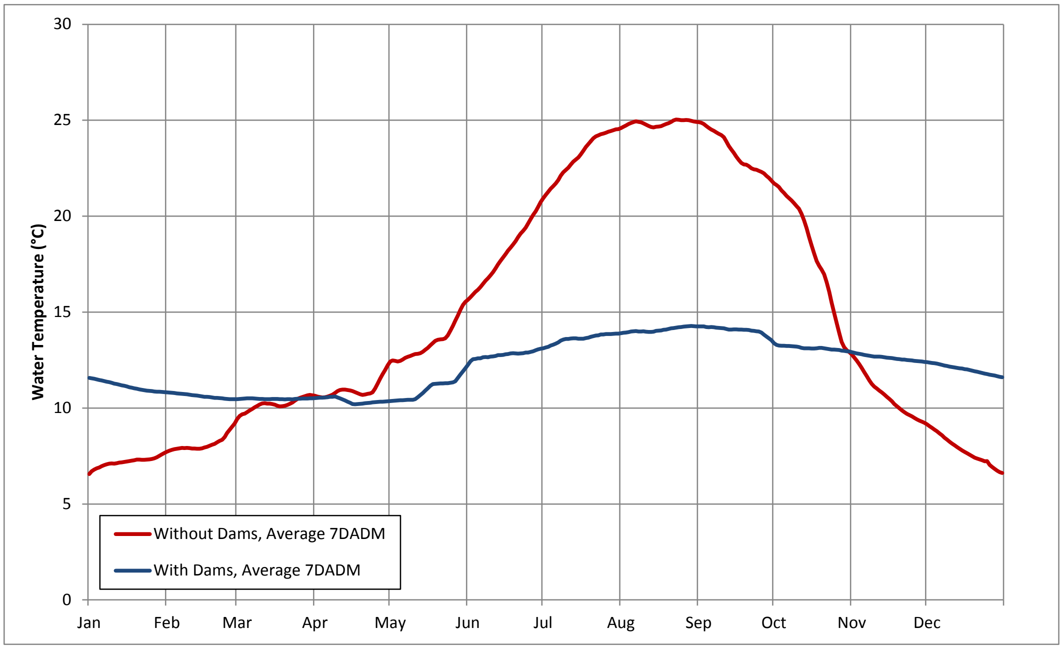

Figure 4.3-10. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 51.5. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 – 2012.

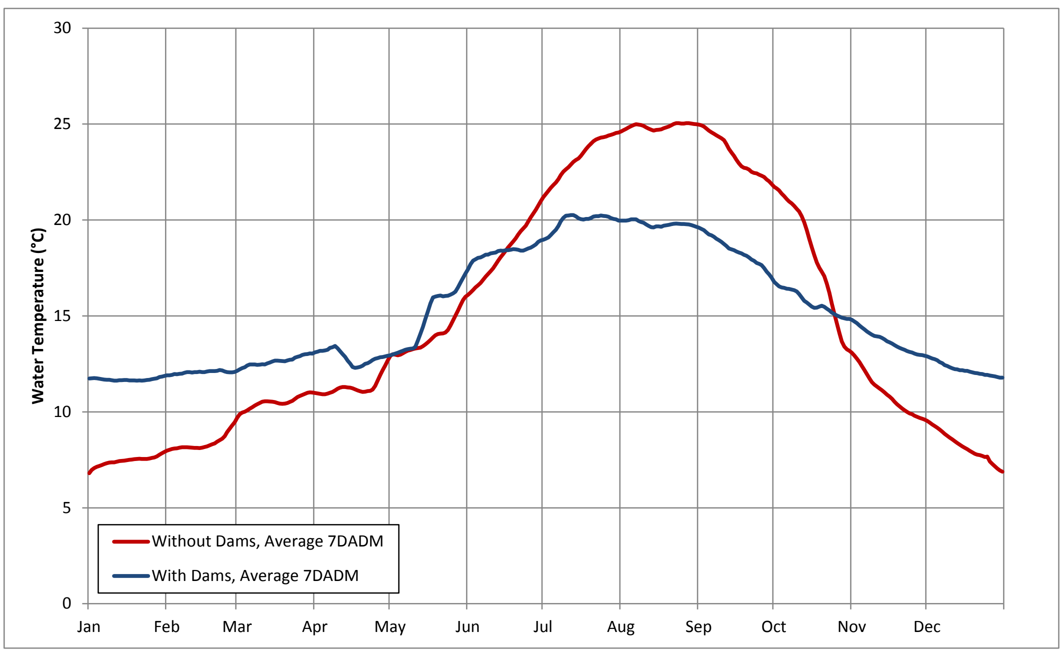

Figure 4.3-11. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 46. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

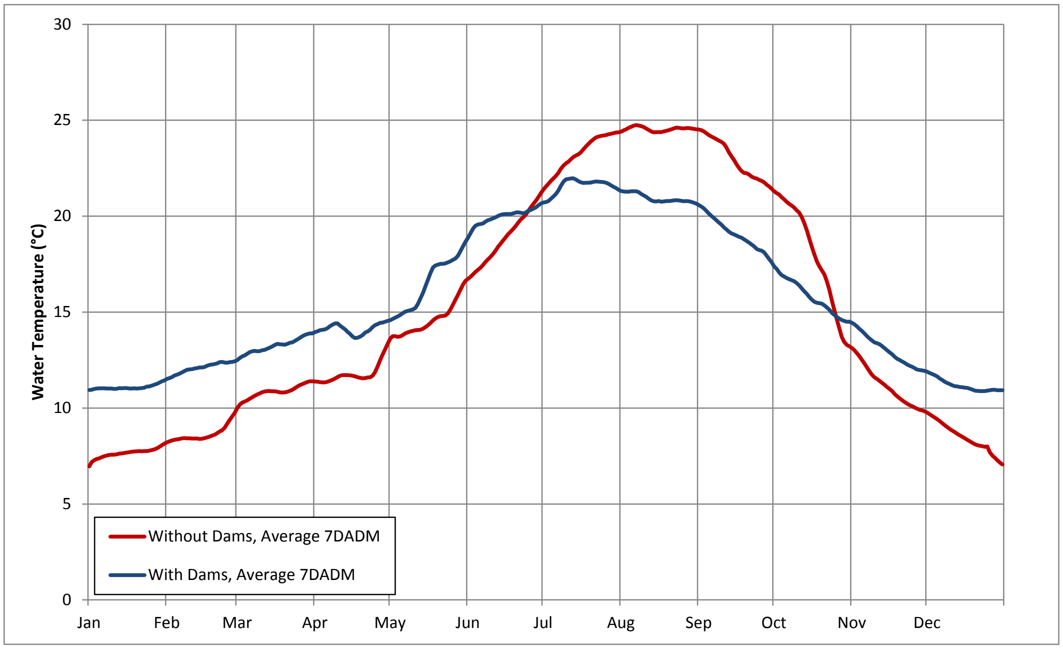

Figure 4.3-12. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 40. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

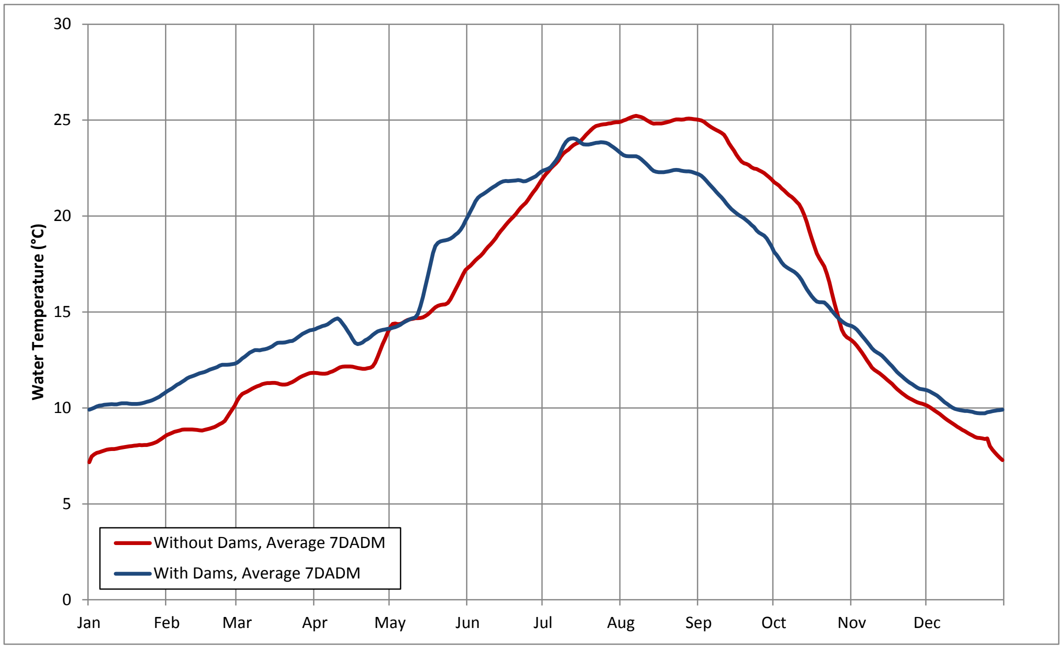

Figure 4.3-13. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 34. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

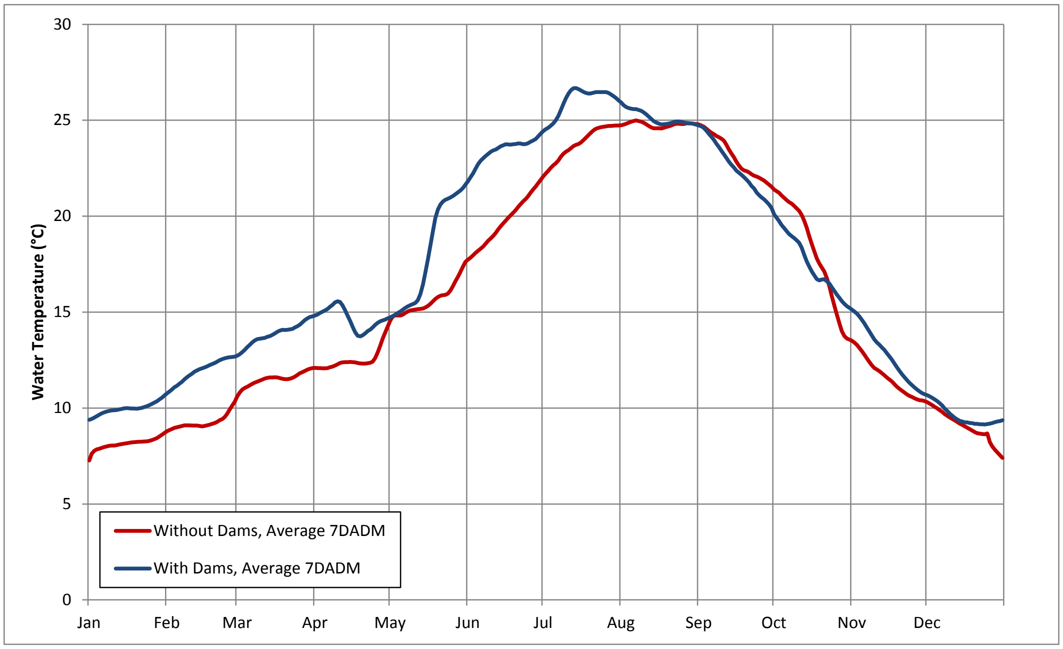

Figure 4.3-14. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 24. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

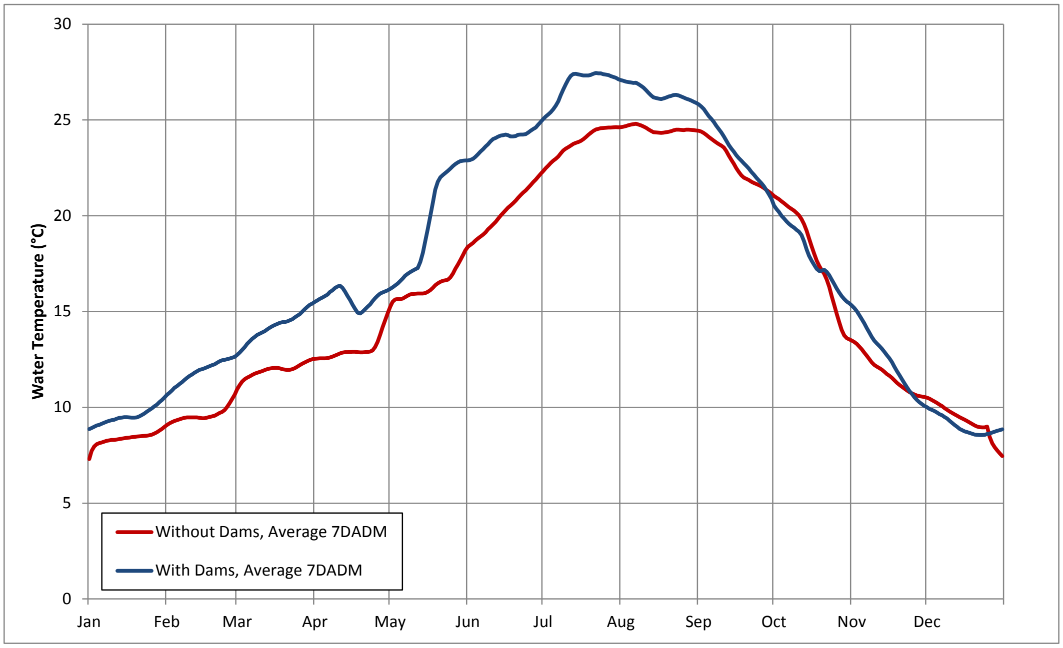

Figure 4.3-15. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 10. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

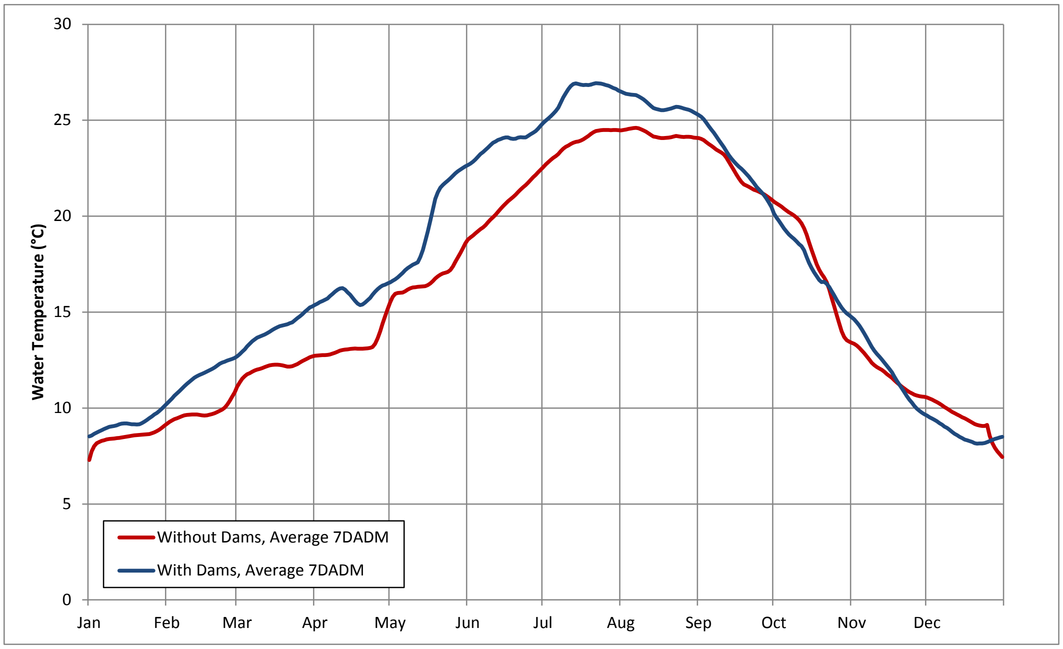

Figure 4.3-16. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 1. Without-dams temperatures (Jayasundara et al. 2014) and with-dams temperatures (TID/MID 2013j) are simulated based on the period 1970 - 2012.

4.1.1.1.32 Effects of Ambient Air Temperatures on Tuolumne River Water Temperatures

As ambient air temperatures and the number of hours of direct sunlight increase in the Tuolumne River valley during spring and summer, water temperatures become heavily influenced by local meteorological conditions. This is demonstrated in Figures 4.3-17, 4.3-18, and 4.3-19. Based on the Districts' HEC-RAS river hydraulic and temperature model (TID/MID 2013j), these figures depict the relationship between ambient air temperatures and river flow at three locations along the lower Tuolumne River, RM 39.5, RM 30, and RM 16.5.

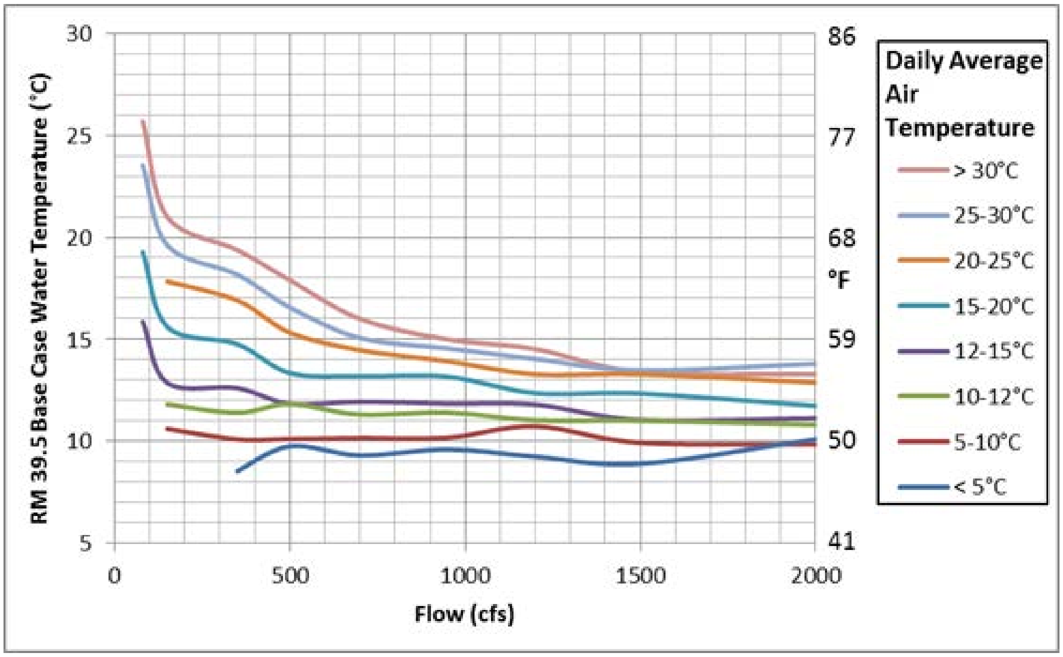

Figure 4.3-17. Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 39.5.

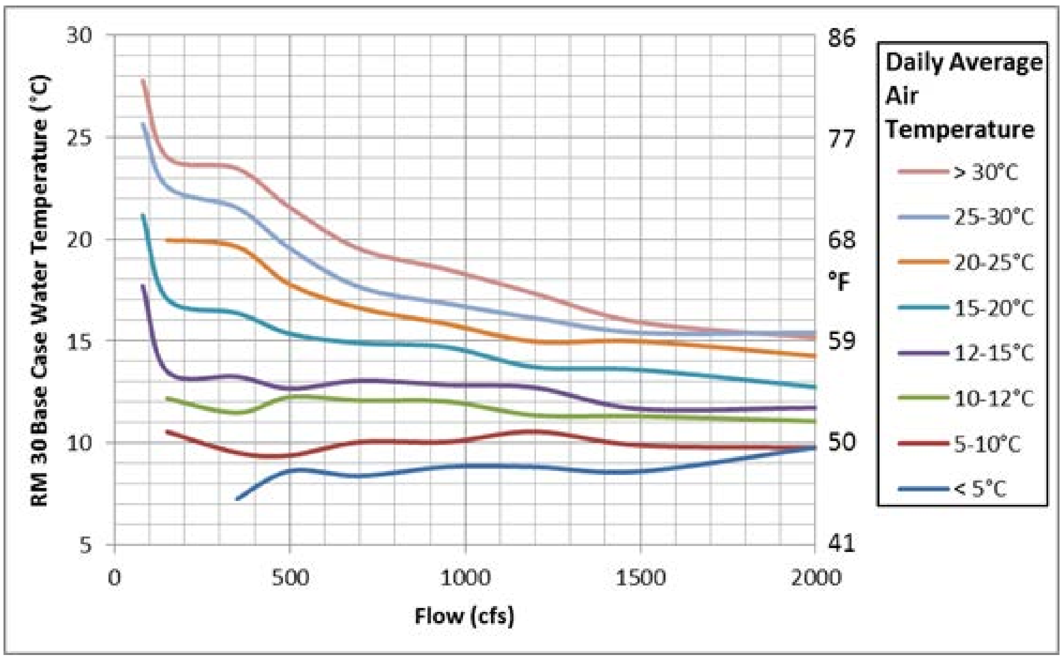

Figure 4.3-18. Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 30.0.

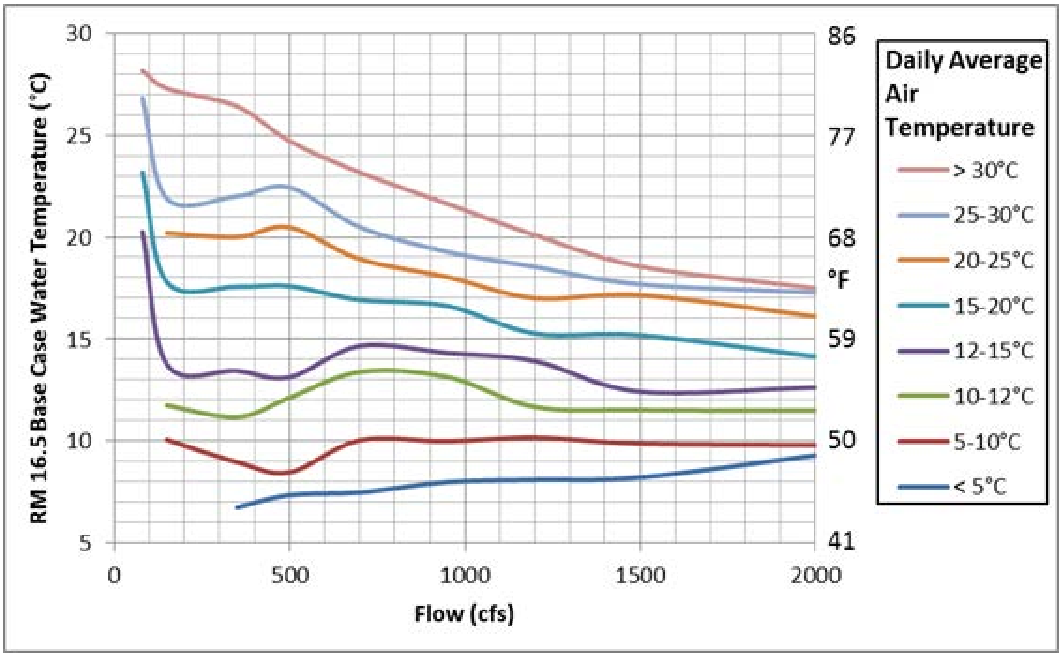

Figure 4.3-19. Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 16.5.

When average daily ambient air temperatures are between 15 and 20°C (April/May), a flow of 100 cfs results in an average daily water temperature at RM 39.5 of 18°C[15] (Figure 4.3-17). A flow increase to 200 cfs would be required to reduce the water temperature by 3°C to 15°C, an increase in flow to 500 cfs would be required to reduce the water temperature to 13°C, and an increase in flow to 2,000 cfs would be required to reduce water temperature just one degree more to 12°C.

As expected, the influence of ambient air temperature is more extreme as air temperatures increase. For example, at the same RM 39.5, in the summer months when average daily air temperatures can routinely reach 25°C (July/August/September), a flow of 100 cfs results in a water temperature of 20°C (Figure 4.3-17). A flow of 300 cfs is required in order to reduce the river temperature by 3°C to 17°C, an increase in flow to 1,000 cfs would be required to reduce the water temperature to 14°C, and an increase in flow to 2,000 cfs would be required to reduce water temperature just one degree more to 13°C.

With increasing distance downstream, the influence of ambient climate on water temperature significantly increases. At just nine miles further downstream, at RM 30, when ambient air temperature is between 25 and 30°C and flow is 100 cfs, the resulting river temperature is 24 °C (Figure 4.3-18). To reduce the river's average daily temperature to 20°C would require a flow increase to 800 cfs and a flow of 1,400 cfs would be required to reduce river water temperature just 2°C more to 18°C. Attaining one additional degree temperature drop to 17°C would require a flow of well over 3,000 cfs, a flow that occurs less than two percent of the time in August under unimpaired flow conditions. Therefore, it is likely that historical average daily water

[15] All starting temperatures are 10°C

temperatures were seldom, if ever, less than 18°C in the lower Tuolumne River from July through September. This result further reinforces the findings of the without-dam assessment discussed above.

4.1.1.1.33 Effects of Accretion Flows on Water Temperature in the Lower Tuolumne River

Accretion flows due to groundwater are normally expected to be about 12–14°C, which would be anticipated to slightly warm streamflows during cold months and cool them during warm months. Data from temperature loggers located in the lower river indicate that some cooling occurs between RM 16.2 and RM 3.5 during most months (Table 4.3-1), and based on the Districts' flow measurements this reach of river appears to receive contributions from groundwater accretion. Withdrawals by riparian water users tend to increase water temperatures during the peak of the irrigation season. The Districts' intensive water temperature data collection conducted during the summer of 2013 (TID/MID 2014) showed no apparent influence on water temperatures from groundwater accretions in the river above RM 24.

4.1.1.1.34 Cumulative Effects on Water Quality in the San Joaquin River and Delta

Factors contributing to cumulative effects to water quality expand significantly downstream of the confluence of the Tuolumne and San Joaquin rivers, with an immense number of actions affecting conditions in the mainstem San Joaquin River and the Delta. Prominent among these are river diversions at Friant Dam on the San Joaquin River, at Crocker-Huffman Dam on the Merced River, at New Melones and other dams on the Stanislaus River, and riparian withdrawals along all these waters. Intense agricultural development along the San Joaquin River and its tributaries has resulted in additional river water withdrawals and introduction of an array of pesticides and herbicides.

The CDPR has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of the Central Valley and Delta (Werner et al. 2008). Agriculture, which is the primary land use adjacent to the Merced River downstream of the Crocker-Huffman Diversion Dam, has the potential to affect water quality and aquatic resources primarily through water returns to the river. Discharge of nutrients such as nitrogen and phosphorus from non-point runoff of agricultural fertilizer and point sources, such as water treatment facilities, stimulates algae growth, with attendant increases in the magnitude of diurnal DO variation.

Reduction in flows in the San Joaquin River, particularly between Gravelly Ford Canal and the Merced River, has increased the concentration of pesticides and fertilizers in the river, which has contributed to pollution that has impacted aquatic species (Cain et al. 2003). Hundreds of agricultural and urban drains discharge into the San Joaquin River downstream of the Merced River confluence, many of which are also designated as impaired water bodies, such as the Harding Drain, the Grayson Drain, the Newman Wasteway, and the Westley Waterway (SWRCB 2010). The San Joaquin River has been identified by the SWRCB as an impaired water body for arsenic, boron, dacthal, *Escherichia coli* (*E. coli*), dichloro-diphenyl-dichloroethylene (DDE), mercury, temperature, selenium, electrical conductivity, and several pesticides, both upstream and downstream of the Merced River confluence.

Table 4.3-1. Monthly seven-day average daily maximum (7DADM) temperatures in the lower Tuolumne River (dates vary).

Month	Average Temperature			7-Day Average Daily Maximum Temperature																	
	Don Pedro Project Outflow			@ USGS 11289650 - Tuolumne River Below La Grange Diversion Dam			Tuolumne River at Riffle 13B			Tuolumne River at Roberts Ferry Bridge			Tuolumne River at Hughson			Tuolumne River at 9th St Bridge			Tuolumne River at Shiloh Bridge		
	RM 54.3			Near La Grange, CA												Near Modesto, CA			Near San Joaquin Confluence		
	1/1987 - 9/1988 and 5/2010 - 2/2013			RM 51.8 Nov 2001 – Oct 2012			RM 45.5 Nov 2001 – Nov 2012			RM 39.5 Aug 1998 – Jul 2010			RM 23.6 Dec 1997 – Jan 2010			RM 16.2 Jul 68-Apr 79 and Sep 88-Jun 13			RM 3.5 Apr 1987 – Dec 2012		
	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest
January	10.46	11.7	8.9	10.9	11.6	10.4	11.0	11.8	10.6	10.9	11.9	10.1	11.1	12.4	9.9	10.7	12.7	9.2	10.7	12.6	8.4
February	9.68	11.4	8.5	10.8	11.2	10.1	11.6	12.2	10.6	11.9	13.0	10.9	12.3	13.9	10.9	12.5	15.9	8.4	12.5	14.6	10.1
March	9.33	11.1	7.8	10.8	11.6	9.7	12.4	13.5	10.5	13.4	15.5	11.0	14.3	17.4	11.1	15.4	19.7	10.5	15.3	18.5	10.5
April	9.38	10.9	8.3	10.8	11.7	9.9	12.8	14.6	10.9	13.5	15.2	11.4	15.1	17.2	11.7	17.8	22.0	11.4	16.7	21.5	11.3
May	9.8	11.1	8.6	11.3	12.0	10.4	14.0	15.6	11.7	15.5	18.1	12.7	18.0	20.9	12.9	20.8	24.6	12.9	19.6	27.4	12.9
June	10.15	11.7	9	12.0	12.9	11.1	16.9	20.6	12.6	20.3	26.0	13.8	23.8	27.9	14.1	25.0	31.3	13.9	23.4	28.7	15.1
July	10.56	11.7	9.4	12.4	13.3	11.7	18.3	21.9	14.1	21.4	26.3	15.3	25.7	28.9	16.0	27.2	31.4	17.4	25.8	29.6	18.0
August	10.87	12.2	9.4	12.7	13.4	12.1	18.0	20.7	13.8	20.8	24.7	16.0	25.0	28.3	19.0	26.1	29.9	16.1	25.0	28.1	17.3
September	11.1	12.2	10	12.7	13.3	12.2	16.9	19.1	15.0	18.8	22.1	14.6	22.3	25.3	16.4	23.1	27.1	18.5	22.2	25.7	16.8
October	11.31	12.2	10	12.3	12.8	12.0	14.0	14.6	13.4	14.8	16.1	13.9	17.0	18.9	15.2	18.1	22.1	14.9	17.7	20.3	14.9
November	11.26	13.3	9.25	11.5	12.0	10.9	12.2	12.6	11.5	12.4	13.3	11.7	13.4	14.6	12.0	13.8	18.6	11.6	13.2	14.7	9.6
December	11.24	12.22	10.1	11.2	11.6	10.7	11.2	11.7	10.3	11.0	11.5	10.0	10.9	12.0	10.1	10.6	12.5	8.5	10.4	11.8	7.5

The flow of subsurface drainage water from intensively irrigated agricultural land on the west side of the San Joaquin Valley into the San Joaquin River has created a well-documented water salinity and specific ion (selenium and boron) problem in the river. The flow of water from the Tuolumne River (and the Merced and Stanislaus rivers) dilutes and improves the overall water quality, including the salinity level, of the San Joaquin River as it moves downstream toward the Delta.

Urbanization along the San Joaquin River and in the Delta has resulted in a number of water quality concerns, including adverse effects from urban runoff and M&I wastewater and stormwater discharges. The development of the Stockton Deep Water Ship Channel resulted in a zone of near-zero DO that has only just recently been addressed by adding aeration directly to the channel portion of the river and reducing nitrogen loads from the Stockton Wastewater Treatment Plant (see Section 4.1.4.4 for a discussion of the Stockton DWSC and associated mitigation measures). In general, the factors affecting water quality in the San Joaquin River and Delta ecosystems are likely proportional to the human population, amount of water development, and number of irrigated acres. The population of the San Joaquin Valley and Bay Area combined exceeds 10 million people; the population served by the Don Pedro Project is about 250,000, or about 2 percent of that total. The irrigated acreage in the San Joaquin Valley exceeds 5 million acres;[16] the Don Pedro Project serves approximately 210,000 acres, or about 4 percent of the total. There are 20 major dams on tributaries to the lower San Joaquin River and Delta that store over 20 million AF of water for irrigation, M&I uses, and flood control;[17] the total usable storage in Don Pedro Reservoir for those purposes is 1.7 million AF, or about 8 percent of the total.

With respect to pollution loadings and DO concerns in the San Joaquin River, the Don Pedro Project does not contribute to cumulative adverse effects on these water quality constituents. As discussed in Section 4.3.2.1.1, the Don Pedro Project has little to no influence on water temperatures by the time flows reach the confluence with the San Joaquin River, and even less by the time water reaches the Delta.

4.3.3 Climate Change

Although it is impossible to quantify the contribution of global climate change to cumulative effects on water resources in the San Joaquin River basin, general patterns of impact can be described. In general, increases in temperature and alteration of precipitation regime are likely to result in higher instream water temperatures, especially in the lower reaches of Central Valley rivers, and a reduction in summer flow.

The global mean surface temperature has increased by 1.1°F since the 1800s (IPCC Synthesis report, 2001, as cited in CEPA 2006), and climate change scenarios indicate that temperatures in the United States are likely to rise by approximately 5–9°F (3–5°C) on average over the next 100 years (CEPA 2006). However, high range estimates for global increases in average temperature are as high as 8.0–10.4°F (4.4–5.8°C) (CEPA 2006).

[16](http://www.idrinkwine.net/the-sjv/)
[17](http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action)

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

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

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

4.4 Fish and Aquatic Resources

FERC's SD2 (pages 35-36) identifies the following potential Don Pedro Project effects on fish and aquatic resources in the Tuolumne River:

- *Effects of project operation and maintenance on fish populations in project reservoirs and the project-affected stream reach including fall Chinook salmon*
- *Effects of retention of sediment in the project reservoir on downstream fish spawning habitat and benthic macroinvertebrate populations*
- *Potential effects of project-related changes in the recruitment and movement of large woody debris on aquatic resources and their habitat*
- *Potential effects of project operations on stranding or displacement of fish*

For aquatic resources, FERC defines the geographic scope of cumulative effects as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. At the time of the release of its SD2, FERC tentatively identified a cumulative geographic scope for anadromous fish and essential fish habitat (EFH) that includes the Tuolumne River basin downstream to the confluence with the San Joaquin River, and the San Joaquin River through the Delta to San Francisco Bay. FERC noted that based on the potential term of a new license, the temporal scope is 30 to 50 years into the future and any consideration of such future effects should focus on reasonably foreseeable future actions.

The fish and aquatic resources of the lower Tuolumne River are affected by a large number of past, present, and potential future anthropogenic actions and background environmental conditions, both within and outside the Tuolumne River watershed. The primary purposes (i.e., storage and release of flows for irrigation and M&I uses and flood control) of the Don Pedro Project contribute to cumulative effects on fish and aquatic resources in the lower river, including positive effects associated with FERC-required flow releases designed to benefit fall-run Chinook salmon and other fish species. However, because the Proposed Action would have no influence on flows downstream of La Grange Diversion Dam, and Don Pedro Reservoir would exist and continue to exist in the absence of hydroelectric generation, the Proposed Action would not contribute to cumulative effects, positive or negative, on fish and aquatic resources in the Tuolumne River. Other factors that influence fish and aquatic resources in the lower river include water management activities by other entities within and outside the basin, past and present in-river and floodplain mining activities, a variety of historical and current land-use practices, introduced non-native species, and ongoing fisheries management.

The cumulative effects of the Don Pedro Project are attenuated with increasing distance downstream in the Tuolumne River and into the San Joaquin River basin and the Delta. As fall-run Chinook salmon and any Central Valley steelhead that may occur in the lower river migrate farther downstream from the Don Pedro Project, the number and complexity of contributing factors affecting the environment grow considerably, and it becomes increasingly difficult to isolate the specific effects of any individual action from all of the contributing factors affecting individual life stages of these fish.

The cumulative effects assessment for fish and aquatic resources includes an assessment of the degree to which the Don Pedro Project may contribute to the cumulatively affected resources identified by FERC. The number and complexity of co-occurring past, current, and future actions in the Tuolumne River basin make it exceedingly difficult, if not impossible, to meaningfully isolate the specific effects on aquatic resources of each of the numerous past and present individual actions, including the actions of the Don Pedro Project. To the extent that the degree of influence of any individual action on a resource is indeterminate, then the effect of modifying that action is also likely to be indeterminate.

4.4.1 Fish and Aquatic Resources Cumulative Effects Assessment

The following cumulative effects assessment section is organized according to the types of effects resulting from the actions described in Section 4.1. Topics include (1) hydrologic and physical habitat alteration, (2) temperature and water quality, (3) connectivity and entrainment, (4) hatchery propagation and stocking, (5) introduced species and predation, (6) benthic invertebrates and fish food availability, and (7) freshwater harvest. The geographic scope of the assessment, as noted above, includes the Tuolumne River from O'Shaughnessy Dam to its confluence with the San Joaquin River and the San Joaquin River downstream through the Delta.

The Don Pedro Project contributes to cumulative effects to fish and aquatics resources, including fall-run Chinook salmon and Central Valley steelhead, in the lower Tuolumne River and downstream in the San Joaquin River and Delta. Other actions conducted within the Tuolumne River basin that contribute to cumulative effects include (see Section 4.1) CCSF's operations of the Hetch Hetchy system, water diversions at La Grange Diversion Dam, riparian withdrawals by water users, discharge of irrigation return flows, historic and current mining activities, agricultural and urban land uses, the presence of non-native species, and stocking of hatchery salmonids. In addition, ongoing operation of reservoir and diversion facilities in the San Joaquin River and its tributaries, along with an array of other actions (see Section 4.1), also contribute to cumulative effects on aquatic organisms within the analysis area for cumulative effects.

4.4.1.1 Hydrologic and Physical Habitat Alteration

4.1.1.1.35 Lower Tuolumne River

Prior to widespread European settlement, the channel form of the lower Tuolumne River consisted of a combination of single-thread and split channels that migrated and avulsed (McBain & Trush 2000). Variation in hydrologic and geological controls, primarily valley width and the location and elevation of underlying bedrock, resulted in variable and complex localized channel morphologies (McBain & Trush 2000). The riparian corridor was miles wide in places where the river lacked confinement (McBain & Trush 2000). More than a century of cumulative impacts have transformed the lower Tuolumne River from a dynamic, alluvial system capable of forming its own bed and bank morphology to a river highly constrained between either man-made dikes or agricultural fields, or constrained by riparian vegetation that has encroached into the low water channel (McBain & Trush 2000).

Hydrologic Alteration

Over the past 120 years, each increment of flow regulation (Wheaton, La Grange, Dennett, O'Shaughnessy, old Don Pedro, and new Don Pedro dams along the mainstem and dams constructed along tributaries above O'Shaughnessy Dam, including Cherry and Eleanor Creeks) has modified the lower Tuolumne River's flow regime. Historically, Wheaton Dam and the present day La Grange Diversion Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain & Trush 2000). CCSF's Hetch Hetchy Project, the Districts' new Don Pedro Dam, and CCSF's Cherry Lake combined to reduce the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River downstream of La Grange Diversion Dam. Indeed, the ACOE contributed financially to the construction of the new Don Pedro Dam for the purpose of flood control. The resulting reduction in flood-flow frequency attests to the successful implementation of that Don Pedro Project purpose.

Analyses of streamflow records from the USGS gaging station at La Grange (Station 11-289650) reveal the following alterations of hydrologic conditions: (1) the magnitude and variability of summer and winter baseflows, fall and winter storms, and spring snowmelt runoff have been reduced and (2) the magnitude, duration, and frequency of winter floods have been reduced (McBain & Trush 2000). Following completion of the New Don Pedro Dam in 1971, compliance with ACOE flood control and other flow requirements reduced the estimated average annual flood (based on annual maximum series) from 18,400 cfs to 6,400 cfs.

Physical Habitat and Riparian Alteration

Gravel and gold mining, as well as other land uses, adversely affected aquatic habitat prior to the construction of dams on the Tuolumne River (TID/MID 2005) (see Section 4.1.1 for a summary of the chronology of current and historical actions within the defined geographic scope for cumulative effects). The presence of dams, aggregate extraction, agricultural and urban encroachment, and other land uses, including hydraulic mining practices near La Grange, have resulted in imbalances of sediment supply and transport in the lower Tuolumne River channel (McBain & Trush 2000). Don Pedro Dam and La Grange Diversion Dam, combined with other dams upstream of the Project Boundary, trap all coarse sediment and LWD that would otherwise pass downstream. In the lower river, in-channel excavation of bed material to depths well below the river thalweg for gold and aggregate has significantly reduced available spawning habitat, eliminated active floodplains and terraces, and created large in- and off-channel pits that provide favorable habitat for non-native predator species.

The cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses has altered the channel downstream of La Grange Diversion Dam (CDWR 1994; McBain & Trush 2004). Sequences of historical photos show that channel corridor width has been progressively reduced by land use (McBain & Trush 2000). Sediment model simulations indicate that without gravel augmentation, the channel bed from RM 52 to 39.7 would undergo a slow loss of gravel and coarsening (armoring) in response to the reduction in coarse sediment supply (TID/MID 2013f). Gravel augmentation, however, has helped to increase coarse sediment storage in this area (TID/MID 2013f). The rate of current gravel transport compared to the stores of gravel in this reach is low and little change in overall gravel availability is expected to occur over the next license term.

Large in-channel pits (SRPs) were created where sand and gravel aggregate were extracted. Historical deposits of dredger tailings (RM 50.5–38.0) confined the active river channel, preventing sediment recruitment that would otherwise have resulted from the normal process of channel migration (McBain & Trush 2000). Under current conditions, channel migration has been substantially curtailed.

More recent aggregate mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Roberts Ferry Bridge (RM 39.5). Floodplain and terrace pits in this reach are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. The January 1997 flood caused extensive damage to dikes separating deep gravel mining pits from the river, breaching or overtopping nearly every dike along a 6-mile-long reach (TID/MID 2011).

Most woody debris captured in Don Pedro Reservoir is small, and it appears that the majority of it would pass through the lower river during normal high flows if it were not trapped in the reservoir (TID/MID 2013e). The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 feet, and woody debris would have a limited effect on channel morphology in this reach (TID/MID 2013e).

Historical clearing of riparian forests in the Tuolumne River basin modified vegetation and associated habitat, halting many attendant ecosystem processes (Katibah 1984, Naiman et al. 2005). Urban and agricultural encroachment and mining have resulted in the direct removal of large tracts of riparian vegetation in the lower Tuolumne River corridor. Livestock selectively graze younger vegetation, which limits the establishment of riparian plants (McBain & Trush 2000). Clearing woody plant cover has also created openings in the riparian corridor where non-native plant species have become established and proliferated (McBain & Trush 2000). Land conversion and levee construction that constrained channel migration, including alteration of meander bends and cutoff/oxbow formations, have reduced riparian complexity (McBain & Trush 2000, Grant et al. 2003).

Mining has also substantially altered riparian conditions along the lower Tuolumne River. Aggregate mining leaves large pits in the floodplain, converting floodplain vegetation to open water. Levees built to isolate mining pits from the river constrain lateral movement of the river (TID/MID 2013b). These activities preclude regeneration of riparian vegetation by eliminating habitat and limit lateral movement of the river, reducing the amount and diversity of riparian habitat surfaces (TID/MID 2013b). Dredger tailings of unconsolidated sediments on the floodplain have replaced rich soils with poor ones, resulting in changes in riparian species composition and a reduced extent and diversity of riparian vegetation (TID/MID 2013b). The reduced development of riparian vegetation on dredger spoil piles has diminished riparian habitat connectivity (TID/MID 2013b).

Flow regulation and sediment trapping associated with upstream dams indirectly affected riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian vegetation. As noted above, each increment of flow regulation (La Grange Diversion Dam, O'Shaughnessy Dam, Old Don Pedro Dam, New Don Pedro Dam) successively reduced the magnitude, duration, and frequency of flood flows, and removed key mortality agents, including scour, channel migration, flood-induced toppling, and inundation (McBain & Trush 2000). In some areas, reduced flood scour has allowed riparian vegetation to encroach along the low water channel, where historically vegetation would have been absent. In other areas, as noted above, the legacy of impacts has altered the structure of the floodplain and reduced the potential for establishment.

The lateral extent of riparian vegetation along the Tuolumne River remains greatly diminished from what it was prior to large-scale settlement along the river. Currently, less than 15 percent of the historical riparian forests remain along the Tuolumne River (McBain & Trush 2000). However, over the past 15 years the areal extent and location of lands dominated by non-native plants has actually decreased (TID/MID 2013b). Overall, the 52-acre average of native riparian vegetation per river mile is slowly changing, with a 419-acre increase in the net extent of native vegetation between 1996 and 2012 (an average increase of about 8 acres/mile), assisted by active restoration projects (TID/MID 2013b).

Effects on Salmonids

Anadromous fish abundance in the Tuolumne River has been reduced by habitat degradation and extensive instream and floodplain mining beginning in the mid-1800s (McBain & Trush 2000). Dams and water diversions associated with mining had affected fish migration as early as 1852 (Snyder 1993 unpublished memorandum, *as cited* in Yoshiyama et al.1996). Access to historic spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 near the site of the present-day La Grange Diversion Dam, was a barrier to salmon migration. In 1884, the California Fish and Game Commission reported that the Tuolumne River was "dammed in such a way to prevent the fish from ascending" (California Fish and Game Commission 1884, *as cited* in Yoshiyama et al. 1996).

During their upstream migration, Tuolumne River flows may affect homing of Tuolumne River origin Chinook salmon, and may also affect straying of salmonids from other rivers into the Tuolumne River (TID/MID 2013c).

Studies conducted in the Tuolumne River indicate that a lack of spawning gravel and curtailed sediment recruitment, due to in-river and floodplain mining, trapping by upstream dams, and other land uses, may result in density-dependent competition and exclusion from suitable spawning sites and may limit the number of female Chinook salmon that successfully spawn in the lower Tuolumne River (TID/MID 1992, Appendix 6; TID/MID 2000, Report 1999-1; TID/MID 2001, Report 2000-1). Model simulations indicate that Chinook salmon are limited by spawning habitat availability only at high spawning densities (TID/MID 2013k). Upstream reaches affected by gold dredger mining in the early part of the century (RM 50–47) were "reconfigured" following removal of dredger tailings for construction of the new Don Pedro Dam and this reach currently supports the majority of Chinook salmon spawning activity (TID/MID 2013c). Due to higher channel gradient, overbank habitats in this reach do not provide the same relative benefits as other river floodplain habitats studied in lowland portions of the Central Valley (Stillwater Sciences 2012a). Further, the remnant dredger pits and multiple connected backwaters along the lower Tuolumne River have been identified as an area of potential juvenile Chinook stranding (TID/MID 2001) and may actually create favorable habitat for predator species (Stillwater Sciences 2012a).

Although there is the potential for Chinook redd scouring to occur during flood events, minimum spawning flows required by FERC have reduced the risk of redd dewatering (TID/MID 2013c). The risk of mortality due to redd scour, redd dewatering, and entombment is expected to be low in the Tuolumne River due to current operations and reduced fine sediment supply (TID/MID 2013c). Egg displacement and mortality resulting from redd superimposition of spawning steelhead is not expected to occur in the Tuolumne River at current spawner levels (TID/MID 2013c).

Because current Don Pedro Project operations do not include power peaking, potential risk of juvenile Chinook salmon and *O. mykiss* stranding and entrapment are low. Some stranding may occur during flow reductions following flood control releases; however, the low frequency of these flood events in combination with ramping rate restrictions required by the current FERC license likely result in a low risk of fish mortality due to stranding and entrapment (TID/MID 2013c). A comprehensive evaluation of stranding surveys was conducted on the lower Tuolumne River (TID/MID 2000, Report 2000-6) and is summarized in the 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs, i.e., the range of flows under which the floodplain is inundated in several areas of the Chinook spawning reach.

Floodplain access for rearing juvenile Chinook salmon is limited in the lower Tuolumne River due to flows and habitat modification. Based on analysis of historical inundation mapping, the majority of floodplain habitat available at flows ranging from 1,000–5,000 cfs is limited to several disturbed areas between RM 51.5 and RM 42 that were formerly overlain by tailings (Stillwater Sciences 2012a).

Although increased structure has been shown to reduce territory size that must be defended (Imre et al. 2002) and improve steelhead feeding opportunities (Fausch 1993), it is unlikely that the alluvial portions of the Tuolumne River downstream of La Grange Diversion Dam historically supported the large wood or boulder features that are more typically found in high gradient streams of the Central Valley and along the coasts of California and Oregon (TID/MID 2013c), so it is unclear to what degree LWD retention by upstream dams has contributed to adverse habitat effects in the lower river. Although LWD provides habitat for salmonids in some systems, there are no data available for the Tuolumne River or neighboring Merced River that specifically address the role of LWD on salmonid abundance (TID/MID 2013e). Of the 121 locations within the W&AR-12 study reach where LWD was recorded, about 80 percent of it was located in or adjacent to runs or pools, which are not typically the preferred habitat of juvenile or adult *O. mykiss* in the lower Tuolumne River. Because most LWD in the lower Tuolumne River is partially or wholly out of the channel, and due to its small size, it does not provide significant cover for fish, which in turn limits its value as protection from avian and aquatic predators. Due to its generally small size, location, and lack of complexity, most LWD from RM 52 to 24 provides little habitat value for *O. mykiss*.

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

4.1.1.1.36 San Joaquin River and Delta

Flows in the San Joaquin River and its tributaries, combined with flow diversions at the SWP and CVP water export facilities, may affect homing of Tuolumne River-origin Chinook salmon during their upstream migration (TID/MID 2013c). Homing fidelity of Chinook salmon to their natal streams is related to the sequence of olfactory cues imprinted during rearing and outmigration, so attraction flows and entrainment of flows into the SWP and CVP may affect the numbers of Chinook salmon returning to the Tuolumne River. However, other than the broad relationships between Vernalis flows, water exports at the SWP and CVP facilities, and subsequent recoveries of hatchery-reared, code-wire-tagged fish recovered in Sacramento and San Joaquin River basin hatcheries (Mesick 2001), the relationship between San Joaquin River tributary homing and attraction flows remains poorly understood. Although almost no upstream migrant steelhead have been documented in either historical or present day monitoring in the Tuolumne River, flows in lower San Joaquin River tributaries and flows entrained by the SWP and CVP water export facilities could also affect homing of any Central Valley steelhead originating in the Tuolumne River (TID/MID 2013c). Flow alterations may also affect straying of salmonids from other rivers into the Tuolumne River (TID/MID 2013c).

The extent of historical flooding in Central Valley rivers was vast (Kelley 1989), and the timing of Chinook salmon outmigration would have allowed juveniles to exploit habitats provided by prolonged periods of floodplain inundation. Reductions in wetland and floodplain habitats in the lower San Joaquin River and South Delta, and changes in tributary flow magnitudes and timing, have reduced access to Delta floodplain habitats used by rearing and emigrating Chinook salmon from the Tuolumne River (Whipple et al. 2012; TID/MID 2013c).

Few locations in the eastern and central Delta provide suitable habitat for rearing salmonids (TID/MID 2013c). Because extended periods of floodplain inundation do not occur in most areas of the lower San Joaquin River and Delta, except as the result of large flood control releases from tributaries, it is likely that changes in Delta habitats have affected the number and growth of rearing Chinook salmon and steelhead smolts, resulting in a reduction in the number and size of smolts entering the ocean and potential reduction in ocean survival (TID/MID 2013c). However, winter inundation of some flood bypasses and floodplains along the lower portions of some San Joaquin River tributaries still provides some juvenile Chinook salmon rearing habitat (Feyrer et al. 2006; Sommer et al. 2001; Sommer et al. 2005; Moyle et al 2007). Although the Delta has generally been considered an outmigration corridor for steelhead, active feeding of juvenile steelhead has been documented in the Yolo bypass during flood conditions in some years (USBR 2008), suggesting that loss of historical floodplain habitat access in the Delta may have effects on steelhead rearing and subsequent smolt emigration.

The Delta is interlaced with hundreds of miles of waterways, and relies on more than 1,000 miles of levees for protection against flooding (Moore and Shlemon 2008). These levees have eliminated the majority of tidally exchanged marsh habitats in the Delta (Whipple et al. 2012), areas historically used as nursery areas for a variety of Delta fish species (Kimmerer et al. 2008), and few locations in the eastern and central Delta now provide suitable habitat for rearing Chinook salmon. The combined effects of continued land subsidence, rising sea level, increased seismic risk, and increased winter flooding increase the vulnerability of the extensive Delta levee system, which can result in degradation of water quality and exposure of habitat adjacent to islands to increased seepage and wave action (CDWR et al. 2013). Much of the rich Delta farmland has lost soil from oxidation, compaction, and wind erosion, resulting in lowered elevations of some islands, in some cases up to 25 ft below sea level.

Measures have been undertaken to address conditions for migratory salmonids in the lower San Joaquin River and Delta. The results of south Delta survival studies indicate that installation of the Head of Old River Barrier (HORB) increases salmon smolt survival through the Delta by 16 to 61 percent (TID/MID 2013c) (see also Temperature and Water Quality, below).

Non-salmonid special status fish species affected by flow and habitat modification in the lower San Joaquin River and/or Delta include the Sacramento splittail (*Pogonichthys macrolepidotus*), hardhead (*Mylopharodon conocephalus*), Sacramento-San Joaquin roach (*Lavinius symmetricus symmetricus*), and delta smelt (*Hypomesus transpacificus*). Historically, Sacramento splittail inhabited sloughs, lakes, and rivers of the Central Valley, with populations extending upstream to Redding in the Sacramento River, to Butte Creek/Sutter Bypass, to Oroville in the Feather River, to Folsom in the American River, and to Friant in the San Joaquin River (Moyle et al. 2004). Their current distribution is limited by dams and other barriers, and the species is largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa River, Petaluma River, and other parts of the Sacramento-San Joaquin estuary (Moyle 2002). Historically, hardhead were widely distributed and locally abundant in the Central Valley. Their specialized habitat requirements coupled with widespread alteration of downstream habitats have resulted in population declines and isolation of populations (Moyle 2002). The Sacramento-San Joaquin roach, although abundant in a large number of streams, is now absent from a number of streams and stream reaches where it once occurred (Moyle 2002). The Delta smelt has been adversely affected by entrainment into the SWP and CVP (CDWR et al. 2013) and habitat and flow alteration in the Delta.

4.4.1.2 Water Quality

4.1.1.1.37 Water Temperature

The effects of impoundments on water temperatures in the Tuolumne River are discussed in detail in Section 4.3.2.1 of Exhibit E. Water temperature conditions in the lower Tuolumne River are unlikely to result in mortality of upstream migrant adult salmonids, either directly or as the result of increased susceptibility to pathogens (TID/MID 2013c). No evidence of Chinook salmon pre-spawning mortality has been identified in the lower Tuolumne River (TID/MID 2013c), and no instances of water temperature related mortality of any fish species have been observed in the lower Tuolumne River (TID/MID 2013c). Because the majority of adult Central Valley steelhead migration occurs from November through March, when water temperatures are low, temperature-related effects on steelhead arrival timing and pre-spawn mortality are unlikely (TID/MID 2013c) in the Tuolumne River (although the vast majority of *O. mykiss* in the lower Tuolumne River display a resident life history). Fall-run Chinook adults must first traverse the much warmer waters of the Delta and San Joaquin River before encountering the Tuolumne River, which has significantly cooler temperatures during the late September through November peak migration periods than these downstream reaches.

Based on assessments of seasonal water temperatures and typical spawning periods, fall-run Chinook salmon in San Joaquin River basin tributaries are unlikely to encounter unsuitable water temperatures leading to reduced egg viability (TID/MID 2013c), and Myrick and Cech (2001) suggested that only the earliest spawners arriving in San Joaquin River basin tributaries during September might encounter unsuitable temperatures. Intragravel water temperatures measured during February and March 1991 at several locations in the lower Tuolumne River ranged from 11 to 15°C (TID/MID 1997, Report 96-11), indicating that water temperature conditions are suitable for Chinook salmon egg incubation.

Rotary screw trap data indicate that two juvenile outmigration life-history strategies exist for Tuolumne River fall-run Chinook salmon: winter outmigration of fry in January-February and spring outmigration of subyearling smolts (>70 mm) from April-June. In all years, water temperatures remain well below the incipient lethal limit (25°C) during winter fry outmigration. In most years, water temperatures for spring outmigrants remain below incipient lethal temperatures, although temporally isolated events of high water temperature can occur. In general, flow releases resulting from the 1996 FERC Order help maintain appropriate water temperatures during Chinook salmon rearing and emigration.

The Central Valley steelhead spawning period extends from December through April and peaks in February and March, so if the lower Tuolumne River had a steelhead run, water temperature would be unlikely to adversely affect spawning success (TID/MID 2013c). However, available information indicates that juvenile *O. mykiss* rearing habitat may potentially be limiting in the lower Tuolumne River during summer due to a combination of high water temperatures and potential territorial interactions with *O mykiss* of older age classes (TID/MID 2013c). Increased densities and downstream distribution of juvenile *O. mykiss* have been documented since implementation of increased summer baseflows under the 1996 FERC Order, and during years with extended flood control releases (TID/MID 2013c).

Because adult resident *O. mykiss* are generally found in upstream habitats year-round (Stillwater Sciences 2012b), temperature related mortality is unlikely to occur in the lower Tuolumne River. It is unknown, however, whether adverse temperature effects occur during potential smolt emigration that would occur late in the spring (TID/MID 2013c). Increased summer baseflows and stable summer temperatures in the Tuolumne River since 1996 appear to select for a largely resident *O. mykiss* life history (TID/MID 2013c).

Water temperature in the lower San Joaquin River and Delta are unlikely to result in direct mortality of upstream migrating adult Chinook salmon and steelhead or increased susceptibility to disease (TID/MID 2013c). However, there are periods when elevated water temperatures in the lower San Joaquin River and Delta likely have substantial effects on juvenile salmonids. Baker et al. (1995) showed that water temperature explains much of the variation in Delta smolt survival studies from 1983–1992 (TID/MID 2013c). By examining the relationship between water temperature in the Delta and predation-related mortality, it is clear that high water temperatures reduce juvenile Chinook salmon survival in the Delta (Williams 2006). Temperatures of 25°C associated with increased salmonid mortality (Myrick and Cech 2001) routinely occur in the south Delta. However, suitable water temperatures for smolt emigration in the range of 18 to 21°C exist at Vernalis as late as mid-May in most years, and it is likely that Delta conditions are suitable for smolt emigration as late as June in some years. Unsuitable temperature conditions in excess of 25°C are likely exceeded at Vernalis by late June in most years, limiting successful emigration or any salmonid rearing in the Delta during summer (TID/MID 2013c).

4.1.1.1.38 Dissolved Oxygen

Measurements of water column and intragravel DO in artificial Chinook salmon spawning redds (TID/MID 2007, Report 2006-7) indicate that water quality conditions in the lower Tuolumne are generally suitable during the egg incubation period.

In the lower San Joaquin River, beginning in the 1960s, CDFW documented potentially adverse effects of low DO levels on adult salmon. Hallock et al. (1970) documented that low DO areas in the Delta blocked adult Chinook salmon upstream migration into the San Joaquin River. More recent water quality data and literature reviews by Newcomb and Pierce (2010) indicate that low DO at Stockton may adversely affect adult anadromous salmonids in September and October during the upstream migration period and juvenile anadromous salmonids in June during the downstream migration period. Chinook salmon are considered more likely to be exposed to low DO levels than steelhead because peak migration for steelhead occurs outside of the months with low DO. For juvenile salmonids, literature reviews by Newcomb and Pierce (2010) suggest that low DO levels can lead to decreased swimming performance, reduced growth, impaired development, and increased susceptibility to predation, pathogens, and contaminants.

Periods of low DO concentrations observed in the Stockton DWSC in the summer and fall months upstream of Turner Cut show that this portion of the lower San Joaquin River does not meet Central Valley Basin Plan (Basin Plan) water quality objectives for DO (5 mg/l December - August and 6 mg/l September -November) (ICF International 2010). In 2008, the Department of Water Resources implemented the Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Aeration Facility Project (Aeration Facility) to increase DO levels and thereby potentially reduce adverse effects on migrating anadromous salmonids (Newcomb and Pierce 2010).

Testing showed that operating strategies for the Aeration Facility can be developed for a range of DWSC flows, depending on inflowing DO and biological oxygen demand (BOD) concentrations (ICF International 2010). At times, water column BOD exceeds the capacity of the Aeration Facility to help meet the DO objective in some portions of the DWSC. Evaluating fisheries data over time will allow researchers to assess trends in Chinook salmon and steelhead populations and the respective timings of their upstream migration runs. If populations increase and fish begin to arrive in the San Joaquin River earlier, it will be reasonable to infer that low DO is no longer a considerable stressor for migrants in the DWSC (Newcomb and Pierce 2010).

Water quality monitoring was conducted on the San Joaquin River from Mossdale Crossing to Turner Cut to assess the benefit of installing the Head of Old River Barrier (HORB) (Brunell et al. 2010). The HORB is installed by CDWR in conjunction with reservoir releases to increase flow and DO concentrations in the DWSC for migrating fall Chinook salmon; these practices can temporarily increase DO. Since 2000, DO levels in the DWSC have been observed to increase about 2 to 3 mg/l with the increased DWSC flows associated with the placement of the HORB (Brunell et al. 2010). However, low DO may recur after removal of the HORB following the spring pulse flow releases from the San Joaquin River's tributaries (Brunell et al. 2010). However, the response of DO in the DWSC is complex and difficult to predict solely by flow management; other factors, such as BOD (see above) and temperature, also influence DO.

4.1.1.1.39 <u>Nutrients and Contaminants</u>

Shoreline protection measures at Don Pedro Reservoir, including prohibition of shoreline disturbances and off-road vehicle use on Don Pedro Project lands, may benefit reservoir water quality, which could translate into limited downstream water quality benefits. There is no evidence that regulated herbicide and pesticide applications near Don Pedro Reservoir have adverse effects on water quality, and as a result aquatic biota, in the lower Tuolumne River.

The CDPR has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of the Central Valley and Delta (Werner et al. 2008). Six pesticides were detected in runoff from agricultural and urban areas during a study conducted in the lower Tuolumne River, and chlorpyrifos, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998). Peak diazinon concentrations measured in the lower Tuolumne River have frequently exceeded levels that can be acutely toxic to some aquatic organisms (Dubrovsky et al. 1998). Like the Tuolumne River, agriculture is the primary land use adjacent to the Merced River downstream of the Crocker-Huffman Diversion Dam, where agricultural chemicals have the potential to affect water quality and aquatic resources primarily through water returns to the river. The return water often contains pollutants, which affect fish, BMI, and other aquatic species.

Reduction in flows in the San Joaquin River, particularly between Gravelly Ford Canal and the Merced River, has increased the concentration of pesticides and fertilizers in the river, which has contributed to pollution that has impacted aquatic species (Cain et al. 2003). Hundreds of agricultural and urban drains discharge into the San Joaquin River downstream of the Merced River confluence, many of which are also designated as impaired water bodies, such as the Harding Drain, the Grayson Drain, the Newman Wasteway, and the Westley Waterway (SWRCB 2010). The San Joaquin River has been identified by the SWRCB as an impaired water body for arsenic, boron, dacthal, *Escherichia coli* (*E. coli*), dichloro-diphenyl-dichloroethylene (DDE), mercury, temperature, selenium, electrical conductivity, and several pesticides, both upstream and downstream of the Merced River confluence.

The flow of subsurface drainage water from intensively irrigated agricultural land on the west side of the San Joaquin Valley into the San Joaquin River has created a well-known water salinity and specific ion (selenium and boron) problem in the river. The flow of water from the Tuolumne River (and the Merced and Stanislaus rivers) dilutes and improves the overall water quality, including the salinity level, of the San Joaquin River as it moves downstream toward the Delta.

Discharge of nutrients such as nitrogen and phosphorus from non-point runoff of agricultural fertilizer and point sources, such as water treatment facilities, stimulates algae growth, with attendant increases in the magnitude of diurnal DO variation. This has caused changes in the food webs of the San Joaquin River and Delta (Durand 2008), and as a result food availability for Delta fish populations (TID/MID 2013c). Large numbers of pesticides are used on lands upstream of and within the Delta (Brown 1996, Kuivala and Foe 1995), and they have been shown to inhibit olfactory-mediated alarm responses in salmonids (Scholz et al. 2000). However, it is unknown whether pesticide levels in Delta waters affect rearing or out-migrating Chinook salmon or steelhead juveniles, and no studies of predation related mortality due to chemical contaminants are available for the Central Valley rivers (TID/MID 2013c).

A range of literature sources suggests that early life history exposure to trace metals, herbicides, and pesticides may impair olfactory capabilities required for homing sensitivity in salmonids

(Hansen et al. 1999, Scholz et al. 2000, Tierney et al. 2010), which could affect arrival of adult steelhead in their natal streams. However, olfactory impairment of Central Valley steelhead has not been documented in the Tuolumne or other Central Valley rivers (TID/MID 2013c).

4.4.1.3 Connectivity and Entrainment

4.1.1.1.40 Upstream Migration Barriers

Dams throughout the San Joaquin River and its tributaries are barriers to upstream migration of anadromous salmonids and other migratory fish species. Dams and water diversions associated with mining adversely affected fish migration in the Tuolumne River as early as 1852 (Snyder 1993 unpublished memorandum, *as cited* in Yoshiyama et al.1996). Access to historic spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 at the site of present-day La Grange Diversion Dam (RM 52.2), was a barrier to salmon and steelhead migration, and in 1884, the California Fish and Game Commission reported that the Tuolumne River was "dammed in such a way to prevent the fish from ascending" (California Fish and Game Commission 1884, *as cited* in Yoshiyama et al. 1996). Currently, La Grange Diversion Dam is a complete barrier to upstream migration of fall-run Chinook, any Central Valley steelhead that occur in the lower Tuolumne River, and other migratory fish species.

4.1.1.1.41 Entrainment

Anadromous fish downstream of the diversion dam are subject to entrainment in numerous intakes along the river. Irrigation withdrawals for frost protection at diversions along the lower reaches of the Tuolumne River are rare during the Chinook salmon in-river rearing period (TID/MID 2013c). Therefore, significant mortality due to entrainment of juvenile Chinook in the lower Tuolumne River is considered unlikely (TID/MID 2013c). It is unknown to what extent these diversions affect resident native and non-native fish.

Juvenile salmonid entrainment and increased exposure to predation occur at major diversion facilities on the lower San Joaquin River and in the Delta. Although entrainment in smaller irrigation diversions has not been well quantified, entrainment related mortality in the SWP and CVP export facilities is considered to be a major source of mortality for rearing and out-migrating Chinook salmon and steelhead juveniles, with effects on the number of Chinook recruits to the ocean fishery and effects on long-term population levels of steelhead.

Based on paired releases of tagged Chinook salmon in the Clifton Court forebay of the SWP, Gingras (1997) estimated pre-screen mortality to be between 63 and 99 percent. Clark et al. (2009) estimated pre-screening mortality of steelhead to be between 78 and 82 percent. Fish entrained in the Clifton Court forebay experience stress and may undergo physical damage during salvage operations (TID/MID 2013c), and salvage losses of Chinook salmon entrained into the SWP and CVP increase with increasing export flows (TID/MID 2013c).

4.4.1.4 Hatchery Propagation and Stocking

Recent studies have increasingly demonstrated potentially adverse effects of hatchery-reared fish on co-occurring wild stocks with which they may interact via interbreeding, competition, or predation. An issue of concern is genetic introgression of hatchery stocks with “natural” stocks, resulting in a decrease in the biological fitness of the natural stocks (e.g., ISAB 2003, Berejikian and Ford 2004, Kostow 2004, Araki et al. 2007, Lindley et al. 2007, CDFG and NMFS 2001).

Hatchery-origin fish represent a large proportion of the Central Valley fall-run Chinook salmon harvest (TID/MID 2013c). Although the proportion of adipose-fin-clipped Chinook salmon identified as originating from hatcheries has been historically low in Tuolumne River spawning surveys, this proportion has increased dramatically from the 1990s to the present (TID/MID 2005; Mesick 2009; TID/MID 2012, Report 2011-8). Recent estimates of the composition of Chinook salmon escapement indicate that up to 50 percent of the escapement to the Tuolumne River is made up of hatchery-produced salmon from other rivers (Merced Irrigation District 2012). In the Central Valley as a whole, it is estimated that hatchery production has provided over half of the Central Valley harvest and escapement of salmon in some years (CDFG and NMFS 2001). Barnett-Johnson et al. (2007) recently estimated that only 10 percent of Central Valley Chinook salmon captured in the ocean troll fishery were not raised in a hatchery setting. Assuming roughly equivalent survival of hatchery- and natural-origin fish from the fishery to the spawning grounds, these results imply that up to 90 percent of annual escapement could consist of hatchery reared fish (TID/MID 2013c).

Facilities that produce anadromous fish whose life histories could overlap temporally or spatially with Tuolumne River anadromous salmonids include the Feather River Hatchery (spring and fall-run Chinook and steelhead), Nimbus Hatchery (fall-run Chinook and steelhead), Mokelumne River Hatchery (fall-run Chinook and steelhead), Merced River Hatchery (fall-run Chinook), and the Coleman National Fish Hatchery, a federal facility that produces fall-run Chinook (ICF Jones & Stokes 2010). Fish from the Merced and Mokelumne hatcheries, because of the proximity of these facilities to the Tuolumne River, may be more likely than fish from other facilities to stray into the lower Tuolumne River, and thereby contribute to cumulative adverse effects on aquatic resources, primarily anadromous salmonids.

To provide more accurate estimates of the proportions of hatchery reared and naturally produced Chinook salmon in Central Valley rivers, a Constant Fractional Marking (CFM) Program was initiated by the Pacific States Marine Fisheries Commission in spring 2007, with an adipose fin clip and coded-wire tag applied to at least 25 percent of the fish released from 2007 through 2012 (Buttars 2011). Although the Merced River Fish Facility does not participate in the CFM Program, observations of adipose-fin-clipped salmon have steadily risen in the Merced, Tuolumne, and Stanislaus rivers since 2007, reflecting a higher proportion of adipose-fin-clipping at the participating hatcheries[18]. Natural and hatchery contributions to historical escapements are not available prior to the CFM years (Newman and Hankin 2004).

[18] Hatcheries participating in the PFMC CFM Program include the Coleman National Fish Hatchery, Feather River Hatchery, Feather River Hatchery Annex, Nimbus Hatchery, and Mokelumne River Hatchery.

In the absence of appropriate hatchery management practices, hatcheries may select for early run timing by spawning a disproportionately higher percentage of earlier returning fish (Flagg et al. 2000), resulting in reduced spawning success (TID/MID 2013c). There is, however, no evidence that the introduction of hatchery fish has altered the run timing of Chinook salmon in the Tuolumne River. Although the proportion of hatchery-origin Chinook salmon in Tuolumne River spawning runs has increased in recent years, size-at-return does not appear to have decreased in response to hatchery introgression for the period 1981–2010, suggesting that any hatchery influences on Tuolumne River spawner fecundity and spawning success are minor (TID/MID 2013c).

Genetic analyses suggest that the majority of Central Valley steelhead stocks have been genetically introgressed by hatchery-produced ancestors, particularly from shared out-of-basin broodstocks (Eel River and American River) used at the Nimbus and other hatcheries (Garza and Pearse 2008). Lindley et al. (2007) suggest that hatchery introductions have altered the genetic structure of salmonid populations in the Central Valley. Although hatchery straying likely affects the number of steelhead spawning in the lower Tuolumne River, the absence of basin-specific data on spawning or straying from out-of-basin hatcheries makes it difficult to estimate the proportion of hatchery-origin steelhead that may spawn in the lower Tuolumne River (TID/MID 2013c). However, based on the low numbers of steelhead relative to resident *O. mykiss* documented in otolith analyses in the Tuolumne River (Zimmerman et al. 2009), it is likely that any effects of hatchery-origin fish would primarily be on resident *O. mykiss* (TID/MID 2013c).

Hatchery Genetic Management Plans (HGMPs) are being prepared pursuant to Section 7 of the ESA for salmon and steelhead hatcheries in California to guide the propagation of Chinook salmon and steelhead. The goal of the plans is to prevent adverse impacts on the genome of federally-listed fish and any potential effects of stocking on the size, abundance, run-timing, and distribution of wild fish.

4.4.1.5 Introduced Species and Predation

Predation on native salmonids by non-native predators introduced to the lower Tuolumne River is influenced by channel modifications that have created habitats favorable to non-native piscivores. Inter-annual variations in flows and water temperatures have been associated with variations in river-wide predator distribution (Ford and Brown 2001) and year-class strength in multi-year surveys conducted as part of the SRP 9 habitat restoration project at RM 25.7 (McBain & Trush and Stillwater Sciences 2006).

High levels of predation related mortality have been documented in direct surveys by the Districts, in multi-year Chinook smolt survival tests, and by comparisons of upstream and downstream smolt passage at rotary screw traps (TID/MID 2013c). Apparent variations in the relationship between spring flows and Chinook smolt passage (Mesick et al. 2008) and subsequent adult Chinook escapement (TID/MID 1992; Speed 1993; TID/MID 1997, Report 96-5; Mesick and Marston 2007; Mesick et al. 2008) suggest that predation, primarily by introduced fish species, is a major source of salmonid mortality, with effects on long-term population levels in the Tuolumne River (TID/MID 2013c). Studies conducted in the lower Tuolumne River identified 12 fish species that potentially prey on Chinook salmon fry and juveniles, but largemouth, smallmouth, and striped bass (all of which are introduced species) are the primary predators (TID/MID 1992, TID/MID 2013g).

Average consumption rates of juvenile Chinook salmon (i.e., number of Chinook salmon per predator) by largemouth and smallmouth bass in the lower Tuolumne River (not scaled by gastric evacuation rates) ranged from 0–0.20 during the 2012 predation study (TID/MID 2013g) and from 0–1.7 in an earlier study conducted by the Districts (TID/MID 1992). In 2012, predation rates averaged for all habitat types and sampling events were 0.07 Chinook salmon per largemouth bass per day and 0.09 per smallmouth bass per day. Striped bass predation rates in the lower river were generally higher than those of smallmouth bass and largemouth bass (TID/MID 2013g). In 2012, predation rate averaged for all habitat types and sampling events was 0.68 Chinook salmon per striped bass per day.

Largemouth bass and smallmouth bass were estimated to have consumed about 37 percent and 49 percent, respectively, of the total potential juvenile Chinook salmon consumed by the three primary non-native predator species (i.e., largemouth bass, smallmouth bass, and striped bass). Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to have consumed nearly 15 percent of the total potential juvenile Chinook salmon consumed by the three predator species. There was no evidence of consumption of Chinook salmon by Sacramento pikeminnow during either the 2012 study or the Districts' previous study (TID/MID 1992).

A conservative estimate of the total consumption of juvenile Chinook salmon by striped, largemouth, and smallmouth bass is about 42,000 during March 1-May 31, 2012 based on observed predation rates and estimated predator abundance. This suggests that nearly all juvenile Chinook salmon may be consumed by introduced predators between the Waterford and Grayson rotary screw traps. Only 2,268 Chinook salmon were estimated to have survived migration through the 25 miles between the screw-trapping sites (Robichaud and English 2013) during January through mid-June, making it plausible that most losses of juvenile Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 can be attributed to predation by non-native piscivorous fish species.

No data exist to document the degree of piscine or avian predation on juvenile *O. mykiss* in the lower Tuolumne River. However, piscine predation risk is probably low because *O. mykiss* distribution during summer is generally restricted to cool water locations upstream of Roberts Ferry Bridge (RM 39.5), and piscine predators are found mostly downstream of this reach (Brown and Ford 2002). In addition to this habitat segregation, the larger body size of adult *O mykiss* limits their risk to predation, so mortality is most likely limited to Age 0+ fish during water-year types with low flows and warmer temperatures that allow predators to move upstream (TID/MID 2013c).

Predation in the lower San Joaquin River, Delta, and at the SWP and CVP export facilities is considered a primary cause of mortality for Chinook salmon, with effects on long-term population levels (TID/MID 2013c). The SWP and CVP facilities create lentic habitats that support the persistence of non-native fish species. Delta water exports, in combination with non-native species introductions, have resulted in dramatic changes in the Delta fish species assemblage, with numerous predatory fish species benefitting from current Delta hydrology (Lund et al. 2007). It is likely that predation has its greatest impact on Chinook salmon populations in the lower San Joaquin River and Delta when juveniles and smolts out-migrate in large concentrations during the spring through the lower reaches of rivers and estuaries on their way to the ocean (Mather 1998). Based on review of available information, predation in the lower San Joaquin River and Delta, as well as predation related mortality in the Clifton Court forebay of the SWP and CVP water export facilities, are key factors affecting the numbers of Chinook salmon recruited to the ocean fishery (TID/MID 2013c). For Chinook salmon outmigrants from the Tuolumne River, increased flows at Vernalis have been shown to reduce predation related mortality, but the relationship is highly dependent on the presence of the HORB (TID/MID 2013c).

Avian and pinniped (seals and sea lions) predation on juvenile Chinook salmon have been documented in San Francisco Bay (Evans et al. 2011) and along the California coast (Scordino 2010), respectively, and it is likely that at least avian predation occurs to some extent in or near the Delta as well. Whether and to what extent such predation is mediated by anthropogenic influences in the region is unknown.

Predation on juvenile salmonids is not the only adverse effect associated with introduced species. Introduced zooplankton species and the overbite clam (*Corbula amurensis*) in the lower Tuolumne and San Joaquin rivers (Brown et al. 2007) may have affected the availability of suitable prey for rearing salmonids (see also, Benthic Invertebrates and Fish Food Availability, below).

Predation also affects non-salmonid native fish species in the San Joaquin River and its tributaries. Predation on hardhead by smallmouth bass has resulted in population declines and isolation of populations (Moyle 2002). Hardhead have at times been abundant in reservoirs. However, most of these reservoir populations have proved to be temporary, presumably the result of colonization of the reservoir by juvenile hardhead before introduced predators became established. Brown and Moyle (1993) found that hardhead tend to disappear from water bodies following colonization by bass.

4.4.1.6 Benthic Invertebrates and Fish Food Availability

Analysis of historical drift samples and stomach contents of rearing juvenile Chinook salmon indicates that there are adequate food resources for juvenile rearing in the Tuolumne River (TID/MID 2013c), and analysis of long-term Hess sampling data gathered from 1988–2009 at Riffle 4A (RM 48.8) indicates that increased summer flows since 1996 have resulted in beneficial shifts in the invertebrate food supply of fishes. Overall invertebrate abundances in Riffle 4A samples declined slightly from 1996 to the present. However, community composition shifted away from pollution-tolerant invertebrate taxa and toward those with higher food value for juvenile salmonids and other fish (TID/MID 2010, Report 2009-7).

A number of factors affect aquatic food sources available to rearing juvenile Chinook salmon in the Delta: changes in flow magnitudes and timing, water exports at the SWP and CVP facilities, construction of levees and the resulting conversion of marsh habitats to agricultural and urban land uses, and anthropogenic introductions of nutrients, contaminants, and non-native species (TID/MID 2013c).

Although warmer waters in the Delta provide a higher growth rate potential for juvenile salmonids than that associated with cooler upstream tributary habitats, degradation of Delta habitat conditions has adversely affected the primary and secondary productivity that support Delta food webs, resulting in low growth rates of Chinook salmon juveniles (TID/MID 2013c) Based on documentation of reduced Chinook salmon growth rates in the Delta, as well as declines in pelagic prey species, including insect drift and zooplankton, food resources may also be limiting for actively feeding steelhead smolts outside of flood conditions (TID/MID 2013c).

As noted above, introduced zooplankton species and the overbite clam in the lower Tuolumne and San Joaquin rivers (Brown et al. 2007) may compete with native fauna and thereby affect the availability of suitable prey for rearing salmonids in these areas.

4.4.1.7 Freshwater Harvest and Poaching

CDFW implemented sport fishing catch limits on salmon in the early 2000s within a portion of the Tuolumne River, and salmon fishing is currently banned in the lower Tuolumne River and San Joaquin River upstream of the Delta. There is no available estimate of the number of Chinook salmon lost to poaching in the Tuolumne or San Joaquin rivers (TID/MID 2013c). However, poaching of Chinook salmon, to the extent that it occurs, would take place during the adult upstream migration period.

McEwan and Jackson (1996) contend that legal harvest in the years prior to the listing of Central Valley steelhead was not the cause of recent population declines. Annual fishing report cards (Jackson 2007) do not provide data to quantitatively assess hooking mortality or other sport fishing impacts on steelhead, and no information appears to be available to assess the effect of poaching on upstream migrating adult steelhead in the Tuolumne River (TID/MID 2013c). Illegal harvest of resident *O. mykiss* could occur year-round, but there is no estimate of its extent in the Tuolumne River.

4.4.1.8 Effects of Ocean Conditions on Fall-Run Chinook Salmon

As noted above, FERC defines the geographic scope of cumulative effects for aquatic resources as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. Although the Pacific Ocean is outside the geographical limits of the analysis, environmental conditions and commercial harvest of Chinook salmon in the ocean exert a strong influence on the abundance and health of the Chinook salmon population in the Tuolumne River, in some years potentially overwhelming the effects of many in- and out-of-basin actions in the rivers or Delta (128 FERC ¶ 61,035 [2009]).

In the open ocean, seasonal and longer-term changes in meteorological and oceanographic conditions determine water temperature and coastal circulation patterns, with effects on nutrient upwelling and primary and secondary productivity of the marine food web that supports ocean feeding and growth of Tuolumne River fall-run Chinook salmon. Major climate-ocean factors such the Pacific Decadal Oscillation (PDO) and shorter-term El Niño/Southern Oscillation (ENSO) influence ocean productivity, and consequently salmon numbers through a series of complex processes (Pearcy 1992, Williams 2006). For example, the recent dramatic collapse of Sacramento fall-run Chinook stocks during the 2007 and 2008 spawning years was attributed to highly anomalous coastal ocean conditions during 2005 and 2006, i.e., late and weakened seasonal upwelling associated with warmer sea surface temperatures led to the deterioration of coastal food webs on which juvenile salmon depend (CalCOFI 2006, 2007, NMFS 2009.

Ocean harvest has the potential to reduce the number of adult Chinook salmon migrating into the Tuolumne River (Williams 2006, PFMC 2013). For many years, an annual average of 60 percent of the Central Valley Chinook salmon population has been taken in the ocean fishery, directly affecting the species' escapement to fresh water (TID/MID 2013c). Harvest mortality of larger fish generally reduces the age- and size-at-return, and consequently the fecundity, of upstream migrating spawners (Williams 2006; TID/MID 2013c). The transition from inland gill net fishing to an ocean troll fishery at the end of the nineteenth century had significant impacts on Central Valley salmon populations; fish are exposed to trolling over a period of years, resulting in younger and smaller salmon returning to California streams. There is evidence that such a reduction in the age-distribution of Central Valley fall-run Chinook salmon has occurred (Williams 2006). Chinook harvest management by the PFMC is based exclusively on meeting escapement goals for the hatchery-supported Sacramento River fall run. Because "mixed stock fisheries supported by strong stocks may overharvest weaker ones," (Williams 2006) there is a potential to overharvest already diminished San Joaquin River Basin stocks. The PFMC dropped its San Joaquin Basin escapement goal in 1984 because of the effects of Delta export pumps on those runs (Boydstun 2001).

4.4.1.9 Climate Change

Although it is impossible to quantify the contribution of global climate change to cumulative effects on fish and aquatic resources in the San Joaquin River basin, general patterns of impact can be described. In general, increases in temperature and alteration of precipitation regime are likely to have adverse effects on cold-water aquatic organisms, including fall-run Chinook and Central Valley steelhead, in parts of the Tuolumne River and throughout the San Joaquin River and Delta.

The global mean surface temperature has reportedly increased by 1.1°F since the 1800s (IPCC Synthesis report, 2001, as cited in CEPA 2006). Climate change scenarios indicate that temperatures in the United States may rise by approximately 5–9°F (3–5°C) on average over the next 100 years (CEPA 2006). However, high range estimates for global increases in average temperature are as high as 8.0–10.4°F (4.4–5.8°C) (CEPA 2006).

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

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

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

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

If the Central Valley warms, Chinook salmon and steelhead, two species at the southern end of their distributions, will be at greater risk than under current conditions (NMFS 2009). If temperatures rise and flows decline in California, it will become more difficult to manage cold-water fisheries, as increasing air temperatures, particularly during summer, would raise water temperatures in rivers and streams, thereby increasing stress on cold-water species.

4.5 Socioeconomics

4.5.1 Districts' Service Areas

A primary purpose of the Don Pedro Project is to provide direct water supply and consumptive use benefits for the two districts irrigation and M&I customers and for the Bay Area communities and industries served by the City and County of San Francisco's Hetch Hetchy water system. The water supply and hydropower generation benefits of Don Pedro are essential components of the economic livelihood and welfare of Stanislaus County communities and the Central Valley region as a whole. The water banking privilege acquired by CCSF through its financial contribution to the construction of the Don Pedro Project is a critical part of CCSF's water supply system which serves 2.6 million people in the Bay Area.

FERC's SD2 (page 38) identifies the following potential Don Pedro Project effects on socioeconomic resources:

- *The socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests.*
- *Water supply effects on San Francisco Public Utility Commission retail and wholesale customers that would result if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation.*

In order to determine the potential socioeconomic impact to the Central Valley and Bay Area regions due to alternative protection, mitigation, and enhancement (PM&E) measures proposed by the Districts, CCSF, or any other party, the Districts and CCSF have both developed economic models of the baseline conditions of their regions assessing the role that water supply plays in the economic welfare of their service areas. In addition, the Districts collaboratively developed the Tuolumne River Operations Model (Operations Model), fully described in Exhibit B of this application, to depict the base case water supply operations of both the Districts and CCSF. In the base case, under certain circumstances the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project consistent with the Fourth Agreement. Another use of the Operations Model is to evaluate the effects of alternative operations scenarios on water supply deliveries to the Districts and CCSF.

In response to FERC's SD2 requirements, the Districts prepared a draft Socioeconomic Study which was issued as part of the Updated Study Report, and the final report is included in this application for new license. The objectives of the Districts' Socioeconomics Study are to qualitatively and quantitatively describe local economic conditions in the regions that are directly and indirectly affected by the existing Don Pedro Project operations; assess the key factors influenced by Don Pedro Project operations that generate economic activity in affected regions; estimate the economic value generated by the water storage in various uses, both consumptive (agriculture and urban) and non-consumptive (reservoir recreation); measure the role and significance of the Don Pedro Project in the local economy; assess the role and significance of the Don Pedro Project to the general welfare of the local communities served; and develop a framework to be able to assess the socioeconomic impacts on affected groups and industries resulting from changes in water supply operations, including economic, community welfare, and environmental justice considerations.

The study area consisted of the three-county area of Stanislaus, Merced, and Tuolumne counties, which captured both the direct and indirect economic effects of the Don Pedro Project. The direct effects are associated with use of related facilities, including the reservoir (recreation) and the hydroelectric plant (power generation), and water use throughout the Districts' water service areas (agriculture and urban uses). The indirect effects of the Don Pedro Project on the broader economy are also important to recognize and are a key component of the study.

The Districts' water service areas cover approximately 300,000 acres, of which approximately 220,000 are currently irrigable with surface water. According to the 2010 census, the population in the three-county exceeds 800,000 people, with population in the Districts' water service area accounting for 466,000 people. Minority groups and Hispanics represent about 35 percent and 44 percent of the regional population, respectively. Between 2007 and 2011, the total civilian labor force averaged approximately 374,800 people with approximately 320,600 employed, which equates to an unemployment rate of 14.5 percent. Farm-level employment in the study area averaged 18,100 jobs over the same time period, or 5.5 percent of the study area total. Indirectly, agriculture also provides numerous jobs in those industries that supply inputs to farming operations (e.g., farm machinery and fertilizers) and industries that are reliant on agricultural commodities (e.g., food processing plants), which are reported in categories outside the farm sector. In Stanislaus County, eight of the 10 largest employers are in agricultural production or food processing, and the remaining two are in health-related industries.

The farmland within the two-county area are highly productive. In 2011, Merced and Stanislaus counties were the fifth and sixth largest counties in California as measured by gross value of agricultural production. Together, they contributed $6.5 billion in gross value, 12.3 percent of total gross value for the state, with a significant portion of this production coming from land irrigated with water supplies provided by MID and TID.

The Districts play key roles in the agricultural economies of Stanislaus and Merced counties and the entire San Joaquin Valley. Through the Don Pedro Project, the Districts have provided highly reliable water supplies to their customers, e.g., consistent annual deliveries of high-quality surface water to maintain crops during periods of drought. With those reliable supplies, growers and producers have invested heavily in high-valued perennial crops, such as almonds and peaches, as well as dairy production, which has resulted in the large complex of agricultural-support industries being developed in the area. In Stanislaus County, the largest crop acreages, averaged over the period 2007 through 2011, are in nuts, at 32.4 percent of the total, corn (including corn silage) at 25.8 percent, hay at 14.5 percent, and vegetables at 8.2 percent, and the gross crop production value from 2007-2011 was over $1.2 billion, with the largest contributions from nuts (at 49.2 percent of the total), vegetables (12.4 percent of the total), field and other (10.9 percent of the total), and fruit (10.0 percent of the total). In Merced County, the largest crop acreages averaged over the period of 2007 through 2011 are in corn silage (27.7 percent), nuts (17.6 percent), hay (15.8 percent) and vegetables at 9.3 percent of total normalized average acres. Merced County gross crop production value from 2007 through 2011 was over $1.1 billion, with the largest contributions from nuts (at 30.4 percent), vegetables (28.2 percent), corn silage (10.7 percent) and field and other crops (10.1 percent).

In addition to crop production, the Districts' service area includes a large dairy sector. In 2011, the value of milk production in Stanislaus and Merced counties was $1.9 billion (Stanislaus County Agricultural Commissioner 2011 and Merced County Agricultural Commissioner 2011). For the five years from 2007-2011, the normalized average of dairy production values in the two-county area was $1.7 billion, and the value of dairy production supported by crops grown in the Districts' service areas is estimated at $537.4 million, or 31.0 percent of the two-county total.

Specifically related to the Districts' service areas, the average of gross crop production value for the period 2007-2011 totaled $527.93 million. The value of dairy production for the same period supported by crops grown in the two districts was $537.4 million. Thus, the gross value of agricultural production (both crops and dairies) for the period 2007-2011 was approximately $1.1 billion.

The Socioeconomic Study also evaluated the economic benefit of the current recreation use of Don Pedro Reservoir. Based on the average use of 378,000 visitor-days annually, recreation has a direct economic value of $6.2 million per year. Hydropower generation was also evaluated in the study and estimated to have an annual value of slightly less than $25 million per year.

The *total* economic impact, or economic contribution, of an industry represents the sum of direct, indirect, and induced effects as defined below. The measurement of total economic effects captures the multiplier (or "ripple") effect associated with direct effects.

- **Direct effects.** Represent the impacts for the expenditures and/or production values specified as direct final demand changes
- **Indirect effects.** Represent changes in output, income, and employment resulting from the iterations of industries purchasing from other industries caused by the direct economic effects.
- **Induced effects.** Represent changes in output, income, and employment caused by the expenditures associated with new household income generated by direct and indirect economic effects.

The model used to estimate total economic contribution for the Don Pedro Project was developed using IMPLAN software and data. IMPLAN (IMpact Analysis for PLANning) is a widely-used and accepted regional economic modeling system that can measure the effect of projects, programs, and/or policies on local economic conditions. It was originally developed by the U.S. Department of Agriculture, Forest Service in the late 1970s to assist in land and resource management planning, but its role has expanded to serve clients in Federal, state, and local governments, universities, and the private companies.

Based on IMPLAN modeling, the agricultural sector alone has a total regional economic benefit of $4.3 billion per year.

4.5.2 City and County of San Francisco Service Area

CCSF manages the San Francisco Regional Water System (RWS). The Hetch Hetchy water system supplies 85 percent of the water supply for CCSF and its 27 wholesale customers in the RWS. The water supply available in the future to the Bay Area from the Hetch Hetchy water system may be affected by the outcome of the Project relicensing. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project.

To understand this potential impact, CCSF prepared an independent study on the potential socioeconomic effects of potential changes in Don Pedro Project operations entitled *Socioeconomic Impacts of Water Shortages within the Hetch Hetchy Regional Water System Service Area*. The report documents the pattern of urban water supplies and demands that may likely occur in the San Francisco Regional Water System service area in the coming decades, and evaluates the socioeconomic impacts of water shortages relative to baseline demands under normal economic and weather conditions. The analysis in this report incorporates the effect of demand growth over the coming decades and the development of non-RWS water supplies developed by CCSF and the Wholesale Customers. Specifically, the impacts of RWS supply reductions are calculated for CCSF and SFPUC's 27 wholesale customers receiving RWS water supplies. Socioeconomic impacts are measured in terms of lost welfare of ratepayers, and changes in business sales and employment. CCSF will be filing this study with FERC as part of the relicensing process.

5.0 DEVELOPMENTAL ANALYSIS

The Developmental Analysis section of this Exhibit E contains the assessment of the cost of hydropower generation under the current license conditions ("base case") and the potential change in costs of generation under alternative future license conditions. This FLA also evaluates the socioeconomic impact of alternative future operations and maintenance requirements associated with the Districts' proposed plan of future operations, including proposed PM&E measures, and alternative operations and PM&E measures considered by the Districts or proposed by others, and not adopted.

The Don Pedro Project provides water storage for irrigation and municipal and industrial (M&I) use, flood control, hydroelectric generation, recreation, and natural resource protection (hereinafter, the "Don Pedro Project"). The environmental analysis contained in this Exhibit E considers all the components, facilities, operations, and maintenance that make up the Don Pedro Project. The Don Pedro Project was originally conceived as a water supply project. The Don Pedro Project is operated for the following primary purposes: (1) to provide water supply for the co-licensees, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts), for irrigation of over 200,000 acres of Central Valley farmland and M&I use, (2) to provide flood control benefits along the Tuolumne and San Joaquin rivers, and (3) to provide a water banking arrangement for the benefit of the City and County of San Francisco (CCSF) and its 2.6 million Bay Area water customers. The original license was issued in 1966. In 1995, the Districts entered into an agreement with a number of parties which resulted in greater flows to the lower Tuolumne River for the protection of aquatic resources.

Hydroelectric generation is a secondary purpose of the Don Pedro Project. Hereinafter, the hydroelectric generation facilities and operations will be referred to as the "Don Pedro Hydroelectric Project", or the "Project". With this license application to FERC, the Districts are seeking a new license to continue generating hydroelectric power. Based on the information contained in this application, and other sources of information on the record, FERC will consider whether, and under what conditions, to issue a new license for the continued generation of hydropower at the Districts' Don Pedro Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of the hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project will aid in defining the scope and substance of reasonable protection, mitigation, and enhancement (PM&E) alternatives to be considered in relicensing. As FERC states in Scoping Document 2 in a discussion related to alternative project operation scenarios: "…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water are…alternative mitigation strategies that could not replace the Don Pedro *hydroelectric* project [emphasis added]. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the proposed action and are not reasonable alternatives for the NEPA analysis."

5.1 Analytical Methods

In accordance with the detailed study plans proposed by the Districts, reviewed and commented upon by relicensing participants, and subsequently approved or approved with modification by FERC, the Districts have developed a suite of five (5) core, river-specific computer models of the Don Pedro Project and the Tuolumne River to evaluate alternative operational scenarios and flow and non-flow PM&E measures. These models represent Don Pedro Project operations and the resource conditions of the Tuolumne River to a refined level of detail and go well beyond a general treatment of the watershed. The development of each of these models has included the conduct of numerous Consultation Workshops with relicensing participants. The final, working models were provided to relicensing participants, along with training sessions on the use of the models. The core models are summarized below:

- Tuolumne River Operations Model,
- Don Pedro Reservoir Temperature Model,
- Lower Tuolumne River Temperature Model,
- Tuolumne River Fall-run Chinook Population Model, and
- Tuolumne River *O.mykiss* Population Model.

The development of each of these models included the conduct of Consultation Workshops with relicensing participants to share information, encourage dialogue, and obtain interim review and comment on model architecture, parameters, and methodologies during the model development process. In total, 17 Workshops were held with relicensing participants over the two year period of model development. This programmatic consultation has been documented in a series of Workshop Meeting Notes, all of which have been previously filed with FERC.

Four additional models have been developed that are also intended to aid informed decision-making. The Districts have developed a model to evaluate in-river gravel resources and predict effects to gravel availability over the next 50-years based on observed trends recorded over more recent years. This model may be used to assess the effects of alternative scenarios on gravel availability. The Districts have also developed an Instream Flow Incremental Methodology (IFIM) study for portions of the lower Tuolumne River to assess flow and habitat relationships for fall-run Chinook and *O.mykiss*, a Socioeconomic Model for the purpose of estimating the effects to the economic welfare of local and regional populations resulting from alternative future operating scenarios that would affect water supplies, and a temperature model for the entire Tuolumne River from above Hetch Hetchy Reservoir to the San Joaquin confluence under "without dams" conditions. The City and County of San Francisco (CCSF) has developed a model for purposes of evaluating socioeconomic effects to its Bay Area service area under alternative scenarios that could affect CCSF water supplies.

All of the Districts' models are described in detail in separate reports. Together, these models provide an in-depth, site-specific analysis of the Tuolumne River, the Don Pedro Project, and affected resources and populations. In addition, the Tuolumne River Operations Model includes the water supply operations of CCSF's Hetch Hetchy Water System (see Exhibit B of this application), enabling an assessment of potential impacts to CCSF and its Bay Area customers' water supply that may result from any increased flows to the lower Tuolumne River.

The models work in an integrated fashion to enable users to understand the complex interrelationships among Don Pedro Project operations, river flows, reservoir and river temperatures, salmonid habitat and in-river life stages, and the effects of alternative operations scenarios on each of these resources. Each model has gone through calibration and validation processes, and the "base case" conditions have been established. The "base case" under FERC's procedures and protocols represents the scenario of future operations under the current license conditions. Specifically for the Tuolumne River Operations Model, the "base case" depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. For purposes of representing CCSF operations, the base case in addition to recent operations, also includes changes in operations resulting from construction of capital improvement projects that are permitted under CEQA, approved by CCSF, and authorized (funded), but not yet fully implemented. The base case is considered the "no action" alternative under FERC's assessment of the effects of alternative operations scenarios. Each of the five core models utilizes the same hydrology covering the 1971 through 2012 period that was collaboratively developed with relicensing participants.

The models are designed to operate in tandem, with the output of one providing input to the next. The Operations Model is a Tuolumne River watershed model. The model depicts the physical operation of the Don Pedro Project in accordance with current FERC license requirements, relevant provisions of the Fourth Agreement between the Districts and CCSF, ACOE's Flood Control Manual, water deliveries to satisfy the water supply needs of the Districts' customers, and Hetch Hetchy water supply operations. The base case can be modified to evaluate alternative operating scenarios. Each alternative scenario provides a new Operations Model output that describes the changes to reservoir inflows, reservoir releases, reservoir water levels, and water supply to the Districts' and CCSF's customers as a result of the different operating regime. Operations Model scenarios serve as the input to the Don Pedro Reservoir Temperature Model, a detailed three-dimensional depiction of the reservoir used to predict changes in reservoir thermal regime and outflow temperatures resulting from alternative operations. The outputs from the reservoir temperature model and Operations Model serve as the input to the lower Tuolumne River temperature model, which in turn provides the flow and temperature inputs to the in-river fall-run Chinook and/or *O.mykiss* models. Changes in water supply to the Districts or to CCSF can then be used as inputs into the respective socioeconomic models to estimate the consequences to local and regional economic welfare.

All of the models have now been completed in accordance with the FERC-approved study plans and are available for use. The Districts have provided user manuals and/or training in the use of the Operations Model, temperature models, and the two salmonid models. The models are easily updated as Tuolumne River-specific empirical data continues to be collected. Data collected as part of the yet-to-be-completed assessment of floodplain hydraulics and habitat, the update to the 2012 predation study, and the *O.mykiss* swim tube study may yield valuable information and lead to model refinements. Schedules for completing these studies, preparing any model updates, evaluating alternative operations and PM&E scenarios, and preparing any needed amendment to this FLA are provided as part of this application (see Section 1.0 of this Exhibit E).

5.2 Applicant Proposed PM&E Measures

As part of the relicensing process, the Districts have undertaken 38 studies examining cultural, terrestrial, recreation, aquatic and water resources potentially affected by Don Pedro Project operations and maintenance practices. While five important water and aquatic resource studies have yet to be completed, all other studies have been completed[19]. When the full suite of water and aquatic resource studies have been completed and any model refinements made, the Districts will undertake a comprehensive evaluation of potential effects and potential PM&E measures related to these resources. For resource areas where studies have been completed, the Districts have evaluated resource impacts and opportunities for resource enhancement and have developed a number of PM&E measures proposed for implementation under the new license. These measures, and their estimated costs, are listed below and described in detail in the relevant sections of this license application.

The Districts have developed cost estimates for each proposed new PM&E measure contained in this application. The associated capital and annual O&M cost are provided in Table 5.2-1 below for each proposed resource-related PM&E measure.

Table 5.2-1. Estimated capital and annual O&M cost for new PM&E measures

PM&E Measure	Capital Cost/Annualized Capital Cost[1] (2014 dollars)	Average Annual O&M Cost (2014 dollars)
Historic Properties Management Plan	$300,000/ $17,350	$270,000/yr for first 15 years[2]; $30,000/yr thereafter.
Bald Eagle Management Plan	N/A	$12,500/yr for the first 5 years; $5,000/yr thereafter.
Vegetation Management Plan	N/A	$23,200/yr.
Bat Protection Measures	N/A	$4,000/yr.
Recreation Resource Management Plan	$1,100,000/$63,600	$289,000/yr for years 2 through 6; and 17 through 21.
Total	$1,400,000/$80,950	$405,700/yr for first 10 years $393,200/yr for years 11-15 $158,200/yr thereafter.

[1] Annualized cost are estimated at an amortization rate of 4% over 30 years.
[2] Starting in year two after the Districts' acceptance of the new license.

The Districts are also proposing to increase the hydropower capacity of the Project from the currently authorized 168 MW to the proposed new authorized capacity of 220 MW, with a maximum output of 244 MW compared to the current maximum of 203 MW at maximum head. The estimated cost of the upgrade is $46.1 million (2014 dollars). The expected increase in

[19] Two cultural resources studies, CR-01 and CR-02, have been issued as draft reports to the Cultural Resources Work Group for review and comment. Both of these studies contain sensitive and privileged information and will be filed with FERC under separate cover as PRIVILEGED once Work Group reviews are completed.

annual energy production is approximately 20 million kWh. The annualized capital cost would be $2.7 million.

Further PM&E measures may be proposed once all supporting studies have been completed.

5.3 Measures Proposed By Others

5.3.1 Operational Measures

During the development of the initial study plans, the Lower Tuolumne Farmers (LTF), a group of irrigators on the Tuolumne River located primarily below the City of Modesto with farmland along the Tuolumne River, raised concerns that the Districts' manner of operating the Don Pedro Project may result in the occurrence of higher spring flows than necessary. LTF asserts that these higher flows can lead to property damage and crop loss. LTF requested that the Districts consider earlier and more frequent snow surveys, additional weather stations, or other means of reliably predicting future flows over the long-term. FERC's December 2011 Study Plan Determination recommended that the Districts evaluate whether obtaining early-season (December, January, February) snowpack information or alternative operational strategies could "improve operations"; that is, reduce the occurrence of higher late spring flows.

The Districts point out that none of the concerns raised by LTF are affected by Don Pedro hydroelectric operations, the specific action being considered by this license application. Additionally, the Districts have never been presented any data or evidence confirming any property or crop damage. The Districts met with LTF to understand more precisely at what flows the asserted "property and crop damage" begins to occur. LTF reported that such "damage" would begin at approximately 6,000 cubic feet per second (cfs) in the lower Tuolumne River below Modesto. It is important to note that such flows are not uncommon on the lower Tuolumne River, and that it is likely that LTF is cultivating lands within the active floodplain. Also, the predominant location of LTF lands is below Dry Creek and in areas where backwater effects from the San Joaquin River can influence water levels along the Tuolumne River.

Nevertheless, in September 2011, the Districts contacted the California Department of Water Resources (CDWR) and inquired as to the potential usefulness and feasibility of earlier-season snowpack measurements and flow forecasting. CDWR is the state agency responsible for developing snowpack and runoff forecasts for the state. CDWR responded on January 31, 2012. CDWR reported that *"… quantitatively, January surveys add no value to the way DWR produces seasonal runoff forecasts. DWR does not begin producing seasonal runoff forecasts (April thru July runoff) until February 1. The reason for this has to do with data available (very few snow courses are measured on January 1) and lack of a good correlation between January 1 surveys and April-July (AJ) runoff."* CDWR's letter went on to conclude *"[a]lso, consider that on January 1 two-thirds of the three major winter months (December, January, and February) are yet to come. As such, it is unlikely that April 1 snow conditions can be predicted from any trends evident in the January 1 surveys. This is why, statewide, only a handful of January 1 surveys are completed, and those that are mostly just satisfy a media curiosity for an "early season look" at water conditions. My opinion is that paying for January snow surveys boils down to a curious* *and costly look at conditions; something that can already be obtained by our remote snow sensor network. The idea of more frequent surveys is also one that is not a viable solution."*

The Districts also considered whether operational changes could be used to potentially reduce flow occurrences below 6,000 cfs. By examining historical and base case flow conditions, it was determined that from 1971 to 2012 flows in the lower Tuolumne River exceeded 6,000 cfs in 18 years of this 42 year period. In 12 of these 18 years, flows exceeding 6,000 cfs occurred in November, December, January, and/or February ('80, '82, '83, '84, '86, '96, '97, '98, '99, '00, '06, '11). High flows in the early part of the water year should serve as an indication not to plant crops in the floodplain prior to the June/July time frame because the reservoir is already near full. As CDWR points out in its letter, additional early season snowpack measurements (December, January) or flow forecasts would not be useful or helpful because the uncertainty associated with such forecasts result in a very large range of potential future flows. This leaves six of 42 years in which potentially different reservoir operations may have resulted in being able to keep flows in the lower Tuolumne River at less than 6,000 cfs. Further examination of the base case model output indicated that, except for one year in the 42 year period (1983), when Don Pedro water levels were below 784 ft on February 1, lower Tuolumne River flows did not exceed 6,000 cfs. By inspection of the base case model, the combination of the Districts adopting an initial target flow of less than 6,000 cfs (say, 5,500 cfs) when February 1 water levels are less than 784 ft, and the LTF farmers not planting in the floodplain when February 1 Don Pedro water levels are above 784 ft would substantially reduce the possibility of damage to crops (once in 42 years according to the base case model). However, there will always be some risk associated with planting in historical floodplains.

5.3.2 Flow Measures

Several relicensing participants recommended alternative scenarios for the schedule and amount of minimum and pulse flows to be released by the Don Pedro Project to the lower Tuolumne River. The Districts identify each of these recommendations in their response to relicensing participants' comments on the draft license application, which the Districts have filed as an attachment to this license application. Several studies yet to be completed deal with resource issues germane to these flow recommendations. Therefore, the Districts will review, consider, and respond to each of these recommendations, and any further such recommendations, upon the completion of all resource studies, and in accordance with the schedule provided in this license application. The Districts point out that none of the flow recommendations put forth by relicensing participants provided a connection between the Project's hydroelectric operations and their effect on the downstream resources to be protected and enhanced by the alternative downstream flows.

The State Water Resources Control Board (SWRCB) requested the Districts evaluate the ability of the Don Pedro Project to meet certain temperature guidelines contained in the EPA (2003) guidance document and outlined in the EPA's October 2011 Tuolumne River impairment decision (EPA 2011) and to determine what flows would be required to be released to the lower Tuolumne River to meet these guidelines. FERC requested the Districts perform a similar evaluation. The Districts performed this analysis using the Tuolumne River-specific operations, reservoir, and river temperature models developed as part of the relicensing process. The analysis is presented as part of the Districts' response to relicensing participants' comments on the draft license application (see Attachment A to this final license application). The operations scenario developed by the Districts to perform this evaluation assumed that the Districts' Don Pedro Project and CCSF's Hetch Hetchy Project were operated for the sole purposes of meeting the EPA temperature "requirements" and the ACOE's flood control guidelines. In summary, the analysis demonstrated that even when all consumptive uses of Tuolumne River water were completely eliminated, there would be temperature exceedances in 41 of the 42 years of the period analyzed (1971-2012), varying from a few days to, in many years, exceedances of the temperature guidelines virtually the entire period for which the temperature thresholds were in effect. The modeled scenario eliminated the delivery of water to the Districts' irrigation and M&I customers, and eliminated 85 percent of the water supply to CCSF's 2.6 million customers in the Bay Area. Even under these unrealistic and extreme circumstances, the EPA temperature benchmarks were not met in 41 of the 42 years. Further, using the Districts' "without dams" model, which employs unimpaired flow conditions, river temperatures would exceed EPA's temperature benchmarks in each of the 42 years analyzed.

5.3.3 Non-Flow Measures

Similar to flow recommendations, several relicensing participants recommended alternative non-flow measures for the lower Tuolumne River. The Districts identify each of these recommendations in their response to relicensing participants' comments to the draft license application, which the Districts have filed as Attachment A to this license application. Several studies that are yet to be completed deal with resource issues germane to these non-flow recommendations. Therefore, the Districts will review, consider, and respond to each of these recommendations, and any further such recommendations, upon the completion of all resource studies, and in accordance with the schedule provided in this license application. The Districts point out that none of the non-flow recommendations put forth by relicensing participants provided a connection between the Project's hydroelectric operations and their effect on the downstream resources to be protected and enhanced by these recommended alternative measures.

6.0 CONCLUSIONS

6.1 Comparison of Alternatives

A comprehensive comparison of alternatives will be provided in the Districts' amended license application following completion of all studies. This section discusses the modeling tools developed by the Districts for evaluation of alternatives and proposed alternatives submitted by relicensing participants for further analysis.

6.1.1 Lower Tuolumne River Management Alternatives

As described in Section 5 of this Exhibit E, the Districts have developed a suite of modeling tools to assist in the evaluation of alternatives. In accordance with the detailed study plans proposed by the Districts, reviewed and commented upon by relicensing participants, and subsequently approved or approved with modification by FERC, the Districts have developed a suite of five (5) core, river-specific computer models of the Don Pedro Project and the Tuolumne River to evaluate alternative operational scenarios and flow and non-flow PM&E measures. These models depict Don Pedro Project operations and the resource conditions of the Tuolumne River to a refined level of detail and go well beyond a general treatment of the watershed. The core models are summarized below:

- Tuolumne River Operations Model,
- Don Pedro Reservoir Temperature Model,
- Lower Tuolumne River Temperature Model,
- Tuolumne River Fall-run Chinook Population Model, and
- Tuolumne River *O.mykiss* Population Model.

The models work in an integrated fashion to enable users to understand the complex interrelationships among Don Pedro Project operations, river flows, reservoir and river temperatures, salmonid habitat and in-river life stages, and the effects of alternative operations scenarios on each of these resources. Each model has gone through calibration and validation processes, and the "base case" conditions have been established. The "base case" under FERC's procedures and protocols represents the scenario of future operations under the current license conditions. Specifically for the Tuolumne River Operations Model, the "base case" depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. For purposes of representing CCSF operations, the base case in addition to recent operations, also includes changes in operations resulting from construction of capital improvement projects that are permitted under CEQA, approved by CCSF, and authorized (funded), but not yet fully implemented. The base case is considered the "no action" alternative under FERC's assessment of the effects of alternative operations scenarios. Each of the five core models utilizes the same hydrology covering the 1971 through 2012 period that was collaboratively developed with relicensing participants.

The resources of the lower Tuolumne River have been extensively studied throughout the term of the current license with no fewer than 200 individual reports being prepared describing individual studies, monitoring, and compilations of environmental investigations. Through this effort, including FERC-ordered studies in connection with the July 2009 Order on Rehearing (128 FERC ¶ 61,035), an abundance of relevant empirical information has been developed on lower Tuolumne River resources. Additional models applicable to issues raised in relicensing were created through these various efforts, including instream flow and pulse flow studies using PHABSIM methods.

Consistent with the most recent study schedules approved by FERC through the ILP's study plan determinations, several important studies involving the resources of the lower Tuolumne River have yet to be completed. Until these studies are completed, the Districts are unable to complete a comprehensive assessment of the direct, indirect and cumulative effects to the resources of the lower Tuolumne River, or complete an assessment of the costs and benefits of potential PM&E measures to enhance the resources of the lower Tuolumne River. The specific studies yet to be completed and their currently scheduled FERC-filing dates are:

- Lower Tuolumne River Predation Study using a mark-recapture approach -- April 2016
- Fall-run Chinook Salmon Otolith Study – February 2015
- Lower Tuolumne River Floodplain Hydraulic Assessment – February 2015
- Non-Native Predator IFIM Assessment -- April 2016
- *O.Mykiss* Swim Tunnel and Temperature Criteria Study -- February 2015

Once these studies are completed, the Districts will use all relevant data, reports, and models then available for the purpose of identifying and evaluating potential resource PM&E measures to address the direct, indirect, and cumulative effects of Project operations and maintenance. This assessment may potentially involve the assessment of a number of flow and non-flow measures, and consider changes to the current operations and maintenance practices of the Districts. The costs of potential measures, their benefit to resources, and their potential impacts to the water supplies of the Districts and the City and County of San Francisco will be determined. Once these assessments are completed, the Districts will prepare any needed amendments to this license application to incorporate the results of the completed studies, the evaluations conducted, and any proposed PM&E measures. The Districts have projected a date of filing of any required amendments to this license application of November 2016. A detailed schedule for completion of studies and filing any amendments is provided in Section 1 of this Exhibit E.

6.2 Alternatives Analysis Requested by Relicensing Participants

6.2.1 Assessment of Don Pedro Project Operations to Meet EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards

The SWRCB and FERC requested the Districts evaluate the ability of the Don Pedro Project to meet four specific temperature benchmarks identified in the EPA's October 2011 Tuolumne River impairment ruling and to determine what flows would be required to be released to the lower Tuolumne River to meet these temperature benchmarks. The Districts performed this analysis using the Tuolumne River-specific operations, reservoir, and river temperature models developed as part of the relicensing process. This analysis is presented as an appendix to the Districts' response to relicensing participants' comments on the draft license application (see Attachment A to this final license application). In summary, the analysis demonstrated that even with both the Districts' Don Pedro Reservoir and all of CCSF's Hetch Hetchy system reservoirs devoted *solely* to trying to meet the referenced EPA temperatures, the benchmark temperatures would not be met in 41 of the 42-year period of analysis, with temperature exceedances of more than 50 days in 70 percent of the years[20]. This modeling scenario eliminated all deliveries of water to the Districts irrigation and M&I customers, and eliminated all of CCSF's San Joaquin Pipeline deliveries to the Bay Area for the full 42-year period of analysis. Even with the complete elimination of all consumptive uses of Tuolumne River water, including the elimination of irrigation of 200,000 acres of Central Valley farmland and 85 percent of the water supply to CCSF's 2.6 million customers in the Bay Area, the EPA temperature benchmarks could not be met.

6.2.2 Operational Changes Requested by Lower Tuolumne Farmers

As detailed in Section 5.0 of this Exhibit E, during the development of the initial study plans, the Lower Tuolumne Farmers (LTF), a group of irrigators on the Tuolumne River located primarily below the City of Modesto with farmland along the Tuolumne River, raised concerns that the Districts' manner of operating the Don Pedro Project may result in the occurrence of higher spring flows than necessary. LTF asserts that these higher flows can lead to property damage and crop loss. LTF requested that the Districts consider earlier and more frequent snow surveys, additional weather stations, or other means of reliably predicting future flows over the long-term. FERC's December 2011 Study Plan Determination recommended that the Districts evaluate whether obtaining early-season (December, January, February) snowpack information or alternative operational strategies could "improve operations"; that is, reduce the occurrence of higher late spring flows.

The Districts point out that none of the concerns raised by LTF are affected by Don Pedro hydroelectric operations, the specific action being considered by this license application. Nevertheless, in September 2011, the Districts contacted the California Department of Water Resources (CDWR) and inquired as to the potential usefulness and feasibility of earlier-season snowpack measurements and flow forecasting. CDWR is the California agency responsible for developing snowpack and runoff forecasts for the state. CDWR responded to the Districts inquiry on January 31, 2012. CDWR reported that the LTF proposals for earlier season snowpack measurement and flow forecasting were not viable, indicating that "… *quantitatively, January surveys add no value to the way DWR produces seasonal runoff.."* and further that

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[20] In fact, the only year where all four EPA temperature benchmarks were met was 1971, the first year of the analysis, because the analysis assumed for modeling purposes that the Don Pedro and Hetch Hetchy reservoirs start out full. The analysis retained the need for Don Pedro Reservoir operations to continue to meet the requirements of the ACOE Flood Control Manual.

"*…statewide, only a handful of January 1 surveys are completed, and those that are mostly just satisfy a media curiosity for an "early season look" at water conditions. My opinion is that paying for January snow surveys boils down to a curious and costly look at conditions; something that can already be obtained by our remote snow* sensor *network. The idea of more frequent surveys is also one that is not a viable solution.*"

The Districts also considered whether operational changes could be used to potentially reduce flow occurrences below 6,000 cfs, a flow guideline provided by LTF. By examining historical and base case flow conditions, it was determined that from 1971 to 2012 flows in the lower Tuolumne River exceeded 6,000 cfs in 18 years of this 42 year period. In 12 of these 18 years, flows exceeding 6,000 cfs occurred in November, December, January, and/or February ('80, '82, '83, '84, '86, '96, '97, '98, '99, '00, '06, '11). High flows in the early part of the water year should serve as an indication not to plant crops in the floodplain prior to the June/July time frame because the reservoir is already near full. As CDWR points out in its letter, additional early season snowpack measurements (December, January) or flow forecasts would not be useful or helpful because the uncertainty associated with such forecasts result in a very large range of potential future flows. This leaves six of 42 years in which potentially a different reservoir operation may have resulted in being able to keep flows in the lower Tuolumne River at less than 6,000 cfs. Further examination of the base case model output indicated that, except for one year in the 42 year period (1983), when Don Pedro water levels were below 784 ft on February 1, lower Tuolumne River flows did not exceed 6,000 cfs. By inspection of the base case model, the combination of the Districts adopting an initial target flow of less than 6,000 cfs (say, 5,500 cfs) when February 1 water levels are less than 784 ft, and the LTF farmers not planting in the floodplain when February 1 Don Pedro water levels are above 784 ft would substantially reduce the possibility of damage to crops (once in 42 years according to the base case model). However, there will always be some risk associated with planting in historical floodplains.

6.2.3 Alternative Flow Measures

In their comments on the draft license application, several relicensing participants recommended alternative scenarios for the amount and timing of minimum and pulse flows to be released by the Don Pedro Project to the lower Tuolumne River. The Districts identify each of these recommendations in their response to relicensing participants' comments on the draft license application in Attachment A of this license application, and summarize these requests for flow measures in Table 6.2-1.

Several studies yet to be completed will provide information regarding resource issues germane to these flow recommendations. Therefore, the Districts will review, evaluate, and respond to each of these recommendations, and any further such recommendations, upon the completion of all resource studies, and in accordance with the schedule provided in this license application. The Districts point out that none of the flow recommendations put forth by relicensing participants provided a connection between the Project's hydroelectric operations and their effect on the downstream resources to be protected and enhanced by the alternative downstream flows. In the evaluation of these alternatives, the Districts will continue to consult with relicensing participants to develop a fuller understanding of these alternatives.

Table 6.2-1. Flow alternatives requested by relicensing participants in comments on the draft license application.

Organization	Page of Comment Letter	Summary of Comment
Conservation Groups	9	The FLA should consider flow increases to improve juvenile rearing habitat. Such flow improvements could include flows to improve juvenile rearing in-channel and to improve the regularity, frequency, and duration of floodplain inundation. The FLA should consider flow pulses in February and March to stimulate downstream migration of juvenile Chinook in the fry and par (sic) life stages to diversify the life history strategies of Tuolumne River Chinook. The FLA should consider flow pulses in April and May in order to stimulate outmigration of Chinook in the smolt stage. For all flow pulses, the FLA should consider both long pulses (or simply higher base flows) and short term pulses to stimulate short-term outmigration events.
Conservation Groups	20	Recommendations: The FLA should include measures to stabilize and increase the O. mykiss population in the lower Tuolumne River. Whether this may reduce the likelihood of anadromy is a second order question. Low flows prior to 1996 certainly did not increase the steelhead population. 0. mykiss juveniles that survive oversummering in the Tuolumne River are 100% more likely to adopt an anadromous life history than 0. mykiss juveniles that do not survive oversummering.
NMFS	12	NMFS is looking forward to the Districts including new environmental measures in the Final License Application which will increase the frequency and duration of overbank areas which are currently negatively affecting salmonids and other species.
USFWS	15	Based on our review of the two final reports, we would propose the following flow requirements (justification for the Service's flow recommendations is contained in Enclosures 6 and 7) to support anadromous salmonids in the Tuolumne River:
USFWS	15	Base flows to improve the quantity, suitability, and consistency (including thermal conditions) of the aquatic habitat for all stages of steelhead: Year-round minimum flow of 275 cfs, during all water year (WY) types. In addition, release the greater of the year-round minimum flow (275 cfs) or the flow required to maintain stream water temperatures of 18° C or less from the LaGrange Powerhouse (RM 52) downstream to Robert's Ferry Bridge (RM 40) or 60% of unimpaired flows whichever is greater.
USFWS	15	Fall flows to improve the migration habitat, including thermal conditions, for adult fall-run Chinook salmon and steelhead, and thereby promote successful immigration: During all WY types, from September 1 through October 31, release the greater of the 275 cfs minimum base flow, or the flow required to maintain stream water temperatures of 18° C or less from the LaGrange Powerhouse (RM 52) to the San Joaquin River confluence (RM 0). In addition, release a flow of 1,200 cfs for 10 days in mid-October, with the timing of release coordinated with releases from the Merced and Stanislaus Rivers, and the San Joaquin Restoration Program.
USFWS	15	Spawning flows to improve the habitat (including thermal conditions) for spawning, egg incubation, and alevin stages of fall-run Chinook salmon and steelhead: During all WY types, from October 15 through February 15, release the greater of the 275 cfs minimum base flow, the 1,200 cfs mid-October immigration flow, or the flow requires to maintain stream water temperatures of 13 •C or less from the LaGrange Powerhouse (RM 52) to Robert's Ferry Bridge (RM40).

Organization	Page of Comment Letter	Summary of Comment
USFWS	15	Winter flow releases to improve the migration habitat for adult steelhead, and to inundate floodplain habitats to promote the survival, growth, and development (rearing) of juvenile fall-run Chinook salmon and steelhead: Release 3,000 cfs between February 1 and March 15, with the frequency and duration of the releases defined by WY type as follows: Critical and Dry WYs: A single, 2-day release in late February. Below Normal and Above Normal WYs: A single, 14-day continuous release, or two continuous 7-day releases, one in February and one in March; Wet WY: Releases in any multiples of continuous 7-day releases adding to 21 days.
USFWS	15	Spring flow releases to improve the migration habitat for adult steelhead, inundate floodplain habitats, and improve thermal conditions to promote rearing and downstream migrations of juvenile fall-run Chinook salmon and steelhead smolts: Critical and Dry WYs: From March 20 through April 20, release the greater of the 275 cfs minimum base flow or the flow required to maintain stream water temperatures of 15° C or less from the LaGrange Powerhouse (RM 52) to the San Joaquin River confluence (RM 0). Below Normal WY: From March 20 through April 30, release the greater of the 275 cfs minimum base flow or the flow required to maintain stream water temperatures of 15° C or less from the LaGrange Powerhouse (RM 52) to the San Joaquin River confluence (RM 0). Above Normal and Wet WYs: From March 20 through May 15, release the greater of the 275 cfs minimum base flow or the flow required to maintain stream water temperatures of 15° C or less from the LaGrange Powerhouse (RM 52) to the San Joaquin River confluence (RM 0).

6.2.4 Non-Flow Measures

Several relicensing participants' recommended alternative non-flow measures for the lower Tuolumne River. The Districts identify each of these recommendations in their response to relicensing participants' comments to the draft license application in Attachment A to this license application and summarize these recommendations in Table 6.2-2. Several studies yet to be completed will provided information on resource issues germane to these non-flow recommendations. Therefore, the Districts will review, evaluate, and respond to each of these recommendations, and any further such recommendations, upon the completion of all resource studies, and in accordance with the schedule provided in this license application. The Districts point out that none of the non-flow recommendations put forth by relicensing participants provided a connection between the Project's hydroelectric operations and their effect on the downstream resources to be protected and enhanced by these recommended alternative measures.

Table 6.2-2. Non-flow measures requested by relicensing participants in comments on the draft license application.

Organization	Page of Comment Letter	Summary of Comment
CDFW	27	A project impact assessment that is missing from the DLA concerns blocked access to historic anadromous fish habitat. CDFW, pursuant to Fish and Game Code Section 5930, has determined that the La Grange and New Don Pedro Dam complex, in there present condition, is impeding upstream migration of salmon and steelhead. To offset this production loss, the Districts should consider how naturally produced salmon and steelhead populations can be augmented with hatchery production from a new

Organization	Page of Comment Letter	Summary of Comment
		hatchery located in the lower Tuolumne River The Districts would fund the construction, and CDFW operation, of a hatchery with production goals to be determined during the relicensing process.
CG	9	The FLA should consider post-licensing implementation of a Chinook Salmon Outmigration Study, similar to the studies proposed by the Districts, USFWS, and Conservation Groups for inclusion in the first and second years of the Study Plan but not adopted by OEP. The study is appropriate because there is inadequate understanding-of short-term or long-term flow management actions that may induce downstream migration.
CG	9	In addition, the FLA should consider measures that would complete the channel restoration projects that were previously recommended by the TAC, or alternative projects that are identified in collaboration with resource agencies and Conservation Groups
NMFS	13/14	As stated above, the current lack of significant LWD in the lower Tuolumne River is a result of project operations, indicates the existing baseline condition, and does not reflect the natural state of the river. The DLA contains no Project actions or PM&E measures to mitigate Project effects or enhance LWD conditions. The Districts should include such PM&E measures in the Final License Application, to mitigate for these negative effects and enhance conditions for anadromous salmonids and other species.

6.3 Districts' Proposed Measures

6.3.1 Resource Measures

Terrestrial, recreation, aesthetic, cultural, and reservoir-related aquatic resource studies are complete, and results of these studies are presented in Section 3 of this Exhibit E. The Districts are proposing certain resource management plans where study results indicate such plans are warranted. The attached draft management plans are intended to guide resource management activities over the term of the new license and provide for the protection and enhancement of resources within the Project Boundary. The management plans attached to this Exhibit E are:

- Historic Properties Management Plan, including proposed cultural resource education exhibits
- Bald Eagle Management Plan
- Vegetation Management Plan
- Recreation Resource Management Plan, including improvements to the current whitewater boating take-out at the Ward's Ferry Bridge

In comments on the draft license application, several relicensing participants' requested additional measures related to aquatic, terrestrial and recreation resource management. These requested measures and the Districts' response are included in the Districts response to DLA comments provided in Attachment A of this license application, and summarized in Table 6.3-1.

6.3.2 Flood Management Modification

The Districts have initiated discussions with the ACOE on the possibility of amending a part of the 1972 Flood Control Manual. Specifically, the Districts are asking the ACOE to consider modifying the date when full flood control space is to be available from the current date of October 7 to November 7. Initial research conducted by the Districts indicates no increased risk of flood damage resulting from this change. The drawdown to elevation 801.9 ft by October 6 appears to have been driven primarily by preparation for a potential early season warm rain on snow event. The Districts believe that improved weather tracking, snow measurement by satellite, and computer-based runoff risk assessment allow extending this date to later in the calendar year. The date of November 7 fits better with possible release of stored water to benefit upmigrating adult fall-run Chinook salmon. Therefore, releases of stored water to reach elevation 801.9 ft could be used as pulse flow water if drawdown to 801.9 ft can be delayed to November 7. The Districts plan to research this potential change further in close coordination with ACOE, and if acceptable to the ACOE, would formally request ACOE approval following the appropriate research and analyses.

Table 6.3-1. Resource measures proposed by relicensing participants.

Organization	Proposed Measure	Districts' Response
BLM	Aquatic Water Resource Plan: We expect to see at least the following addressed in this plan: reservoir fish, western pond turtle, riparian vegetation, water temperature, and water quality.	As described in the FLA, resource studies do not indicate either a need for or Project effects to the reservoir resources noted by BLM. Therefore, there is not a specific, identified resource concern that calls for an Aquatic Resource Plan for the reservoir. The Districts have proposed a Vegetation Management Plan for the Project, which deals with riparian vegetation
BLM	Recreation Facilities Plan: This plan will include at the very minimum Licensee contact, Annual Recreation Coordination Meeting, Review of Recreation Developments, Recreation Survey and Monitoring, General Measures for all Recreational Sites, Vegetation Management in Recreation Sites, Recreation Operation, Maintenance, Administration, and Recreation costs, and Recreation Plan Revision.	The Districts have provided a Draft Recreation Resource Management Plan with the FLA and will continue to consult with the BLM regarding the RRMP.
BLM	Fire Management Plan: Licensee's will develop a Fire Management Plan that will include pile of burning, campfires, notification and written approval by BLM Authorized Officer and other BLM Fire Staff for all Burn plans, season of use, reporting of all project fires to the BLM, and procedures that the licensee will have to abide by while working on BLM land.	A Fire Management Plan has not been provided, however, as a part of the current routine DPRA activities, the Districts have strict regulations dealing with fires within the Project Boundary. The Districts also comply with state air quality regulations for prescribed burns of accumulated wood collected in the reservoir.
BLM	Terrestrial Invasive Species Management Plan: This plan will cover how the licensee will monitor, report and eradicate terrestrial invasive species of plants on BLM lands.	The Draft Vegetation Management Plan submitted with the FLA discusses noxious weed management on BLM lands.
BLM	Aquatic Invasive Species Management Plan: The scope of this plan will include public education and outreach, monitoring, and actions if they are discovered.	The DPRA participates in state-wide efforts to limit the spread of aquatic invasive species and provides educational materials regarding recommended boat cleaning and other prevention efforts that lake users can do to reduce the spread of aquatic invasive species. The Districts do not believe an additional Aquatic Invasive Species management plan is necessary at this time. The Districts summarize ongoing activities to monitor for aquatic invasive species in Section 3.5 of the FLA. A report, Potential Distribution of Zebra Mussels *(Dreissena polymorpha)* and Quagga Mussels *(Dreissena bugensis)* in California, prepared for CDFW, assessed the threat of these mussels to California water bodies based on the mussels' ability to tolerate a range of temperatures, calcium concentrations, pH, dissolved oxygen, and salinity (Cohen 2008). Based on its ambient conditions, Don Pedro Reservoir is not considered to be vulnerable to colonization.
BLM	Transportation Plan" BLM has not received any information on project roads that cross BLM land including dirt, gravel, and paved roads need to be identified and a condition and maintenance schedule	The Districts will meet with the BLM to review this information request to better understand which roads are being referenced by BLM.

Organization	Proposed Measure	Districts' Response
	will need to be developed.	
BLM	Large Woody Debris Management Plan: The BLM notices that the Licensees' use a log boom contraption to capture the large woody material and burns it on barren soil during fall and winter months. BLM is concerned that the Licensees' may be burning on the BLM land which requires a burn plan authorized by BLM. BLM desires a condition that allows large woody debris to pass through the dam and pass through LaGrange powerhouse so that it moves downstream where there is a deficiency of large woody debris material rather than burning it in place.	The Districts studies demonstrate that LWD collected in the reservoir is not of sufficient size to effectively serve as habitat for the lower Tuolumne River. In addition, the LWD is collected near the upper end of the reservoir in order to limit its being a public safety hazard for recreationists using the reservoir. DPRA does not believe the burn occurs on BLM lands but will further confirm if this is the case.
BLM	Visual Resource Plan: This plan will discuss the visual resource that have been studied and any future recommendations to remedy visual impacts.	The Visual Quality Study was conducted consistent with the methods in the Study Plan approved by FERC, and the Don Pedro Project has been evaluated for consistency with the BLM's visual objectives. Based on the results of the approved study, the Districts do not agree that there is a need for a Visual Resource Plan at this time.
BLM	Facilities and road maintenance: There should be no application of herbicides on BLM lands unless specific stipulations are met. BLM needs to have all roadways used by the Licensees' the public, or other authorized users, identified that are on BLM land that are both within and outside the project boundary.	On BLM lands, herbicide use will only be applied in full compliance with BLM standards. The Districts have provided a Draft Vegetation Management Plan with the FLA which addresses procedures for consultation regarding herbicide use and other vegetation management activities on BLM land.
BLM	Recreation Area Maintenance: There should be no application of herbicides on BLM lands unless specific stipulations are met, and will be included in the Terrestrial Invasive Species Management Plan. Burro Blasting may require additional authorizations.	See response directly above.
BLM	The Vegetation Management Plan should include the following: Revegetation Guidelines and Criteria, Revegetation Methods, Revegetation Monitoring and Consultation, VELB Management, General Vegetation Management for Facilities, Recreation Sites and Hazard Trees, Annual Consultation and Rare Plant Resurvey Requirements, and Sensitive Areas Protection including Special-status Plants mitigation.	A Draft Vegetation Management Plan has been provided with this FLA.
BLM	BLM agrees with the need to submit a Bald Eagle Management Plan as the licensees have suggested they will do in the FLA. This plan should include the following sections: Nest Surveys, Nest buffers (physical and temporal), Mitigation against disturbances, Annual awareness training, Annual consultation meeting, Reporting, Plan revisions	A draft Bald Eagle Management Plan has been provided with the FLA.
BLM	BLM is concerned with potential and existing disturbances for two endangered plant species: Layne's ragwort and California vervain.	A Draft Vegetation Management Plan that addresses these issues has been provided with this FLA.

Organization	Proposed Measure	Districts' Response
	Mitigations for impacts such as dispersed recreation near plants, noxious weed occurrences and cattle grazing will be addressed in the Vegetation Management Plan and Recreation Plan for those occurrences on BLM land.	
Multiple parties	Ward's Ferry Take-Out improvements	The Districts' study resulted in identifying a cost-effective option for river-egress which represents a substantial improvement over the current methods of egress and recognizes the physical constraints of the Ward's Ferry site. The proposal is detailed in the Recreation Resource Management Plan.

6.4 Consistency with Comprehensive Plans

The Districts have reviewed relevant comprehensive plans during conduct of relicensing studies and development of the proposed measures, and have included applicable information in this final license application. Section 6.4.1 below describes comprehensive plans that Section 10(a) of the FPA requires FERC to consider. These plans are referred to as Qualifying Comprehensive Plans. Section 6.4.2 references the Districts approach to addressing additional resource management plans related to resources in the vicinity of the Don Pedro Project.

6.4.1 Qualifying Comprehensive Plans

As described above, Section 10(a) of the FPA requires FERC to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the Project. On April 27, 1988, FERC issued Order No. 481-A which revised Order No. 481, issued October 26, 1987, establishing that FERC will accord FPA Section 10(a)(2)(A) comprehensive plan status to any federal or state plan that meets the following three criteria:

- Is a comprehensive study of one or more of the beneficial uses of a waterway or waterways,
- Specifies the standards, the data, and the methodology used to develop the plan, and
- Is filed with FERC.

A review of FERC's *Revised List of Comprehensive Plans* (December 2013) shows that 68 comprehensive plans have been filed with FERC specifically for the State of California and six plans that apply to multiple states have been filed by U.S. governmental agencies (FERC 2013). The Districts identified 17 of these qualifying comprehensive plans that have the potential to be related to the Don Pedro Project. Each of these plans is discussed below by resource area. It is important to note that all of the qualifying comprehensive plans that may apply to the Don Pedro Project were developed after project construction. . Consequently, the Don Pedro Project was an existing condition during each qualifying comprehensive plan's development. The comprehensive plans have been listed in the order they were presented in FERC's 2011 SD2.[21]

6.4.1.1 Restoring the Balance (California Advisory Committee on Salmon and Steelhead Trout 1988)

The California Advisory Committee on Salmon and Steelhead Trout was established by California legislation in 1983 to develop a strategy for the conservation and restoration of salmon and steelhead resources in California. To streamline its process, the committee divided California's steelhead and salmon resources into 11 groups—the Tuolumne River is located in the San Joaquin River System. The report focuses mostly on the Central Valley, and the Don Pedro Project Boundary was not specifically identified. The committee recommended among other things that California should seek to double its steelhead and salmon populations, and

[21] FERC's 2011 SD2 referenced FERC's January 2011 *List of Comprehensive Plans*; the Districts have reviewed FERC's most recent *List of Comprehensive Plans* from December 2013, and did not identify any additional qualifying plans.

recommended strategies to do so. Many of the recommendations were advanced and discussed in subsequent related publications described below.

6.4.1.2 Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990)

This plan was released by CDFW in April 1990. This plan is intended to outline CDFW's restoration and enhancement goals for salmon and steelhead resources of the Sacramento and San Joaquin river systems and to provide direction for various CDFW programs and activities. This plan is also intended to provide the basis for the restoration and enhancement of the state's salmon and steelhead resources.

6.4.1.3 Restoring Central Valley Streams (CDFG 1993)

This plan was released by CDFG in November 1993. The goals of the plan, all targeted toward anadromous fish, are to restore and protect California's aquatic ecosystems that support fish and wildlife, to protect threatened and endangered species, and to incorporate the state legislature mandate and policy to double populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

6.4.1.4 Steelhead Restoration and Management Plan for California (CDFG 1996)

This plan was released by CDFG in February 1996. This plan focuses on restoration of native and naturally produced (wild) stocks because these stocks have the greatest value for maintaining genetic and biological diversity. Goals for steelhead restoration and management are: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses. Information presented in Sections 3.5 and 4.0 of this Exhibit E may be used to determine consistency with CDFW's restoration goals.

6.4.1.5 Public Opinions and Attitudes in Outdoor Recreation (CDPR 1998)

CDPR's Public Opinions and Attitudes in Outdoor Recreation survey (POAOR), the most recent version of which is 2002, provides information used in the development of the CDPR's CORP. The POAOR identifies: (1) California's attitudes, opinions, and values with respect to outdoor recreation; and (2) demand for and participation in 42 selected outdoor recreation activities.

6.4.1.6 California Outdoor Recreation Plan (CDPR 1994)

The objectives of California Department of Parks and Recreation (CDPR) California Outdoor Recreation Plan (CORP, the most recent version of which is 2008, are to determine outdoor recreation issues that are currently the problems and opportunities most critical in California, and to explore the most appropriate actions by which State of California, federal and local agencies might address these issues. The CORP also provides valuable information on the state's recreation policy, code of ethics, and statewide recreation demand, demographic, economic, political, and environmental conditions. The plan lists the following major issues: (1) improving resource stewardship; (2) serving a changing population; (3) responding to limited funding; (4) building strong leadership; (5) improving recreation opportunities through planning and research; (6) responding to the demand for trails; and (7) halting the loss of wetlands. The CORP applies to state and local parks and recreation agencies, and does not apply to federal and private-sector recreational providers.

Because the recreation facilities in the Project Boundary are not state or local parks, the CORP has little direct application other than general guidance. However, information on regional trends in recreation from the most recent version of the CORP was incorporated into the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (TID/MID 2013).

6.4.1.7 California Water Plan (CDWR 1983) and California Water Plan Update (CDWR 1994)

The CDWR first published the California Water Plan in 1957. The plan focused on the quantity and quality of water available to meet the State of California's water needs, and management actions that could be implemented to improve the state's water supply reliability. Since then, CDWR has updated the plan numerous times including in 1983 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan) and 1994 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan Update). The most recent update was in March 2009. The Don Pedro Project is located in what the Water Plan calls the "San Joaquin River Hydrologic Region." The Don Pedro Reservoir represents a small portion of the water supply in the hydrologic region.

6.4.1.8 Final Programmatic Environmental Impact Statement/Environmental Impact Report for the CALFED Bay-Delta Program (CDWR 2000)

The California Water Policy Council and the Federal Ecosystem Directorate united in June 1994 to form CALFED. In June 1995, CALFED established its Bay-Delta Program (Program) to develop a long-term, comprehensive solution to environmental issues in the Sacramento-San Joaquin Delta and San Francisco Bay. The Program is a cooperative, interagency effort involving 15 state and federal agencies with management and regulatory responsibilities in the San Francisco Bay-San Joaquin Delta Estuary (Bay-Delta).

The Program was divided into three phases. In Phase I, completed in September 1996, the Program identified the problems confronting the Bay-Delta, developed a mission statement, and developed guiding principles. Following scoping, public comment, and agency review, the Program identified three preliminary alternatives to be further analyzed in Phase II. The three Phase II preliminary alternatives each included Program elements for levee system integrity, water quality improvements, ecosystem restoration, water use efficiency, and three differing approaches to conveying water through the Bay-Delta.

In Phase II, completed in July 2000, the Program refined the preliminary alternatives, conducted a comprehensive programmatic environmental review, and developed implementation strategies. The Program added greater detail to each of the Program elements and crafted frameworks for two Program elements: water transfers and watershed management. The Phase II report contains a general summary of the Program plans. More fundamentally, the report also describes the Program process, the fundamental Program concepts that have guided their development, and analyses that have contributed to Program development. Further, this report describes how this large, complex Program may be implemented, funded, and governed in the future. The following plans outline Program actions:

- Ecosystem Restoration Program Plan (Volumes 1, 2, and 3)
- Water Quality Program Plan
- Water Use Efficiency Program Plan
- Water Transfer Program Plan
- Levee System Integrity Program Plan
- Watershed Program Plan

The goals of the Water Quality and Watershed programs under CALFED include improving overall water quality by reducing the loadings of many constituents of concern that enter Bay-Delta tributaries from point and non-point sources. Principal targeted constituents include heavy metals (such as mercury), pesticide residues, salts, selenium, pathogens, suspended sediments, adverse temperatures, and disinfection byproduct precursors such as bromide and total organic carbon. The remaining Program plans include the:

- Implementation Plan
- Multi-species Conservation Strategy (MSCS)
- Comprehensive Monitoring, Assessment, and Research Program

Phase II was completed, with publication of the final programmatic EIS/EIR in July 2000.

Phase III is on-going and consists of implementation of the Preferred Program Alternative over 20-30 years. Information from the final programmatic EIS/EIR will be incorporated by reference into subsequent tiered environmental documents for specific projects in accordance with NEPA and California Environmental Quality Act (CEQA) guidelines. The Don Pedro Reservoir does not flow directly into the Bay-Delta. Agencies participating in the Bay-Delta plan are also participating in the relicensing. The Bay-Delta Plan is discussed further in the cumulative effects Section 4 of this Exhibit E.

6.4.1.9 Water Quality Control Plan Report (SWRCB 1995)

This reference is to the first edition of the water quality control plans adopted by the California SWRCB pursuant to the CWA. The nine plans, which apply to different areas of California, formally designate existing and potential beneficial uses and water quality objectives. The water quality control plan applicable to the Project area is the CVRWQCB Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (referred to as the Basin Plan in this document). The SWRCB has updated the water quality control plans a number of times since 1995 and details of the current plan relevant to the Don Pedro Project are included in Section 3.4 of this Exhibit E.

6.4.1.10 Recreation Needs in California (The Resources Agency 1983)

In response to the Roberti-Z'berg Urban Open Space and Recreation Program Act of 1976, the CDPR conducted a statewide recreational needs assessment. The report consisted of two major elements: (1) the Recreation Patterns Study that surveyed current participation and projected recreation demand; and (2) the Urban Recreation Case Studies that examined the leisure behavior and needs of seven underserved populations. The purpose of the needs analysis was to: (1) develop statewide recreation planning data; (2) analyze the recreation needs of California's urban residents; and (3) modify project selection criteria used in the administration of grants to local agencies under the Roberti-Z'berg Act.

In general, this report is a wide-ranging, programmatic document providing guidance for statewide planning. The urban-specific study has little relevance to the Project Boundary, which is mostly remote.

6.4.1.11 The Nationwide Rivers Inventory (NPS 1982)

The Nationwide Rivers Inventory (NRI) is a listing by the USDOI, NPS of more than 2,400 free-flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values (ORV) judged to be of more than local or regional significance. In addition to these eligibility criteria, river segments are divided into three classifications: Wild, Scenic, and Recreational river areas. Under a 1979 Presidential Directive and related Council on Environmental Quality procedures, all federal agencies must seek to avoid or mitigate actions that would adversely affect one or more NRI segments. Such adverse impacts could alter the river segment's eligibility for listing and/or alter their classification. This Exhibit E includes information in Section 1 and Section 3.9 regarding Wild and Scenic designation in the upper Tuolumne River.

6.4.1.12 Water Quality Control Plans and Policies (SWRCB 1999)

This reference refers to an April 1999 submittal by the SWRCB to FERC of a listing of all SWRCB plans and policies. This submittal stated that all of the listed plans and policies are part of the "State Comprehensive Plan," even though it does not exist as a single plan. Relevant SWRCB plans are discussed in Section 3.4 of this Exhibit E.

6.4.1.13 Central Valley Habitat Joint Venture Implementation Plan (USFWS 1990) and North American Waterfowl Management Plan (USFWS 1986)

The California Central Valley Habitat Joint Venture (CCVHJV) is one of 12 current joint ventures charged with implementation of the North American Waterfowl Management Plan, an agreement between Canada, Mexico, and the U.S. to restore waterfowl populations through habitat protection, restoration, and enhancement (USFWS 1986). The CCVHJV was formally established by a working agreement signed in July 1988 and is guided by an Implementation Board comprised of representatives from the California Waterfowl Association, Defenders of Wildlife, Ducks Unlimited, National Audubon Society, Waterfowl Habitat Owners Alliance, and The Nature Conservancy. Technical Assistance is provided to the Board by the USDOI, USFWS, CDFG, CDFA, and other organizations and agencies.

The Central Valley of California is the most important wintering area for waterfowl in the Pacific Flyway, supporting 60 percent of the total population. Historically, the Central Valley contained more than four million acres of wetlands; however, only 291,555 acres remained in 1990 when the CCVHJV was first implemented. The primary cause of this wetland loss was conversion to agriculture, flood control, and navigation projects, and urban expansion.

When completed, the CCVHJV will (1) protect 80,000 acres of existing wetlands through the fee acquisition or conservation easement; (2) restore 120,000 acres of former wetlands; (3) enhance 291,555 acres of existing wetlands; (4) enhance waterfowl habitat on 443,000 acres of private agricultural land; and (5) secure 402,450 ac-ft of water for existing State Wildlife Areas, National Wildlife Refuges, and the Grasslands Resource Conservation District. These habitat conservation efforts are intended to result in a fall flight of one million ducks and 4.7 million wintering ducks. The wintering bird totals will include 2.8 million pintails, a species whose wintering population is vitally dependent on the Central Valley.

The CCVHJV is a regional approach to conservation and management of waterfowl populations in the Central Valley, but has no specific relevance to operation and management of the Don Pedro Project.

6.4.1.14 Final Restoration Plan for Anadromous Fish Restoration Program (USFWS 2001)

This plan was released by USFWS as a revised draft on May 30, 1997 and adopted as final on January 9, 2001. This plan identifies restoration actions that may increase natural production of anadromous fish in the Central Valley of California. This plan is split up into watersheds within the Central Valley and restoration actions are identified for each watershed. It also lists the involved parties, tools, priority rating, and evaluation of each restoration action. The plan encompasses only Central Valley waters accessible to anadromous fish, including the Sacramento-San Joaquin Delta.

6.4.1.15 The Recreational Fisheries Policy of the USFWS (USFWS Undated)

This is a 12-page policy signed by John F. Turner, then Director of the USFWS, on December 5, 1989. Its purpose is to unite all of the USFWS' recreational fisheries capabilities under a single policy to enhance the nation's recreational fisheries. Regional and Assistant directors are responsible for implementing the policy by incorporating its goals and strategies into planning and day-to-day management efforts. The USFWS carries out this policy relative to FERC-licensed hydroelectric projects through such federal laws as the Fish and Wildlife Coordination Act (FWCA), the CWA, the ESA, NEPA, and the FPA, among others.

6.4.2 Additional Resource Management Plans and Agreements

In addition to the FERC approved qualifying comprehensive plans, Section 4.0 -- Cumulative Effects Analysis -- includes discussion of a number of additional plans relevant to the assessment of cumulative impacts on the lower Tuolumne River.

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8.0 CONSULTATION RECORD

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 5.18(b)(5)(G) describes the required content of the Consultation Record.

> *5.18(b)(5)(G) Consultation Documentation. Include a list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in preparation of the Environmental Document.*

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have established and maintained an extensive Relicensing Participants Email Group, which has been used to keep all relicensing participants, including agencies, tribes, non-governmental organizations (NGOs), and interested members of the public, advised of all relicensing activities. The current list of participants, by name and affiliation, is contained in Attachment B to this license application.

The total relicensing Consultation Record, to date, consists of:

- Previously filed with FERC:
  - Consultation Record filed as Appendix A to the PAD on February 10, 2011
  - Consultation Workshops Record filed as Attachment A to the Draft License Application on November 26, 2013
- Filed with this license application as Attachment B:
  - Relicensing Participants Consultation Record
  - Agency Consultation Record
  - Relicensing Website Announcements Record