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5.2.4 AQUATIC RESOURCES

This section describes the aquatic resources in the vicinity of the four Big Creek ALP Projects, including fish and aquatic macroinvertebrate communities and their habitats; state and federally listed threatened and endangered fish species; and other special-status fish and aquatic macroinvertebrate species. The first subsection describes the environmental setting, management objectives, the approach used to evaluate and assess aquatic resources, and to identify potential resource issues. The second subsection describes the affected environment for each of the four Big Creek ALP Projects, including existing conditions resulting from current operations and maintenance of the Projects, non-project activities, and natural factors. This assessment of aquatic resources was based on a review of relevant information, extensive agency and other stakeholder consultation, and results of the Combined Aquatic Working Group (CAWG) technical studies implemented in support of this analysis and application. The third subsection describes the impacts of the Proposed Action. The impacts of an additional alternative are described in APDEA, Section 6 *Comparison of Alternatives*.

5.2.4.1 Environmental Setting and Evaluation Approach

This section describes historic and current fish populations, and the management objectives for aquatic resources within the affected environment. Also provided is a brief summary of the technical studies implemented by the CAWG. Finally, the general approach for evaluating existing conditions within the affected environment is described.

5.2.4.1.1 Historic and Current Fish Populations

Historically, the steep, bedrock/boulder-dominated upper reaches of the San Joaquin watershed, above the 5,000-foot (1,524-meter) elevation, were barren of fish owing to the precipitous upstream access (State Fish and Game Commission Biennial Report, 1913-14). The SJR and its tributaries upstream of Mammoth Pool Dam historically were fishless. Also fishless were Big Creek, Stevenson Creek and their tributaries, which join the SJR downstream of Mammoth Pool Dam, but passage barriers prevent fish migration from the SJR. Since then, several species of trout were stocked in many of the alpine reaches of the upper watershed by settlers, soldiers, fishermen, and government agencies, with the intent to establish consumptive use and sport fisheries (State Fish and Game Commission Biennial Reports, 1913-14, 1915-16, 1919-20)[1]. The stocking history over the past 150 years within the Project Area is summarized in Appendix C of the CAWG 7 Fish Population Report (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Even today, reaches of several tributaries of the SFSJR and of Big Creek remain fishless.

[1] Brown and brook trout, native to Europe and the eastern U.S, respectively, are not currently stocked. Rainbow trout has been extensively stocked with out-of-basin strains, and continues to be stocked in portions of the basin. Golden trout are not native to the SJR drainage, but were introduced.

Historically, the portion of the SJR upstream and downstream of Redinger Lake was a transition zone between species adapted to warm water and those adapted to colder water. The species composition in this reach shifted seasonally and annually depending on water supply and water temperature. Moyle (2002) describes the pikeminnow-hardhead-sucker assemblage as currently occupying a narrow altitude range in the Sierra Nevada foothill streams of the San Joaquin drainage, from 27 to 450 m (89 to 1,476 feet) above mean sea level (MSL). The Big Creek Powerhouse 3 is at an elevation of 1,414 feet MSL, which indicates a portion of the Project Area is within this range.

Currently, fish populations of streams in the majority of the Project Area are dominated by differing combinations of four species of trout (rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), or rainbow x golden hybrids (*Oncorhynchus mykiss x Oncorhynchus mykiss aguabonita*)), depending on the stream reach. Rainbow trout is the only trout species currently stocked, and many trout populations are self-sustaining. The presence of trout species not currently stocked indicates these populations are self-sustaining. The bypass reach of the SJR downstream of Dam 6, which generally has warmer summer water temperatures than streams in the upper watershed, supports a pikeminnow-hardhead-sucker assemblage, and has low numbers of trout. The status and origin of fish species found within the Big Creek System are listed in Table 5.2.4.1-1. The life histories, phenology, and general habitat requirements of fish species in Project impoundments and streams are discussed in Attachment H - Life History and Habitat Requirements of Fish Species in the Project Area (Volume 4 (Book 5)).

5.2.4.1.2 Reservoir Fish

Reservoir fish species include trout, Sacramento sucker (*Catostomidae occidentalis*) and prickly sculpin (*Cottus asper*), as well as introduced species such as kokanee (*Oncorhynchus nerka*), smallmouth bass (*Micropterus dolomieu*), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis sp*) and carp (*Cyprinus carpio*), among others. Big Creek ALP Project reservoirs occur at a wide range of elevations, and include those characterized as alpine. Alpine lakes, such as Florence Lake and Huntington Lake, support cold-water fish including trout and, in the case of Huntington Lake, kokanee. Other Project reservoirs, such as Shaver Lake and Mammoth Pool Reservoir, are characterized by Moyle (2002) as mid-elevation, Central Valley reservoirs. He describes these reservoirs as often supporting warmwater fish species in surface and edge waters and cold water species (salmonids) in deeper, cooler waters. Warmwater species include, among others, bass and other centrarchids. Cold water species found in Mammoth Pool and Shaver include trout and, in the case of Shaver Lake, kokanee.

5.2.4.1.3 Stream Fish

<u>Trout and Salmon</u>

Streams in the majority of the Project Area are dominated by trout, including rainbow trout, brown trout, brook trout, and rainbow x golden hybrids (CAWG 7, Characterize

Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Rainbow trout occur in many streams throughout the Project Area, and probably are the most widely distributed fish in California (Moyle 2002). They are found at a wide range of elevations and temperatures. Golden trout are native to the upper Kern River basin at elevations above 2,300 meters (7,456 feet) (Moyle 2002), but were introduced into this drainage and can interbreed with rainbow trout. Brown trout, also an introduced species, has a wide distribution in California waters and within the Project Area. Brook trout, another introduced species, are among the most cold-tolerant of the trout species, and are found in small, higher-elevation streams. In many of these streams, they may be the only trout species present.

Native Transition Zone

A *native transition-zone* fish community is found in the Stevenson Reach (Big Creek Dam 6 to Redinger Lake) of the SJR. The *native transition-zone* fish community occurs in those mid-elevation streams and rivers that are included in Moyle's (2002) *pikeminnow-hardhead-sucker fish assemblage.* The pikeminnow-hardhead-sucker fish assemblage is part of the *Native Cyprinid-Catostomid Zone* community[2] (Moyle 1976). The native *transition-zone* community[3] exists between the *Native Cyprinid-Catostomid Zone* community on the SJR valley floor and the *Rainbow Trout Zone* community[4] in the higher elevations. In the SJR, the pikeminnow-hardhead-sucker assemblage generally occurs in lower elevation streams than the rainbow trout assemblage,[5] although rainbow

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[2] The *Native Cyprinid-Catostomid* community, as described by Moyle and Nichols (1973) and Moyle (1976), is characterized by the presence of hardhead, sucker, and Sacramento squawfish (pikeminnow). The stream and river habitats within this zone can be characterized as containing deep rocky pools and wide shallow riffles. Water temperatures may become quite warm, with daily average usually exceeding 20°C. Rainbow trout tend to be present on a limited basis due to summer water temperatures.

[3] The native *Transition-Zone* community may be characterized as occurring in those streams and rivers which largely correspond to the *Native Cyprinid-Catostomid* community's (corresponding to Moyle's (2002) *pikeminnow-hardhead-sucker fish assemblage*) characteristics, but are transitional (intermediate) with that of the *Rainbow Trout Zone* community (Moyle and Nichols 1973, Moyle 1976). A principal feature of this community is that habitat conditions can support rainbow trout during much of the year during normal water years. During one or more of the warm summer months for normal and dry water years, conditions become limiting to rainbow trout due to warm temperatures. During wetter years, adequate conditions for rainbow trout may persist through the summer months.

[4] The *Rainbow Trout Zone* community originally was characterized by clear headwater streams of higher gradient. These streams generally contain more riffles than pools and water temperatures are cooler. Substrates of this zone are generally characterized by cobbles, boulders, and bedrock and the banks are well shaded (Moyle and Nichols 1973, Moyle 1976).

[5] The rainbow trout assemblage (Moyle 2002) is found in clear, cold, high-elevation, high-gradient streams. The dominant native fish include rainbow trout, but additional species include sculpin, Sacramento sucker, speckled dace, and in some streams, California roach. The rainbow trout assemblage has been extended by extensive trout planting programs, poisoning operations in stream sections normally inhabited by the pikeminnow-hardhead-sucker assemblage, and habitat created in cold tailwaters below dams (Moyle 2002). Non-native trout species have also been introduced into this assemblage.

trout can occur within the native transition-zone community. Thus, rainbow trout can be found with the pikeminnow-hardhead-sucker assemblage in the upper limits of the transition zone. Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker, hardhead (*Mylopharodon conocephalus*), rainbow trout, brown trout and prickly sculpin were found in Project bypass reaches within this transition zone.

Moyle (2002) reports that this native assemblage of the Sacramento-San Joaquin rivers is currently in decline in California and especially in the San Joaquin Valley. However, this assemblage has been relatively stable over a number of years in Redinger Lake and the SJR between Redinger Lake and Big Creek Powerhouse 4. Redinger Lake is located downstream of Big Creek Powerhouse 3 (Redinger Lake is not part of the ALP projects). Native species comprised over 91% of the fish collected during qualitative surveys in Redinger Lake in 1995 and hardhead comprised 46% of the total catch (SCE 1997). Adult hardhead likely migrate into the Stevenson Reach of the SJR to spawn, and utilize stream habitat for fry and juvenile rearing.

5.2.4.1.4 Macroinvertebrates

The streams support diverse communities of aquatic macroinvertebrates. A few benthic macroinvertebrate taxa were abundant, regardless of site location or stream (CAWG 10, Macroinvertebrates, 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)). Many of these were members of families within the Diptera (flies) and included Orthocladiinae, Tanytarsini, and Simuliidae. The most common family of the Ephemeroptera (mayflies) was Baetidae. The most common Plecoptera (stoneflies) were members of the family Nemouridae. For Trichoptera (caddisflies), the most common family was Hydropsychidae. Other families and genera of these groups were abundant in some individual streams, as well.

Visual surveys for mollusks located a few individuals, generally small in size, at a limited number of locations downstream of the Project Area[6]. Crayfish trapping in Shaver Lake and Mammoth Pool Reservoir suggests that crayfish are well distributed within these reservoirs.

5.2.4.1.5 Regulatory Status and Management Objectives

No threatened or endangered fish species, state of federal, have been documented in the Project Area. Historically, spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss)* both occurred in the San Joaquin Basin as far upstream as the vicinity of the present-day Mammoth Pool Dam (Yoshiyama, et al. 1998). Prior to the construction of Mammoth Pool Dam, impassable dams, including Friant Dam (SJR RM 267) and Kerckhoff Dam (SJR RM 292), were constructed on the

[6] A mollusk survey was conducted in the area of Native American traditional harvest sites in a Project bypass reach not part of the four licenses considered under the ALP. The results are provided in Volume 6, with other confidential information related to cultural resources.

SJR, preventing anadromous fish passage. Therefore, these species are not present in the Project Area.

Hardhead (*Mylopharodon conocephalus*) are present in the SJR downstream of Dam 6 (Stevenson Reach). Hardhead is classified as a sensitive species in Region 5 of the U.S. Forest Service (which includes the Sierra National Forest) (USFS-DA 1998), and is listed as a California Department of Fish and Game (CDFG) species of concern (Class 3 Watch List) (Moyle, et al. 1995).

The USFS Record of Decision for the Sierra Nevada Plan Amendments (USFS-DA 2004) lists as a management objective:

> Maintain instream flows to protect aquatic systems to which species are uniquely adapted. Minimize the effects of stream diversions or other flow modifications from hydroelectric projects on threatened, endangered, and sensitive species.

For stream reaches, the applicable management objectives of the Central Valley Water Quality Control Board (CRWQCB) Basin Plan for the Central Valley Region Sacramento River Basin and the SJR Basin (CRWQCB 1998) include the following beneficial uses related to aquatic resources:

> Warm Freshwater Habitat (WARM) – Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
>
> Cold Freshwater Habitat (COLD) – Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

CDFG management objectives for large Project reservoirs focus on maintaining adequate populations of lake-rearing sport fish (e.g., rainbow trout, brown trout, and kokanee). For Shaver Lake, a specific objective is to also provide suitable habitat for warmwater fisheries (smallmouth bass, blue gill, and crappie) while protecting habitat for cold-water fish.

For most streams in the Project vicinity, management objectives focus on providing suitable habitat conditions in Project waters to support coldwater fish populations, and other aquatic species. Management objectives also focus on managing Project waters to protect warmwater fish species, or to provide seasonal transition zones, where appropriate. CDFG currently manages several project bypass reaches as put and take or stock and grow fisheries for rainbow trout.

5.2.4.1.6 Technical Study Reports

Technical studies were conducted from 2000 through 2004 to characterize the aquatic resources of the four Big Creek ALP Projects and related bypass stream reaches. Additionally, information from other studies in the available literature evaluating factors that affect aquatic resources was used for evaluation of the affected environment and potential Project impacts. Detailed descriptions of the methods are provided in the Final Technical Study Plans for the Big Creek Alternative Licensing Process (Final Technical Study Plan Package (FTSPP) (SCE 2001; Volume 4, SD-B (Books 6 and 21)). Study results are provided in the 2003 through 2005 Technical Study Report Packages (TSRP) for the Big Creek Alternative Licensing Process (2002 Final Technical Study Report Package (2002 FTSRP) (SCE 2003; Volume 4, SD-C (Books 7-10, 21 and 22)), 2003 FTSRP (SCE 2004a; Volume 4, SD-D (Books 11-17 and 23)), and 2004 Final TSRs (FTSR) and 2005 Supplemental Reports (SCE 2004b; Volume 4, SD-E (Books 18, 19 and 24)). The studies include:

- CAWG 1 Characterize Stream and Reservoir Habitats Report (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23))
- CAWG 1 Supplemental (SCE 2003; Volume 4, SD-D (Book 11))
- CAWG 2 Geomorphology Report (SCE 2003; Volume 4, SD-C (Books 7 and 21))
- CAWG 3 Instream Flow Studies (SCE 2003; Volume 4, SD-D (Books 11 and 23))
- CAWG 5 Water Temperature Monitoring Report (SCE 2004a; Volume 4, SD-D (Books 12 and 23))
- CAWG 5 Water Temperature Modeling Report (SCE 2004b; Volume 4, SD-E (Books 18 and 24))
- CAWG 6 Hydrology Report (SCE 2004a; Volume 4, SD-D (Books 13 and 23))
- CAWG 7 Characterize Fish Populations Report (SCE 2003; Volume 4, SD-C (Books 8 and 21))
- CAWG 8 Amphibians and Reptiles (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 9 and 21) and SD-D (Books 14 and 23))
- CAWG 9 Entrainment Report (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26))
- CAWG 10 Macroinvertebrate Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23))
- CAWG 13 Anadromous Fish (SCE 2004a; Volume 4, SD-D (Books 14 and 23))
- CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23))

Data collected during these studies were used to describe the environmental setting and existing conditions in the affected environment, as well as to assess impacts and evaluate potential enhancement measures.

5.2.4.1.7 Key Information Collected

Habitat

Habitats of Project Area impoundments and streams were characterized and mapped. Flow-related habitat was evaluated based on two methods. One approach involved the use of Physical Habitat Simulation (PHABSIM) models of the Instream Flow Incremental Methodology (IFIM) to assess habitat for fish life history stages and spawning (Milhous, et al. 1989). Alternatively, the wetted perimeter approach was used to evaluate flows for fish and macroinvertebrate habitat in smaller streams, generally without upstream storage (Lohr 1993) and with insufficient depths to obtain accurate velocity measurements or widths to obtain an adequate number of verticals along transect lines at natural low flows.

Water Temperature

Water temperature monitoring was conducted throughout Project waters for two years, 2000 and 2001 (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Meteorological data also were collected in key locations. The 2000 summer monitoring period represents an Above Normal Water Year with normal meteorology, and the 2001 summer monitoring period represents a Dry Water Year with warm meteorology (i.e., extreme conditions). An updated version of the U.S. Fish and Wildlife Service's (USFWS) SNTEMP model (Theurer, Voos, and Miller 1984) was used to model stream water temperatures in relation to different flows and meteorological conditions (CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)). Models were calibrated for bypass reaches with warm summer water temperatures to assess the effect of alternative flow regimes under a range of meteorological conditions for water temperature enhancement. The modeling used two sets of meteorological conditions to represent an "average or normal condition" (Above Normal Water Year flows with average meteorological conditions) and an "extreme condition" (Dry Water Year flows with 20% exceedance air temperatures [warm] and associated meteorology).

Fish Collection

Fish were sampled in Project impoundments and study streams using a variety of techniques including electrofishing, netting, snorkeling, and hydroacoustic surveys.

All fish captured during the CAWG 7 study fish sampling (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) were identified to species, measured for length, and weighed. Scale samples were collected from trout and hardhead for age and growth determinations. Individual fish were examined for external signs of disease. Growth and condition factors[7] for trout were evaluated for

[7] The ratio of the weight of a fish to its length, called condition factor, is an indicator of the robustness or state of nutrition of fish. Comparisons can be made to other populations from published values, or to a standard for a species. However, comparisons between species are not valid.

fish at the individual and population levels. Growth evaluations were based on a comparison of fish length at age between bypass and reference sites, and reference literature. The criterion used for mean condition factor for healthy, adult trout is a condition factor of greater than, or equal to, 1.0[8]. At the population level, the age structure and size of the population gives an indication of whether successful reproduction and recruitment occurs. Trout populations also were evaluated for adult density and total biomass, and compared to values that would be expected in unimpaired Sierra Nevada streams at comparable elevations (Attachment J - Regional Fish Densities Memo (Volume 4 (Book 5)).

Macroinvertebrates

The CAWG 10 Macroinvertebrates study (CAWG 10, Macroinvertebrates, 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)), implemented in 2002, involved three major elements: 1) application of the California Stream Bioassessment Procedure (CSBP); 2) visual surveys for mollusks at fish sampling locations; and 3) crayfish trapping in Shaver Lake and Mammoth Pool Reservoir.

5.2.4.1.8 Approach to Evaluation

Evaluation of the fish in the various stream reaches and impoundments was based upon the characteristics described by Moyle, et al. (1998) to evaluate whether fish populations are in “good condition.” CAWG studies addressed these characteristics to the extent practicable and appropriate.

Evaluation of Fish Populations: Fish in Good Condition

Moyle, et al. (1998) describes characteristics of “fish in good condition” at three levels: individual, population, and community. At the individual level, fish should have a robust body, be free of disease, parasites and lesions, have reasonable growth rates, and have appropriate behavioral patterns. At the population level, multiple age classes indicate reproduction is occurring, the population should be viable and self-sustaining (adequate numbers), and individuals should be healthy. At the community level, co-evolved species should dominate the community, there should be a predictable community structure (limited niche overlap and trophic levels), and the community should be resilient to stochastic events. Many Project reaches that historically were fishless are now dominated by introduced trout species, which have not coevolved with local, native, aquatic communities or physical conditions. Most of the large reservoirs and medium impoundments that now support fisheries, historically did not exist.

[8] In the case of trout, a condition factor of 1.00 or more is considered to be an indicator of good condition, based on values found in the literature (Reimers 1963, Stickney 1991). Reimers (1963) found that experimental hatchery rainbow trout in a mountain stream had a “normal or adequate condition factor” of roughly 0.80 to 0.90, those in the range of 0.70 to 0.8 are lean but usually vigorous, and those in the range of 0.60 to 0.70 were “marginal in vitality.” Stickney (1991) found that hatchery trout should be fed to maintain a condition factor near 1.0.

Therefore, the Moyle, et al. (1998) community characteristics may not be applicable to many Project streams and reservoirs. A notable exception is the Stevenson Reach of the SJR, which is dominated by a native fish assemblage.

Macroinvertebrate Evaluation

Macroinvertebrate populations, an important source of food for fish, also were sampled and evaluated. Sampling was conducted using the California Stream Bioassessment Procedure (CSBP), visual techniques, and trapping. Densities of macroinvertebrates and taxa representing important fish food organisms were calculated.

To identify areas with potential resource issues, densities of total macroinvertebrates and densities of Ephemeroptera, Plecoptera, and Trichoptera (EPT) in bypass reaches were compared to unimpaired reference reaches. Results of wetted perimeter studies conducted as part of flow-related habitat assessments for fish also were used to evaluate the potential for proposed and alternative actions to affect the amount of habitat available for benthic macroinvertebrates.

Temperature Evaluation

Water temperatures were evaluated with respect to information for trout and hardhead found in the literature and target water temperatures used by the State Water Board. Stream temperature conditions were assessed through two years of temperature monitoring and the use of simulations of water temperatures using a calibrated stream temperature model. Results were compared to temperature needs of fish species. A literature review for rainbow trout response to water temperature is provided in Attachment I – Trout Temperature Requirements - Literature Review (Volume 4 (Book 5)). Water temperature criteria applied to this evaluation are described for trout and hardhead. Daily mean temperature targets were applied to assess whether temperatures would be suitable for fish growth and daily maximum temperature targets were used to assess conditions that would stress fish. Fish can withstand short-term exposure to water temperatures higher than those needed for longer-term growth or survival without significant negative effects. A daily mean temperature of 20°C or less and a daily maximum temperature 22°C or less are the temperature targets identified by the State Water Board for Project reaches to be managed as CRWQCB COLD Freshwater Habitat.

Trout

Based upon the best available information in the literature for regional streams, the temperature evaluation criterion applied to assess conditions for suitable trout growth is a mean daily average water temperature at or below 20°C. A daily maximum temperature of 24°C was applied as an initial criterion for short-term high-temperature exposure, above which temperatures are expected to be stressful for trout, based on published study results. State Water Board target temperatures for COLD Freshwater Habitat are daily mean water temperatures of 20°C or less and daily maximum temperatures of 22°C or less. Therefore, the number of days in which temperatures exceeded a daily mean of 20°C or a daily maximum of 22°C and 24°C was tabulated for all study streams or stream segments to be managed for trout, and for Project reaches to be managed as CRWQCB COLD Freshwater Habitat. Tables provided in Appendix H of CAWG 5 (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) report the number of days during which daily mean water temperatures exceeded each of a range of temperatures from 15°C to 20°C, and the number of days daily maximum water temperatures exceeded each of a range of temperatures from 20°C to 26°C during the CAWG 5 temperature monitoring period.

The temperature criteria are based on recent studies focused on California rainbow trout stocks, which are summarized in a review by Myrick and Cech (2001) that focused on California's Central Valley populations. Myrick and Cech (2000) studied growth rates of two strains of resident California rainbow trout at temperatures of 10°C to 25°C. Growth was at a maximum near 19°C, and declined at study temperatures greater and lower than 19°C. Trout grew well at daily mean water temperatures near 22°C, but growth rates declined rapidly as temperatures approached 25°C. These studies suggest that if daily mean summer water temperatures are less than or equal to 20°C in the Project Area, conditions would be suitable for trout growth (Attachment I – Trout Temperature Requirements - Literature Review).

For brown trout, Moyle (2002, citing Armour 1994) reports preferred temperatures of 12°C to 20°C, and optimal temperatures that appear to be approximately 17°C to 18°C. Brown trout can survive temperatures up to 29°C for short periods of time, depending upon acclimation temperature. Ojanguren, et al. (2001) found juvenile trout growth was above 90% of maximal potential between 14°C and 20°C, and dropped sharply at higher temperatures (experimental temperatures were as high as 24°C), based on constant temperature exposure over 14 days. Fitting their data to the model developed by Elliott, et al. (1995), they predicted an upper limit for positive growth at 24.74°C and a minimum at 1.24°C.

Based on available literature drawn largely from laboratory studies (Cherry, et al. 1977, Raleigh, et al. 1984, Currie, et al. 1998, Coutant 1977) the upper incipient lethal temperature (UILT) for rainbow trout is within the range of 25°C to 30°C. Brown trout have been characterized as being tolerant of temperatures of up to 27°C. The U.S. Environmental Protection Agency (USEPA 1976) identified maximum weekly temperatures for survival for rainbow and brook trout as 24°C. Eaton, et al. (1995) identified upper temperature criteria for rainbow and brown trout as 24.0°C and 24.1°C, respectively. Myrick and Cech (2001) report critical thermal maximum (CTM)[9] tolerances of 27.7°C to 29.7°C for juvenile California steelhead, and as high as 32°C for Eagle Lake rainbow trout acclimated to 25°C. These studies suggest that a criterion of a daily maximum of 24°C representing a short-term exposure may be considered

[9] CTM studies subject fish to more rapid temperature increases than ILT studies. The slower rates of change of ILT studies generally reflect rates found in field observations. Critical thermal limits are higher than chronic lethal limits. The approximate cutoff for chronic values is 24 hours or greater (Myrick and Cech 2001).

conservative (very protective) for the Project Area. The State Water Board target of 22°C would be extremely protective.

Hardhead

Moyle (2002) said of hardhead, "Most streams in which they occur have summer temperatures in excess of 20°C, and optimal temperatures for hardhead (as determined by laboratory choice experiments) appear to be 24°C to 28°C." These experiments primarily focused on juvenile hardhead. Preliminary work by Cech suggests that adult hardhead acclimated to water temperatures below 20°C prefer temperatures at or above 20°C (J. Cech, University of California at Davis, pers. comm. 2006). This represented the envelope of suitable temperatures for this species, and was compared to daily mean temperatures in the Stevenson Reach of the SJR and downstream, where hardhead were found.

Flow-Related Habitat Evaluation

The effects of the alternatives (No Action Alternative, Proposed Action, and CDFG Alternative) on flow-related habitat were evaluated, based on the results of the CAWG 3 reports (CAWG 3, Flow-Related Habitat - Upper Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21)), CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2004a; Volume 4, SD-D (Books 11 and 23)), CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2004a; Volume 4, SD-D (Books 11 and 23)); and Attachment E - Stranding Report (Volume 4 (Book 5)), information about hydrology (CAWG 6, Hydrology, TSRPs (SCE 2004a; Volume 4, SD-D (Books 13 and 23)), and fish life histories and habitat information (Attachment H – Life History and Habitat Requirements of Fish Species in the Project Area). The CAWG 3 Study Plan (Final Technical Study Plan Package (FTSPP) (SCE 2001; Volume 4, SD-B (Books 6 and 21)) called for assessment of flow-related habitat in larger streams where diversion occurs throughout the year, using PHABSIM, and in smaller streams where diversions occur only seasonally, using the wetted perimeter technique. Both approaches are based on measurements collected at selected transects over a range of flows. The CAWG assisted in deciding transect number and placement and approved the final selection of transects and the methods used to perform these evaluations. The potential for the alternatives to affect passage and stranding of fish and eggs was evaluated based on transects used for the PHABSIM and for the wetted perimeter studies. The evaluation of flow-related habitat is summarized briefly below.

PHABSIM provides a habitat-flow relationship for a stream based on measurements along transects placed through important habitat types. These transects are then weighted to represent the proportion of these habitat types present within the stream. PHABSIM produces an index of habitat called weighted usable area (WUA) over a series of simulated flows. WUA is an index of fish habitat, which combines the quantity and quality of the habitat. WUA is based on depth, velocity and substrate for spawning, and depth and velocity for other lifestages. When fish populations are limited by flow-related habitat, WUA may provide an indication of the effect that a given change in flow can have on fish habitat and therefore fish populations (Bovee 1982). However, when other limiting factors are in effect, there may be little or no relationship between WUA and fish population size.

For each PHABSIM reach, the amount of WUA provided at a proposed minimum instream flow (MIF) was assessed and considered in concert with other important factors potentially affecting fish populations in that reach (Attachment C – Limiting Factors (Volume 4 (Book 5)). The habitat requirements of fish were used to assess the potential effects of this flow on fish habitat and fish populations, using monthly MIFs and the habitats they would provide. Since actual stream flows are often higher than MIFs due to accretion, runoff, spills, etc., this approach provides a conservative estimate of the amount of habitat available for fish populations, as it may underestimate habitat availability. The results of this evaluation are provided in Attachment D – WUA Tables (Volume 4 (Book 5)). Also included in these tables is the percent of maximum WUA provided by a flow for adult rearing and spawning trout, with a separate table for native transition zone species, where present. These are used by resource agencies in assessing MIFs. However, the analyst applying such approaches needs to carefully consider whether flow-related habitat is likely to be limiting fish populations. Routine insistence on a specific percentage of maximum WUA often ignores the underlying assumption that WUA will only be predictive of the response of a fish population to changes in flow if flow-related physical habitat is limiting fish populations. Where this is not true, then increasing MIFs is unlikely to increase fish populations, although providing potential increases in habitat. Also, particular life-stages could be limiting a population, which should then influence the selection of flows to increase WUA for that limiting life-stage.

In streams where PHABSIM was applied, a habitat time series analysis also was conducted based upon the CAWG's protocols (Attachment K – Habitat Time Series Analysis (Volume 4 (Book 5)). The habitat time series evaluates the daily flow values over a period of record (typically 20 years in this study) to estimate the amount of habitat (WUA) that would be provided over time. Adult and juvenile habitat was evaluated using flows present throughout the year. Spawning habitat was assessed from April through June for rainbow trout, and October through December for brown trout. Using the daily habitat values, the time series analysis generated exceedance statistics (the probability that a specified amount of habitat will be provided more than a given percentage of the time) for each alternative (Attachment K – Habitat Time Series Analysis). The time series analysis incorporates flows higher than the proposed MIFs when the presence of such flows is indicated by the existing hydrologic record and by implementation of proposed channel riparian and maintenance (CRM) flows. However, days with stream flows exceeding the extrapolation range of the hydraulic models were not included in the results. The time series analysis is based on actual flows expected to occur in a reach, which may be different than MIFs, which formed the basis of the impact analysis and so the results of the two analyses may differ.

The wetted perimeter analysis evaluates the amount of stream channel inundated by a particular flow. A range of flows is compared to the resulting width of stream bed inundated. Where sharp changes in the rate of increased bed inundation with increasing flows is detected, an assumption is made that there is a change in stream channel morphology, i.e., transition from stream channel bottom to bank. Beyond this point, additional increments of flow would provide proportionately less increased habitat (Lohr 1993). A stream flow that wets the entire bottom of the stream channel is considered protective of fish and macroinvertebrate habitat. Transects are placed through riffles, preferably, although some transects were placed through runs in streams where riffles were limited in abundance. This is because riffles are considered to be the highest in productivity for macroinvertebrates because of the increased bottom surface area, aeration and complex topography, and because riffles can provide limitations for fish passage due to their limited depth. Alternatives were evaluated based on whether flows were protective of fish and invertebrate habitat. Hydrology also was considered, as many of these streams experience low flows under unimpaired conditions during the summer and fall that may be less than the protective flow identified using the wetted-perimeter analysis. Where such flows are present, these flows likely represent the most restrictive habitat for fish populations (Attachment C – Limiting Factors). An additional factor considered in this evaluation is the structural nature of the habitat in these streams, and the likely effect of flow changes on this habitat, as described in Attachment C – Limiting Factors.

Passage flows were evaluated using the riffle transects, as riffles are the most likely place for fish passage to be restricted by flow. Passage was evaluated based on a set of passage depth and velocity criteria for trout (Thompson 1972). Thompson's approach was used to identify the flow that would allow fish to migrate upstream through a typical riffle (selected by the CAWG to represent riffle habitats in general within each stream). For each alternative, the proposed MIFs were compared to passage flows to determine potential passage opportunities. A second consideration in this evaluation was the frequency of occurrence of structural barriers to fish passage within a stream. Structural barriers (waterfalls, bedrock sheets, trench chutes) often cannot be made passable by providing a different amount of flow in the stream. Where structural barriers occurred more frequently than once in every 1,000 feet of stream on average, these barriers would likely limit upstream fish migration, regardless of flow.

Fish stranding was evaluated using the change in wetted perimeter observed at all transects in the reach as flows receded. This analysis focused on the period from May through July, when young of spring-spawning fish, such as rainbow trout, are just emerging from the redds. At this time, they are poor swimmers and associate most strongly with the stream margins. These factors make them more susceptible to stranding caused by changing water levels than at other times of their lives. The potential for stranding was assessed based on the largest decrease in wetted perimeter that occurred during the evaluation period. A larger decrease in wetted perimeter is expected to create a larger potential for stranding. This analysis looked at flow changes in MIFs, since flow changes due to CRM flows were largely beyond the range of extrapolation of the hydraulic models. Flow changes due to other factors, (e.g., local area runoff, spills, rainstorms) are beyond the control of the Project and are assumed to be similar for all of the alternatives.

Redd stranding was evaluated for PHABSIM streams, where information on spawning habitat was available (Attachment E - Stranding Report). For each alternative, changes in MIFs were evaluated to determine the potential for stranding rainbow and brown trout redds. The spawning and incubation evaluation period for rainbow trout was April through June, and for brown trout from October through May. For the redd stranding, using a starting flow that represented the range of alternatives, the areas suitable for spawning were identified and tracked as flows were reduced. The spawning area was considered viable if it was covered by a water depth of 0.1 ft or more. The dewatering potential was evaluated using the percentage of viable spawning area remaining at the end flow. These values were then used to assess dewatering potential for each alternative. The results are sometimes expressed as ranges of dewatering potential. As with the fish stranding analysis, the effect of CRM flows could not be evaluated, and flow changes due to other factors are assumed to be similar for all of the alternatives.

Operations and Reservoir Levels Evaluation

SCE (2005) developed a flow-routing model, HydroBasin, to evaluate flows, reservoir levels, and generation. This model provides weekly flows and reservoir volumes based on changes in MIFs, releases for CRM flows, and whitewater boating flow releases. The model results were used to assess the effects of the Proposed Action and CDFG Alternative on reservoir elevations and storage.

Entrainment Evaluation

Hydroelectric power generation potentially can result in the entrainment and subsequent mortality of fish due to impingement on intake screens (if of sufficiently narrow openings), rapidly changing pressures during passage through penstocks and powerhouses, or from physical trauma caused by turbine passage. The CAWG 9 study (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)) characterized entrainment mortality at power diversions in the Big Creek Hydroelectric system.

A three-tiered study approach was implemented. The first step was to review scientific literature addressing potential turbine mortality associated with turbine types used at Big Creek power generation facilities. The second step was to conduct an initial evaluation of the potential for entrainment and mortality at major Project intakes, including intakes in the major and medium-sized impoundments. The evaluation was based on power intake design, location, depth, water velocities, type of intake screen or trash rack, and relative abundance of potentially vulnerable fish near the intakes. Information on the abundance of fish in the vicinity of intakes at the major ALP Project reservoirs was determined from fish sampling data and hydroacoustic data collected as part of the CAWG 7 Fish Populations Report (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). The potential for entrainment at smaller diversions also was evaluated based on characteristics such as intake design, approach velocities, and presence of potentially vulnerable fish near the intakes. The third step in the study approach was to select locations for entrainment sampling, with concurrence of the CAWG, and then document actual entrainment rates at intakes most likely to result in sizable fish entrainment and potential mortality.

5.2.4.2 Affected Environment

This section describes the affected environment. Information from the various studies associated with the existing Project operations is summarized. Identified resource issues and the potential limiting factors for aquatic species in the bypass reach are discussed. A more detailed description of these issues is found in Attachment C – Limiting Factors.

5.2.4.2.1 Mammoth Pool Project (FERC Project No. 2085)

Management Objectives

Management objectives for stream reaches include the same beneficial uses for Cold and Warm Freshwater Habitat (COLD and WARM) identified in the Basin Plan (CRWQCB 1998).

CDFG manages Mammoth Pool Reservoir as a put-and-take fishery for catchable rainbow trout, and a stock-and-grow fishery for fingerling and subcatchable rainbow trout. Rock Creek also is currently managed by CDFG as a put-and-take fishery.

Mammoth Pool Reservoir

Over a 21-year period of record (1980 to 2001), average maximum yearly storage was 114,922 acre-feet and average minimum yearly storage was 12,764 acre-feet corresponding to water levels of approximately 3,325.3 and 3,175.7 feet above MSL, respectively (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). At the spill elevation of 3,330 feet above MSL, the surface area of Mammoth Pool Reservoir is 1,952 acres and storage is 119,940 acre-feet.

Habitat

Reservoir Fluctuation

During most years, Mammoth Pool Reservoir fills during the spring, reaching its maximum volume by June, and then drops to its annual minimum level by the beginning of November. Since the reservoir has steep sides, shallow water habitat is relatively rare at all reservoir elevations. The amount of deep-water habitat changes relatively little with changes in reservoir elevation (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Water temperatures and thermal stratification in the reservoir affect temperatures of water released to the bypass reach. Thermal stratification typically occurs in Mammoth Pool Reservoir during the summer months (June through August). The reservoir begins to mix in late August or early September. By September, the reservoir is well-mixed over much of its depth and is fully mixed by October.

In 2001, when stratified, the mean temperature for the epilimnion (upper water layer of the reservoir) ranged from 21.7°C (June) to 22.6°C (July), and the hypolimnion (deeper layer) ranged from 15.0°C (June) to 17.4°C (July) at the dam. A similar pattern occurred in 2000, but with lower surface temperatures during the stratified period (Figure 5.2.4.2-1).

Both the Howell-Bunger Valve (and fishwater generator) used for making instream releases and the powerhouse intake are situated at considerable depth in the reservoir near the dam, where the coolest water is found during periods of temperature stratification. Over the course of the summer, cooler bottom water is withdrawn from the reservoir through these deep outlets to provide instream flows and generate electricity. This decreases the cool water volume in the hypolimnion of the lake. Temperature monitoring results from 2001, a Dry Water Year with above average air temperatures, represent temperature and stratification patterns during an extreme year. Seasonal summer warming of the lake and the inflow of warm water from upstream (Figure CAWG 5-25, CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) increased the volume of the epilimnion and began the mixing of warm and cool waters, so instream releases contained an increasing proportion of warm epilimnetic waters that continued to heat over the summer. Temperatures deep in the lake warmed from June through September, but water with temperatures desirable for trout growth (less than 20°C) were available throughout this period. However, by mid-September, only the deepest waters, in a small area in the deepest portion of the lake (45 m and deeper in Figure 5.2.4.2-1) had temperatures that did not exceed 20°C. While a thermal gradient remained near the bottom in September, the reservoir was mixing (i.e., thermal stratification was no longer present through most of the lake) and water temperatures through most of the water column exceeded 20°C. By late August to September, there was little or no cooler water available for instream flow releases. Toward the end of October, the reservoir was fully mixed with no thermal gradient, but ambient temperatures cooled resulting in cooler water temperatures in the reservoir. This resulted in cooler water again being released from the dam.

The temperatures of inflows from the SJR upstream of Mammoth Pool Reservoir exceeded a daily mean of 20°C for eight days (July through September) in 2001, but did not exceed 18°C in 2000. There was no day when observed water temperatures exceeded a daily maximum of 22°C or 24°C in either year of monitoring in the SJR upstream of the reservoir (CAWG 5 Appendix H Tables H-A42 and H-B42; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Water temperatures desirable for trout growth (up to 20°C) were available within the reservoir in the summer in 2000, but temperatures exceeding 20°C (ranging from 20°C to 21°C) were observed through most of the water column on

September 19, 2001, after the reservoir destratified. Toward the end of October, temperatures cooled, ranging from 17.7°C to 18.3°C throughout the water column.

Aquatic Community

Stocking

Historically rainbow trout, brook trout, coho salmon, and Eagle Lake strain rainbow trout were stocked in Mammoth Pool Reservoir. While no historical stocking records were found for brown trout, they are known to have been stocked in waters upstream of Mammoth Pool Reservoir. The presence of coho salmon has not been documented since 1977, the last year they were stocked. Rainbow trout is the only species currently stocked in Mammoth Pool Reservoir (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). During the period 1998 to 2002, CDFG has stocked an average of 7,975 catchable-sized rainbow trout, 4,002 subcatchables, and 12,070 fingerlings per year in Mammoth Pool Reservoir.

Fish and Crayfish

The aquatic community in Mammoth Pool Reservoir appears to be healthy, supporting a self-sustaining population of brown trout and a put-and-take rainbow trout fishery (Table 5.2.4.2-1). Mean condition factors for trout were greater than 1.00.

Sampling data indicate the brown trout population dominated the fish community (71% of the sampled fish) followed by rainbow trout (29%). No other species of fish were collected. Rainbow trout that were collected appeared to be of hatchery origin, based on physical appearance and scale analysis (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Fish densities were greatest at mid-lake and relatively low densities were found at the depth and location of the intake to the Mammoth Pool Powerhouse (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Crayfish also are found in Mammoth Pool Reservoir. Crayfish are abundant, with a catch per unit effort (CPUE) of approximately 0.44 crayfish/hour (10.90 crayfish/trap-night) collected in 2002 (CAWG 10, Macroinvertebrates, 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Summary of Resource Issues

No aquatic resource issues were identified for Mammoth Pool Reservoir. Mammoth Pool Reservoir loses thermal stratification and mixes in the fall of all years. In September of drier and warmer years, when the lake mixes, water temperatures exceed 20°C through much of the water column. However, a small volume of cooler water is available in the deepest portion of the lake for use by fish. Under existing conditions, flows to Mammoth Pool from upstream of the reservoir occasionally exceed 20°C in the summer of warm, dry years. Fish appear to be in good condition under the Moyle, et al. (1998) criteria for individual and population levels.

San Joaquin River - Mammoth Pool to Dam 6 (Mammoth Reach)

The Mammoth Reach of the SJR is the bypass reach of the SJR from the Mammoth Pool Dam downstream to the Mammoth Pool Powerhouse, a distance of approximately 8.4 miles.

Habitat

Physical Habitat

The Mammoth Reach is a moderately low gradient, boulder/bedrock stream with areas of finer substrate materials, and lies within a deep, steep-walled bedrock canyon. The stream channel consists of Rosgen Level I B and G channels, with B channel type predominant in the lower portion of the reach. Habitats include large deep pools with long run-type habitats and complex habitats such as pocket water and riffles (Table 5.2.4.2-2). Pools are the dominant habitat comprising 72.2% of the reach length. Bedrock and boulders dominate the channel substrate and there is a low abundance of spawning gravel (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)), although neither spawning gravel nor spawning habitat appears to limit the trout population.

Water Temperature

Water temperatures were recorded at four locations in the Mammoth Reach during spring through fall of 2000 and 2001 (Figure 5.2.4.2-2) (Table CAWG 5-120; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Exceedance analysis of air temperatures, which affect water temperatures in the Mammoth Reach, indicate conditions were warmer than average in May, June, and August of 2000 (Table CAWG 5-11; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). The summer 2001 monitoring period represented a much warmer than average period with all months warmer than average except July. May 2001 was the warmest May in the period of record.

During 2001, at the monitoring station immediately below the dam, release water temperatures were cooler than temperatures in the reach of river upstream of Mammoth Pool Reservoir in the summer months, until mixing in the reservoir began (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Mean monthly water temperatures ranged from 14.7°C to 19.8°C, and maximum temperatures did not exceed 21.0°C (Table 5.2.4.2-3) (Table CAWG 5-120; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed

20°C during 2000 (Above Normal Water Year) and exceeded 20°C for 13 days in September of 2001 (Dry Water Year with warmer than normal temperatures), when the reservoir was mixing (Figure 5.2.4.2-2) (CAWG 5 Appendix H Table H-A43; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

At the monitoring station upstream of Rock Creek, mean monthly water temperatures ranged from 15.0°C to 19.3°C in 2000 and 16.4°C to 19.2°C in 2001. Daily maximum temperatures exceeded 22°C for 1 day (but did not exceed 22.3°C) in 2000, and exceeded 21°C for two days (but did not exceed 21.3°C in 2001) (Table CAWG 5-120; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures exceeded 20°C for eight days in 2000 and four days in 2001 (CAWG 5 Appendix H Table H-A44; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperature exceedances are presented in Table 5.2.4.2-3.

Upstream of Ross Creek, mean monthly water temperatures ranged from 14.4°C (October 2000) to 20.8°C (July and August 2001), and daily maximum temperatures did not exceed 24.8°C (July 2001). Daily mean temperatures upstream of Ross Creek exceeded 20°C for 30 days in 2000, primarily in July and August and 67 days in 2001 (Figure 5.2.4.2-2) (CAWG 5 Appendix H Table H-A45; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for 31 days in 2000 and 74 days in 2001. Daily maximum temperatures exceeded 24°C for four days in 2000 and eight days in 2001 (Table 5.2.4.2-3).

Upstream of the Mammoth Pool Powerhouse, at the most downstream water temperature monitoring station, mean monthly water temperatures ranged from 14.5°C (October 2000) to 20.7°C (July 2001), and daily maximum temperatures were as high as 26.8°C (one day in July 2000). Daily mean temperatures exceeded 20°C for eight days of 34 days monitored in 2000 (primarily August) and 65 days in 2001 (Figure 5.2.4.2-2) (CAWG 5 Appendix H Table H-A46; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for 13 days in 2000 and 62 days in 2001, but rarely reached or exceeded 24°C (Table 5.2.4.2-3). At the Mammoth Pool Powerhouse tailrace, the discharge of cold water withdrawn from the hypolimnion of Mammoth Pool Reservoir resulted in cool temperatures from June through August.

Water temperatures in the portion of the bypass reach downstream of Rock Creek were found to be warmer than desirable for trout growth (daily mean temperatures greater than 20°C).

Aquatic Community

Fish Stocking

No historical fish stocking records were found for the Mammoth Reach of the SJR (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Fish sampling was conducted at two sites in the Mammoth Reach during 2002 (one located in the vicinity of Rock Creek and the other downstream of Ross Creek). The results indicate that this reach supports self-sustaining populations of Sacramento sucker, rainbow trout, and brown trout. The fish communities at both sites are predominantly composed of Sacramento sucker, which represents over 70% of the fish abundance at both sites. Total trout density is greater downstream of Ross Creek than near Rock Creek: 436 trout/km compared to 241 trout/km, and 172 versus 112 catchable trout/km (trout greater than 150 mm fork length [fl]), respectively. Among the trout, rainbow trout have greater density in the lower site and brown trout have greater density in the upper site (Table 5.2.4.2-4). Multiple age classes are present for all three species, indicating that recruitment is successful for each (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). The mean condition factors for all species are greater than 1.00.

Benthic Macroinvertebrates

Densities of total macroinvertebrates at all sites in the bypass reach are greater than those in the SJR upstream of Mammoth Pool Reservoir (Table 5.2.4.2-5). Densities of EPT (Ephemeroptera, Plecoptera, and Trichoptera; mayflies, stoneflies, and caddisflies) in the bypass reach are greater than EPT densities in the SJR upstream of Mammoth Pool Reservoir at all bypass reach sites except the site approximately 3.4 miles downstream of Mammoth Pool Dam. EPT densities are greatest at the two most downstream sites in the bypass reach.

Summary of Resource Issues

The principal resource issues for the bypass reach under existing conditions are low trout abundance and warm summer water temperatures in the lower portion of the reach that are, at times, warmer than is suitable for good trout growth, particularly in drier water years with warm air temperatures. Uncontrolled spills from Mammoth Pool Dam in the spring of Wet and Above Normal Water Years likely scour embryos and result in substantial fry mortality, which may affect recruitment in some years.

The existing fish community in the bypass reach below Mammoth Pool Dam is dominated by Sacramento sucker. The densities of trout are lower than expected, compared with unimpaired regional streams at a relatively similar elevation range.

The high numbers of Sacramento sucker in this reach suggest that Sacramento suckers are better adapted to the water temperatures under existing conditions and the general channel structure (predominance of large pools with deep runs) of the bypass reach than are trout. However, there is little indication in the literature of direct competition between suckers and trout (Moyle 2002); although removal of Sacramento sucker and native minnows has allowed temporary increases in trout abundance in southern Sierra Nevada streams, such as the Kern River (Mills 1974).

Daily mean water temperatures in the lower portion of the bypass reach are at times warmer than 20°C, which is the temperature that is generally regarded as being the upper daily mean water temperature consistent with good trout growth. This is especially true in drier water years with warm air temperatures. Water temperatures found in the SJR near the confluence with Ross Creek, and downstream of that confluence (the lower mile of the reach), may reach levels stressful to trout. However, sampling in 2002 (the second of two consecutive Dry Water Years) indicated that trout densities are actually greater downstream of Ross Creek than those sampled upstream near Rock Creek, where temperatures are cooler. However, summer water temperatures are sufficiently warm during warm and dry conditions to be of concern. Benthic macroinvertebrate data suggest that sufficient food organisms are available for fish.

The existing minimum instream flows (MIFs) provide sufficient physical habitat (WUA) to support the current trout population, although less than needed to support the density of trout (absent similar densities of Sacramento sucker) in reference streams at similar elevations (Attachment C - Limiting Factor Analysis). Spawning habitat is of relatively more limited abundance than that for other trout lifestages. Existing MIFs provide sufficient depth for upstream movement of adults through typical riffles in the reach. In addition, the stranding of young fish or dewatering of redds due to monthly changes in MIFs does not appear to be an issue.

Spring to early summer flows in the bypass reach are characterized by spills at very high flows in Wet and Above Normal Water Years (CAWG 6, Hydrology, TSRPs (SCE 2004a; Volume 4, SD-D (Books 13 and 23)). These flows are of sufficient magnitude to move gravel (CAWG 2, Geomorphology, 2002 FTSR (SCE 2003; Volume 4, SD-C (Books 7 and 21)). This can result in physical damage to incubating embryos and alevins still present in redds or among other substrate due to moving substrate materials (Attachment H – Life History and Habitat Requirements of Fish Species in the Project Area). This has the potential to result in extensive mortalities and decreased trout recruitment (DeVries 1997). These spills are not under the control of the Project.

Rock Creek

Rock Creek is a diverted tributary of the Mammoth Reach of the SJR. Rock Creek is diverted approximately 0.4 miles upstream of its confluence with the SJR, which is located approximately three miles downstream of Mammoth Pool Dam.

Habitat

Physical Habitat

Rock Creek is a steep, bedrock/boulder stream with a Rosgen Level I Aa+ channel. Rock Creek has an elevation of 3,561 feet above MSL at the upstream end of the evaluated portion of the reach. The spill elevation of the Rock Creek Diversion is 3,336 feet above MSL. Rock Creek then drops steeply to an elevation of 2,670 feet above MSL at its confluence with the SJR. It has mostly step pool, cascade and bedrock sheet habitats, with small components of other pool habitats (Table 5.2.4.2-2). No spawning gravel was observed during CAWG studies, which suggests reproduction may occur in upstream locations or in tributaries. The relative abundance of cascade and bedrock sheet habitats in Rock Creek limits habitat available for trout (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Water temperatures were monitored above the diversion and upstream of the confluence with the SJR during the spring through fall of 2000 and 2001. The diversion was operational throughout the monitoring period.

At the monitoring station above the diversion, mean monthly water temperatures ranged from 10.1°C to 17.7°C in 2000 and 12.8°C to 18.8°C in 2001 (Table CAWG 5-141; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In the bypass reach upstream of the confluence with the SJR, mean monthly water temperatures ranged from 11.0°C to 18.2°C in 2000, and 12.6°C to 20.2°C in 2001. Water temperatures upstream of the confluence with the SJR exceeded a daily mean of 20°C for seven days in 2000 and 40 days in 2001 (Figure 5.2.4.2-3) (CAWG 5 Appendix H Table H-A48; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for one day in 2000 and 26 days in 2001, but did not exceed 24°C (Table 5.2.4.2-6).

Aquatic Community

Stocking

Rainbow trout/steelhead, brown trout and brook trout have been stocked in this stream (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Brown trout and brook trout are not currently stocked. Rainbow trout were stocked in the early 1950s, and were stocked every year from 1956 to the present. During the period 1998-2002, an average of 2,688 catchable rainbow trout was stocked each year.

Fish

Fish sampling conducted in 2002 indicates Rock Creek supports self-sustaining populations of rainbow and brown trout in addition to planted hatchery rainbow trout. Brown trout density is higher upstream of the diversion, while rainbow trout density is greater below the diversion (Table 5.2.4.2-4). Multiple age classes are present in the bypass reach, including rainbow trout smaller than the catchable-sized hatchery fish planted, which indicates that successful recruitment occurs in Rock Creek or its tributaries. Mean condition factors for both trout species are greater than 1.00 and densities are relatively large for a stream of this size.

Benthic Macroinvertebrates

Densities of total macroinvertebrates (Table 5.2.4.2-5) in Rock Creek in the bypass reach are greater than, or comparable to, those upstream of the diversion. Within the bypass reach, densities of EPT are greatest immediately downstream of the diversion; density is lowest upstream of the SJR confluence.

Summary of Resource Issues

There currently are no required MIFs in the Rock Creek bypass reach. Trout are relatively abundant in the bypass reach of Rock Creek and have condition factors of 1.00 or more indicating good growth conditions. However, physical habitat availability appears to be limiting, especially spawning habitat. Spawning gravel below the diversion appears to be in limited supply, as is habitat suitable for trout spawning. Trout recruitment did not appear to be successful in 2002 (no age 0+ trout present in the second of two Dry Water Years), although successful recruitment appeared to take place in 2001 (abundant presence of age 1+ trout). Rearing habitat also appears to be limited. However, the only habitats suitable for fish are plunge pools, thus the availability of habitat is not substantially responsive to changes in flow.

Summer water temperatures in Rock Creek above and below the diversion are frequently warm and are warmer than desirable for trout growth in the section upstream of the confluence with the SJR.

Ross Creek

Ross Creek is a diverted tributary of the Mammoth Reach of the SJR. Ross Creek Diversion is located approximately 0.85 miles upstream of its confluence with the SJR, which is approximately seven miles downstream of Mammoth Pool Dam.

Habitat

Physical Habitat

Ross Creek is a very steep, bedrock/boulder stream with a Rosgen Level I Aa+ channel. Ross Creek has an elevation of 3,763 feet above MSL at the upstream end of the evaluated portion of the reach, then drops to an elevation of 2,289 feet above MSL at the confluence with the SJR. The spill elevation of the Ross Creek Diversion is 3,359 feet above MSL. Ross Creek. Ross Creek has mostly shallow, step pool habitats above and below the diversion, with substantial components of cascade and bedrock sheet (Table 5.2.4.2-2). No spawning gravels were observed during surveys (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Ross Creek has a relatively small drainage area and the creek was dry upstream of the diversion by mid-June or early July in both years monitored. During the early summer, upstream non-Project diversions may result in areas upstream of the diversion going dry (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

The diversion was operational (not turned out) through most of the temperature monitoring period, although flow was not always present (i.e., the stream went dry). Upstream of the diversion, mean monthly water temperatures ranged from 16.4°C to 20.1°C in 2000 and 14.8°C to 20.5°C in 2001 (Table CAWG 5-145; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In 2001, a Dry Water Year with above average air temperatures, Ross Creek provided relatively warm water to the SJR when flow was present. Observed mean monthly temperatures ranged from 18.7°C to 23.1°C at the monitoring site upstream of its confluence with the SJR in 2001. Mean monthly water temperatures in 2000 (Above Normal Water Year) at this site were substantially cooler, ranging from 12.0°C to 14.0°C, but fewer data are available for 2000 (Table CAWG 5-145; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures upstream of the confluence with the SJR did not exceed a daily mean of 20°C in 2000 (11 days monitored during summer 2000). However, 20°C was exceeded at this location for 49 days in 2001 (mostly in June and July) (Figure 5.2.4.2-4) (CAWG 5 Appendix H Table H-A50; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Under conditions of diminished flow reaching the diversion, daily maximum temperatures frequently exceeded 22°C and 24°C during 2001 (Table 5.2.4.2-7).

Aquatic Community

Fish and Macroinvertebrates

Ross Creek was not sampled for fish or benthic macroinvertebrates because the reach upstream of the diversion and a large segment below the diversion were dry during the summer of 2002 (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) and CAWG 10, Macroinvertebrates, 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Summary of Resource Issues

Under existing conditions, Ross Creek is dry above and below the diversion during much of the summer and fall due to an upstream non-Project diversion. There are no required MIFs under the current FERC license. The lack of summer base flows limits the value of this stream for fish. However, it is used by reptiles and amphibians.

5.2.4.2.2 Big Creek Nos. 1 and 2 (FERC Project No. 2175)

Water from Huntington Lake on Big Creek is diverted to Big Creek Powerhouse 1 via Tunnel 1. Two reaches of Big Creek between Huntington Lake and the Big Creek Powerhouse 2/2A tailrace are defined by the presence of Project features. The most upstream reach extends from downstream of Dam 1 at Huntington Lake to upstream of Big Creek Powerhouse 1. The second reach extends from Dam 4 (Powerhouse 1 tailrace) to Big Creek Powerhouse 2/2A. Dam 4 is located approximately four miles downstream of Dam 1 and the Big Creek Powerhouse 2/2A tailrace is located approximately 3.8 miles downstream of Dam 4. Tributaries to Big Creek associated with Project facilities include Balsam, Adit No. 8 and Ely creeks. Each stream has its confluence with Big Creek downstream of Dam 4.

Management Objectives

Management objectives for stream reaches include the same beneficial uses for Cold and Warm Freshwater Habitat (COLD and WARM) identified in the Basin Plan (CRWQCB 1998) and discussed in Section 5.2.4.1 Environmental Setting and Evaluation Approach.

CDFG manages Huntington Lake as a put-and-take fishery for catchable rainbow trout and a stock-and-grow fishery for fingerling and subcatchable rainbow trout. A stock-and-grow fishery for kokanee also is maintained.

Historically, rainbow trout, brook trout and kokanee were stocked in Huntington Lake. The only record of planting of brown trout was for 1984. Rainbow trout and kokanee are the only species that are currently stocked in Huntington Lake (SD-C CAWG 7 Fish Population Report, SCE 2003). During the period 1998-2002, CDFG stocked an average of 30,320 catchable-sized rainbow trout and 18,407 fingerlings per year, and an average of 4,103 fingerling kokanee per year. CDFG personnel have suggested that reproduction of kokanee in lake tributaries is undesirable and could contribute to lowered growth rates (Wickwire pers. comm.).

Historically, CDFG and other entities have stocked or moved several species of fish in the Big Creek drainage. Stocking records indicate rainbow trout, brook trout, and brown trout have been planted in the bypass reach of Big Creek. No historical fish stocking records were found for the Powerhouse 2 forebay (Dam 4), but rainbow trout have occasionally escaped from the nearby SCE fish hatchery (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). No records of historical fish stocking were found for Project-affected tributaries of Big Creek.

However, stocking of hatchery catchable-sized rainbow trout occurs in tributaries of Huntington Lake at road crossings.

Huntington Lake

Dam 1 on Big Creek, located 9.9 miles upstream of the confluence with the SJR, impounds Huntington Lake. Dams 2, 3 and 3A, located in other areas of the lake, also form the current Huntington Lake. Over a 21-year period of record (1980 to 2001), average maximum yearly storage was 88,619 acre-feet and average minimum yearly storage was 32,404 acre-feet, corresponding to water levels of approximately 6,949.6 feet and 6,901.8 feet above MSL, respectively (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). At the spill elevation of 6,950 feet above MSL, the surface area of Huntington Lake is 1,435 acres and storage is 89,166 acre-feet.

Habitat

Reservoir Fluctuation

During most years, Huntington Lake begins to fill in mid-April, reaching its maximum volume by June. Water level is generally maintained at high levels until Labor Day to support recreation, and then drops quickly from about mid-September through December. Water level drops to the annual minimum level by January. In some drier water years, higher reservoir storage is maintained over the winter than in some wetter years. A relatively large amount of shallow habitat is available at most reservoir elevations (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Thermal stratification was documented in Huntington Lake during the summer months of 2000 (August) and 2001 (May through August) (Figure 5.2.4.2-5). The water column was mixed in the fall (September and October). Mixing occurred when water temperatures cooled, so that density differences between the epilimnion and hypolimnion were insufficient to maintain stratification. Instream flow releases to Big Creek and power diversions are made from deep in the reservoir, which means cool water is released during the summer when the lake is thermally stratified. Diversions to Balsam Meadow Forebay and North Fork Stevenson Creek also are made from deep in the lake, but at a shallower depth than releases to Big Creek (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)).

Water temperatures suitable for trout were available in the reservoir. In 2001 (a Dry Water Year), when stratified, the mean temperature for the epilimnion ranged from 11.3°C (May) to 19.2°C (August), and the hypolimnion ranged from 6.5°C (May) to 13.1°C (August) at the dam. When not stratified, mean temperature ranged from 14.6°C (October) to 15.1°C (September). A similar pattern occurred when stratified in August 2000; the mean temperature of the epilimnion (upper layer) was 15.4°C and the hypolimnion (deeper layer) was 10.7°C (Figure 5.2.4.2-5).

Aquatic Community

Fish

The fish community of Huntington Lake includes a self-sustaining population of brown trout, as well as hatchery-stocked and reproducing fisheries for rainbow trout and kokanee. Mean condition factors were greater than 1.00 for trout and 2.94 for kokanee (Table 5.2.4.2-8).

Sampling data documented self-sustaining populations of brown trout (11% of the fish collected), Sacramento sucker (39%), and prickly sculpin (40%). Kokanee (5%), which are stocked, also may spawn naturally. Most of the rainbow trout (5% of the sampled fish) collected were catchable-sized hatchery fish. The presence of young-of-the-year rainbow trout and Sacramento sucker, as well as the ongoing presence of brown trout, indicates that these species successfully reproduce in streams tributary to Huntington Lake. There were no external signs of disease observed (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Summary of Resource Issues

No aquatic resource issues were identified for Huntington Lake.

Big Creek Dam 1 to Powerhouse 1 Reach

The Big Creek bypass reach between Dam 1 and Powerhouse 1 has a length of approximately 3.6 miles. Dam 1 has three 42-inch pipes passing through its base to Big Creek at elevation 6,808 feet above MSL, and a 72-inch pipe through the right abutment at elevation 6,921 feet above MSL. Big Creek drops to an elevation of about 4,818 feet above MSL at the confluence with the Big Creek Powerhouse 1 tailrace.

Habitat

Physical Habitat

Big Creek lies in a deep, steep-walled bedrock canyon and has long step-pool and step-run habitats. Bedrock dominates the channel substrate.

The Dam 1 to Powerhouse 1 reach of Big Creek is a sandy, bedrock/boulder stream composed mostly of Rosgen Level I Aa+ channel type, with B, A, and G-type channels also present. It has a mixture of habitat types, including some that are fairly-complex (Table 5.2.4.2-9). In the lower gradient channel types, there is considerable encroachment of riparian vegetation in the stream channel. Pools are mostly shallow, and small amounts of spawning gravel are observed (SD-C CAWG 1 Characterize Stream and Reservoir Habitats Report, SCE 2003). An eight-foot high waterfall in Big Creek, 242 feet upstream of Powerhouse 1, forms a natural, complete barrier to upstream fish migration at all flows. The area upstream of this point (within a 6,513-foot-long, steep, inaccessible section) consists of a very tall waterfall, at the bottom of a series of cascades. There are many waterfalls located within the approximately 7,438 feet of Aa+ channel upstream of Big Creek Powerhouse 1 that form natural, complete barriers to upstream fish migration at all flows (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Water temperatures were recorded at three locations in this reach during spring through fall of 2000 and 2001 (Figure 5.2.4.2-6). Water temperatures were suitable for trout throughout the bypass reach. Air temperatures heavily influence water temperatures in the reach (Table CAWG 5-11; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). During 2000, air temperatures were hot in June, cooler than normal in July, and warmer than normal in August. The summer 2001 monitoring period represented a warmer than average period; with the hottest May on record, warmer than normal in June, and near normal temperatures during July. August 2001 also was warmer than normal.

Releases from the hypolimnion of Huntington Lake are very cool for most of the summer. Stream temperatures warm as water flows downstream. In September and October when the lake mixes, release temperatures are warmer (but still relatively cool) and stream temperatures cool as flows travel downstream from Dam 1 to Powerhouse 1. At the monitoring station below Dam 1, observed mean monthly temperatures increased steadily from 6.9°C to 15.5°C during 2001 (Table CAWG 5-176; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 15°C in 2000 and 16°C in 2001 (Figure 5.2.4.2-6) (CAWG 5 Appendix H Table H-A55; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

At the monitoring station in Big Creek Canyon, 2.4 miles downstream of the release point of Dam 1, mean monthly water temperatures were cool at 14.1°C or less (Table CAWG 5-176; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 16°C (Figure 5.2.4.2-6) (CAWG 5 Appendix H Table H-A56; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Upstream of Powerhouse 1, mean monthly water temperatures were 14.1°C or less and daily maximum temperatures did not exceed 20°C (Table 5.2.4.2-10) (Table CAWG 5-176; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a;

Volume 4, SD-D (Books 12 and 23)). Daily mean water temperatures did not exceed 16°C (Figure 5.2.4.2-6) (CAWG 5 Appendix H Table H-A57; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

These data indicate that water temperatures in this reach of Big Creek were suitable for trout growth and met the target temperature for compliance with the Basin Plan (mean daily temperatures less than 20°C).

Aquatic Community

Fish

Fish sampling conducted in 2002 indicates this reach supports self-sustaining populations of brown trout and prickly sculpin (Table 5.2.4.2-11). Mean condition factor for trout was greater than 1.00, although slightly less (0.92) in the B channel type. Mean density and biomass for brown trout were high. Prickly sculpin, which was only found in the G channel site, had a mean density of 14 fish/km.

Benthic Macroinvertebrates

Three sampling sites were located in Rosgen Level 1 Aa+ channel and a fourth in a Rosgen B type channel (Site B). Of the four sites sampled, densities of total macroinvertebrates and of EPT were greatest at the downstream site near Powerhouse 1, approximately 3.5 miles downstream of Dam 1 (Table 5.2.4.2-1) and lowest at the site 2.0 miles downstream of the dam.

Summary of Resource Issues

Under existing conditions, potential fisheries issues include numerous structural passage barriers throughout the reach, owing to its steep, bedrock nature; and low flows from December 15 through April 15. There currently is no MIF release requirement for this reach from December 15 to April 15, although SCE releases flow during this period. A guarantee of flow during that period is desirable for incubation of brown trout embryos and overwinter survival. In spite of these potential limitations, densities and biomass of brown trout are at or above reference levels and trout are healthy. However, recruitment success may be less than desired. Temperatures are well within the range considered suitable for trout.

In collaboration with the Big Creek ALP stakeholders, it was decided not to assess flow-related habitat. This decision was reached because the extensive encroachment of riparian vegetation into the channel would have made the results of such studies inaccurate at any flow level substantially higher than those currently present. The two-mile low-gradient section is an adjustable, moderately entrenched channel, with erodible banks, and co-dominated by sand and boulders, with poorly sorted gravels. Existing flows in the first two-mile segment of the Big Creek channel are insufficient to maintain sediment transport. Therefore, spawning gravels have a high fine sediment content, which exceeds the criteria for successful reproduction of trout and sedimentation may decrease pool habitat (Section 5.2.3 Geomorphology).

Dam 4 Impoundment (Big Creek Powerhouse 2 Forebay)

Dam 4, located approximately 4 miles downstream of Dam 1, forms a medium-size impoundment. At a normal annual maximum surface water elevation of approximately 4,808 feet above MSL, the forebay has a storage volume of 49.3 acre-feet and a surface area of 3.2 acres. At the spill elevation of 4,810 feet above MSL, the impoundment has a storage volume of 60 acre-feet and a surface area of 3.61 acres. Inflow to the forebay comes from the Powerhouse 1 tailrace, Big Creek upstream of Powerhouse 1, and undiverted flows from Pitman Creek. Water in the impoundment is diverted through Tunnel 2 to Powerhouse 2 located upstream of Dam 5. The intake for Tunnel 2 is located on the north side of the forebay, with an invert elevation of 4,788.5 feet above MSL, which is approximately 42 feet higher than the release point near the bottom of the dam. Additional flow is diverted into Tunnel 2 from Balsam Creek and Ely Creek.

Habitat

Impoundment Fluctuation

The water surface elevation in the forebay may vary on occasion, but generally remains near 4,808 feet above MSL. It occasionally drops to elevations as low as 4,799 feet above MSL (23.4 acre-feet of storage) (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

During typical operation of Powerhouse 1, the volume of water in the Dam 4 Impoundment (Powerhouse 2 forebay) is replaced many times in a single day. Due to the small size of the forebay and the large volumes of water that pass through it, thermal stratification is not likely to occur. Water temperatures are cool and reflect temperatures of water drawn from deep, cool depths in Huntington Lake and transported through tunnels and penstocks.

Water temperatures recorded at the Tunnel 2 intake, located near the bottom of the impoundment, were cold, with mean monthly water temperatures ranging from 11.6°C (July) to 14.0°C (September) in 2000, and 10.4°C (June) to 14.6°C (October) in 2001. Observed temperatures did not exceed a daily maximum of 15.7°C. Big Creek Powerhouse 1 tailrace provided cold water input to the forebay, with mean monthly temperatures 15.1°C or less and daily maximum temperatures that did not exceed 16.1°C. Temperatures of water flowing from Pitman Creek into the forebay also were relatively cool with mean monthly temperatures of 16.7°C or less, and daily maximum temperatures that did not exceed 22.3°C (Figure 5.2.4.2-7) (Table CAWG 5-214; CAWG 5, Water Temperature Monitoring, TSRPs (SCE

2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for only one September day in the Pitman Conduit Diversion in each of the two years, 2000 and 2001 (CAWG 5 Appendix H Table H-B68 and H-B69; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Fish

Sampling conducted in 2002 indicates the forebay supports brown trout (21%), rainbow trout (46%), and prickly sculpin (33%). Mean condition factors for trout were greater than 1.00 (Table 5.2.4.2-8). Multiple age classes were sampled, including young-of-the-year trout (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Summary of Resource Issues

Powerhouse 2 Forebay is a small waterbody whose temperature and flow is dominated by discharges from Powerhouse 1 and withdrawals to Tunnel 2 and Powerhouse 2. No aquatic resource issues were identified for the forebay.

Big Creek Dam 4 to Powerhouse 2/2A Reach

The reach of Big Creek from Dam 4 to upstream of Big Creek Powerhouse 2/2A is approximately 3.8 miles long. Big Creek Powerhouse 2/2A is located near the confluence of Ordinance Creek with Big Creek. Big Creek below Dam 4 has an elevation of 4,775 feet above MSL and drops to an elevation of 2,972 feet above MSL at Powerhouse 2/2A. There is no requirement for a MIF from Dam 4 in the current FERC license. Flow in the reach derives from dam seepage, local run-off, tributaries and accretion.

Habitat

Physical Habitat

This reach of Big Creek is a moderately steep, bedrock/boulder stream comprised primarily of Rosgen A channel, with a small inclusion of B channel. It primarily has step pool and cascade habitats, with substantial amounts of pools, riffle, and flatwater habitats also present (Table 5.2.4.2-9). Generally, pools are moderately deep to very deep, but fine sediments may affect pool depth. A small amount of spawning-sized gravel is present, mostly located in step pools and plunge pools. Relatively small amounts of gravels are found in high gradient riffles, habitats often used by trout for spawning (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Water temperatures in this reach were recorded at three monitoring stations in the spring through fall of 2000 and 2001. Observed water temperatures directly downstream of Dam 4 were cool; but during the summer, they generally increased from Dam 4 to Big Creek Powerhouse 2/2A, where powerhouse outflow provided cool water again. Summer water temperatures in 2001 at the monitoring station upstream of the confluence with Balsam Creek often were higher than would be suitable for trout growth and occasionally reached stressful levels. Cool tributary inflows from Balsam Creek and Ely Creek (diverted tributaries), when present, beneficially influenced summer water temperatures within the reach. Temperatures in Big Creek upstream of Powerhouse 2/2A were cooler than upstream of Balsam Creek.

At the monitoring station downstream of Dam 4, mean monthly water temperatures were 17.2°C or less and maximum temperatures did not exceed 21.0°C (Table 5.2.4.2-13) (Table CAWG 5-218; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean water temperatures did not exceed 17°C in 2000 and 19°C in 2001 (Figure 5.2.4.2-8) (CAWG 5 Appendix H Table H-A58; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

At the monitoring station located upstream of the confluence with Balsam Creek, one mile downstream of Dam 4, mean monthly stream temperatures ranged from 8.7°C to 20.3°C (Table CAWG 5-218; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for 30 days and 24°C for two days in 2001 (maximum of 24.2°C), but did not exceed 20.5°C in 2000 (Table 5.2.4.2-13). Daily mean water temperatures did not exceed 20°C in 2000 but exceeded 20°C for 39 days in 2001 (Figure 5.2.4.2-8) (CAWG 5 Appendix H Table H-A59; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

At the monitoring station upstream of Powerhouse 2/2A, water temperatures reflected the influence of tributary inflows from Balsam and Ely creeks in 2000 and 2001, with average monthly water temperatures of 18.5°C or less and a daily maximum of 22.8°C or less (Table 5.2.4.2-13) (Table CAWG 5-218; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean water temperatures did not exceed 20°C in 2000 and exceeded 20°C for only two days in 2001 (CAWG 5 Appendix H Table H-A60; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures exceeded 22°C for only one day in 2000.

Water temperatures in some portions of this reach were higher at times than would be desirable for trout growth (mean daily temperatures greater than 20°C), particularly in the Dry Water Year (2001) with warm meteorology.

Aquatic Community

Fish

Fish sampling conducted in 2002 (the second of two Dry Water Years in a row) indicated there were equal densities of rainbow trout and brown trout. Age 1+ brown and rainbow trout were more common in sites downstream of Dam 4 than in the reach upstream of Powerhouse 1. However, no age 0+ trout were collected. The presence of multiple age classes of rainbow trout and of brown trout, which are no longer stocked, in each reach indicates the presence of self-sustaining populations. The average total trout density for the reach was higher than in the reach between Dam 1 and Powerhouse 1 (726 fish/km versus 670 fish/km), but the average adult trout density was lower (274 fish/km versus 373 fish/km) (Table 5.2.4.2-11).

Benthic Macroinvertebrates

Macroinvertebrate densities, including EPT densities, in this reach are relatively high. Of three sites sampled, densities of total macroinvertebrates and of EPT are greatest at the site in the downstream end of the reach (upstream of Powerhouse 2/2A), and lowest at the middle site, approximately 1.1 mile downstream of Dam 4 and upstream of Balsam Creek (Table 5.2.4.2-12).

Summary of Resource Issues

The potential fisheries resource issues under existing conditions in Big Creek between Dam 4 and Powerhouse 2/2A include (i) temperatures exceeding the Central Valley Regional Water Quality Control Board Basin Plan (CVRWQCB) “COLD” objective (i.e., water temperatures unsuitable for trout growth); (ii) potentially insufficient flow (no MIF required under the current FERC license); (iii) potential adult rearing and spawning habitat limitations; (iv) apparent recruitment failure in 2002 (although the presence of all other year classes indicates that recruitment is successful in most years); (v) potential insufficient overwinter habitat for trout due to lack of flow and sediment in pools; and (vi) periodic sedimentation of downstream pools due to sediment releases during periodic dewatering of Dam 4 for tunnel inspections (Section 5.2.3 Geomorphology). Despite these resource issues, trout are relatively abundant with condition factors over 1.00.

Balsam Creek - Diversion to Big Creek

Balsam Creek, a diverted tributary, has its confluence with Big Creek 1.0 mile downstream of Dam 4. Balsam Creek Diversion is located approximately 0.7 miles upstream of the confluence with Big Creek. Balsam Creek has an elevation of 4,872 feet above MSL at the base of the Balsam Creek Diversion dam, then drops to an elevation of 4,140 feet above MSL at the confluence with Big Creek.

Balsam Diversion

Balsam Diversion forms a very small impoundment on Balsam Creek. This small diversion has a horizontal intake and a 12-inch diameter conduit to Tunnel 2, controlled by an upstream gate valve. The Balsam Diversion spill elevation is 4,880 feet above MSL. Diverted water is conveyed to Tunnel No. 2, where it enters through Adit No. 3, and flows to Powerhouse 2. Flows in the reach upstream of the diversion are augmented by releases made at Balsam Meadow Forebay, part of the Big Creek Nos. 2A, 8 and Eastwood Project.

No aquatic resource issues were identified for the impoundment.

Balsam Creek Bypass Reach

There is no MIF release requirement below the diversion in the current FERC license.

Habitat

Physical Habitat

Balsam Creek is a steep, bedrock stream with steep channel slopes and a Rosgen Level I Aa+ channel. It is predominantly composed of step pool, bedrock sheet and high gradient riffle habitats. There also are components of cascade; flatwater habitat including step run, run, and trench chute; and additional pool habitat (Table 5.2.4.2-9). All pools, except for one, are shallow. Numerous natural barriers to upstream migration fragment fish habitat in Balsam Creek and, combined with a low amount of spawning gravel, may naturally limit reproduction downstream of the diversion (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Two water temperature recorders were deployed in Balsam Creek: at the diversion and near the confluence with Big Creek. The Balsam Creek Diversion was not in operation during the 2000 and 2001 monitoring periods, but was in operation from March 28 to November 14 of 2002. Observed water temperatures were suitable for trout growth during this monitoring period (daily mean temperatures less than 20°C).

Water temperatures increased in Balsam Creek between the Balsam Diversion and upstream of the confluence with Big Creek in 2000, 2001 and 2002 (Figure 5.2.4.2-9) (Table CAWG 5-301; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures recorded upstream of the confluence of Big Creek in May through October of 2000, 2001 and 2002 were cool; mean monthly stream temperatures were 16.5°C or less; and daily maximum temperatures did not exceed 21.6°C (Figure 5.2.4.2-9). In the Balsam Creek Diversion, water temperatures did not exceed 16°C in 2000 or 2001, and exceeded a daily mean of 16°C for only four days in 2002 (Figure 5.2.4.2-9)

(CAWG 5 Appendix H Table H-A70; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Upstream of the confluence with Big Creek, water temperatures did not exceed a daily mean of 18°C in 2000 or 2001, and exceeded 18°C for only three days in 2002 (Figure 5.2.4.2-9) (CAWG 5 Appendix H Table H-A71; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum water temperatures did not exceed 22°C at either monitoring station (CAWG 5 Appendix H Tables H-B70 and H-B71; S CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Fish

One rainbow trout was collected below the Balsam Creek diversion, which indicates fish density is low. Its condition factor was greater than 1.00 (Table 5.2.4.2-11).

Benthic Macroinvertebrates

Macroinvertebrate densities, including EPT densities, were relatively high. Of the two sites sampled below the diversion, densities of total macroinvertebrates and of EPT were slightly higher at the downstream site (Table 5.2.4.2-12). Densities of total macroinvertebrates and EPT were lower than in the site in the reach upstream of Balsam Creek Diversion, in which flow is augmented.

Summary of Resource Issues

Currently, there is no existing minimum flow requirement in this reach. The trout population in the bypass reach is lower than expected in terms of fish densities and biomass. The extremely steep, bedrock stream channel provides limited physical habitat for fish. Natural, structural passage barriers are abundant and restrict upstream movement of fish.

Adit No. 8 Creek

The Adit No. 8 diversion is not currently in use, but gives SCE the flexibility to divert water from one water system into another if required. Adit No. 8 Creek has an upstream elevation of 4,320 feet above MSL, then drops to an elevation of 3,242 feet above MSL at the confluence with Big Creek. The spill elevation of Adit 8 is 4,825 feet above MSL. There is generally little to no flow in Adit No. 8 Creek and much of that derives from tunnel leakage.

Habitat

Physical Habitat

Adit No. 8 Creek is a very steep, boulder-dominated stream with a Rosgen Aa+ channel. Above the diversion, the stream is dry most of the year. Below the diversion, Adit No. 8 Creek flow results from minor leakage from Tunnel 2 and some reaches naturally go dry during the summer, particularly in dry water years. A substantial component of the habitat is cascade, which may limit the habitat value for trout (Table 5.2.4.2-9). However, the wetted reaches contain some components of more complex habitat like riffles as well as some shallow pools. Canopy cover is high. A fair amount of spawning gravel is present (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Temperature monitoring was not conducted in Adit 8 Creek, due to insufficient flow.

Aquatic Community

Fish

Not a single fish was collected from Adit No. 8 Creek below the diversion.

Summary of Resource Issues

No fisheries issues have been identified on Adit 8 Creek, which is naturally intermittent, fishless, and without populations of sensitive amphibians or reptiles. SCE has a diversion structure on this watercourse that may be used to transfer water from Tunnel 5 to Tunnel 2 in the event of an outage at Powerhouse 2A. This diversion structure has not been used in several decades. Flows, to the extent they are present, result from leakage from the Tunnel 2. SCE cannot control this flow, except to decrease it by more effective sealing. Therefore, SCE cannot provide a specific flow to Adit 8 Creek.

Ely Creek

The confluence of Ely Creek with Big Creek is located approximately 2.6 miles downstream of Dam 4. Ely Creek Diversion is located less than 1.0 mile upstream of the confluence with Big Creek.

Ely Creek Diversion forms a small impoundment on Ely Creek. This small diversion has a horizontal intake and a 12-inch diameter conduit to Tunnel 2, controlled by an upstream gate valve. Diverted water is conveyed to Tunnel No. 2, where it enters through Adit No. 6. The diversion was not in operation during 2000 and 2001, when the CAWG temperature studies were implemented.

The spill elevation of the diversion dam is 4,844 feet MSL. Ely Creek drops to an elevation of 3,454 feet above MSL at the confluence with Big Creek.

Flows are intermittent upstream of the diversion. There is no MIF release requirement to the reach below the diversion in the current FERC license.

Habitat

Physical Habitat

Ely Creek is a very steep, granitic stream with a Rosgen Level I Aa+ channel. The reach above the diversion has primarily cascade and bedrock sheet habitats, which may limit spawning and rearing habitat. This reach went dry on August 6, 2001 (a Dry Water Year). However, there also are smaller components of plunge pool and flatwater habitats. Much of the reach downstream of the diversion (65.3%) was dry during habitat mapping, but the wetted reaches were composed primarily of step run, shallow step pool and high gradient riffle (Table 5.2.4.2-9). Small amounts of spawning gravel are present below the diversion in flatwater habitats and pools (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Because the diversion was not in operation during the monitoring periods in 2000 and 2001, all observed water temperatures were due to natural conditions and not due to Project diversion of water in this reach. Two water temperature recorders were deployed in Ely Creek. However, during 2001, a Dry Water Year, the creek upstream of the diversion went dry on August 6. Water temperatures were generally cool when flow was present; but in 2001, when there was no flow upstream of the diversion, temperatures may have occasionally been stressful for trout in isolated pools. Observed daily mean temperatures did not exceed 20°C.

Water temperatures were monitored in the spring through the fall above the diversion and upstream of the confluence with Big Creek, except in the reach upstream of the diversion after it went dry in 2001. Stream temperatures at the diversion were cool, with mean monthly temperatures of 15.2°C or less and daily maximum temperatures of 20.0°C or less. Upstream of the confluence with Big Creek, mean monthly temperatures ranged from 9.4°C to 15.3°C in 2000 and 10.7°C to 16.3°C in 2001 (Table CAWG 5-306; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures did not exceed 20.4° in 2000, but occasionally were as high as 25.7°C in 2001, after portions of the stream went dry (Table 5.2.4.2-14) (Table CAWG 5-306; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). However, some or all of these maximum temperatures may have occurred when the temperature recorder was not submerged, reflecting air temperature rather than water temperature. Daily mean temperatures did not exceed 18°C in 2000 or 2001 at either monitoring station (Figure 5.2.4.2-10) (CAWG 5 Appendix H Table H-A72 and H-A73; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Fish

Only rainbow trout age 3+ and greater were collected above the Ely Creek diversion during sampling in 2002. Downstream of the diversion, multiple age classes of rainbow trout and golden/rainbow trout hybrids were collected, which suggests reproduction and recruitment occurs in the vicinity. Total trout and adult trout densities were higher below the diversion (368 fish/km versus 190 fish/km, and 190 adults/km versus 204 adults/km) (Table 5.2.4.2-11). Total trout biomass was slightly lower below the diversion. Mean condition factors for trout above and below the diversion were greater than 1.00.

Benthic Macroinvertebrates

Densities of total macroinvertebrates and EPT at all sites in the bypass reach are substantially lower than in the reach upstream of Ely Creek Diversion. Within the bypass reach, EPT density is greatest at the downstream-most site, located 0.3 miles upstream of the confluence with Big Creek (Table 5.2.4.2-12) and total density is greatest at the upstream-most site.

Summary of Resource Issues

There is no MIF requirement on Ely Creek in the current FERC license. Little historic flow information is available for Ely Creek above and below the diversion. However, observations indicate that Ely Creek above the diversion goes dry and habitat in the bypass reach downstream may be restricted to isolated pools or small accretion flows regardless of whether diversions occur (SCE observations, CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Natural passage barriers along the bypass reach restrict fish movement upstream, including substantial lengths of dry streambed observed even when the diversion was turned out.

5.2.4.2.3 Big Creek Nos. 2A, 8, and Eastwood Project (FERC Project No. 67)

Management Objectives

Reservoirs and Impoundments

There are two major reservoirs included in this Project, Florence and Shaver lakes. Balsam Forebay is a medium-sized impoundment. All three of these bodies of water are stocked with fish and contain self-sustaining populations. Florence Lake supports a self-sustaining brown trout fishery. CDFG last stocked Florence Lake in 1998 with rainbow trout. CDFG manages Shaver Lake as a put-and-take fishery for catchable rainbow trout, and as a stock-and-grow fishery for fingerling and subcatchable rainbow trout, and kokanee. Shaver Lake also supports a warmwater fishery, including smallmouth bass, blue gill, and crappie. To discourage angling and protect wildlife, fish stocking is currently not recommended in Balsam Meadow Forebay; however stocking has taken place (FERC 1982a, cited in SD-C CAWG 7 Fish Population Report, SCE 2003).

Stream Reaches

Management objectives for stream reaches include the same beneficial uses for Cold and Warm Freshwater Habitat (COLD and WARM) identified in the Basin Plan (CRWQCB 1998) and discussed in Section 5.2.4.1. CDFG manages the SFSJR as a put-and-take fishery for rainbow trout to supplement wild trout present. CDFG does not currently stock trout in Mono Creek below the diversion, but rainbow trout have been stocked upstream of the diversion, which is part of the Vermilion Valley Project (FERC Project No. 2086). CDFG does not currently stock trout in Bear or Hooper creeks, although historically stocking has occurred. No fish stocking has been documented in Tombstone Creek. North Slide and South Slide creeks currently do not contain fish and are not recognized as important fishing streams. Small tributaries to the south side of the SFSJR, including Crater, Chinquapin, Camp 62 and Bolsillo creeks contain only brook trout, a nonnative species that currently is not stocked (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Florence Lake

Florence Lake Dam, located on the SFSJR 28 miles upstream of the confluence with the SJR, impounds Florence Lake. Over a 21-year period of record (1980 to 2001), average maximum yearly storage was 60,096 acre-feet and average minimum yearly storage was 1,008 acre-feet corresponding to water levels of approximately 7,323.0 and 7,230.8 feet above MSL, respectively (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). At the spill elevation of 7,327.5 feet above MSL, the surface area of Florence Lake is 962 acres and storage is 64,406 acre-feet.

In a deep part of Florence Lake, an intake diverts water to Ward Tunnel. Downstream of Florence Lake, Ward Tunnel also receives and transports flow from other diverted tributaries to the SFSJR. Flow from the Ward Tunnel is discharged through either an HB bypass valve or through the turbine at Portal Powerhouse to Huntington Lake. No powerhouse exists upstream of Portal Powerhouse.

Habitat

Reservoir Fluctuation

The reservoir usually begins to fill in the spring. By July, it is at its maximum volume. It then drops slowly from July to the beginning of September, falls quickly from September to November, and by December is usually at its minimum volume and surface area. The relatively small amount of shallow habitat available at most higher reservoir elevations is indicative of the steep sides of the reservoir within this elevation range.

Water Temperature

Florence Lake was thermally stratified during the summer months (July through August of 2000 and May through September of 2001), and mixed in the fall. Instream flow releases to the SFSJR originate deep in the reservoir, so cool water is released during the summer when the lake is thermally stratified.

Water temperatures suitable for trout growth (less than 20°C) were available in the reservoir. When stratified, the mean temperature of the epilimnion ranged from 15.9°C (August) to 16.3°C (July) in 2000, and 10.7°C (May) to 19.4°C (August) in 2001. The hypolimnion ranged from 11.4°C (July) to 14.0°C (August) in 2000, and 6.6°C (May) to 15.2°C (August) in 2001. When not stratified, mean temperature ranged from 11.3°C (October) to 15.7°C (September) in 2000, and was 13.3°C (October) in 2001 (Figure 5.2.4.2-11).

Aquatic Community

Stocking

Species historically introduced to Florence Lake include rainbow/steelhead trout, brown trout, brook trout, kokanee, and golden shiner. Fish (rainbow trout fingerling) were last stocked in Florence Lake in 1998 (SD-C CAWG 7 Fish Population Report, SCE 2004).

Fish

Sampling in 2002 indicated there are self-sustaining populations of brown trout in Florence Lake and its tributaries, with relatively large numbers of fish (Table 5.2.4.2-15). Rainbow trout, although not collected in 2002, were observed by ENTRIX fishery biologists during a subsequent visit to the reservoir. The mean condition factor for brown trout was greater than 1.00. A hydroacoustic survey conducted in Florence Lake near the Ward Tunnel Intake in August of 2002 showed that most fish were concentrated above a depth of 15.7 meters (50.5 feet), and that substantially lower densities were found near the depth of the intake (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Summary of Resource Issues

No aquatic resource issues were identified for Florence Lake

South Fork San Joaquin River

The bypass reach between Florence Lake Dam and the confluence with the SJR is approximately 28 miles long. The SFSJR has an elevation of 7,218 feet above MSL at Florence Lake, and then drops to an elevation of 3,721 feet above MSL at the confluence with the SJR.

Habitat

Physical Habitat

Approximately half of the bypass reach of the SFSJR from its confluence with the SJR upstream to Rattlesnake Crossing lies in a deep, bedrock dominated canyon. The upstream half of the bypass reach is a mix of small canyon and open channel. The habitats are composed mostly of large pools, with approximately equal amounts of turbulent (riffle and cascade) and nonturbulent (run and pocket water) habitats (Table 5.2.4.2-16).

The reaches between Florence Lake Dam and Rattlesnake Creek are primarily composed of Rosgen Level I B-type channels, with inclusions of C and G-type channels. The reach between Rattlesnake Creek (approximately 13.4 miles downstream of the dam) and Hoffman Creek (21.5 miles downstream of the dam) is classified as a G-type channel, while the remainder of the river to the confluence is classified as G-type channel with small B inclusions.

The low to moderate gradient reach between Florence Lake and Bear Creek (located approximately 5.6 miles downstream of the dam) is a mixture of complex habitat types and pools. Little spawning gravel is present, except in the inclusions of Rosgen C channel areas. Gravel is abundant below Florence Lake and through the Jackass Meadow Complex (Section 5.2.3 Geomorphology), but little spawning gravel is present in other areas of this subreach. This portion of the mainstem is one of the few stream reaches that contains appreciable concentrations of finer sediments, including sands and gravels.

The low to moderate gradient reach between Bear Creek and Mono Crossing (reach length of 4.3 miles) is a mixture of complex habitat types and contains pools. Little spawning gravel is present. This portion of the mainstem is one of the few stream reaches that contains appreciable concentrations of finer sediments, including sands.

From Mono Creek Crossing (9.9 miles downstream of Florence Lake Dam) to downstream of Rattlesnake Creek crossing (reach length of 3.5 miles), habitats are predominantly pools and riffles, but a mixture of complex habitat types are found. The reach contains deep pools. Habitat units are frequently dominated by finer sediments, including sand. This segment of the SFSJR had a greater amount of spawning gravel than reaches upstream. Spawning gravel was relatively abundant in the Rosgen B channel type, the channel type that comprises approximately half of this subreach.

The low-gradient reach downstream of Rattlesnake Creek to upstream of Hoffman Creek (reach length of 8.1 miles) has a mixture of pool, riffle and flatwater habitats. It contains deep pools and had large woody debris, which provides cover. A smaller amount of spawning gravel was observed than in the reach immediately upstream.

Between the Hoffman Creek confluence and the SJR (reach length of 6.4 miles), ground surveys were not completed because of access and safety concerns. Mapping from aerial photography, video, and overflight indicated that pools and flatwater habitats are dominant features of this segment. The Rosgen G-type channel is dominated by pool habitats, with cascade, riffles, pocket water and runs making up the rest. In the smaller inclusions of B channel, large, mid-channel pools and dammed pools are the predominant habitat type (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

The most prominent barrier to fish upstream migration within the surveyed reach is a 36-foot high waterfall located 6.9 miles upstream of the confluence with the SJR (0.5 mile upstream of Hoffman Creek). This waterfall forms a natural barrier that isolates the SFSJR watershed from the lower basin. Five other natural barriers to upstream fish migration, only one of which was a complete barrier at all flows, were identified on the mainstem, downstream of Mono Crossing (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Water temperatures were monitored at multiple locations in the Project bypass reach during the spring through fall of 2000 and 2001 (Figures 5.2.4.2-12 through 14) (Tables CAWG 5-14, 5-112; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Data from the monitoring station directly downstream of Florence Lake represent release water temperatures as flows first enter the river reach. Water is released from near the bottom of the lake, which means that the coolest water is released during times when the lake is thermally stratified (most of the summer). However, mixing occurs by late August or mid-September, when water temperatures in the SFSJR downstream of Florence Lake equaled or exceeded temperatures upstream of the lake, due to the release of mixed lake water containing the heat stored in the lake's epilimnion.

During the summer months, water temperatures increased fairly rapidly in the first 12 miles downstream of Florence Lake, then stabilized or decreased slightly between Warm and Hoffman creeks. The cooling trend in this segment of the SFSJR may be due, in part, to the constriction of the river through a very deep, narrow canyon, where it is less subject to warming from solar radiation and summer air temperatures. Cold water additions from tributaries to this reach also may contribute to cool water temperatures. A less dramatic trend of temperature increase was apparent from downstream of Hoffman Creek to the SJR confluence station. Water temperatures decreased substantially in September and October in all reaches.

Daily mean water temperatures in this reach occasionally exceeded 20°C for a few days in the summer months, particularly in July and August of 2001 (a dry and warm year). This occurred at the monitoring stations upstream of Camp 61 Creek and upstream of Mono Creek, and for a greater number of days at the station upstream of the SJR confluence (Figure 5.2.4.2-14) (CAWG 5 Appendix H Tables H-A3 through H-A16; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Daily maximum temperatures exceeded 22°C in 2001, but not 24°C. In 2001, daily maximum temperatures of 22°C were exceeded for 37 days upstream of Camp 61 Creek, 39 days upstream of Mono Creek, one day upstream of Rattlesnake Creek, and 15 days upstream of the confluence with the SJR. In 2000, daily maximum temperatures exceeded 22°C for only four days upstream of Mono Creek (CAWG 5 Appendix H Tables H-B3 through H-B16; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). However, a daily maximum of 24°C was not exceeded (Table 5.2.4.2-17).

Aquatic Community

Stocking

Historically, CDFG and other entities have stocked or introduced several species of fish to the SFSJR including brown trout, brook trout, rainbow trout/steelhead, cutthroat trout (*Oncorhynchus clarki*), and golden trout. Numerous strains of these trout species were introduced. Eighty-two percent of the fish stocked since 1931 have been rainbow trout, and after 1941, the SFSJR was primarily stocked with rainbow trout, although brook trout was planted in 1966 and 1979. Based on available information, it appears that historically, most of the fish were planted between Mono Hot Springs and Florence Lake Dam and upstream of Florence Lake. Rainbow trout was the primary species planted in the Florence Lake to Bear Creek segment of the SFSJR, and brown trout was the primary species planted between Rattlesnake Creek and Mono Crossing (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Hatchery rainbow trout are still stocked, but not brown trout or other trout species. During the period 1998-2002, CDFG stocked an average of 4,798 rainbow trout per year. Fishing pressure may currently be higher in areas with developed recreation areas (Jackass Meadow Campground, Mono Hot Springs) than in less accessible areas.

Fish

Fish sampling conducted in 2002 indicated the mainstem of the SFSJR downstream of Florence Lake supports abundant, self-sustaining populations of brown and rainbow trout. Trout densities were greater in the bypass reach downstream of Florence Dam than in the Rosgen B channel reference site in the SFSJR upstream of Florence Lake. Trout densities at sites heavily used by fisherman tended to have lower densities. Higher densities of brown trout occurred upstream (upstream of Bear Creek and Mono Crossing) and sites downstream were dominated by rainbow trout (Table 5.2.4.2-18). Mean condition factors for trout were greater than 1.00. Most of the rainbow trout collected were presumed to be wild fish, based on their appearance and scales. The presence of multiple age classes of wild fish of both species indicates that reproduction and successful recruitment occur in the mainstem (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

In the SFSJR upstream of Florence Lake, only brown trout were collected. However other species, including rainbow trout and golden trout, are known to occur. Brown trout were observed moving upstream from Florence Lake to the river, likely as part of their spawning migration, which occurs in fall.

Benthic Macroinvertebrates

Densities of total macroinvertebrates and EPT were higher at six of the eight sites in the bypass reach than at Site 9, a reference site located in the SFSJR upstream of Florence Lake. Densities were lower than the reference site at Sites 2 and 3, located 15.4 miles (between Mono and Rattlesnake Creeks) and 16.95 miles (upstream of Mono Creek), respectively, upstream of the confluence with the SJR (Table 5.2.4.2-19). EPT density was highest at Sites 1 and 6 and, as with total macroinvertebrate density, was lowest at Site 2. Site 2 is located in a reach of the SFSJR that flows through a very deep, narrow canyon, where the river is exposed to shorter periods of solar radiation than other sites, which may affect primary productivity.

Summary of Resource Issues

Under existing conditions, water temperature is a resource issue that has the potential to adversely affect trout in the localized portions of SFSJR bypass reach between Florence Lake Dam and its confluence with the SJR. Temperature modeling shows that during July of a Dry Water Year with warm air temperatures, maximum daily water temperatures frequently approach those that might be stressful for trout and daily mean temperatures are occasionally warmer than suitable for trout growth in the 2.5 mile reach upstream of Mono Creek. Daily mean water temperatures in Dry

Water Years with warm air temperatures are warmer than suitable for trout in the most downstream portion of the reach (the lower five miles in July and 0.3 miles in August).

Trout populations vary in abundance between reaches. Fish population estimates collected as part of the licensing studies indicate that fishing pressure in some areas may reduce populations, as populations were lower in areas with developed recreation facilities (Jackass Meadow Campground, Mono Hot Springs), than in less accessible areas.

Bear Creek Forebay

At the spill elevation of 7,350 feet above MSL, the surface area of Bear Diversion Forebay is 13.25 acres and storage is 103 acre-feet. Water from the forebay is diverted to the Mono-Bear Siphon, which conveys water to Ward Tunnel.

Habitat

Impoundment Fluctuation

The seasonal water surface elevation fluctuates very little. Shallow water habitat is available at all forebay water surface elevations (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Water temperatures were monitored in the upper elevations of the impoundment in June through October of 2000 and 2001. Mean monthly temperature ranged from 6.8°C (October) to 14.2°C (August) in 2000 and from 12.7°C (October) to 18.2°C (August) in 2001, and daily maximum temperatures did not exceed 22.0°C (Table 5.2.4.2-20) (Table CAWG 5-87, CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 20°C and thus were suitable for trout growth (Figure 5.2.4.2-15) (CAWG 5 Appendix H Table H-A30; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

The only historical fish stocking record found was for 1948, when 4,050 rainbow trout were stocked in the Bear Creek Diversion Dam Forebay. No record of stocking was found for Bear Creek upstream of the diversion since 1962.

Fish

Fish collected during sampling in the forebay in 2002 included brown trout (93% of the fish collected) and rainbow trout (7%). The presence of young-of-the-year (age 0+) brown and rainbow trout shows that successful spawning occurs in the area of (upstream of) the Bear Creek Diversion Forebay. The mean condition factor for brown trout was greater than 1.00, but was 0.85 for rainbow trout (Table 5.2.4.2-15).

Upstream migration into Bear Creek from the impoundment is blocked by a steep, bedrock sheet located immediately upstream of the forebay. This suggests that recruitment to the forebay may occur through downstream movement of fish from upstream areas, or that some upstream passage may be available during high spring flows, when rainbow trout spawn (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Summary of Resource Issues

No aquatic resource issues were identified for the impoundment.

Bear Creek Bypass Reach

Bear Creek is part of a large watershed located on the northeast side of the SFSJR between Florence Lake and Lake Thomas A. Edison. Bear Creek Diversion is located 1.6 miles upstream of the confluence with the SFSJR. Bear Creek has an elevation of 7,350 feet above MSL at the diversion and drops to 6,715 feet above MSL at the confluence with the SFSJR.

Habitat

Physical Habitat

Bear Creek is a bedrock/boulder stream. The reach upstream of the diversion is a Rosgen Level I B channel, while the reach below the diversion is primarily an A channel type. The reach above the diversion has a large amount of riffle, run and shallow pool habitats. The reach below the diversion is predominantly composed of step pool and high gradient riffle habitats (Table 5.2.4.2-21). Pools below the diversion are a little deeper. A fair amount of large woody debris is present in the channel. A fair amount of spawning gravel is present, primarily located in pools, with smaller amounts in riffles (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

During the spring through fall of 2000 and 2001, four water temperature recorders were deployed in Bear Creek, two of which were located in the reach below the diversion. Bear Creek Diversion was operated throughout the monitoring period.

In the bypass reach below the diversion, monthly mean stream temperatures ranged from 7.1°C to 14.9°C in 2000 and 9.2°C to 16.5°C in 2001, and daily maximum temperatures did not exceed 19.2°C (Figure 5.2.4.2-15; Table 5.2.4.2-20) (Table CAWG 5-87; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 20°C (CAWG 5 Appendix H Tables H-A27 through H-A30; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) and were suitable for trout growth.

Aquatic Community

Stocking

Historically, Bear Creek upstream of Bear Diversion was planted with wild golden trout, initially in 1914. Fish from this location were subsequently used to stock other locations in Bear Creek and other tributaries of the SFSJR. Rainbow trout stocking first occurred in 1934. Based on the information available, Bear Creek was not stocked with fish below its diversion. No stocking has occurred since 1962 (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Bear Creek supports self-sustaining populations of brown trout above and below the diversion (Table 5.2.4.2-18). Mean condition factors for brown trout above and below the diversion were greater than 1.00. Fish densities and biomass were substantially higher (more than three-fold greater) in the reach below the diversion than above it. Fish density in the bypass reach was one of the highest of the Project reaches.

Benthic Macroinvertebrates

Density of total macroinvertebrates at Site 1 below the diversion, located 0.05 mile upstream of the confluence with the SFSJR, was greater than the reference site above the diversion; but at Site 2 below the diversion, located 1.5 miles upstream of the confluence, density was lower than at the reference site (Table 5.2.4.2-19). Mean EPT density was greater in the site above the diversion than in both sites below the diversion. Higher densities of fish below the diversion may result in high rates of predation and lower macroinvertebrate densities.

Summary of Resource Issues

The Bear Creek bypass reach does not have identified resource issues. The brown trout population is abundant at or above reference stream densities with successful recruitment. However, due to the abundance of brown trout, physical habitat may be approaching limiting values. The limiting factors analysis suggests that adult rearing and spawning habitat is heavily utilized by an abundant trout population (Attachment

C – Limiting Factors). In this reach, the amount of available habitat is close to the level that may potentially limit the trout population. Therefore, enhancement of physical habitat may have the potential to lead to increases in the brown trout population. Water temperatures are well within the suitable range for trout at all times. Bear Creek bypass reach supports a healthy population of brown trout, with one of the highest densities of trout of any stream in the Project Area. This population, supported by the existing flow regime, is greater in the bypass reach than in the stream above the diversion.

Mono Diversion Forebay

Water released from Lake Thomas A. Edison (or FERC No. 2086) flows through Mono Creek to the Mono Diversion Forebay for transport through the Mono-Bear Siphon to Ward Tunnel. During peak releases from Lake Edison, retention of water in the forebay may last from one to a few hours. Mono Creek upstream of the forebay was addressed as part of the relicensing of the Vermilion Valley Hydroelectric Project (Southern California Edison Company, Vermilion Valley Hydroelectric Project (FERC Project No. 2086) Final Application for New License for Minor Project – Existing Dam, Exhibit E, Volume 2, Section 2.4 [SCE 2001b]).

At the spill elevation of 7,350 feet above MSL, the surface area of Mono Diversion Forebay is 6.69 acres and storage is 46 acre-feet.

Habitat

Impoundment Fluctuation

There is little information on water surface elevations, as they are not recorded at Mono Diversion Forebay.

Water Temperature

The small Mono Diversion Forebay has a short retention time when flows are released from Lake Edison and consequently, a well-mixed thermal structure. Temperature trends reflect release temperatures from Lake Thomas A. Edison. There generally were minimal daily fluctuations in water temperatures, reflecting the source of the water deep within Lake Edison.

Water temperatures monitored in the diversion during June through October of 2000 and 2001 were cool. The monthly mean temperature of the impoundment ranged from 10.7°C (August and October) to 13.6°C (June) in 2000, and from 10.8°C (July) to 15.9°C (September) in 2001. Daily maximum temperatures were 18.4°C or less (Figure 5.2.4.2-16, Table 5.2.4.2-22) (Table CAWG 5-93, CAWG 5 Appendix H Table H-A39; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

Stocking records indicate that trout were only stocked in the reach above the diversion impoundment in Mono Creek, which is part of the Vermilion Valley Project. However, fish may pass from upstream to the impoundment and potentially to the bypass reach below the diversion dam. Historically, CDFG stocked rainbow, brown, and brook trout, as well as several strains of rainbow trout hybrids, in Lake Thomas A. Edison. Rainbow trout and brook trout also have been stocked in Mono Creek downstream of Vermilion Valley Dam. Catchable-sized rainbow trout are the only fish currently stocked in Mono Creek upstream of the diversion (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Fish sampling conducted in 2002 indicates that the brown trout population (24% of the catch), which has not been supplemented by stocking for many years, is self-sustaining. Rainbow trout (76%) were all of hatchery origin, based on scale analysis and appearance. Mean condition factors for trout species were greater than 1.00 (Table 5.2.4.2-18).

Summary of Resource Issues

No aquatic resource issues were identified for the impoundment.

Mono Creek Bypass Reach

Mono Diversion is located 5.9 miles upstream of the confluence of Mono Creek with the SFSJR. Mono Creek has an elevation of 7,333 feet above MSL at the diversion and drops to an elevation of 6,313 feet above MSL at the confluence with the SFSJR.

Habitat

Physical Habitat

The stream is mostly steep, boulder/bedrock habitats with Rosgen B channels. It is primarily composed of pool, step run, and cascade habitats. However, there are components of complex habitat types such as pocket water and riffles (Table 5.2.4.2-21). There is a fair amount of canopy cover in some of the habitat units. Many pools are deeper than those found in other tributaries of the SFSJR. Large amounts of spawning gravels are present in a few local concentrations (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). A low-gradient reach flows through Mono Meadow, which is grazed by cattle. The abundance and widespread distribution of fine sediments present when habitats were characterized and fish were sampled likely reduced the habitat value of Mono Creek for trout and macroinvertebrates. More recently, after high flows in 2005 and 2006, fine sediments have been less abundant in pools (Section 5.2-3).

Water Temperature

Two water temperature recorders were deployed in the bypass reach below the diversion (Figure 5.2.4.2-16). Water temperatures were cool. In the bypass reach, monthly mean stream temperatures ranged from 9.0°C to 14.8°C in 2000 and 10.6°C to 16.0°C in 2001, and daily maximum temperatures were 18.7°C or less (Table CAWG 5-93; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures did not exceed 20°C (Table 5.2.4.2-22), and daily mean temperatures did not exceed 17°C at any monitoring location (Figure 5.2.4.2-16) (CAWG 5 Appendix H Table H-A36 through H-A39; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

No historical record of stocking was found for Mono Creek below the diversion And CDFG does not currently stock trout there. However, rainbow trout have been stocked upstream and can be transported downstream to this reach (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Brown trout and rainbow trout were collected during sampling in the bypass reach of Mono Creek downstream of the Mono Diversion in 2002. The presence of multiple age classes, including age 0+, indicates suitable habitat is available for all life history stages and suggests that trout may be self-sustaining in this reach. Mean condition factors is greater than 1.00 for brown trout and less than 1.00 for rainbow trout (0.91). For both species, mean density and biomass are low (Table 5.2.4.2-18). Mono Creek historically supported higher fish densities, even though MIFs have not changed (Bartholomew and Loudermilk 1985).

Benthic Macroinvertebrates

Four sites were sampled below the Mono Creek Diversion (Table 5.2.4.2-19). Total macroinvertebrate density was highest at Site 2, located 1.3 miles upstream of the confluence with the SFSJR, but similar densities were found at Site 4 located just downstream of Mono Diversion. Mean EPT density was highest at Site 4 below Mono Diversion, with relatively similar densities found at Site 2. Total macroinvertebrate and EPT densities were lowest at Site 1, located 0.4 mile upstream of the confluence with the SFSJR.

Summary of Resource Issues

Under existing conditions, the presence of trout populations at low abundances in Mono Creek is a resource issue. The available information suggests that large quantities of sand and fine sediment found in this reach in 2000 through 2002 may be limiting fish populations. Sedimentation of habitat, including loss of pool depth and embeddedness of spawning gravels likely has adverse effects on trout habitat, recruitment, and overwinter survival. Sediment conditions are the most likely limiting factor in this reach.

MIFs requirements under the current FERC license during the fall of dry years are lower than the identified passage flows for trout. However, the actual flows in the reach (based on the USGS record) are usually sufficient to provide passage. This is a result of SCE releasing slightly more than the required MIF to maintain compliance. Although flow-related habitat is plentiful, habitat for some lifestages, including spawning does not appear to be fully utilized. Water temperatures are suitable for trout at all times throughout the reach. Mono Creek has historically supported much higher populations of trout than are currently present under the same MIF requirements as those that currently exist (Bartholomew and Loudermilk 1985). If sediment conditions were improved in this stream, trout populations would be expected to increase. Additional physical habitat might contribute to further increases of trout populations, with sediment management.

North-side Small Tributaries – Tombstone, North Slide, South Slide and Hooper Creeks

Small tributaries to the north side of the SFSJR include Tombstone, North Slide, South Slide and Hooper creeks. The diversions on Tombstone, North Slide and South Slide are currently not in operation. There are no fish in North Slide and South Slide creeks. The spill elevation for diversions on North Slide and South Slide creeks is 7,501.5 feet above MSL, and is 7,673 feet above MSL on Tombstone Creek. The spill elevation of the Hooper Diversion is 7,505 feet above MSL, with a surface area of 0.38 acres and storage of 3.76 acre-feet.

Habitat

Physical Habitat

Tombstone, North Slide, South Slide and Hooper creeks are very steep, boulder/bedrock streams with Rosgen Aa+ channels. Most habitats are cascade or bedrock sheet, naturally limiting the value of these streams for trout habitat (Table 5.2.4.2-23). However, there are smaller components of complex habitat types in Tombstone, South Slide and North Slide creeks. There are no pools in South Slide or North Slide creeks, but there are deep pools below the diversion in Tombstone Creek. Some spawning gravels are present in all but North Slide Creek (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). A small portion of stream below the North Slide Creek diversion was dry during habitat mapping, even though the diversion was not in operation. In North Slide Creek, a 15-foot high waterfall in a cascade located 17 feet upstream of the confluence with the SFSJR forms a total barrier at all flows and precludes the use of most of this creek by fish resident in the SFSJR (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Tombstone Creek flattens out through its lower reach in Jackass Meadow into a Rosgen C/E channel. The lower gradient C/E channel is composed predominantly of run and pool habitat. This reach contains habitat that is relatively rare in this portion of the watershed, with a low gradient stream channel and substantial amounts of fine sediments.

Multiple, natural, physical barriers limit access to Hooper Creek from the SFSJR. The cascades located 0.11 miles from the confluence of the SFSJR are barriers to brown trout (which dominate this reach of the SFSJR) and brook trout migration during the low flows that occur in the fall spawning season. These likely would not be barriers to rainbow trout or their hybrids that spawn in the spring during runoff, depending upon flow available below the diversion.

Water Temperature

Daily mean water temperatures did not exceed 15°C at any monitoring station in any of these creeks in 2000 or 2001 (Figures 5.2.4.2-17 and -18) (CAWG 5 Appendix H Tables H-A17 through H-A23; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Monthly mean water temperatures in Tombstone Creek (11.8°C or less), South Slide Creek (12.4°C or less) and North Slide Creek (11.8°C or less) were cold, and daily maximum temperatures did not exceed 19.5°C, 20.5°C and 15.7°C, respectively (Figure 5.2.4.2-17, Table 5.2.4.2-24) (Table CAWG 5-73; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

In the bypass reach of Hooper Creek, water temperatures also were cold. Hooper Creek Diversion operated from May 29 to September 30 in 2000, and from April 26 to July 20 in 2001. Monthly mean water temperatures ranged from 4.4°C to 10.7°C in 2000 and 5.8°C to 11.5°C in 2001, and daily maximum temperatures did not exceed 16.3°C (Figure 5.2.4.2-18, Table 5.2.4.2-24) (Table CAWG 5-79; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

No historical fish stocking records were found for Tombstone Creek. North Slide and South Slide creeks were not recognized as important fishing streams (Dill

1945a, cited in CAWG 7 Fish Population Report, SCE 2003). However, in 1950 CDFG planted 500 fingerling rainbow trout in South Slide Creek.

In Hooper Creek, fish were largely stocked above the diversion. The majority of fish stocking records were from 1949, when wild golden trout were caught from the Bear Creek drainage and transplanted to locations in Hooper Creek. A few brown trout were planted in the Hooper Creek diversion pond in 1963. Rainbow trout fingerlings were planted in 1949 at the diversion and 300 rainbow trout were planted in 1963 (location not known) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

During sampling conducted in 2002, no fish were found in North Slide Creek, South Slide Creek, or in Tombstone Creek above the diversion. Brown trout were found in Tombstone Creek below the diversion. Self-sustaining populations of rainbow x golden trout (hybrids) were found in Hooper Creek above and below the diversion (Table 5.2.4.2-18).

Mean condition factors for trout were greater than 1.00. Below the Tombstone Creek Diversion, mean density and biomass for brown trout were relatively high. In Hooper Creek, estimated trout densities and biomasses were higher below the diversion (962 fish/km and 124.9 kg/ha, respectively) than above (663 fish/km and 71.3 kg/ha, respectively).

Benthic Macroinvertebrates

Of the two sites sampled below the diversion in Tombstone Creek, total macroinvertebrate density and mean EPT density were highest at the downstream site located 0.7 miles upstream of the confluence with the SFSJR (Table 5.2.4.2-19). At this site, total macroinvertebrate and mean EPT densities were higher than in the reference site above the diversion. Densities at Site 2 in the bypass reach (0.95 miles upstream of the confluence) were lower than the reference site. Tombstone Creek diversion was not in operation for many years prior to sampling.

In South Slide and North Slide creeks, total macroinvertebrate densities and EPT densities were higher in the sites above the diversions than below, although the diversions were not in operation. Of the two sites sampled in the bypass reach below the North Slide Creek Diversion, the site located near the confluence of the SFSJR had higher densities for both total macroinvertebrates and EPT.

In Hooper Creek, total macroinvertebrate densities in the bypass reach were lower than in the reach above the diversion, but mean EPT density was higher at Site 2 in the bypass reach (located 0.55 mile upstream of the confluence with the SFSJR) than the site above the diversion. Mean EPT density was substantially lower at Site 1 (located 0.05 mile upstream of the confluence). Of the two sites sampled below Hooper Creek Diversion, total macroinvertebrate density and mean EPT density were higher at Site 2 than Site 1.

Summary of Resource Issues

Tombstone Creek, North Slide Creek, and South Slide Creek diversions are currently not in operation, thus there are no project impacts to fish populations in these streams. Of these streams, only Tombstone Creek currently supports trout, below the diversion.

In Hooper Creek, flows for fish passage were identified as a potential resource issue. Under existing conditions, current MIFs of 2 cfs are less than the 2.5 cfs needed for passage through a typical riffle on this creek. The current MIFs exceed the flow needed to protect fish and macroinvertebrate habitat, as identified by the wetted perimeter study, and water temperatures are suitable for trout, throughout the reach at all times.

South-Side Small Tributaries – Crater, Chinquapin, Camp 62 and Bolsillo Creeks

Small tributaries to the south side of the SFSJR include Crater, Chinquapin, Camp 62, and Bolsillo creeks. The only trout species found in these streams is brook trout. The Crater Creek diversion channel carries flow to Florence Lake. Chinquapin, Camp 62, and Bolsillo creeks are partially diverted directly into the Ward Tunnel. Chinquapin Creek enters Camp 62 Creek about 1.05 miles upstream of its confluence with the SFSJR, which is about 7.7 miles downstream of Florence Lake. Bolsillo Creek enters the SFSJR about 8.3 miles downstream of Florence Lake. The spill elevation of diversions on Crater, Chinquapin, Camp 62 and Bolsillo creeks are 8,764.6, 7,628, 7,257, and 7,532.5 feet above MSL, respectively.

Camp 61 Creek and Portal Forebay were evaluated as part of the relicensing of the Portal Project (Southern California Edison Company, Portal Hydroelectric Power Project Application for New License, Exhibit E [SCE 2003]).

There is no MIF requirement in Crater Creek in the current FERC license, but seepage from the diversion provides flow to the creek when the diversion is in operation. MIFs are required at the other diversions on tributaries in this group.

Habitat

Physical Habitat

Crater, Chinquapin, Camp 62 and Bolsillo creeks are steep, boulder/bedrock streams with Rosgen Level 1 Aa+ channels. Bolsillo Creek has approximately equal components of Rosgen Aa+ and B channels below the diversion. Crater Creek has mostly cascade and step run habitats, and the large percentage of cascade habitat above the diversion may limit the habitat value for fish. Bolsillo Creek and Chinquapin Creek, a tributary of Camp 62 Creek, have mostly step pool, step run, and cascade habitats. Camp 62 Creek has fair amounts of complex habitat types as well as a substantial amount of large woody debris (Table 5.2.4.2-25). Fair amounts of spawning gravel are found in Chinquapin, Camp 62, and Bolsillo creeks and large amounts are found in Crater Creek (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Crater Creek flattens out near the confluence with the SFSJR through Hell Hole Meadow, and has a short segment of Rosgen C/E channel below the diversion and near the confluence with the SFSJR. In the reach below the diversion, more complex habitat types were observed. The Rosgen C/E channel had a substantial amount of shallow pool habitat.

Crater Creek Diversion Channel (7,260 feet from Crater Creek Diversion to Florence Lake) is a combination of ditch and natural channel. It is a steep, bedrock stream with a Rosgen Aa+ channel. Much of the habitat is cascade or bedrock sheet that may limit the habitat value of this stream, but small components of the more complex habitat types are present (Table 5.2.4.2-25). Pools are very shallow and no large woody debris has been observed. Spawning gravels of poor to fair quality are distributed over many habitat types (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). There is flow in this channel during the runoff period when rainbow trout spawn, which could provide spawning habitat for fish from the lake, but there are apparently relatively few rainbow trout in Florence Lake. When operation of the diversion ceases, channel flow declines. There is little flow in this channel during the fall, when brown trout spawn or when brook trout (in Crater Creek) spawn.

Large waterfalls located 0.07 and 0.2 miles from the SFSJR in Camp 62 and Bolsillo creeks, respectively, naturally limit access to the creeks for fish originating from the river (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)). A 45-foot-high waterfall limits access from the SFSJR to the lower 0.7 miles of Camp 62 Creek, as well as to Chinquapin Creek, which is a tributary to Camp 62 Creek. In this 0.07-mile stream segment, spawning gravel is accessible to fish, but the waterfall blocks access to relatively large amounts of good to excellent quality spawning gravel in the bypass reach. A waterfall in Chinquapin Creek located only 785 feet upstream of the confluence with Camp 62 Creek blocks fish from upstream migration to most of Chinquapin Creek. In Bolsillo Creek, no spawning gravel is located below the waterfall blocking access from the SFSJR.

Water Temperature

The Crater Creek Diversion operated from April 28 to July 23 in 2000, and from March 12 to July 15 in 2001. Water temperatures were suitable for trout growth in Crater Creek and the Crater Creek Diversion Channel. Upstream of the Crater Creek Diversion, monthly mean temperatures ranged from 11.8°C to 15.4°C, and daily maximum temperatures did not exceed 20°C (Table 5.2.4.2-26) (Table CAWG 5-83; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In the Crater Creek diversion channel, monthly mean water temperatures ranged from 2.5°C to 10.8°C in 2000, and 4.5°C to 9.9°C in 2001; daily maximum temperatures did not exceed 14.7°C (Table 5.2.4.2-26) (Table CAWG 5-83; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In the diversion channel at the inflow to Florence Lake, daily mean temperatures did not exceed 18°C, and daily maximum temperatures exceeded 22°C for only one day in 2000 and for two days in 2001 (Table CAWG 5 Appendix H Table H-B25; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In the bypass reach of Crater Creek, monthly mean water temperatures were cool, ranging from 10.0°C to 14.4°C in 2000 and 9.1°C to 12.1°C in 2001; and daily maximum temperatures did not exceed 19.2°C (Table 5.2.4.2-26) (Table CAWG 5-83; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 18°C at any monitoring station in Crater Creek or the Crater Creek Diversion Channel (Figures 5.2.4.2-19 and -20) (Tables CAWG 5 Appendix H-A24 through H-A26; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

A recorder placed in Camp 62 Creek 0.05 miles upstream of the confluence with the SFSJR represents the downstream temperature for the combined waters of Camp 62 and Chinquapin creeks. Water temperatures were suitable for trout in Camp 62 and Chinquapin creeks. Monthly mean water temperatures at this station ranged from 8.5°C to 14.6°C in 2000, and 10.7°C to 15.6°C in 2001; and daily maximum temperatures did not exceed 18.2°C (Table 5.2.4.2-26) (Table CAWG 5-99; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 17°C at any monitoring station in Camp 62 or Chinquapin creeks (Figure 5.2.4.2-21) (Tables CAWG 5 Appendix H Tables H-A31 through H-A33; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

In Bolsillo Creek, stream temperatures near the confluence with the river were cool. Monthly mean stream temperatures ranged from 7.0°C to 12.0°C in 2000, and 8.7°C to 14.4°C in 2001; and daily maximum temperatures did not exceed 18.4°C (Table 5.2.4.2-26) (Table CAWG 5-105; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 16°C at any monitoring station in this creek (Figure 5.2.4.2-22) (CAWG 5 Appendix H Tables H-A34 and H-A35; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

No historical fish stocking records were found for any reaches in Chinquapin, Camp 62, or Crater creeks. In Bolsillo Creek, rainbow trout was apparently the only species historically stocked below the diversion. Currently, trout are not stocked in these streams. However, the presence of self-sustaining populations of non-native trout species, despite the presence of impassable barriers to migration, clearly indicates stocking activity at some time in the past.

Fish

Fish sampling conducted in 2002 indicates that Crater, Chinquapin, Camp 62 and Bolsillo creeks support self-sustaining populations of brook trout above and below the diversions (Table 5.2.4.2-18). Mean condition factors for trout are greater than 1.00. Mean trout densities and biomasses are high in all creeks except in Crater Creek, both above and below the diversion. In Crater Creek, total trout density and biomass are lower below the diversion (276 fish/km and 29.8 kg/ha, respectively) than above the diversion (547 fish/km and 21.2 kg/ha). However, the highest trout densities are found in the Crater Creek diversion channel. In Camp 62 Creek, total trout densities are greater in the bypass reach than above the diversion, although catchable-sized trout density is lower. In Chinquapin Creek total trout density is much greater downstream of the diversion than above. In Bolsillo Creek, trout densities are lower below the diversion than above. This may be due, in part, to differences in channel morphology and types of habitats present above and below the diversion.

Benthic Macroinvertebrates

In Crater Creek, densities of total macroinvertebrates and of EPT are lower in the site downstream of the diversion than in the site upstream of the diversion (Table 5.2.4.2-19). In Chinquapin and Camp 62 creeks, of two sites sampled below the diversions, densities of total macroinvertebrates and of EPT are highest at the downstream sites. In Chinquapin Creek, densities of total macroinvertebrates are higher at Site 1 (located 0.35 miles from the SFSJR) than in the reference site above the diversion, but not at Site 2 (located 0.6 miles from the SFSJR). Densities of EPT are lower at both bypass reach sites than in the site above the diversion. In Camp 62 Creek, densities of total macroinvertebrates are higher in sites below the diversion than in the site above the diversion. Densities of EPT are higher at Site 1 (located 0.05 miles from the SFSJR) than in the site above the diversion, but are lower at Site 2 (located 1.20 miles from the SJR). In Bolsillo Creek, both total BMI density and EPT density are higher at the site below the diversion than above, or upstream of the SFSJR confluence.

Summary of Resource Issues

Crater Creek

Under existing conditions, Crater Creek above and below the diversion has lower than expected trout densities. Trout densities above the diversion are greater than those below the diversion. There is no MIF requirement under the current FERC license. The diversion is constructed so low flows are preferentially passed to the diversion channel rather than the natural channel. Flows below the diversion are due to seepage, accretion, spills (if peak flows exceed the capacity of the diversion and go over the flashboards to the diverted reach), and surface runoff. The operation of the diversion results in periods where flows below the diversion are less than the flow identified by the wetted perimeter analysis as protective of fish and macroinvertebrates in this stream. Natural base flows less than this protective flow likely occur in this stream during the summer and fall. The structural nature of the habitat in Crater Creek also may limit trout populations. Habitat and fish populations in Crater Creek are highly fragmented by numerous falls and areas of bedrock sheet. Extensive upstream fish migration is unlikely at any flow. Temperatures are suitable for trout throughout this stream at all times.

Chinquapin Creek

The existing MIFs approximate the flow indicated by the wetted perimeter analysis to be protective of fish and macroinvertebrate habitat throughout the year. Current MIFs are slightly higher during the summer months (when habitat is most likely to limit fish populations), and slightly lower during the winter months (when trout are less active and require less habitat). However, MIFs are only met when sufficient flow is available. The most severe habitat bottleneck likely occurs in the summer and fall when the natural base flow upstream of the diversion drops below the protective flow (as identified by the wetted perimeter study) so that actual flows in the bypass reach may drop to less than existing MIFs for several months. During this time, the diversion is turned out (not diverting) and the stream flow is unaffected by the Project. Passage is restricted by frequent structural barriers. Natural low summer base flows and fish passage are the factors most likely to constrain fish populations in this bypass reach (Attachment C – Limiting Factors). Temperatures are suitable for trout throughout the reach at all times.

Camp 62 Creek

Natural low summer base flows and structural barriers to fish migration are the two factors most likely to constrain fish populations in Camp 62 Creek below the diversion (Attachment C – Limiting Factors). The existing MIFs in Camp 62 Creek are less than the flow identified by the wetted perimeter analysis as protective of fish and macroinvertebrate habitat. However, as with many of the small diversions, the most severe habitat bottleneck likely occurs in the summer and fall when the natural base flow drops below the protective flow (and the current MIF) for several months. During this time, the diversion is not operated. Passage is restricted by frequent structural barriers. Temperatures are suitable for trout throughout the reach at all times.

Bolsillo Creek

Natural low summer flows upstream of the diversion, structural barriers to fish migration, and the presence of fine sediments are the factors most likely to constrain fish populations in the bypass reach of Bolsillo Creek (Attachment C – Limiting Factors). Existing MIFs in Bolsillo Creek are less than the flow identified as protective of fish habitat by the depth suitability analysis. In fact, natural base flows in Bolsillo Creek are less than the protective flow except during the runoff season. The summer and fall unimpaired flows likely create the most severe habitat bottleneck for trout populations. During this time, the diversion is turned out under current operations. Upstream passage is restricted by frequent natural structural passage barriers. Fine sediment accumulations are present in pools both up and downstream of the diversion. Temperatures are suitable for trout throughout the reach at all times.

Balsam Forebay

Balsam Dam, located 2.75 miles upstream of the Balsam Creek confluence with Big Creek, impounds Balsam Forebay. Water moves from Huntington Lake and Pitman Creek to Balsam Forebay, and from there to Shaver Lake through Eastwood Powerhouse. Water also is pumped from Shaver Lake to Balsam Forebay for pump-storage operation. Only a small, ephemeral stream flows into the forebay. An MIF release is made to Balsam Creek downstream. At the spill elevation of 6,670 feet above MSL, the surface area of Balsam Forebay is 60 acres and storage is 1,648 acre-feet. At a normal annual maximum surface water elevation of approximately 6,662 feet above MSL, forebay volume is 1,247 acre-feet. When the forebay reaches a normal annual minimum elevation of 6,639 feet, its volume drops to 326 acre-feet.

Habitat

Impoundment Fluctuation

Water surface elevation in the forebay varies daily during pump storage operations, but generally is higher in the summer than in the winter. The Eastwood Powerhouse intake area (and pumpback discharge) is located on the north side of the forebay. The forebay contains suitable habitat for fish, but shallow water habitat is limited by the small size and relatively steep shoreline of the forebay (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Water temperature profiles were measured in 2001. Although the forebay can be thermally stratified during the summer, thermal stratification is not often likely to occur or persist due to the regular movement of large volumes of water through the forebay. In this relatively small impoundment, there was only a small thermal gradient (3°C or less between surface and bottom layers), which occurred in May and July. The mean temperature of the shallow waters ranged from 8.3°C (May) to 20.8°C (July), and the deeper waters ranged from 6.4°C (May) to 19.0°C (August) (Figure 5.2.4.2-23). These data suggest that water temperatures suitable for trout growth (less than 20°C) were available throughout the summer months.

Aquatic Community

Stocking

Fish were not stocked in the Balsam Forebay before the late 1990's. To discourage angling and protect wildlife, fish planting was not recommended (FERC 1982a, cited in CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). In 1999, catchable-sized rainbow trout were stocked into Balsam Forebay. No additional historical fish stocking information was available.

Fish

Fish species collected during sampling in the forebay in 2002 included brown trout (2% of the catch), rainbow trout (7%), Sacramento sucker (19%) and prickly sculpin (41%). This was the only medium-sized impoundment where kokanee (28%) and smallmouth bass (3%) were collected. Most of these species originate from Huntington Lake or Shaver Lake through pumpback and did not historically occur in what was formerly an ephemeral stream. Multiple age classes, including younger fish, were represented in the sampled fish, except brown trout, which indicates that rearing may occur in the forebay or that multiple age classes originate from Shaver or Huntington Lakes. Only age 6+ and older brown trout were identified in this location, although younger fish have been sampled here (SCE 1993). Mean condition factors for trout species were greater than 1.00 and there were no external signs of disease (Table 5.2.4.2-15).

Summary of Resource Issues

No aquatic resource issues were identified for Balsam Forebay.

Balsam Creek – Forebay to Diversion

Natural flow in Balsam Creek is augmented by releases from Balsam Forebay between Balsam Dam (located 2.75 miles upstream of the confluence with Big Creek) and Balsam Creek Diversion (0.7 miles upstream of the confluence), a distance of 2.05 miles. Balsam Creek has an elevation of 6,517 feet above MSL at the upstream end and drops to an elevation of 4,865 feet at Balsam Creek Diversion.

Habitat

Physical Habitat

This reach of Balsam Creek is a steep, bedrock stream with a mix of Rosgen Level I channel types Aa+ and B. It is predominantly composed of step pool and high gradient riffle. There also is a substantial component of flatwater habitat including run, step run and trench chute, as well as additional pool habitat, bedrock sheet and cascade (Table 5.2.4.2-27). One pool is deep. Small amounts of spawning gravel are observed (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Numerous natural barriers throughout Balsam

Creek are likely to fragment habitat in the creek (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Water temperatures were recorded downstream of Balsam Forebay and above the Balsam Creek diversion during the spring through fall of 2000, 2001 and 2002. Water temperatures were cool. Monthly mean temperatures below the forebay ranged from 10.2°C to 16.2°C in 2000, 6.5°C to 17.0°C in 2001, and 8.5°C to 16.1°C in 2002; and temperatures did not exceed a daily maximum of 19.1°C. Monthly mean temperatures above the diversion ranged from 8.3°C to 12.6°C in 2000, 8.8°C to 13.6°C in 2001, and 7.4°C to 14.8°C in 2002; and temperatures did not exceed a daily maximum of 18.9°C (Table 5.2.4.2-28) (Table CAWG 5-301; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Upstream of the Balsam Creek Diversion (the downstream end of this bypass reach), mean daily temperatures did not exceed 17°C (Figure 5.2.4.2-25) (CAWG 5 Appendix H Table H-A70; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

No historical fish stocking records were found for Balsam Creek.

Fish

Multiple age classes of rainbow trout, including age 0+, were collected in 2002, indicating the population is self-sustaining (Table 5.2.4.2-18). The mean condition factor for trout is greater than 1.00. Fish density (1,335 fish/km) and biomass (171.6 kg/ha) is high.

Benthic Macroinvertebrates

Balsam Creek above the diversion was sampled as a reference site for Balsam Creek downstream of the diversion (Table 5.2.4.2-12). Both total macroinvertebrate density and EPT densities are greater above the diversion than below.

Summary of Resource Issues

Flows in Balsam Creek below the forebay are augmented by flows from Balsam Forebay. Existing MIF requirements are greater than the flow identified by the wetted perimeter analysis as protective of fish and macroinvertebrate habitat during the summer months, and slightly less than this flow in the winter months. However, higher than required releases made to maintain compliance result in flows that exceed the protective flow at all times. The only factor that appears to be a resource issue in Balsam Creek between the Forebay and the Balsam diversion is the frequent, natural, structural passage barriers that limit upstream migration at any flow (Attachment C – Limiting Factors). Temperatures are suitable for trout throughout the reach at all times.

Pitman Creek

Pitman Diversion is located approximately 1.5 miles upstream of the confluence with Big Creek. Flow is diverted through Tunnel No. 7 (HPS), which transports water from Huntington Lake to Balsam Forebay and North Fork Stevenson Creek. The Pitman Diversion has a spill elevation of 6,998 feet above MSL. Pitman Creek drops steeply to an elevation of 4,843 feet above MSL at its confluence with Big Creek.

Habitat

Physical Habitat

Pitman Creek is a bedrock/boulder stream with a moderate gradient channel above the diversion and a very steep channel below the diversion. The Rosgen Level I B channel above the diversion consists of mostly step pool and flatwater habitats including run and glide, but has small components of complex habitats such as pocket water and riffle. The steep, Rosgen Aa+ and B channels below the diversion are almost completely step pool, cascade and bedrock sheet, with small components of other pool habitats and pocket water, and many pools are moderately to very deep (Table 5.2.4.2-27). The only spawning gravels observed are small amounts above the diversion, mostly in runs (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). A weir (not related to the project) located 0.16 mile upstream of the confluence with Big Creek blocks upstream fish migration to Pitman Creek from Big Creek (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Observed stream temperatures in the bypass reach of Pitman Creek were cool, with monthly mean stream temperatures ranging from 7.7°C to 16.7°C in 2000, and 9.1°C to 16.1°C in 2001; and daily maximum temperatures of 19.3°C or less (Table 5.2.4.2-28) (Table CAWG 5-214, CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). During the months of May through July, when the diversion was operational, Pitman Creek provided cold water input to Tunnel No. 7. Monthly mean water temperatures ranged from 5.3°C to 15.3°C in 2000, and 6.5°C to 15.8°C in 2001; and daily maximum temperatures did not exceed 22.3°C. Daily maximum temperatures exceeded 22°C for only one day in September in the Pitman Conduit Diversion in both 2000 and 2001 (CAWG 5 Appendix H Table H-B68 and H-B69; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean temperatures did not exceed 19°C at any monitoring station in Pitman Creek (Figure 5.2.4.2-24) (CAWG 5 Appendix H Table H-A68 and H-A69; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

Catchable-sized rainbow trout were stocked in Pitman Creek almost every year since 1956. Brook trout were stocked only in 1966 and 1979. During the period 1998-2002, an average of 1,345 rainbow trout was planted each year (with no trout planted in 2002) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

The self-sustaining trout community sampled in 2002 included rainbow trout (73% of the catch), brown trout (21%), and brook trout (6%) both above and below the Pitman Creek Diversion. Below the diversion, rainbow trout made up about 94% of the fish collected in the Rosgen B channel site and only rainbow trout were found in the Rosgen Aa+ channel site. Mean condition factors are greater than 1.00 for all trout species (Table 5.2.4.2-18). The presence of age 0+ and older fish suggests reproduction and recruitment may occur in the vicinity (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). However, the low densities of brown and brook trout below the diversion suggest populations may be seeded from upstream habitat, or may be less successful in competition with the more numerous rainbow trout. There is no statistically significant difference between brown and brook trout condition factors above and below the diversion (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Benthic Macroinvertebrates

Three sites were sampled below the diversion, representing two different channel types. Only Site 2, below the diversion, was located in the same channel type as above the diversion, which may have affected results. Density of total macroinvertebrates is highest at Site 1, located 1.3 miles upstream of the confluence with Big Creek, and is lowest at Site 2, located 1.45 miles upstream of Big Creek (Table 5.2.4.2-19). Site 2 is the only site below the diversion that does not contain higher densities of macroinvertebrates than upstream of the diversion. EPT densities upstream of the diversion are higher than those downstream. Within the bypass reach, density of EPT is highest at Site 1.

Summary of Resource Issues

The existing MIF requirement is less than the flow suggested as protective of fish by the wetted perimeter analysis, however this is a minor resource issue. Structural habitat is the factor most likely to limit fish populations in Pitman Creek (Attachment C – Limiting Factors). Pitman Creek below the diversion is a steep, bedrock-dominated stream. About half of this reach is plunge pool and step pool habitat with bedrock controls, which provide the vast majority of usable habitat for fish. This type of habitat is not responsive to changes in flow. Most of the remaining habitat is cascade and bedrock sheet, which provides very limited habitat for fish. Upstream migration through this channel is prohibited by numerous, natural, structural barriers.

In spite of these constraints, fish populations in the Pitman Creek bypass reach are abundant and healthy under existing conditions. While numbers are lower than above the diversion, the more diverse habitat structure above the diversion provides far better conditions for trout than that below the diversion. Temperatures are suitable for trout throughout the reach at all times.

North Fork Stevenson Creek

Natural flow in North Fork Stevenson Creek is augmented by instream flow releases from Tunnel 7 (Huntington-Pitman-Shaver [HPS] conduit) (North Fork Stevenson Creek RM 3.55). Prior to the construction of Eastwood Power Station, this reach was used to transport water to Shaver Lake.

Habitat

Physical Habitat

North Fork Stevenson Creek has a moderate to steep gradient, bedrock/boulder stream with Rosgen Level 1 type Aa+, A, B, C, and G channels. The reach upstream of the Tunnel 7 outlet is a narrow channel, primarily composed of cascade and bedrock sheet, with smaller components of shallow pools, limiting the habitat value of this reach. Much of the reach downstream of the outlet is step pool and cascade or step run, but small components of riffles and other pools are observed (Table 5.2.4.2-29). The reach downstream of the outlet contains distinct sections of either steep or lower gradient habitats. Many pools downstream of the outlet are up to three feet deep. Small amounts of fair to good quality spawning gravels are distributed downstream of the outlet, with little gravel of poor quality upstream (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Inflow from Huntington Lake controls water temperatures directly downstream of Tunnel 7, while meteorological conditions have more influence on stream temperatures downstream near the confluence with the lake. Observed monthly mean water temperatures at the monitoring station below the Tunnel 7 outlet ranged from 12.8°C to 16.4°C in 2001, and 7.7°C to 16.6°C in 2002, during the summer months. Water temperatures were warmer in May through August near Shaver Lake, than below Tunnel 7 outlet, but cooler in mid-August through September. North Fork Stevenson Creek provided cold water input to Shaver Lake with monthly mean temperatures of 15.6°C or less, and daily maximum temperatures that did not exceed 21.2°C (Table 5.2.4.2-30) (Table CAWG 5-312; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D

(Books 12 and 23)). Water temperatures did not exceed a daily mean of 18°C or a daily maximum of 22°C at any monitoring station in North Fork Stevenson Creek, thereby providing water temperatures suitable for trout growth and protective of COLD freshwater habitat beneficial uses (Figure 5.2.4.2-26) (CAWG 5 Appendix H Tables H-A76 and H-A77; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

No historical fish stocking records were found for North Fork Stevenson Creek above or below the Tunnel 7 outlet.

Fish

Beginning in October of 2000, fish population monitoring studies have been conducted downstream of the Tunnel 7 outlet after a failure of Gate 2 resulted in higher than normal streamflows (since operation of the Balsam Meadow Project was initiated) (ENTRIX 2001 and 2002). Smaller fish populations and changes in year class structure were documented following this high-flow event. In 2001, fish populations began to recover. The sampled fish community in 2001 was predominantly composed of rainbow trout, with a smaller component of brown trout. Sacramento sucker and riffle sculpin also were found.

In 2002, not a single fish was found in the Rosgen Aa+ channel site upstream of the Tunnel 7 outlet. The sampled fish communities downstream of the Tunnel 7 outlet were predominantly composed of brown trout, rainbow trout and golden x rainbow trout hybrids, with a small component of Sacramento sucker (Table 5.2.4.2-18). The mean condition factor of trout species was greater than 1.00. Mean density and biomass of trout species were high. The absence of age 0+ and juvenile Sacramento suckers suggests successful reproduction may not always occur in this stream and that these fish may originate from introductions through Tunnel 7 flows (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Benthic Macroinvertebrates

Three sites were sampled below the Tunnel 7 outlet and one above the outlet (Table 5.2.4.2-19). Densities of total macroinvertebrates and EPT were higher at Sites 1 and 2 (located 1.35 and 2.75 miles, respectively, upstream of the Stevenson Creek confluence in Shaver Lake) than at the reference site above the outlet. Densities were lower at Site 3, located 3.45 miles upstream of Shaver Lake.

Summary of Resource Issues

Flows are augmented by Project releases from Tunnel 7 (Huntington-Pitman-Shaver [HPS]). Existing MIFs are sufficient to support more than the current number of trout for all lifestages, including spawning. These flows are sufficient to provide fish passage through typical riffles at all times (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)), although frequent, natural, structural barriers prevent extensive upstream passage. North Fork Stevenson Creek is only accessible from Shaver Lake when the reservoir is at maximum elevation, and a complete barrier to fish migration exists 457 feet upstream from the lake. Gravel in this reach is limited in abundance. Temperatures are suitable for trout throughout the reach at all times.

Resource issues relate to a widening of the channel due to its use as a flow transport reach by SCE prior to the construction and operation of the Eastwood Power Station. This channel may occasionally be used to convey high flows in the spring, if the Eastwood Power Station is offline. Trout populations are lower than expected due to high flow releases in several past years, which adversely affected recruitment. Currently, fish populations are recovering from recent large flow events.

Shaver Lake

Shaver Dam, located on Stevenson Creek 4.25 miles upstream of its confluence with the SJR, impounds Shaver Lake. Local inflow to Shaver Lake is primarily from Stevenson and North Fork Stevenson creeks. Shaver Lake receives most of its water volume through the Huntington-Pitman-Shaver (HPS) conduit from Huntington Lake through Balsam Forebay and the Eastwood Power Station. Flow in North Fork Stevenson Creek also is augmented by Project MIF releases from Tunnel 7 (HPS) and may occasionally receive flows bypassing Eastwood Power Station.

Over a 21-year period of record (1980 to 2001), average maximum yearly storage in Shaver Lake was 113,884 acre-feet and average minimum yearly storage was 48,875 acre-feet, corresponding to water levels of approximately 5,359.8 feet and 5,321.5 feet above MSL, respectively (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). At the spill elevation of 5,370 feet above MSL, the surface area of Shaver Lake is 2,184 acres and storage is 135,568 acre-feet.

Releases to Stevenson Creek downstream are made from near the bottom of Shaver Dam. Water from Shaver Lake not released to Stevenson Creek is diverted through Tunnel 5 to Big Creek Powerhouse 2A. The Tunnel 5 intake is located near the bottom of the lake.

Habitat

Reservoir Fluctuation

The lowest water surface elevations usually occur in the spring and the reservoir is usually at its maximum volume in the summer, generally around July. The relatively large amount of shallow habitat available at most reservoir elevations is indicative of the general shallow depth and large size of the reservoir. Artificial, shallow-water reefs or spawning terraces were constructed by SCE near the lake margin to provide additional habitat for smallmouth bass. Shallow, reef-like areas, which become islands at lowered lake elevations, are scattered around the edges of the reservoir.

Upstream fish passage from Shaver Lake to North Fork Stevenson Creek is only available when the reservoir is at maximum elevation. However, a waterfall located only 457 feet upstream from the lake forms a natural barrier to upstream migration. Upstream passage from the lake to Stevenson Creek (upstream of Shaver Lake) is maintained at the full range of operational lake elevations (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Flows entering Shaver Lake influence water temperatures. Flows may enter from North Fork Stevenson Creek (discussed above), Stevenson Creek, and Eastwood Power Station, as well as from minor creeks and local area runoff.

Monthly mean temperatures in the Eastwood Powerhouse tailrace ranged from 15.3°C to 20.5°C in 2000, and 12.0°C to 21.6°C in 2001. Daily maximum temperatures frequently exceeded 22°C, particularly in 2001, but did not exceed 23.7°C (Figure 5.2.4.2-27) (Table CAWG 5-310; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Shaver Lake surface water temperatures influenced the recorded temperatures, when the Eastwood Power Station was off line.

Stevenson Creek (upstream of Shaver Lake) provided cold water input to Shaver Lake with monthly mean temperatures of 14.1°C or less. Daily maximum temperatures did not exceed 18.4°C (CAWG 5 Table 5-310, CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Water temperature profiles of Shaver Lake were taken monthly in the spring through fall of 2000 and 2001 (Figure 5.2.4.2-28). Temperature gradients occurred in May through August, but in September and October mixing occurred and water temperatures cooled at the surface. A thermocline developed only in the summer months of 2001 and mixing occurred by September or October.

Water temperatures suitable for trout growth (less than 20°C) were available in Shaver Lake. When stratified, the mean temperature of the epilimnion (upper layer) ranged from 16.1°C (May) to 21.1°C (July) and the hypolimnion (deeper layer) ranged from 7.6°C (May) to 13.6°C (July) in 2001. When not stratified (August through October of 2000 and 2001), mean temperature ranged from 14.9°C (August) to 17.2°C (September) and 16.8°C (August) to 18.0°C (September) in 2000 and 2001, respectively (Figure 5.2.4.2-28).

Aquatic Community

Stocking

Historical fish stocking records for Shaver Lake date back to 1908, before the current dam was built. Species historically stocked include brown trout, rainbow trout, brook trout, kokanee, threadfin shad, smallmouth bass, and largemouth bass. Rainbow trout was the primary species stocked, beginning in 1950. Brown trout were planted from 1908 through 1911, then again in 1975 and 1983. Brook trout were stocked from 1970 through 1996. Kokanee were stocked from 1982 through 2002. Threadfin shad and smallmouth bass were only stocked once, in 1963 and 1912, respectively (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Rainbow trout and kokanee are the only species that are currently stocked in Shaver Lake. During the period 1998-2002, CDFG stocked an average of 35,383 catchable-sized trout, 26,082 fingerling trout, and 50,133 fingerling kokanee per year in Shaver Lake.

Fish and Crayfish

In Shaver Lake, rainbow trout (37%), kokanee (19%), Sacramento sucker (3%), smallmouth bass (27%), bluegill, crappie, unidentified centrarchids, and a carp were collected in 2002 (Table 5.2.4.2-15). Other species were introduced to the lake and are still found there, although in lower numbers. Multiple age classes are represented for most species. Rainbow trout and kokanee are likely of largely hatchery origin (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

A hydroacoustic survey conducted in July of 2002 showed fish at the dam end, which is the deepest portion of the lake, concentrated in the upper layers of the lake (above depth of 21.6 meters [70.9 feet]). Low fish densities were found at deeper depths near the intake. A hydroacoustic survey conducted in October 2002 showed all fish at depths shallower than the intake (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)); CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)).

Crayfish also were found in Shaver Lake. Catch per unit effort (CPUE) for crayfish (*Pacifastacus leniusculus*) collected in 2002 was 0.05 crayfish/hour.

Summary of Resource Issues

No aquatic resource issues were identified for Shaver Lake.

Big Creek Powerhouse 8 Forebay (Dam 5)

Big Creek Powerhouse 8 Forebay is a relatively small water body. Dam 5, which impounds the forebay, collects water from Big Creek upstream of Powerhouse 2/2A and the discharge from Powerhouse 2/2A. Water from Dam 5 forebay is subsequently released into Big Creek below Dam 5 and diverted into the intake for Big Creek Powerhouse 8. At the spill elevation of 2,943 feet above MSL, the surface area of Dam 5 Forebay is 3.32 acres and storage is 49 acre-feet.

Habitat

Impoundment Fluctuation

Water surface elevation in the forebay, which rarely varies substantially, remains near the normal annual maximum of 2,942 feet above MSL (43.4 acre-feet), but occasionally drops to elevations as low as 2,938 feet above MSL (31.5 acre-feet). The intake is near the bottom of the impoundment.

Water Temperature

During typical operation of Big Creek Powerhouse 2/2A, the volume of water in the forebay is replaced many times in a single day. Due to the small size of the forebay and the large volumes of water that pass through it during the summer months, thermal stratification is not likely to occur. Water temperatures in the forebay were cool, with monthly mean temperatures that did not exceed 17.7°C during either year of monitoring.

Big Creek Powerhouse 2/2A (Big Creek RM 1.85) tailrace discharged cool water inflow to the forebay, with monthly mean temperatures of 17.6°C or less and 17.2°C or less, respectively, during the temperature monitoring study (Figure 5.2.4.2-29) (Table CAWG 5-268; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures in the tailrace were cooler than those in Big Creek upstream of Big Creek Powerhouse 2/2A in the early summer, but by about September, when water temperatures begin to cool in the creeks, tailrace temperatures were warmer due to the origin of water in upstream reservoirs. Water temperatures recorded in the depths of the forebay near the Tunnel 8 intake also were cool. Monthly mean water temperatures ranged from 15.9°C or less and daily maximum temperatures did not exceed 18.3°C (CAWG 5-268; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

The only fish stocking record for the Powerhouse 8 Forebay was from 1979, when rainbow trout (1,600) were planted (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Brown trout (84%), rainbow trout and prickly sculpin (8% each) were collected in 2002 (Table 5.2.4.2-15). Multiple age classes for brown trout were represented. The mean condition factor for brown trout was greater than 1.00.

Summary of Resource Issues

Under existing conditions, the only resource issue is related to the accumulation of sediment in the impoundment and its periodic release (about once every seven years) during tunnel walks and inspections.

Big Creek Dam 5 to Powerhouse 8 Reach

Dam 5 is located 1.65 miles upstream of the confluence with the SJR where Big Creek Powerhouse 8 is located. Big Creek has an elevation of 2,910 feet above MSL at the release point below Dam 5, and drops to an elevation of 2,284 feet above MSL at Powerhouse 8.

Habitat

Physical Habitat

Big Creek downstream of Dam 5 is a moderately steep, bedrock/boulder stream composed primarily of Rosgen A channel, with a smaller component of Aa+ channel at its downstream end. It has mostly step pool and other pool habitats, with only small amounts of riffle and flatwater habitats (Table 5.2.4.2-29). Most of the pools are shallow, but many pools are moderately to very deep. Small amounts of spawning gravel are observed in pools (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Fine sediments may be found at times, generally associated with material discharged during tunnel inspections. A tall, vertical waterfall located 0.09 mile upstream of the confluence with the SJR prevents fish upstream migration to Big Creek from the SJR (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Water temperatures were suitable for trout growth in the upper portion of the bypass reach, but daily mean water temperatures were greater than 20°C in the downstream portion for part of the summer of 2001 – a dry, warm year. Water temperatures in Big Creek directly downstream of Dam 5 are affected by releases from Powerhouse 2/2A. During all months monitored in 2000 and the summer months of 2001, water temperatures increased from Dam 5 to upstream of Big Creek Powerhouse 8, where this powerhouse discharged cool water (Figure 5.2.4.2-30, Table 5.2.4.2-31) (Table CAWG 5-270; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Monthly mean stream temperatures in the reach ranged from 12.0°C to 18.8°C in 2000, and

7.7°C to 19.3°C in 2001, during the summer months. Daily maximum temperatures were 18.1°C or less in the upstream portion of the reach, and 23.6°C or less in the downstream portion of the reach. Daily mean temperatures did not exceed 18°C at the monitoring station downstream of Dam 5, but they exceeded 20°C at the monitoring station upstream of Powerhouse 8 for 11 days in 2001 (Figure 5.2.4.2-30) (CAWG 5 Appendix H Table H-A61 and H-A62; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum temperatures did not exceed 22°C at the monitoring station downstream of Dam 5, but exceeded 22°C at the monitoring station upstream of Powerhouse 8 for 24 days in 2001 (CAWG 5 Appendix H Table H-B61 and H-B62; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Aquatic Community

Stocking

Historically, CDFG and other entities have stocked or moved rainbow trout, brook trout, and brown trout in Big Creek between Dam 1 (Powerhouse 1) and Powerhouse 8, but stocking records do not indicate specific locations (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Fish

Brown and rainbow trout were collected during sampling in 2002 (Table 5.2.4.2-18). Rainbow trout had greater abundance than other fish species in this lower elevation reach of Big Creek, and fish were in good condition. There were many age 0+ rainbow trout collected in the A channel site, which suggests reproduction occurs in or near this reach (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Mean trout density was high (1,231 trout/km), but trout biomass was relatively low (4.2 kg/ha).

Benthic Macroinvertebrates

Total macroinvertebrate and EPT densities are relatively high. Density of total macroinvertebrates was higher at Site 1, located 0.55 miles upstream of the confluence with the SJR, than at Site 2 located 1.55 miles upstream of the confluence. The reverse was true for density of EPT, which was higher at Site 2 than at Site 1 (Table 5.2.4.2-19).

Summary of Resource Issues

Under existing conditions, the principal resource issues in this reach are warm water temperatures, upstream migration in the fall of dry years, overwinter flows in dry years, and periodic (approximately once every seven years) sedimentation when the impoundment is drained for tunnel inspections (Attachment C – Limiting Factors). Despite these resource issues, trout density is similar to that for reference locations.

Mean daily water temperatures exceeded 20°C at the bottom of the reach for 11 days in 2001, a Dry Water Year with warm air temperatures. MIFs in the fall of dry years are lower than the flow necessary for passage through a typical riffle, which may affect brown trout spawning migration. On average, however, records indicate that passage flows were exceeded at all times under actual operations, due to the release of extra water to maintain compliance with the MIF. However, numerous, natural, passage barriers occur along the bypass reach preventing extensive upstream migration under any flow conditions. Periodic sedimentation may decrease stream depth and smother spawning gravels and redds until flows of sufficient magnitude and duration occur to move the sediment downstream into the SJR. Overwinter habitat may also be an issue in dry water years due to low flows and the dominance of shallow habitats.

Stevenson Creek – Shaver Dam to San Joaquin River

The bypass reach of Stevenson Creek extends from Shaver Dam to the confluence with the SJR, a distance of 4.25 miles. Stevenson Creek has an elevation of 5,252 feet above MSL at Shaver Dam and drops to an elevation of 1,638 feet above MSL at the confluence with the SJR. Flow originates from releases made at Shaver Dam.

Habitat

Physical Habitat

Over half of the bypass reach is composed of Rosgen Level I Aa+ channel type, with the rest composed of A and B channels and a small section of G channel. The dominant habitat types are cascade and pools, with small components of other habitat types (Table 5.2.4.2-29). Some pools are moderately to very deep. Large woody debris is observed in many of the habitat units. Small amounts of spawning gravel are observed in pools (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Stevenson Creek Falls and a series of other waterfalls within the first half-mile of the creek upstream of the SJR form natural barriers at all flows, limiting fish upstream migration (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)). No spawning gravels are found in this stream section.

Water Temperature

Observed water temperatures were suitable for trout throughout Stevenson Creek. Water temperatures in Stevenson Creek at the release point of Shaver Dam were cold, with monthly mean temperatures ranging from 6.7°C to 15.1°C and daily maximum temperatures that did not exceed 15.7°C (Table 5.2.4.2-32) (Table CAWG 5-316; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). When Shaver Lake is stratified during the summer, cold water is released to the stream, but by the end of summer when the lake begins to lose its thermal stratification, the water released reflects the mixed water temperature of the lake.

Water warmed in Stevenson Creek between the dam and the monitoring station at the railroad grade (2.4 miles upstream of the confluence with the SJR), and from there to upstream of the confluence with the SJR, over the summer months; but cooled in October. Over the reach, monthly mean temperatures ranged between 10.5°C to 16.8°C in 2000, and 6.7°C to 16.9°C in 2001 during the summer months; and daily maximum temperatures did not exceed 22°C (Table 5.2.4.2-32) (Table CAWG 5-316; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Water temperatures were suitable for trout growth. Daily mean water temperatures did not exceed 20°C at any monitoring station in this bypass reach (Figure 5.2.4.2-31) (CAWG 5 Appendix H Table H-A75, H-A78, and H-A79; SD-D CAWG 5 Temperature Monitoring Report, SCE 2004).

Aquatic Community

Stocking

Historical stocking records indicate five plantings of rainbow trout occurred during the 1950's (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Fish are currently not stocked.

Fish

Multiple age classes of rainbow trout were collected in 2002, including age 0+ fish, which indicates that suitable habitat is available for all life history stages, including spawning. Mean condition factors were greater than 1.00. Mean trout density (615 trout/km) and biomass (63.6 kg/ha) were high (Table 5.2.4.2-18).

Benthic Macroinvertebrates

Five sites were sampled in the bypass reach below Shaver Dam (Table 5.2.4.2-19). Macroinvertebrate densities are relatively high, but variable. Densities of total macroinvertebrates and EPT were much higher at Site 4, located 2.6 miles upstream of the SJR, than any other site. Densities were lowest at Site 3, located 2.4 miles upstream of the SJR.

Summary of Resource Issues

The availability of spawning habitat and passage flows were identified as potential resource issues in Stevenson Creek (Attachment C – Limiting Factors) under existing conditions. Spawning habitat in Stevenson Creek is likely rare because suitable spawning gravels are uncommon. Current MIFs also contribute to the low availability of spawning habitat. There are few gravel sources within the watershed, and the steep bedrock channel tends to transport gravels rather than retain them (CAWG 2, Geomorphology, 2002 FTSR (SCE 2003; Volume 4, SD-C (Books 7 and 21)). However, MIFs during the spawning season provide only about 20% of maximum habitat for spawning, so higher flows during this time could provide substantially more spawning habitat, with the gravel currently available. MIFs are less than required for passage through a typical riffle, which may reduce access to areas of suitable spawning habitat, but natural structural passage barriers along this stream would prevent migrations longer than 1,000 to 2,000 feet, on average, at any flow. Recruitment appears to be lower than expected.

Rearing habitat under existing conditions does not appear to limit current rainbow trout populations. However, enhancement of physical habitat may provide increased potential for population increases, if provided in conjunction with increased spawning habitat. Mean daily water temperatures currently are suitable for trout.

5.2.4.2.4 Big Creek No. 3 (FERC Project No. 120)

The Big Creek Powerhouse 3 forebay is located behind Dam 6 on the SJR. The Big Creek Powerhouse 3 forebay receives water from Mammoth Pool Powerhouse, Big Creek Powerhouse 8, the SJR and Big Creek. Water from the forebay is diverted through Tunnel 3 to Big Creek Powerhouse 3. The Stevenson Reach of the SJR is the bypass reach for this Project.

<u>Management Objectives</u>

Management objectives for this reach of the SJR include the same beneficial uses for Warm Freshwater Habitat (WARM) and Cold Freshwater Habitat (COLD) identified in the CRWQCB Water Quality Control Plan (Basin Plan) and discussed in Section 5.2.4.1 Environmental Setting and Evaluation Approach.

The Stevenson Reach of the SJR contains a native fish assemblage including hardhead, Sacramento pikeminnow, and Sacramento sucker (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)), in addition to low numbers of rainbow and brown trout. Hardhead, a member of the native transition zone community, has sensitive species status in Region 5 of the US Forest Service (which includes the Sierra National Forest) (USFS 1998), and is listed as a CDFG species of concern (Class 3 Watch List) (Moyle, et al. 1995). Hardhead is only present in this one reach in the Big Creek ALP, although it is also present in Redinger Lake and the bypass reach of the Big Creek No. 4 Project (FERC No. 2017) downstream. The USFS Record of Decision for the Sierra Nevada Plan Amendments (USFS 2004) states:

> Maintain in streams flows to protect aquatic systems to which species are uniquely adapted. Minimize the effects of stream diversions or other flow modifications from hydroelectric projects on threatened, endangered, and sensitive species.

Big Creek Powerhouse 3 Forebay (Dam 6)

Big Creek Powerhouse 3 forebay is a relatively small water body. At the spill elevation of 2,230 feet above MSL, the forebay has a volume of 993 acre-feet and a surface area of 23.2 acres.

Habitat

Impoundment Fluctuation

Water surface elevation in the forebay, which rarely varies significantly, remains near 2,229 feet above MSL for most of the year, but occasionally drops to elevations as low as 2,214 feet above MSL (587 acre-feet of storage) (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Water Temperature

Monthly water temperature profiles were measured directly upstream of the dam from May through October of 2001 (Figure 5.2.4.2-32). Thermal gradients formed in June and July and a thermocline formed between four and five meters depth in August and September. No thermal stratification was observed in May or October (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Daily mean water temperatures suitable for trout (≤ 20°C) were available within the impoundment. In 2001 (a Dry Water Year with warm air temperatures) mean temperature of the epilimnion ranged from 17.3°C (August) to 19.5°C (September) and the hypolimnion ranged from 14.6°C (August) to 17.2°C (September) (Figure 5.2.4.2-32). When not stratified (May through July, October of 2001), mean monthly temperature ranged from 8.7°C (May) to 17.1°C (October) (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). After Mammoth Pool Reservoir begins to mix in late August to September, its warmer waters dominate temperatures in the forebay.

Water temperatures were monitored in the spring through fall of 2000 and 2001 in the forebay near the Powerhouse 3 intake (recorder depth of about five meters, Table CAWG 5-148; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). In 2000, an Above Normal Water Year, mean monthly water temperatures near the Powerhouse 3 intake ranged from 11.8°C (June) to 18.0°C (September) (Table CAWG 5-148; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). During 2001, mean monthly water temperatures ranged from 9°C in May to 20.2°C in September. Releases from Dam 6 to the Stevenson Reach are made from an intake located near the bottom of the forebay. When the forebay is stratified, it tends to provide cool flow releases to the SJR downstream. Water temperatures at the deepest points of the water temperature profiles were cool, ranging from 8.6°C to 16.8°C from May through October. At times other than summer, temperatures in the SJR are cool, as is the water released from Dam 6.

Aquatic Community

Stocking

Rainbow trout were stocked in the Powerhouse No. 3 forebay in 1979. Rainbow trout were reported to have been planted in some subsequent years, but records are not available (SD-C CAWG 7 Characterize Fish Populations Report, SCE 2003).

Fish

Sampling conducted in 2002 indicated Sacramento sucker is the most abundant species (79%), with smaller components of brown trout (15%) and rainbow trout (6%). The fish community composition of the forebay resembles that of the SJR upstream and immediately downstream of the forebay (with the exception of hardhead, which are only found downstream of Stevenson Creek). Mean condition factors for trout species are greater than 1.00 (Table 5.2.4.2-33) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Multiple age classes are represented for all fish species.

Summary of Resource Issues

No aquatic resource issues were identified in the Powerhouse 3 Forebay.

San Joaquin River Stevenson Reach (Dam 6 to Redinger Lake)

The Stevenson Reach of the SJR is the reach from Dam 6 downstream to Big Creek Powerhouse 3 near Jose Creek, a distance of approximately 5.7 miles. Releases from Dam 6 and Stevenson Creek (which has its confluence with the SJR at 3.45 miles downstream of Dam 6) contribute the majority of the flow to this bypass reach.

Habitat

Physical Habitat

Stevenson Reach is a moderate gradient, boulder/bedrock stream with a Rosgen Level I channel type G. Habitats include moderately to very deep pools and complex pocket water habitats, as well as very small components of riffles (Table 5.2.4.2-34). Canopy cover is low and no large woody debris is observed. Small amounts of relatively widely distributed spawning gravels are observed (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Dam 6 is the only structure that forms a complete barrier to upstream migration at all flows (CAWG 14 Barriers Report (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Water Temperature

Water temperature monitoring in 2001 showed that cool water released from Dam 6 resulted in cool temperatures in the river directly below the dam. Water temperatures increased rapidly to the next monitoring site, upstream of Stevenson Creek (Figure 5.2.4.2-33) (Table CAWG 5-150; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). The inflow of cool water from Stevenson Creek decreased water temperatures in the SJR. Temperature warmed again beginning from that location to the downstream end of the bypass reach, where discharge from Big Creek Powerhouse 3 again decreased water temperatures during warmer months. Water temperatures generally are more suitable for trout in the upper portion of the reach, but cooler than optimal for hardhead. Water temperatures in the lower portion of the reach are more suitable for hardhead, but warmer than suitable for trout.

At the upstream monitoring station below Dam 6, mean monthly water temperatures in 2001 ranged from 9.5°C to 16.5°C and daily maximum temperatures were 20.1°C or less (Table CAWG 5-150; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures exceeded a daily mean of 18°C for only one day (CAWG 5 Appendix H Table H-A51; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Temperature data are not available for 2000.

At the monitoring station located upstream of Stevenson Creek, mean monthly water temperatures ranged from 12.8°C to 18.0°C in 2000, and 12.8 to 21.4°C in 2001. Daily maximum temperatures were as high at 24.9°C, exceeding 24°C for three days, in July of 2001 – a warm, Dry Water Year (Table 5.2.4.2-35). Daily maximum water temperatures exceeded 22°C for 65 days in the summer of 2001, but did not exceed 22°C in 2000 – an Above Normal Water Year (CAWG 5 Appendix H Table H-B-52; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Observed water temperatures exceeded a daily mean of 20°C for only four days in 2000, but for 70 days in 2001 (CAWG 5 Appendix H Table H-A52; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Temperatures at this site ranged from below the hardhead preference range to well within that range during 2000 and 2001. While these temperatures are favorable to hardhead, they are less suitable for trout growth. Moyle (2002) states that hardhead are usually found in streams that have summer temperatures in excess of 20°C. Optimal temperatures, as determined from laboratory studies (primarily juvenile hardhead), appear to be 24°C to 28°C.

Summer water temperatures were cooler downstream of Big Creek Powerhouse 3, where flow diverted from the Powerhouse 3 forebay reenters the stream. Mean monthly water temperatures ranged from 11.8°C to 17.2°C and 9.5°C to 17.5°C in 2000 and 2001, respectively. Temperatures did not exceed a daily maximum of 20.1°C (Table CAWG 5-164; S CAWG 5, Water Temperature Monitoring, TSRPs

(SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean water temperatures did not exceed 20°C in either 2000 or 2001 (CAWG 5 Appendix H Table H-A51; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures near the Powerhouse 3 tailrace are generally more favorable for trout growth than temperatures in the lower portion of the Stevenson Reach, just upstream of the confluence with Jose Creek.

Aquatic Community

Stocking

No historical fish stocking records were found for the Stevenson Reach.

Fish

Fish communities differ between the two (upper and lower) sampling sites in the Stevenson Reach (Table 5.2.4.2-36). The upper site, located 1.6 miles downstream of Dam 6 and upstream of Stevenson Creek, is dominated by Sacramento sucker (76% of fish collected). Smaller numbers of rainbow trout (9%), brown trout (2%), Sacramento pikeminnow (2%), and prickly sculpin (11%), are found here. Mean condition factors for trout are greater than 1.00 and for Sacramento sucker was 1.62.

Sampling at the lower site, about 2.1 miles downstream of Stevenson Creek and 0.7 miles upstream of Powerhouse 3, indicates that this portion of the reach supports populations of Sacramento pikeminnow (56%), hardhead (40%), and Sacramento sucker (less than 1%), all representing components of the native transition zone community. One brown trout was present, with a mean condition factor greater than 1.00. All of the hardhead sampled were juveniles. In addition, large numbers of small (0 to 3 inches Total Length) unidentified cyprinids were found in the margins of the snorkeled pool habitats. Based on their morphological features, these were likely Sacramento pikeminnow or hardhead. Juvenile hardhead condition factors ranged from 0.69 to 1.51, for a mean of 0.97[10].

Sacramento pikeminnow and hardhead densities at the lower site were 597 and 295 fish/km, respectively. Densities of Sacramento suckers were higher at the upper site (514 fish/km) than at the lower site (15 fish/km). For both trout species, mean density and biomass are relatively low; total rainbow trout density at the upper site was 100 fish/km and total brown trout densities were 7 fish/km at both sites (Table 5.2.4.2-36) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

[10] Condition factors for hardhead are not comparable to those for trout. There is little information available to suggest what an appropriate condition factor may be for this species.

The pikeminnow-hardhead-sucker assemblage of the Sacramento-San Joaquin Province (Moyle 2002) is currently in decline in California and especially in the San Joaquin Valley, but it has been relatively stable over a number of years in Redinger Lake and the Horseshoe Bend reach below it (Big Creek No. 4 Project – FERC Project No. 2017) (SCE 1997). Hardhead and other members of this assemblage from Redinger Lake likely spawn in the Stevenson Reach of the SJR and potentially in other tributaries. It is likely that adult fish return to the lake after spawning.

Benthic Macroinvertebrates

Macroinvertebrates in this reach are abundant and have greater total and EPT densities than the reference site upstream of Mammoth Pool Reservoir (Table 5.2.4.2-5, used as a reference site). Of four sites sampled, densities of total macroinvertebrates and of EPT were greater immediately below Dam 6 and at the sampling site located downstream of Stevenson Creek (about 3.6 miles downstream of the dam) (Table 5.2.4.2-37). EPT densities were considerably lower at the other two sites. EPT densities upstream of Mammoth Pool Reservoir were similar to the two Stevenson Reach sites with the lowest densities.

Summary of Resource Issues

The potential fisheries resource issues under existing conditions in the SJR between Dam 6 and Powerhouse No. 3 include (i) water temperatures exceeding the CVRWQCB Basin Plan "COLD" objective in the lower portion of the reach; and (ii) water temperatures within portions of the reach that are cooler than the preferred temperature range for hardhead. Trout abundance is lower than expected, and outside of the spawning season, adult hardhead do not reside in the lower portion of the reach. Uncontrolled spills from Mammoth Pool Dam and subsequently from Dam 6 in Wet and Above Normal Water Years may scour trout embryos from redds and result in fry mortality, which may affect recruitment in some years.

Management objectives for this reach of the San Joaquin include the beneficial uses for Warm Freshwater Habitat (WARM) and Cold Freshwater Habitat (COLD) identified in the CVRWQCB Water Quality Control Plan (Basin Plan) and discussed in Section 5.2.4.1. A second management objective relates to hardhead, a fish species that is a member of the native transition zone community. This species has sensitive species status in Region 5 of the US Forest Service (which includes the Sierra National Forest) (USFS 1998), and is listed as a CDFG species of concern (Class 3 Watch List) (Moyle, et al. 1995).

For hardhead, the juvenile lifestage is of particular concern within the Project Area. Adult hardhead are infrequently observed in the reach below Dam 6 and above Redinger Lake outside of the spawning season, in spite of the presence of many large deep pools that provide suitable habitat. Adult hardhead are thought to migrate from Redinger Lake into this reach to spawn and then return to Redinger Lake to rear. This is supported by the observation that the many juveniles, who are not strong swimmers, were present in the reach, but very few adults were observed during sampling in August of 2002, which occurred outside of the spawning season.

Summer water temperatures in the lower portion of this reach are too warm to meet the COLD objective of the CVRWQCB Basin Plan, which is based upon water temperatures generally suitable for trout (daily mean temperature of 20°C or less). However, temperatures that meet the COLD objective of the Basin Plan are generally too cool to be suitable for hardhead. Temperatures in lower portions of this reach under existing conditions are in the preference range for hardhead and Sacramento pikeminnow (Moyle 2002), but are too warm for trout (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Flows that increase physical habitat for trout, particularly flows that may result in cooler water temperatures, may not be suitable for native transition zone species, including hardhead. Cooler water temperatures that are less suitable for transition zone species, like hardhead, however are more suitable for trout. This results in a conflict of management objectives for this reach.

Flow-related habitat is not considered to be limiting for trout. There is sufficient habitat (WUA) at current MIFs to support more than twice the expected population for an unimpaired stream at this elevation (Attachment J - Regional Fish Densities Memo, Attachment C - Limiting Factors) and more than 10 times the current population. A resource issue raised by the resource agencies is the need for increased adult hardhead and Sacramento pikeminnow habitats. This is based on the observation that there is an absence of adult hardhead after spawning in the reach.

5.2.4.3 Impacts of Proposed Action

The Proposed Action is composed of measures selected to address resource issues and enhance habitats for aquatic organisms. The Proposed Action is designed to maintain and enhance viable populations and habitats for native and resident aquatic life, focusing largely on fish species, but providing benefits for reptiles and amphibians in certain reaches. Essentially, the Proposed Action enhances conditions for coldwater fish, in this case, species of trout found in the Project bypass reaches. It should also be neutral or benefit hardhead in the SJR between Dam 6 and Redinger Lake, the only reach in the ALP Project Area in which they occur.

Resource issues identified for aquatic organisms generally consisted of bypass reaches without currently required MIFs, where water temperatures were too warm for trout growth, where trout populations were low, and where enhancement of physical habitat was desirable to increase aquatic populations.

Objectives for enhancement give specific consideration to special status species, which includes hardhead. Specific consideration also is given to game species, including trout, kokanee and bass in reservoirs.

5.2.4.3.1 Mammoth Pool Project (FERC Project No. 2085)

Project Effects on Project Waters

The following subsections describe how the Proposed Action will affect conditions for aquatic resources in each water body affected by the operation of Project 2085, and how the proposed changes address the resource issues described in Section 5.2.4.2. The discussion of each reach begins with a summary of the Proposed Action and a summary of effects. This is followed by a more detailed description of effects.

Mammoth Pool Reservoir

Proposed Action

The Proposed Action would increase MIFs to the reach below Mammoth Pool Dam (Table 3.1.7-1), which would increase releases from Mammoth Pool Reservoir. The additional release of water would result in minimal change to reservoir elevation and volume. As part of SCE's ALP Recreation Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)), SCE will make every effort to secure recreational benefits by maintaining the water surface at the maximum elevation practical for water storage, with minimum noticeable fluctuation, from June 1 to September 1 of each year. Since little change is expected to reservoir volumes and operations, little effect is expected on habitat, water temperatures, or the potential for entrainment in wetter water years. In drier water years, the increased releases would tend to induce mixing of the epilimnion and hypolimnion slightly earlier than under the No Action Alternative. The Proposed Action is not expected to adversely affect fish using the reservoir.

Water temperature profiles would be measured in Mammoth Pool Reservoir during the implementation of the Water Temperature Monitoring and Management Plan. Measurements would be made on a monthly basis between June through September, or starting after the cessation of spill. Measurements will be made in two locations, one near the dam, the other upstream.

SCE would conduct monitoring studies to characterize trends in the relative abundance and species composition of the fish community. This would include fish monitoring during the 8th year after license issuance, and every 10 years thereafter for the length of the license (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). The study would be implemented in the same years fish monitoring in stream reaches. The sampling methods would be similar to those of the CAWG 7 study (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Trends in bioaccumulation of silver in fish and crayfish in Mammoth Pool Reservoir also would be monitored to evaluate whether upstream mining activities or cloud seeding activities in the upper watershed or other sources of silver may affect aquatic resources. This monitoring program would be conducted in conjunction with fish monitoring in several Big Creek ALP Project reservoirs. This monitoring program is further discussed in Section 6.1.2 *Water Quality*[11].

Habitat Impacts

Proposed Action MIF releases downstream of Mammoth Pool Dam would result in relatively small changes in seasonal water surface elevations in Mammoth Pool Reservoir (based on the results of SCE's HydroBasin model). The volume of water released for generation and MIFs under the Proposed Action would increase by four to 8% on average, over existing conditions during summer months in normal water years, and 10 to 13% in dry water years. The reservoir has steep sides that result in small changes to shallow water and deep-water habitat areas over a wide range of water surface elevations. Therefore, this proposal would have little effect on quality or quantity of reservoir habitat.

Temperature

Under the Proposed Action, changes would occur to both downstream water temperatures and to the volume of cool hypolimnetic water available as fish habitat for trout in Mammoth Pool Reservoir. The Proposed Action releases would reduce the volume of cool water in the reservoir more rapidly than under existing conditions. This would be especially evident in drier water years with warm meteorology, when the increased MIFs in combination with generation, would likely deplete the cool water pool about two weeks earlier than currently occurs under similar conditions. This may have a small adverse effect on reservoir trout. However, considering the relatively healthy fish populations in the reservoir, and the desire to achieve lower instream temperatures in the bypass reach below to meet target temperatures for trout and Basin Plan objectives, the earlier summer thermal destratification of the reservoir is not a reasonably controllable Project effect.

Entrainment

No entrainment of fish from Mammoth Pool Reservoir through Mammoth Pool Powerhouse was observed during entrainment sampling (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The intake to the Mammoth Pool Powerhouse is located deep in the lake. Because of the depth, very few fish were found near the intake and there is little potential for fish to encounter it, including times when the reservoir was drawn down (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The population of trout in Mammoth Pool Reservoir consists primarily of larger fish, with juveniles rearing in tributaries (Section 5.2.4.2.1 Affected Environment). Intake approach velocities are well within the swimming capabilities of the adult fish. Based on low likelihood of fish encountering the intake and their capability of escaping from intake velocities, the

[11] Fish monitoring, as well as monitoring for bioaccumulation of silver in fish and crayfish, would also be conducted in Lake Thomas A. Edison, which is part of the SCE's Vermillion Valley Project.

potential for entrainment is low. Since no increase in generation flow or reservoir elevations is expected under the Proposed Action, no change from the current low entrainment potential is anticipated.

Reservoir Fisheries

The aquatic community in Mammoth Pool Reservoir appears to be healthy, supporting a self-sustaining population of brown trout and a put-and-take rainbow trout fishery (Table 5.2.4.2-1). Little change is expected to reservoir habitat or entrainment. The earlier depletion of cool water in dry water years due to higher MIFs may be considered to have a slight adverse effect on reservoir trout.

Mammoth Pool Bypass Reach – Mammoth Pool Dam to Mammoth Pool Powerhouse (San Joaquin River - Mammoth Reach)

Proposed Action

The Proposed Action would increase MIF requirements below Mammoth Pool Dam to the Mammoth Pool Powerhouse bypass reach (Mammoth Reach). The MIFs under the Proposed Action would increase by 2 to 12 times over existing MIFs and are proposed to be the same for all water year types (Table 3.1.7-1). These MIFs would provide water temperatures desirable for trout growth, when and where such temperatures are not achieved under existing conditions, and when temperatures in the bypass reach are controllable by the Project. A temperature monitoring program would be implemented using telemetered water temperature monitoring and flows to maintain target temperatures in summer in the bypass reach, when water temperatures are controllable by the Project, or reduce warming in the bypass reach to 2.7°C (5°F) if feasible. If water temperatures exceed criteria, as may occur when Mammoth Pool Reservoir is mixing, the licensee will consult with the State Water Board and other agencies to determine alternate approaches, or document that water temperatures are not fully controllable by the Project (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)).

The existing MIFs provide sufficient physical habitat (WUA) to support the current trout population, although less than needed to support the density of trout (absent similar densities of Sacramento sucker) in reference streams at similar elevations (Attachment C - Limiting Factor Analysis). Spawning habitat is of relatively limited abundance than for other trout lifestages. There would be substantial enhancement of aquatic physical habitat under the Proposed Action. MIFs would substantially increase flow-related habitat for adult and spawning rainbow trout, and decrease habitat for juvenile and fry of both species. The potential for redd and fish stranding would decrease (although it is not currently an issue), but MIFs would not affect stranding caused by spills. Adult sucker habitat would also be increased, while habitat for fry and juvenile sucker would be reduced. The Proposed Action and the existing MIFs both provide sufficient depth for upstream passage.

Existing frequent spills (not under Project control) would continue to provide the same geomorphically beneficial flows (Section 5.2.3) provided under existing conditions and the same adverse effects on trout recruitment in Wet and Above Normal Water Years.

As part of the Proposed Action, fish population trends would be monitored over the course of the new license (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the monitoring plan the trout population would be monitored at years 3, 8, 18, 28 and 38, after the implementation of the proposed enhancement measures, depending on the length of the license through the remainder of the license period.

Habitat Impacts

Flow-Related Habitat (WUA)

Flow-habitat relationships for the SJR, Mammoth Pool Dam to the Mammoth Powerhouse tailrace (Mammoth Reach), were determined based upon models of 31 PHABSIM transects (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) for flows from 10 to 500 cfs. The resultant WUA vs. flow functions are provided in Tables Attachment D-1 and D -3 (Figures 3-19 to 3-21, CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) for rainbow and brown trout.

The Proposed Action would increase summer habitat (July through September) for adult rainbow trout by about 35% in normal and dry water years. Adult habitat would be increased over the course of the entire year by about 50% in both water year types (Table Attachment D-4). The Proposed Action would provide 91% of maximum WUA during the summer months, and more than 82% of maximum WUA during the entire year (Table Attachment D-6) for adult rainbow trout. The corresponding values under No Action (existing conditions) are 69 and 61% of maximum WUA, for these same periods, respectively. For rainbow trout spawning, the Proposed Action would increase habitat by an average of 87% over existing conditions in normal years and by 150% or more in dry years. The Proposed Action would provide 63% of maximum WUA in all years, as compared to the 36 and 25% of maximum WUA provided under No Action during normal and dry years, respectively.

The Proposed Action would increase summer habitat for adult brown trout habitat by 20% in the summer months of normal and dry years relative to existing conditions, and by an average of about 30% over the course of the entire year (Table Attachment D-5). The Proposed Action would provide at least 98% of maximum adult brown trout WUA during the summer, and at least 94% during the rest of the year (Table Attachment D-6). Under existing conditions, over 80% of maximum adult brown trout WUA is provided in the summer of normal and dry years, and about 75% would be provided over the course of the entire year, on average. In normal years, brown trout spawning habitat would be increased by 67% in October, and by over 130% in November and December, relative to existing conditions. In dry years, the brown trout spawning increase would be 136 to 165%

in all three months. The Proposed Action would provide 60 to 66% of Maximum brown trout spawning WUA in normal and dry years, this is compared with a maximum WUA of 26 to 40% under existing conditions.

Rainbow and brown trout juvenile and fry habitat respond similarly to the flow changes under the Proposed Action. Juvenile habitat would decrease by about 10% during the summer months, and about 5% throughout the year (Tables Attachment D-4 to D-6). The Proposed Action would provide 82 to 96% of maximum WUA at all times for juveniles, while under existing conditions, approximately 95% of maximum WUA is provided, on average. Fry habitat would decrease by an average of 20% during June through September, when fry are present, in normal and dry years. The Proposed Action would provide about 78% of maximum fry WUA on average, while an average of about 95% is provided under existing conditions for this species/lifestage.

Sacramento sucker habitat would respond to the Proposed Action MIFs in a similar manner to that described for the two trout species (Table Attachment D-7). Adult sucker habitat would increase by about 27% during the summer months of normal and dry water years, with an average change of about 40% over the entire year, for both water year types. The Proposed Action would provide 85% of maximum adult sucker WUA during the summer and at least 78% of maximum WUA the rest of the year (Table Attachment D-8). Under existing conditions, an average of 68% of maximum adult sucker WUA is provided in the summer of normal and dry water years, and over 60% during the entire year for both water year types. Juvenile habitat would decrease by about 10% during the summer and throughout the year in normal and dry water years. In both water year types, about 88% of maximum WUA would be provided for juvenile Sacramento suckers under the Proposed Action, compared with 99% under existing conditions.

The time series analysis confirms the results of the WUA analysis above, showing similar increases in habitat for all species and lifestages (Tables Attachment K-2 to K-9). The time series analysis does indicate a somewhat smaller increase in rainbow trout spawning habitat than was indicated by the WUA analysis (about a 100% increase over the 20-year period analyzed. This lower value incorporates lower habitat values during spill events within the reach.

Passage and Stranding

The Proposed Action is not expected to substantially affect passage or the potential for fish stranding in the Mammoth Reach relative to existing conditions.

Under the Proposed Action MIFs, as is true with the Existing MIFs, flows exceed the 10 cfs needed to provide upstream passage in this reach at all times (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). Therefore, it is anticipated fish would be able to move upstream and downstream without impediment related to low flows.

The potential to strand young fish due to scheduled seasonal decreases in MIFs as part of the Proposed Action is expected to be negligible in early summer, when young-of-the-year fish are abundant (Attachment E - Stranding Report) (Table Attachment D-9). The Proposed Action would change only MIFs, and would not affect spills in the Mammoth Reach. No CRM flows are proposed for this reach. Therefore, the Proposed Action would not change stranding potential during periods when spill occurs relative to the existing condition.

Dewatering of rainbow trout redds would not occur as a result of the Proposed Action as MIFs are stable or increasing during the incubation and emergence period (April into July). However, uncontrolled spills in Wet and Above Normal Water Years may result in rainbow trout spawning outside of the portion of the channel that would be used for spawning at seasonal MIFs or cause loss of young-of-the-year trout through movement of the substrate. This would occur under both Existing MIFs and the Proposed Action.

During the brown trout spawning and incubation period (October through May), uncontrolled spills do not occur and flows would consist of MIFs. The MIFs would decrease from 80 to 55 cfs over the spawning period. The analysis shows that 4% of the suitable spawning habitat would be outside the wetted channel due to changes in MIFs during this period (Attachment E - Stranding Report) (Table Attachment D-10). Under existing conditions, 8% of the potential redds could be lost as a result of changes in MIF that occur during the brown trout spawning and incubation period. Therefore, the Proposed Action could result in a slight improvement relative to the existing condition. Redd loss estimates are conservative (over estimates), in that the analysis assumes that the redd is lost if water levels over the redd are less than 0.1 ft. Studies show that redd survivorship can be quite high, even when redds are dewatered, as long as the temperatures within the redd do not become too warm, and the humidity remains high (Bjornn and Reiser 1991). Given the time of year (November and later) and the fact that the egg pocket is located a few inches below the bed surface, temperatures are likely to remain cool and humidity will remain high until MIFs increase in the spring, prior to emergence.

Temperature

Under existing conditions, the lower portion of the bypass reach frequently attained daily mean temperatures in excess of 20°C during July and August (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). This occurred most frequently during Dry Water Year conditions with warm air temperatures (2001), when daily mean water temperatures in the SJR upstream of Ross Creek downstream of Mammoth Pool Powerhouse exceeded 20°C for more than 60 days. In late August to September during the Dry Water Year (2001), after thermal stratification in Mammoth Pool Reservoir no longer was present, the temperatures of water released into the bypass reach were near 20°C, reflecting average water temperatures in the reservoir. Daily mean temperatures in excess of 20°C are considered to be warmer than desirable for long-term trout growth, but occur frequently in the bypass reach during dry, warm years. Maximum temperatures that may be stressful for trout also occurred under the same conditions. These temperatures are considered to be within the preferred temperature range for Sacramento sucker.

The effect of the Proposed Action MIFs on water temperatures in the bypass reach was simulated, using the temperature models developed for this Project (CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)). The proposed MIFs resulted in decreased water temperature predictions during June, July, and August of both Normal and Dry Water Year types. As shown in Figures 5.2.4.3.1-1 through -4, daily mean water temperatures during June, July and August would be reduced to 19.1°C or less throughout the reach. The range of predicted daily mean temperatures in June through August is 9.9°C to 19.1°C, which may at times result in temperatures cooler than the optimal range for rainbow trout growth in the upper portion of the reach, but suitable for brown trout. During late August and September of dry and warm years, after the reservoir mixes, water released from the reservoir is warmer, and no cool water is available for release. Daily mean temperatures at such times are predicted to exceed 20°C, (and be as warm as 20.2°C) in the lower 0.86 miles of the reach, which is higher than the optimal range and target temperature for rainbow trout growth. Increased flows would not result in lower temperatures under these conditions. Daily maximum water temperature predictions are reduced to less than 21°C for all months (Figures Attachment F-1 through F-4, Attachment F – Temperature Figures (Volume 4 (Book 5)).

The Proposed Action, therefore, provides the beneficial impact of achieving water temperatures desirable for trout growth when and where such temperatures are not achieved under existing conditions, and are controllable. However, the higher MIFs associated with the Proposed Action during dry years would result in earlier depletion of the cool water pool stored in Mammoth Pool Reservoir. In drier water years, this depletion would occur up to three weeks earlier than under the No Action Alternative, and daily mean water temperatures may be higher than 20°C in the lower portion of the reach, but daily maximum temperatures should not reach more than 21°C.

As part of the Proposed Action (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)), summer water temperatures would be monitored in the Mammoth Reach of the SJR, as identified in the Temperature Monitoring and Management Program, to confirm that the water temperatures in this reach, when controllable, meet target temperatures. When the target maximum daily temperatures cannot be met, release flow adjustments will be made to prevent temperatures from increasing more than 2.7°C. Telemetry would be used to monitor real-time water temperatures in the bypass reach and releases from Mammoth Pool Dam would be adjusted, as described in an Operational Water Temperature Control Plan. Monthly water temperature profile data would be collected during the summer months in Mammoth Pool Reservoir. In consultation with resource agencies, a Long-Term Operational Water Temperature Control Plan would be developed to meet water temperature targets and to prevent excess warming, when meeting water temperatures is feasibly under Project control.

Aquatic Life

Fish

The MIFs under the Proposed Action would be the same for all water year types for the Mammoth Pool Dam to Mammoth Pool Powerhouse bypass Reach (Mammoth Reach). This would contribute to increased habitat in all water years over existing conditions (No Action Alternative), especially drier water years. These higher MIFs would substantially increase habitat for adult and spawning rainbow and brown trout, and decrease habitat for juvenile and fry of both species. The Proposed Action would slightly decrease the potential for redd and fish stranding resulting from changes in MIFs, but would not affect stranding caused by spills. The higher MIFs under the Proposed Action would not likely provide a benefit to passage, relative to the No Action Alternative, since the existing MIFs provide sufficient depth for upstream movement of adults through typical riffles. Adult sucker habitat would be increased, while habitat for fry and juvenile sucker would be reduced.

Decreased water temperatures in the lower portion of the bypass reach would be expected to improve conditions for trout growth. Reduced temperatures also would reduce stressful conditions for trout during hot meteorological conditions occurring in drier water years. The temperature monitoring program for this reach would contribute to maintaining target water temperatures, when controllable by the Project, and reduce warming when water temperatures are not controllable, as occurs when Mammoth Pool Reservoir is mixing.

Data suggest that food supply (macroinvertebrates) does not appear to be a factor limiting trout populations or individual growth in the bypass reach. However, increased flows would likely benefit the macroinvertebrate community. The effect of uncontrollable spills on substrate movement in spring and early summer, during Wet and Above Normal Water Years, likely results in substantial young-of-the-year fish mortality. No enhancement measure is likely to improve this source of mortality.

Fish monitoring would be implemented to help document the benefits of the Proposed Action for fish populations. As part of the Proposed Action (Fish Monitoring Plan, SCE 2007a; Volume 4, SD-G (Book 19)), fish population trends will be monitored over the course of the new license.

Rock Creek

Proposed Action

The Proposed Action would implement MIFs in the bypass reach, where none are required under existing conditions. The only habitats in Rock Creek suitable for fish are plunge pools, which are not responsive to changes in flow. Thus, increasing flows is unlikely to result in a substantial improvement in the amount of physical habitat available. Decreased water temperatures in dry water years and flow continuity during the summer are likely to benefit trout by providing a longer period of temperatures suitable for trout growth and fewer days with stressful water temperatures. Increased flows also may benefit macroinvertebrates, reptiles and amphibians.

Habitat Impacts

The Proposed Action would provide a MIF of the lesser of natural inflow or 1 cfs during January through March and July, 2 cfs from April through June, and 0.5 cfs for the remainder of the year. This would provide a small improvement in the suitability of habitat, to the extent these flows are available upstream of the diversion.

Analyses indicate that fish populations in Rock Creek are likely limited by low summer base flows and the structural nature of the habitat (Attachment C - Limiting Factors). The stream reach is comprised primarily of cascade and bedrock sheet, with some plunge pools. Fish would be largely confined to plunge pools, which represent only about 20% of the total reach length. Plunge pools are not responsive to changes in flow, and thus increasing flow is unlikely to result in a substantial improvement in the amount of habitat that would support an increase in fish populations.

Temperature

The Proposed Action MIFs would reduce water temperatures in the bypass reach of Rock Creek from those present under the No Action Alternative (Figures 5.2.4.3.1-5 and -6) (Figures Attachment F-5 and F-6). However, daily mean water temperatures would still exceed 20°C in the lower portion of the bypass reach during July of both normal and (hot and) dry water years. Modeled daily mean water temperatures in July exceeded 20°C for 43% of the reach in normal and 55% in warm, dry years. Normally when water temperatures exceed 20°C, insufficient flow is present upstream of the Rock Creek diversion to reduce them further (CAWG 6, Hydrology, Appendix I, TSRPs (SCE 2004a; Volume 4, SD-D (Books 13 and 23)); CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)).

Entrainment

The evaluation (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)) found that there is little potential for entrainment at Rock Creek Diversion. The Proposed Action would not likely change conditions for entrainment.

Aquatic Community

Fish and Macroinvertebrates

Decreased water temperatures and flow continuity during the summer are likely to be beneficial to fish and macroinvertebrates by providing a longer period of temperatures suitable for growth and fewer stressful days. Flows also may benefit reptiles and amphibians.

Ross Creek

Proposed Action

Under existing conditions, Ross Creek is dry above and below the diversion during much of the summer and fall due to an upstream non-Project diversion. There currently is no MIF requirement. The Proposed Action establishes an MIF of 0.5 cfs below the diversion in Wet through Below Normal Water Year types, or inflow, whichever is less. In Dry and Critical Water Years, the diversion would likely be turned out during July through November.

The lack of summer flows available upstream of the diversion and consequent unavailability of flow below the diversion would continue to limit the value of this stream for fish. The absence of fish precludes entrainment impacts to fish.

Under existing conditions, observed daily mean water temperatures near the confluence with the SJR frequently exceeded 20°C and daily maximum temperatures exceeded 22°C and 24°C. These temperatures were generally associated with periods of little flow and water present in isolated pools. These temperatures would be too warm for optimum trout growth, if trout were present. The Proposed Action MIFs may reduce water temperatures in early summer, but not when flows upstream of the diversion cease.

The provision of MIFs, when flow is available, may extend the availability of wetted habitats and provide benefits to macroinvertebrates, western pond turtles, Pacific tree frogs, and aquatic garter snakes, all of which are found in Ross Creek.

5.2.4.3.2 Big Creek Nos. 1 and 2 (FERC Project No. 2174)

Project Effects on Project Waters

The following subsections describe how the Proposed Action will affect conditions for aquatic resources in each water body affected by the operation of Project 2175, and how the proposed changes address the resource issues described in Section 5.2.4.2. The discussion of each reach begins with a summary of the Proposed Action and a summary of effects, followed by a more detailed description of effects.

Huntington Lake

Proposed Action

No aquatic resource issues were identified for Huntington Lake. The Proposed Action would increase MIFs in Big Creek, released from Huntington Lake (Table 3.1.7-1). There would be little or no change in operation of the reservoir, or of storage, compared to existing conditions. Under the Recreation Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)), SCE will make every reasonable effort to maintain the water surface at as high an elevation and with as little fluctuation as feasible during the period from May 1 to September 10 of each water year. This is the way the reservoir is currently operated, so little change is expected to reservoir fish habitat, water temperatures, or entrainment.

SCE would conduct monitoring studies to characterize trends in the relative abundance and species composition of the fish community in Huntington Lake. This would include fish monitoring during the 8th year after license issuance, and every 10 years thereafter for the length of the license (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). The study would be implemented in the same years as fish monitoring in stream reaches. The sampling methods would be similar to those of the CAWG 7 study (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

In conjunction with the collection of fish for the fish monitoring study, monitoring would be implemented to document trends in bioaccumulation of silver in reservoir fish. This study could help to identify potential impacts, if any, from mining activities in the basin or from SCE's cloud seeding activities in the upper watershed. No objective for aquatic resources was identified for this measure.

Habitat Impacts

The Proposed Action of increased MIFs would not result in a notable change in seasonal water surface elevations in Huntington Lake, compared to existing conditions (based on the use of SCE's flow-routing model). A relatively large amount of shallow habitat is available at most reservoir elevations (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Under the Recreation Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)), at Huntington Lake SCE will make every reasonable effort to maintain the water surface at as high an elevation and with as little fluctuation as feasible during the period from May 1st to September 10th of each water year as is consistent with the primary purpose of the reservoir, existing water rights, and contracts. This should result in little or no difference from current operations.

Temperature

The proposed MIF releases downstream of Huntington Lake from Dam 1 would result in relatively small changes in the volume of water in the reservoir during the summer months when thermal stratification occurs. Therefore, there would be little change in the temperature or volume of cool hypolimnetic water available for fish (trout) habitat in Huntington Lake. There also would be little change in the temperature or amount of cool water available for release to Big Creek downstream.

Entrainment

No entrainment of fish from Huntington Lake through Big Creek Powerhouse 1 was observed during entrainment sampling (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The intake to Powerhouse 1 is located deep in the lake. Only larger fish would be expected to be found at the depth of the intake port. Very few fish were found near the intake location or at the depth of the intake port (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)). Therefore, there is little potential for fish to encounter the intake port. Additionally, intake approach velocities are well within the swimming capabilities of adult fish species present in the reservoir. Because the likelihood of fish encountering the intake is low and fish are capable of escaping from intake velocities, the potential for entrainment is low.

Huntington Lake water also may be diverted through Balsam Meadow Forebay to Shaver Lake through Tunnel 7 (also known as the Huntington-Pitman Siphon) (Figure CAWG 9 Appendix A-6, CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)) to Eastwood Power Station. Water from Huntington Lake also flows through Tunnel 7 to provide augmented flow to North Fork Stevenson Creek. Calculated approach velocities at the Tunnel 7 intake were low, at a maximum, monthly, 50% exceedance value of 0.32 ft/sec in June (Table CAWG 9-10, CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). This suggests that when fish are near the intake, their vulnerability to entrainment would be low. The Tunnel 7 intake, with an invert elevation of 6,885 feet above MSL, is located at a shallower depth than the intake to Tunnel 1. Hydroacoustic surveys conducted in 2002 showed that most fish were concentrated at depths shallower than the intake in June. In October, when the lake is drawn down, approach velocities were lower, but a higher density of fish was found at depths similar to the intake. This still results in little potential for entrainment. Fish entrained into Tunnel 7 from Huntington Lake to Balsam Meadow Forebay do not experience turbine passage, but subsequent entrainment at other locations may have the potential to result in turbine passage. Therefore, there is little potential for adverse effects associated with this intake. Subsequent, potential entrainment associated with Balsam Forebay is discussed Section 5.2.4.3.3 Big Creek Nos. 2A, 8, and Eastwood.

Since no increase in generation flow or change in reservoir elevations is expected under the Proposed Action, no change from the existing low entrainment potential is expected from existing conditions from either intake.

Reservoir Fisheries

Since little change is expected to reservoir habitat, water temperatures, or entrainment, the reservoir fisheries are not expected to be adversely impacted by the Proposed Action.

Big Creek - Dam 1 to Powerhouse 1

Proposed Action

The Proposed Action for this reach (Table 3.1.7-1) consists of instituting winter and spring MIFs (December 15 through April 15) and increasing late spring and summer MIFs. There is currently no required MIF from December 15 to April 15, although SCE releases flow during this period (CAWG 6, Hydrology, TSRPs (SCE 2004a; Volume 4, SD-D (Books 13 and 23)). Required MIFs would maintain dependable flows to protect brown trout embryo incubation and support aquatic life over the winter. Increased spring and summer flows are proposed to provide enhancement for this reach in the spring and summer. During the spring, this would result in habitat enhancement for fish and macroinvertebrates.

Riparian encroachment and sediment in the stream in the low gradient portion of the reach would not be mitigated. Under existing conditions the sediment transport capabilities in the upper 2-mile section of this reach is different than it was historically, and would continue to function in the same manner under the Proposed Action. It is impractical to change the existing condition in this reach, due to infrastructure constraints (flow-release capacity from Huntington Lake is limited to approximately 15 cfs by low-level outlet), and to protect the safety and integrity of downstream infrastructure. This reach of Big Creek would continue to function as a first order, headwater channel, rather than a third order channel.

Habitat Impacts

The Proposed Action increases required MIFs throughout most of the year (Table 3.1.7-1). These flows would increase habitat, although these changes are expected to be minor, except for incubation of brown trout embryos. SCE currently releases flow in the winter and spring, but the required MIF would provide more consistent habitat during this period. Increased MIFs also may be beneficial to habitat conditions for macroinvertebrates. These flows would not reduce riparian encroachment upon the stream channel, nor would they provide improved passage, as most of the passage barriers identified are structural, rather than flow-related.

Temperature

Under existing conditions, temperatures in this reach are cool throughout the summer and suitable for trout. Releases from the hypolimnion of Huntington Lake are very cool for most of the summer. Stream temperatures warm as water flows downstream. The Proposed Action would increase MIFs during the summer, which may provide a small reduction in water temperatures. The Proposed Action also would increase required MIFs in winter months to two cfs. This would not represent a substantial change from actual flows that are currently released during this period. Therefore, little change is expected in winter temperatures.

Aquatic Life

This reach supports self-sustaining populations of brown trout and prickly sculpin. Area-adjusted densities and biomass of brown trout (adult fish/area and pounds/acre, respectively) are at or above reference levels under current conditions and condition factors are good. Increased flows in winter and spring may provide a benefit to incubating embryos, but not to spawning habitat, since brown trout is a fall spawning species. Proposed MIFs would guarantee flow to maintain overwinter habitat. Although changes to habitat are expected to be minor, they should be beneficial. Increased MIFs also may be beneficial to habitat conditions for macroinvertebrates.

Powerhouse 2 Forebay (Dam 4 Impoundment)

Proposed Action

Powerhouse 2 Forebay is a small waterbody whose temperature and flow is dominated by discharges from Powerhouse 1 and withdrawals to Tunnel 2 and subsequently, Powerhouse 2. No aquatic resource issues were identified for the forebay. The Proposed Action would institute of MIF releases from the forebay to the bypass reach (Table 3.1.7.1) and implement sediment management prescriptions (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)). The proposed MIFs released from this impoundment would have no significant effect on water levels or temperatures in the forebay, so would not affect aquatic habitat. Sediment management prescriptions are designed to mobilize sediment from the banks of the forebay and decrease sediment build up. Sediment prescription measures would maintain pool depth (space) for fish and improve aquatic habitat conditions in the forebay.

Habitat Impacts

Little change in operations is expected under the Proposed Action. Sediment Prescriptions for this forebay would result in decreased sediment build up. These measures would improve habitat conditions.

Temperature

Water temperatures in the forebay are cool and reflect temperatures of water drawn from deep depths in Huntington Lake. These temperatures are suitable for trout and are expected to remain suitable under the Proposed Action.

Entrainment

Under existing conditions, the majority of flow passing through the forebay has first passed through Powerhouse 1, and as discussed for Huntington Lake, the potential for entrainment to Powerhouse 1 is low. Relatively little flow comes from Big Creek upstream of Powerhouse 1, and that flow descends a series of tall water falls, including one hundreds of feet in height. Additional flow comes from Pitman Creek. Due to the principal source of flow and the small size of the forebay, the relative numbers of additional fish vulnerable to entrainment in the source waterbody is low. During typical operation of Big Creek Powerhouse 1, the volume of water in the forebay is replaced many times in a single day, and fish presence near the intake face is low. Intake velocities to Tunnel 2 are low. Therefore, fish vulnerability to entrainment at the intake is low under existing conditions (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)) and would not be expected to change under the Proposed Action.

Big Creek - Dam 4 to Powerhouse 2/2A

Proposed Action

The Proposed Action for this reach involves the institution of MIF requirements below Dam 4 to the bypass reach and sediment management prescriptions (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)). There are no currently required MIFs for this reach and existing flows derive from seepage, tributaries, and local area run-off. Proposed MIFs were selected, in part, to address summer water temperatures in portions of this reach that under current conditions are warmer than suitable for trout growth and may be stressful. In addition, proposed flows address potential resource issues by enhancing habitat for adult rearing throughout the year and spawning.

Sediment Management Prescriptions for this reach would be implemented to decrease the accumulation of fine sediments and improve pool depths (Section 5.2.3). Sediment pass through activities would occur within five years of FERC approval of this prescription and subsequently at least once every five years. Pass through activities would be followed by a clear water release of a minimum of 600 cfs for 24 hours to allow for continued mobilization of sediment downstream. Monitoring of pools downstream of the dam prior to, and after implementation of the prescription would determine if the sediment prescription has resulted in deposition of fine sediment in the stream. SCE will consult with USDA-FS, CDFG, SWB and other interested government agencies to determine if modifications to the sediment prescription are warranted (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)).

The implementation of the proposed sediment management prescription would provide a means to avoid sedimentation from materials that may otherwise be released and deposited in this reach during tunnel walks, valve testing, or removal of accumulated sediment in the Powerhouse 2 Forebay. This, in addition to MIFs, would result in improved habitat and overwinter conditions, also identified as a resource issue. It would result in short-term turbidity increases during this activity. However, the benefits of managing sediments in this reach would provide an overall net benefit.

These measures would address the likely cause of recruitment failure identified in 2002. The trout population in this reach of Big Creek will be monitored under the Proposed Action (Fish Monitoring Plan, (SCE 2007a; Volume 4, SD-G (Book 19)). Under the plan, the trout populations of this reach of Big Creek would be monitored at years 8, 18, 28 and 38, after implementation of the proposed enhancement measures, through the remainder of the license period. The Fish Monitoring Plan would document trends of fish populations in response to enhancement measures. The Proposed Action MIFs also will enhance habitat for macroinvertebrates.

Habitat Impacts

Flow-Related Habitat (WUA)

Flow-habitat relationships for Big Creek below Dam 4 were determined based upon models of 14 PHABSIM transects (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) for flows from 1 to 100 cfs. The resultant WUA vs. flow functions are provided in Tables Attachment D-22 and D-23 (Figures 3-27 to 3-28, CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) for rainbow and brown trout.

The Proposed Action would provide dependable MIFs to this reach throughout the year, where existing flows depend upon seepage, runoff, spills, and tributaries. This would increase flows over existing levels (estimated to be near 1 cfs, but seasonally variable). This increase would be from seven to 12 times the existing flow, with an average increase of over 800% as described in Section 2 (Description of Proposed Action).

The Proposed Action would increase rearing habitat for adult rainbow trout during the summer months by 194% (Table Attachment D-24) and provide 54% of maximum WUA (Table Attachment D-26). Adult rainbow trout habitat would be increased over the course of the entire year by an average of 159%, and would provide more than 41% of maximum WUA in the fall and winter. Current MIFs provide approximately 18% of maximum available habitat. Rainbow trout spawning habitat would increase by over 2,200%, providing 87% of maximum spawning habitat. Under existing conditions, 4% of maximum available habitat is provided for rainbow trout spawning.

Adult brown trout habitat would increase by 160% during the summer (Table Attachment D-25) with more than 76% of maximum WUA provided (Table Attachment D-26). Adult habitat would be increased over the course of the entire year by 137%. The Proposed Action flows would provide more than 62% of maximum WUA at all times, as compared with 29% provided under existing conditions. Brown trout spawning habitat would increase by more than 500% over current levels and 83% of maximum spawning habitat would be provided. Under existing conditions, 13% of maximum available habitat is provided for brown trout spawning.

The proposed action would increase habitat for rainbow and brown trout juvenile and fry by similar amounts. Over the course of the year, juvenile habitat would roughly double, relative to the current levels (Tables Attachment D-24 and D-25). During the summer months the increase in habitat would be slightly higher (126% for rainbow trout, and 107% for brown trout). The Proposed Action would provide over 95% of maximum WUA for juveniles of both species during the summer (Table Attachment D-26). Over the course of the year, these flows would provide at least 83% of maximum WUA for rainbow trout juveniles and 91% of maximum WUA for brown trout juveniles. Under existing conditions, 42% of maximum WUA is provided for juvenile rainbow trout, and 48% is provided for juvenile brown trout. Fry habitat for both species would increase by about a third relative to current levels, during June through September, when fry are present. These values would provide over 98% of maximum WUA for both species, compared to 72% under existing conditions.

Adult rearing and spawning habitat have been identified as potential limiting factors for trout in Big Creek below Dam 4 under existing conditions. The MIFs under the Proposed Action would increase habitat for both rainbow and brown trout with negligible effects on fish and redd stranding. This reach has a relatively high density of trout and the ratio of adult trout habitat to actual trout under existing conditions is the second lowest of all the streams studied among the ALP streams. This suggests that the additional rearing and spawning habitats would likely result in increased trout populations within this reach.

A time series analysis was not performed for this reach, as adequate flow information was unavailable.

Passage and Stranding

Fish would be able to move freely up and downstream under the Proposed Action, as the MIFs would always exceed the 0.77 cfs calculated to provide passage through a typical riffle (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). Flow estimates by SCE indicate that sufficient flows for passage are generally provided under the No Action Alternative. Therefore, the Proposed Action would provide a minor benefit.

The potential to strand young fish and redds due to Proposed Action MIFs is expected to be negligible. Flows are stable or increasing in early summer, when young-of-the-year fish are abundant and most susceptible to stranding (Attachment E - Stranding Report) (Table Attachment D-27). The stranding conditions under the Proposed Action are similar to those that occur under existing conditions. Flows are stable or increasing during the rainbow trout spawning and incubation period (April through July). During the brown trout spawning and incubation period (October through May), the required MIFs would decrease from eight to seven cfs. All of the suitable spawning habitat would be retained over this flow change (Attachment A3 - Stranding Report) (Table Attachment D-28). Therefore, no redd stranding losses are expected for either species under the Proposed Action, nor are such losses expected under existing conditions, as flows are generally stable.

Temperature

Under existing conditions in this reach, water temperatures are cool below Dam 4, but water temperatures warm substantially in a downstream direction to the confluence with Balsam Creek. During dry water years with warm air temperatures, daily mean water temperatures at that location can become quite warm during the summer, exceeding temperatures desirable for trout growth for substantial periods. Daily maximum water temperatures also can be stressful during these periods (Section 5.2.4.2.2). Flow from Balsam Creek reduces temperatures in Big Creek downstream of the confluence. Temperatures warm during the summer as water flows downstream, and daily mean water temperatures upstream of Powerhouse 2/2A may infrequently reach levels undesirable for trout growth. Under the Proposed Action, the MIFs that would be released from Dam 4 and Balsam Creek would fully mitigate the warm temperatures present under hot and dry conditions. This is shown in Figures 5.2.4.3.2-1 and 5.2.4.3.2-2, which indicate that daily mean water temperatures simulated for this reach for June, July and August would be less than 17.4°C. Daily maximum temperatures would not exceed 20.0°C (Figures Attachment F-7 and F-8; Attachment G – Temperature Tables (Volume 4 (Book 5)).

Aquatic Life

The Proposed Action MIFs would substantially enhance trout habitat and water temperatures by providing MIFs below Dam 4, which currently are not required or measured. The proposed MIFs would provide sufficient potential habitat to address resource issues (potential limiting factors) due to the amount of adult rearing and spawning habitat available under existing conditions. The summer MIFs under the Proposed Action should provide sufficient adult rearing habitat to support substantially more trout than currently present. The MIFs would provide sufficient spawning habitat to support an increased population, as well. This would address the recruitment failure identified in 2002, assuming that it was due to limited habitat. The other resource issue for this reach is warm summer water temperatures. The proposed MIFs would mitigate these conditions and enhance conditions for trout growth.

The implementation of the proposed sediment management prescription (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)) would reduce sedimentation from materials released during tunnel walks, valve testing, or flushing of accumulated sediment in the forebay. This measure, in conjunction with increased winter MIFs, would result in improved pool depths, spawning habitat and overwinter conditions for trout. Although implementation of a sediment management prescription would result in short-term turbidity increases, there would be an overall net benefit to managing sediments in this reach. These enhancements should increase spawning success and trout abundance.

Macroinvertebrate densities, including EPT densities, in this reach are relatively high. The Proposed Action MIFs would be beneficial for macroinvertebrates, which in turn could further benefit trout.

The trout population in this reach of Big Creek will be monitored. The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)) to monitor population trends over the term of the license.

Balsam Creek – Diversion to Big Creek

Balsam Diversion

No resource issues were identified for the impoundment. The Proposed Action involves the institution of MIFs to the bypass reach. Sediment management prescriptions would include sediment pass through activities and, if needed, physical removal of sediment (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)). Under the Proposed Action, there would be little, if any, change from existing conditions.

Habitat Impacts

Balsam Diversion is a very small impoundment on Balsam Creek. Water temperatures under existing conditions are cool (Section 5.2.4.2.2) and suitable for trout. Under the Proposed Action MIFs, there would be little, if any change.

Entrainment

Entrainment sampling was conducted and entrainment potential assessed for the Balsam Creek diversion (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Intake velocities are low and few fish were found in the diversion pool or moving towards the intake. Entrainment potential under existing conditions was determined to be very low. No change is expected under the Proposed Action.

Balsam Creek Bypass Reach

Proposed Action

The Proposed Action for this bypass reach involves the institution of MIFs. There are no current MIFs for this reach and existing flows derive from seepage and local area run-off. The trout population in this reach is low and the extremely steep, bedrock stream channel provides limited habitat for fish. The Proposed Action MIFs (Table 3.1.7-1) are based on the results of the wetted perimeter study. However, the summer flows are set at a slightly higher flow (1 cfs) than the wetted perimeter study recommended (0.6 cfs). Winter flows are set slightly lower than the wetted perimeter recommendation, due to the reduced activity of fish and macroinvertebrates at that time of year.

The Proposed Action would provide improved summer rearing conditions for trout, with flows that exceed the 0.6 cfs flow identified by the wetted perimeter analysis as being protective of fish and invertebrate habitat. (CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) (Table Attachment D-29) During the winter, when habitat requirements are lower, the Proposed Action MIF (0.5 cfs) is slightly lower than this flow, but would be sufficient to support trout at this time of year. The Proposed MIFs would provide more habitat, as there is no MIF requirement under the current license. Increased flow from this creek may result in enhancement for spawning in Big Creek below its confluence. Numerous, natural, structural passage barriers throughout the reach, and the steep habitat, would continue to limit upstream passage and the use of the enhanced habitat.

Passage and Stranding

There are numerous, natural, structural passage barriers in this stream reach, with an average frequency of more than one in every 500 feet of stream. There is a waterfall near the mouth of Balsam Creek that prevents fish from emigrating from Big Creek. These barriers prevent extensive fish movement, regardless of flow levels. Therefore, the Proposed Action does not provide flows that the passage analysis indicated were needed to provide passage through typical riffles (CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). Passage conditions in this reach would remain similar to those under the No Action Alternative.

Temperature

Water temperatures in this reach were cool under existing conditions and suitable for trout. MIFs under the Proposed Action would maintain cool temperatures.

Aquatic Life

The Proposed Action MIFs would enhance habitat downstream of Balsam Diversion. These flows would address the resource issue related to flow-related habitat in this reach by providing MIFs where they do not currently exist. Based on the wetted perimeter analysis, flows would be protective of fish and invertebrates during the summer months. Due to numerous, structural barriers throughout the reach and the steepness of the habitat present, upstream passage would remain limited, as would the use of the enhanced habitat. While seasonal benefits may be provided under the Proposed Action, overall habitat conditions are not likely to change for trout in this stream.

Adit No. 8 Creek – Diversion to Big Creek

Proposed Action

No fisheries issues have been identified on Adit 8 Creek, which is intermittent and fishless. Under current conditions, flows, to the extent they are present, result from leakage from the tunnel, the volume of which SCE cannot control, except to decrease it by more effective sealing. The Proposed Action does not include provision of MIFs in Adit No. 8 Creek.

Habitat Impacts

Adit No. 8 Creek is naturally intermittent, fishless, and has no populations of sensitive amphibians or reptiles.

Ely Creek – Diversion to Big Creek

Proposed Action

There are no current MIF requirements for the bypass reach and existing flows derive from seepage, tributaries, and local area run-off. Ely Creek may go dry upstream of the diversion and habitat in the bypass reach may be restricted to isolated pools or small accretion flows regardless of whether diversions occur. The stream is inhabited by rainbow trout and rainbow trout hybrids. Under existing conditions, the trout population below the diversion is greater than above.

The Proposed Action for this creek involves the institution of MIF requirements below the diversion dam to the bypass reach. Sediment management prescriptions would be implemented (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)).

Ely Creek Diversion

Ely Creek Diversion forms a small impoundment on Ely Creek. Flows are intermittent upstream of the diversion. The Proposed Action would have little effect on aquatic habitat in the diversion impoundment. This is not expected to change under the Proposed Action.

Entrainment

The intake to Tunnel 2 for the Ely Creek Diversion is very similar to that in the Balsam Creek Diversion. The Balsam Creek Diversion was studied to represent similar diversions such as the one on Ely Creek. Under existing conditions, there was little potential for entrainment at this diversion (CAWG 9 Entrainment Report, SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). No change is expected under the Proposed Action.

Aquatic Life

Under the Proposed Action, little change would be expected from existing conditions.

Ely Creek Bypass Reach

Proposed Action

The Proposed Action MIFs (Table 3.1.7-1), based on the results of the wetted perimeter study, of 0.5 cfs would be instituted in June through February. A 1 cfs MIF would be instituted during March and a 2 cfs MIF in April and May, to enhance rainbow trout spawning. The proposed action would address resource issues associated with flow-related habitat, when these flows are available upstream of the diversion. Increased flow from this creek also may result in further enhancement for spawning in Big Creek below its confluence. A decrease in MIFs in June could result in fry stranding.

Habitat Impacts

Flow–related Physical Habitat

The Proposed Action would provide increased habitat relative to existing conditions. These flows meet or exceed the flow that the wetted perimeter analysis identified as protective of fish and macroinvertebrates (CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)) (Table Attachment D-31). Ely Creek has been observed to go dry above and below the diversion in some years, even when the diversion was turned out (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). This may limit potential habitat benefits of increased MIFs.

Passage and Stranding

The abundance of cascades, natural barriers, and areas that go dry limit passage in this stream, regardless of MIF levels. Therefore, the Proposed Action does not attempt to provide the 2.5 cfs required for passage through a typical riffle.

Flows would drop from 2 to 0.5 cfs in June, resulting in a 45 to 48% loss of wetted perimeter. At this time of year, fry may still be emerging from the gravels, and the Proposed Action could result in some fry stranding.

Temperature

Water temperatures in this stream are generally cool, when flow is present. During periods when flow is unavailable upstream of the diversion, stagnant pools can reach temperatures stressful for trout. The Proposed Action MIFs would enhance water temperatures for trout, when flow is available.

Aquatic Life

The Proposed Action would address resource issues associated with flow-related habitat in this reach, when flow is available upstream of the diversion. It would provide a MIF requirement where one does not currently exist and provide flows protective of fish and invertebrates when these flows are available in the stream. A decrease in MIFs in June could result in fry stranding. Water temperatures for trout would be enhanced, when flow is available. The overall effect of the Proposed Action MIFs would be to seasonally enhance conditions for trout and macroinvertebrates, when flow is available.

5.2.4.3.3 Big Creek Nos. 2a and Eastwood (FERC Project No. 67)

<u>Project Effects on Project Waters</u>

The following sections describe how the Proposed Action would affect conditions for aquatic resources in each water body and stream reach affected by the operation of Project 67, and how the proposed changes address the resource issues described in Section 5.2.4.2. The discussion of each reach begins with a summary of the Proposed Action and a summary of effects, followed by a more detailed description of effects.

Florence Lake

Proposed Action

Florence Lake Dam, located 28 miles upstream of the confluence with the SJR, impounds Florence Lake on the South Fork SJR. No aquatic resource issues were identified for Florence Lake. The Proposed Action would increase MIFs to the reach below Florence Lake Dam over those currently required (Table 3.1.7-1), and provide CRMF in Wet and Above Normal Water Years, which would increase releases from Florence Lake. During Wet Water Years, natural spills may be augmented to meet flow requirements. In Above Normal Water Years, CRMF requirements would largely be met by releases. During these conditions, flows diverted to the Ward Tunnel may be reduced. However, there would be little or no change in lake levels or of storage, in comparison with existing conditions (No Action Alternative) (based on the use of SCE's HydroBasin model). There would be little change in the availability of cool water in the lake or for release downstream. The principal difference would be due to the decommissioning of the Crater Creek diversion and the loss of its flow.

Water temperature profiles would be measured in Florence Lake during the implementation of the Water Temperature Monitoring and Management Plan. Measurements would be made on a monthly basis between June through September, or starting after the cessation of spill. Measurements will be made in two locations, one near the dam, the other upstream.

SCE would conduct monitoring studies to characterize trends in the relative abundance and species composition of the fish community. This would include fish monitoring during the 8th year after license issuance, and every 10 years thereafter for the length of the license (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). The study would be implemented in the same years fish monitoring in stream reaches. The sampling methods would be similar to those of the CAWG 7 study (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Habitat Impacts

The lake typically ranges from a low storage of 1,008 acre-feet in the winter to a maximum of 60,096 acre-feet during July. There is relatively little shallow water habitat available, due to the steep sides of the reservoir within this elevation range (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Under the Proposed Action, there would be little or no change in lake levels or storage, in comparison with existing conditions (No Action Alternative). Thus, there would be little potential for habitat impacts within the reservoir.

Temperature

Under existing conditions, Florence Lake stratifies during the summer and begins to mix in the fall. Cool water temperatures suitable for trout growth (<20°C) were always available within the lake. Cool water from the lake's hypolimnion also was available for release to the SFSJR when the lake was stratified. Under the Proposed Action, there would be little change in the availability of cool water in the lake or for release downstream. The principal loss of flow to the lake would be due to the decommissioning of the Crater Creek diversion. No adverse impact to water temperatures is anticipated.

Entrainment

The intake at Florence Lake begins Ward Tunnel, which carries diverted flow from tributaries of the SFSJR through an HB valve or Portal Powerhouse to Huntington Lake. In the upper Big Creek basin (upstream of Huntington Lake), no other powerhouse exists; therefore, no source of turbine mortality exists upstream of Portal Powerhouse. Under existing conditions, fish vulnerability to entrainment at Florence

Lake is low because intake velocities are low (less than 1 ft/sec) and trout presence near the deep water intake is low, consisting of mostly larger fish able to escape from the vicinity of the intake (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)).

Entrainment vulnerability for Portal Powerhouse, which represents the potential entrainment for the entire SFSJR drainage including Florence Lake and diverted tributaries, was studied for the Portal traditional license application (SCE 2003). Portal Powerhouse has a Vertical Francis turbine and a low head (230 feet), therefore if fish are entrained, the potential for turbine mortality is low (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Few fish were collected during sampling of the Portal Powerhouse tailrace and two of the three fish were hatchery rainbow trout, which are stocked in Portal Forebay and Mono Creek. It was concluded that while some fish may be transported through Ward Tunnel to Huntington Lake, this represents a relatively small source of fish loss under existing conditions.

Fisheries

Under existing conditions, Florence Reservoir supports a brown trout fishery with a smaller number of rainbow trout. Since little change is expected in reservoir habitat, water temperatures, or entrainment, the Proposed Action is expected to have little or no effect on fish populations in the reservoir.

South Fork San Joaquin River

This reach is occupied by rainbow and brown trout. Both species are found throughout the river, but the proportion of brown trout decreases with distance downstream from Florence Lake. One or both species are found in many tributaries to the SFSJR. However, brook trout is the only species present in several of the tributaries entering from the southern side of the river, and this species has not been observed in the SFSJR in recent studies.

Effects of the Proposed Action were assessed in each of four stretches of the single bypass reach. These four subreaches of the SFSJR are identified as: from Florence Lake to the confluence with Bear Creek, from the Bear Creek confluence to the Mono Creek confluence, from the Mono Creek confluence to the Rattlesnake Creek confluence, and from the Rattlesnake Creek confluence to the confluence with the SJR. Flow-habitat relationships for the SFSJR were evaluated using PHABSIM. Habitat was assessed for flows ranging from 10 to 300 cfs in each of the four subreaches of the bypass reach. Water temperature effects of the Proposed Action were assessed using the stream temperature model of the SFSJR, developed as part of the CAWG 5 Temperature Modeling Report (CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)).

Proposed Action

The Proposed Action would increase flows over those currently required as described in Table 3.1.7-1. These flow changes are proposed to help address water temperatures in portions of the downstream reaches of the SFSJR (upstream of Mono Creek and upstream of the SJR confluence) and to enhance flow-related habitat, especially in dry years. Passage and stranding conditions are not currently, and would not become, issues. Temperatures would remain favorable for trout. Little change is expected to macroinvertebrate habitat.

Wet and Above Normal Water Year CRMFs would be released from Florence Dam. Additional Wet Water Year releases would be made from Bear Creek and small tributaries. Both Wet and Above Normal Water Year CRM flows would be released from Mono and Camp 61 creeks. These releases may transport finer sediments, improve tributary habitats and to a lesser extent, enhance habitat in the creeks and the SFSJR. These flows are not expected to have adverse effects on fish resources. Benefits to the existing aquatic communities in this reach are expected to be moderate and vary by location. These findings are discussed in more detail below.

As part of the Proposed Action, SCE will monitor water temperatures in the SFSJR as part of the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)). Objectives of the monitoring plan include 1) document compliance with water temperature targets for daily mean and maximum water temperatures under the new MIFs, and 2) obtain information about potential Project controllable factors. The monitoring results will be used to prepare a *Long-Term Water Temperature Control Program* that will be added to this Plan. Temperature profiles will be measured on a monthly basis in Florence Reservoir to characterize water temperatures and reservoir temperature stratification. These data would provide an indication of the status of reservoir stratification and may assist in assessing the controllability of downstream water temperatures. Temperature recorders in the SFSJR downstream of Florence Dam will provide indicate when Florence Lake destratifies during this monitoring program.

An Interim Water Temperature Control Program (Interim Program) will be prepared by SCE within one year of license acceptance. The Interim Program will contain measures (e.g., increased flow releases) that may be feasibly implemented by SCE to maintain water temperatures below temperature criteria, when water temperature is a Project controllable factor. Water temperatures in the SFSJR just above the confluence with the SJR will be monitored during July of the first Dry or Critical Water year[12], and SCE will perform additional modeling regarding the relationship between atmospheric and water conditions. If atmospheric and water conditions indicate daily

[12] If daily mean air temperatures monitored during July are cooler than the 20% long-term daily exceedance, the evaluation will be repeated during the next Dry or Critically Water Year.

mean temperatures will likely exceed the 20°C target at the SFSJR/SJR confluence, SCE will undertake real time monitoring of the actual daily mean water temperature at the confluence to confirm the model's predictions. If the water temperatures exceed 20°C, SCE will increase water releases from Mono Creek by an additional three cfs. If the increased water releases do not reduce water temperature to 20°C or less, SCE will continue to increase water releases and monitor water temperatures at the confluence at least every other day that daily mean water temperatures are predicted to exceed 20°C until water temperatures are 20°C or less. SCE will use this information to develop a revised protocol to maintain water temperatures at 20°C or less at the confluence of the SFSJR and SJR.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the monitoring plan, trout populations of the SFSJR would be monitored at years 8, 18, 28 and 38, after the implementation of the proposed enhancement measures through the remainder of the license period.

South Fork San Joaquin River - Florence Lake to Bear Creek Subreach

Proposed Action

The MIFs under the Proposed Action would be the same for all water year types. The Proposed Action would increase flows by 30 and 75% on average in the summer of normal and dry years, respectively. Over the course of the entire year, the average flow would be increased by about 60 to 120% relative to current conditions (Table Attachment D-40).

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of 18 PHABSIM transects for flows ranging from 10 to 300 cfs in this reach. The flow-habitat relationships for rainbow and brown trout are shown in Tables Attachment D-38 and D-39.

The Proposed Action would increase adult rainbow trout summer habitat by 9% during normal water years, and 22% in dry years (Table Attachment D-40). Over the course of the entire year, habitat would increase by an average of 20 and 37% in normal and dry years, respectively, over existing conditions. The Proposed Action would provide 90% of maximum WUA during the summer, and more than 80% of maximum WUA over the entire year (Table Attachment D-42). Under existing conditions, 83 and 74% of maximum available habitat is provided during the summer in normal and dry years, respectively, while a year round average of 72 and 64% of maximum WUA is provided in the respective year types. Under the Proposed Action, rainbow trout spawning habitat would be 12 and 30% greater than that under current conditions in normal and dry years, respectively. The Proposed Action would provide the maximum WUA available for spawning.

Current conditions provide 90% of maximum available rainbow trout spawning WUA in normal years, and 79% in dry years.

For adult brown trout, the habitat provided by the Proposed Action would be similar to that provided by existing conditions in normal years, providing less than 10% more habitat in the summer and over the course of the year (Table Attachment D-41). In normal years, existing condition MIFs provide over 97% of maximum WUA during the summer, and 91% averaged throughout the year (Table Attachment D-42). The Proposed Action would provide at least 96% of maximum WUA at all times. During dry water years, habitat under the Proposed Action would increase by an average of 7% during the summer and 18% across the entire year. The Proposed Action would provide at least 96% of maximum available habitat. In dry years, MIFs under existing conditions provide an average of over 84% of maximum WUA throughout the year, and over 93% during the summer months.

Under the Proposed Action, brown trout spawning habitat would increase by 13% in normal years and by 36% in dry water years (Table Attachment D-41). This Action would provide the maximum spawning WUA available (Table Attachment D-42). Current MIFs provide an average of 88 and 73% of maximum available spawning habitat in normal and dry years, respectively.

Under the Proposed Action, the amount of juvenile brown and rainbow trout habitat available would be similar to that available under existing conditions, with an average decrease of less than 10% during the summer and throughout the year. For fry of both trout species, the amount of habitat available would be nine to 15% less than that available under existing conditions throughout the year (Tables Attachment D-40 and D-41). Both scenarios provide an average of more than 90% of maximum available habitat for juveniles of both species during the summer and throughout the year, and more than 80% for fry (Table Attachment D-42).

The results above were confirmed in the habitat time series analysis (TSA), which showed similar changes in habitat for all species and lifestages with the exception of rainbow trout spawning (Tables Attachment K-10 through K-15). For rainbow trout spawning, the median spawning habitat would decrease by 14% and the 90% exceedance habitat value would decrease by 33%. This difference between the WUA and TSA analyses occurs because flows during the rainbow trout spawning period often exceed the MIF due to spills and releases and often reach the descending limb of the flow habitat relationship for spawning rainbow trout.

Passage and Stranding

The Proposed Action would result in little potential for fish or redd stranding.

Trout would be able to move freely upstream and downstream under the Proposed Action. The MIFs under the Proposed Action exceed the 8.3 cfs needed to provide passage at all times (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE

2003; Volume 4, SD-D (Books 11 and 23)), as do existing conditions, so there is no change to fish passage.

There would be a low potential for fish stranding during April through July, the time when fish stranding for young-of-the-year is most likely to occur. The stranding analysis (SCE 2005) shows that decreasing flows from 40 to 35 cfs would result in a change in wetted perimeter of about 1% (Table Attachment D-43). This is not expected to adversely affect fish populations. The Proposed Action also would require CRM flows in Wet and Above Normal Water Years that are intended to flood habitats in the Jackass Meadow Complex (JMC) along the SFSJR. In Wet Water Years, these CRM flows would be provided mainly by spill (with some augmentation), similar to what occurs under existing conditions. In Above Normal Water Years, Florence Lake does not now typically spill, so stranding losses may be higher under the Proposed Action. As the CRM flows flood meadow habitats, which may retain substantial pockets of water as flows recede, the potential for stranding trout fry would be relatively greater than under the No Action Alternative, depending upon whether young-of-the-year trout have emerged by that time. It is not possible to quantify how many fish might be stranded by these events.

The redd stranding analysis shows that all of the suitable spawning habitat would be retained as the Proposed Action MIFs decrease from 40 to 35 cfs during the rainbow trout spawning and incubation period (Attachment A3 - Stranding Report) (Table Attachment D-44), similar to existing conditions. CRM flows included in the Proposed Action in Wet Water Years are not expected to result in additional stranding. In Above Normal Water Years, Florence Dam generally does not spill and the CRM flows are much higher than the extrapolation range of the PHABSIM models used to evaluate redd stranding potential. Therefore, potential impacts could not be fully evaluated. The highest flow extrapolated in the PHABSIM models is 300 cfs, which is unlikely to be representative of habitat conditions at much higher flows.

During the brown trout spawning and incubation period (October through May/June), the required MIFs would decrease from 30 to 25 cfs. The redd stranding analysis shows that all of the suitable spawning habitat would be retained over this flow change (Attachment A3 - Stranding Report) (Table Attachment D-44). CRM flows would not occur during this period.

Temperature

Under existing conditions, this subreach of the SFSJR is consistently cool during the summer months, reflecting the cool water released from Florence Lake and tributaries. Temperatures are suitable for trout. The Proposed Action would have relatively little effect on water temperature in this subreach, as predicted by the stream temperature model developed by SCE (Figures 5.2.4.3.3-1 through -4, Figures Attachment F-9 through F-12) (CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)). SCE proposes to monitor water temperatures in the SFSJR as identified in the Temperature

Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)) to confirm that water temperatures in this subreach are in compliance with the Basin Plan (CVRWQCB 1998).

Aquatic Life

Fish

Under existing conditions, trout are relatively abundant in this subreach and trout density is greater than at the reference site upstream of Florence Lake. Trout also have condition factors over 1.00 and recruitment is successful. Wild trout abundance is lower in the vicinity of Jackass Meadow, where angler access may result in higher trout mortality than in less accessible areas.

The Proposed Action would result in increased habitat for trout in this subreach in dry water years, as a byproduct of providing higher flows to address temperature impacts downstream. The most limiting habitat conditions for trout occur in drier years under existing conditions. CRM flows may provide minor habitat benefits by transporting fine sediments in Above Normal Water Years, but would provide little difference in Wet Water Years. Water temperatures currently are suitable for trout growth and would remain so under the Proposed Action. The Proposed Action would result in a net habitat enhancement in dry years and little enhancement during normal water years. There may be increased potential for stranding of rainbow trout redds and both brown trout and rainbow trout young-of-the-year due to CRM flows in Above Normal Water Years.

Macroinvertebrates

Under existing conditions, macroinvertebrates (including total macroinvertebrates and EPTs) were more abundant in this subreach than in the reference site upstream of Florence Lake. The Proposed Action MIFs are expected to have little effect on macroinvertebrate production since there would be little change in wetted perimeter with the proposed flow changes (Table Attachment D-43). CRM flows are expected to have minor benefits, if any.

South Fork San Joaquin River - Bear Creek to Mono Creek

Proposed Action

Under existing conditions, during July of a dry year with warm air temperatures, maximum daily water temperatures frequently approach those that might be stressful for trout and daily mean temperatures are occasionally warmer than those suitable for trout growth in the 2.5-mile river segment upstream of Mono Creek.

The Proposed Action would result in increased flows over those currently present under existing conditions. As described in Table 3.1.7-1, increased MIFs from Florence Lake and Bear Creek diversion, and other small tributaries would contribute to higher flows in this subreach (Table Attachment D-48). These flow changes will address warm summer water temperatures in drier water years with warm air temperatures in both the lower portion of this subreach and in the lower portion of the subreach downstream of Rattlesnake Creek immediately upstream of the confluence with the SJR. Both subreaches attain water temperatures in hot and dry conditions under existing flows that are not conducive to good trout growth. The Proposed Action MIFs would provide a beneficial impact to trout.

The increased MIFs also would enhance flow-related habitat, especially in dry years. Increased physical habitat may potentially increase trout populations. Passage and standing conditions are not currently, and would not become, resource issues.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based on modeling of 27 PHABSIM transects for flows ranging from 10 to 300 cfs in this subreach. The flow-habitat relationships for rainbow and brown trout are shown in Tables Attachment D-45 and D-46 (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). Flows in this subreach derive from releases from Florence Lake, Bear Creek Diversion, and the other small tributaries to the SFSJR upstream of Bear Creek, as well as local runoff and accretion.

The Proposed Action would increase summer habitat (July through September) for adult rainbow trout by 14 and 32%, respectively, in normal and dry years; and by 27 and 48%, respectively, on average over the entire year (Table Attachment D-47). The Proposed Action MIFs would provide over 80% of maximum WUA during the summer months and at least 70% of maximum available habitat during the entire year (Table Attachment D-49). Current MIFs provide 71% of maximum habitat in summer in normal years, and 62% in dry years. Averaged throughout the year, the existing conditions provide 62 and 53% of maximum WUA in normal and dry years, respectively. For rainbow trout spawning, the Proposed Action would increase habitat by an average of 10% over existing conditions in normal years and 23% in dry years. The Proposed Action would provide more than 70% of maximum spawning WUA at all times, as compared to 49 to 69% of maximum spawning WUA provided under existing conditions.

The Proposed Action would increase adult brown trout summer habitat by 8% in normal years and 18% in dry years (Table Attachment D-48). Over the course of the entire year, adult brown trout habitat would be increased by 16% for normal years and 29% for dry years in relation to existing conditions. The Proposed Action would provide an average of 93% of maximum WUA throughout the year in both water year types (Table Attachment D-49). This is compared to an average of 80 and 72% of maximum available habitat provided under current conditions in normal and dry years, respectively. Brown trout spawning habitat would be increased by 6% in normal years, and 19% in dry years relative to existing conditions. The amount of WUA provided under the Proposed Action for brown trout spawning would be nearly 80% of maximum spawning WUA for both water year types, as compared with 74% in normal years, and 66% in dry years under existing conditions.

Rainbow and brown trout juvenile and fry habitats respond similarly to the flow changes under the Proposed Action. Juvenile habitat would remain similar (within 10%) to that of the No Action Alternative (Tables Attachment D-47 and D-48). Proposed Action MIFs would provide more than 98% of maximum WUA on average (Table Attachment D-49). Fry habitat would decrease by about 10% on average, providing about 85% of maximum WUA on average. Existing conditions provide 92 and 97% of maximum fry habitat in normal and dry years, respectively.

The habitat time series analysis indicated similar changes in median habitat values to that derived from the WUA MIF analysis for normal years for all species and lifestages (Tables Attachment K-16 through K-21).

Passage and Stranding

The Proposed Action would result in little potential for fish or redd stranding relative to existing conditions. Like the No Action Alternative, the Proposed Action would provide sufficient flows for passage at all times (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)),

Fish stranding would be slightly more likely to occur between the April through June period and July. Fry are most likely to be present in June and July, when the flows decrease. During this period, the Proposed Action MIFs would decrease from 50 to 42 cfs on July 1. This flow change would result in less than a 3% change in wetted perimeter (Table Attachment D-50). The potential for fish stranding would be minor. More than 94% of available rainbow trout redd habitat would remain viable under the flow reductions occurring under the Proposed Action. This is unlikely to adversely affect fish populations. During the April to July period, this subreach also would be subject to CRM flows in Wet and Above Normal Water Years, as previously described for the Florence to Bear Reach. In addition, spills and Wet Year turn out flows from Bear Creek and small tributaries would result in increased flows. These CRM flows exceed the range of the PHABSIM models and cannot be fully evaluated. In Wet Water Years, the CRM flows resemble spills that occur under current conditions, and the Proposed Action would likely have little effect relative to existing conditions on fry or rainbow trout redd stranding. In Above Normal Water Years, spills generally do not occur from Florence Lake, so the CRM flows may increase the potential for stranding as flows decrease from CRM levels to MIFs.

The redd stranding analysis indicates that less than 2% of the potential brown trout redd habitat would be lost over the entire flow change during the brown trout spawning and incubation season (Table Attachment D-51). This slight loss of habitat is not expected to adversely affect brown trout spawning success.

Temperature

Under existing conditions during normal water years, this subreach is cool throughout the summer with water temperatures suitable for trout growth. During drier water years (Dry and Critical Water Years) with warm air temperatures, the lower 2.5 miles of the subreach upstream of the Mono Creek confluence may occasionally be warmer than suitable for trout growth, with daily maximum water temperatures approaching values stressful for trout, particularly in July (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Warm inflows from thermal springs in the Mono Hot Springs area likely contribute to warming in this subreach. The Proposed Action, including releases from Florence Lake, Bear Creek, and to a lesser extent, other tributary streams, would provide cooler stream temperatures. Under the Proposed Action, daily mean water temperatures would be 18.5°C or less (dry year with warm air temperatures) (Figures 5.2.4.3.3-1 through -4) and daily maximum water temperatures would not exceed 22°C anywhere in the SFSJR (Figures Attachment F-9 through F-12). SCE proposes to monitor water temperatures in the SFSJR as identified in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)) to confirm that the water temperatures in this subreach are in compliance with target temperatures and the Basin Plan (CVRWQCB 1998).

Aquatic Life

Fish

Under existing conditions, trout are relatively abundant in this subreach. Condition factors equal or exceed 1.00. Trout densities are greater than at the reference site upstream of Florence Lake. Wild trout densities in this subreach are lowest in the vicinity of Mono Hot Springs, where there is a concentration of angling pressure. The Proposed Action flows would result in substantial habitat enhancement and improvement of passage in dry years. This may benefit trout populations.

Warm water temperatures under existing conditions in dry years with warm meteorology in the lower portion of this subreach can be unsuitable for trout at times. The Proposed Action, including flows from Bear Creek and other tributaries, would provide substantial enhancement to water temperatures. This would result in suitable water temperatures throughout the summer. The enhancement of water temperatures and passage may result in some increase in trout recruitment and density.

Macroinvertebrates

Macroinvertebrates, including EPTs, are relatively abundant in this subreach and exceed the density sampled at the reference site upstream of Florence Lake. At the most downstream sampling site, upstream of Mono Creek, densities of both total macroinvertebrates and EPTs were less abundant than at the reference site.

This may reflect a direct response to warm water temperatures during the Dry Water Year in which they were sampled. It also may represent a higher level of predation by trout in a warm subreach, a condition under which trout will tend to consume more prey to compensate for higher metabolic rates. The temperature enhancement expected under the Proposed Action should provide a benefit to macroinvertebrate populations.

South Fork San Joaquin River from Mono Creek to Rattlesnake Creek

Proposed Action

Flows in this subreach would be greater than the No Action Alternative as a result of the Proposed Action MIFs described in Table 3.1.7-1. Higher MIFs from Florence Lake, Bear and Mono Creek diversions, and other small tributaries would increase flows in this subreach of the SFSJR. These releases would be made primarily to enhance habitat and control water temperatures in the SFSJR in the lower portion of the Rattlesnake Creek to the confluence with the SJR. The sum of these releases for the Proposed Action and No Action Alternatives are provided in Table Attachment D-55. The increased flows would enhance flow-related habitat, especially during drier water years, although this habitat may not currently limit the existing trout populations in this subreach (Attachment C - Limiting Factors). Benefits to the existing aquatic communities in this subreach are expected from improved water temperatures for trout growth near the confluence in the lower portion of the subreach. Increased physical habitat may provide the potential to support increased trout populations. These findings are discussed in more detail below.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of PHABSIM transects in the Bear Creek to Mono Creek subreach were used to represent the habitat in the SFSJR downstream of Mono Creek in accordance with the CAWG 3 Study Plan (Final Technical Study Plan Package (FTSPP) (SCE 2001; Volume 4, SD-B (Books 6 and 21)). This approach was selected in collaboration with the CAWG based on accessibility and safety concerns in the subreaches below Mono Creek. Below the confluence of Mono Creek, the SFSJR runs through a steep, narrow, bedrock-confined canyon (predominately Rosgen G-type channel). These transects were used with hydrology that represented flow downstream of Mono Creek to represent habitat. The flow-habitat relationships for rainbow and brown trout are shown in Tables Attachment D-52 and D-53.

The Proposed Action would increase flows (from cumulative inflows upstream of this subreach) on average by two to three times relative to existing conditions (Table Attachment D-54).

The Proposed Action would increase habitat for adult rainbow trout by 16 and 32% during the summer (July through September) in normal and dry years, respectively, and by 29 and 48% on average, respectively, over the course of the entire year (Table Attachment D-54). This action would provide 93% of maximum WUA during the summer months and at least 82% of maximum available habitat during the entire year (Table Attachment D-56). Current MIFs provide 80% of maximum habitat in summer in normal years, and 70% in dry years. The existing conditions provide an average of approximately 65% of maximum WUA throughout the year in both water supply conditions. For rainbow trout spawning, the Proposed Action would increase habitat by an average of 26% over existing conditions in normal years and 35% in dry years. The Proposed Action would provide 82% of maximum rainbow trout spawning WUA at all times, compared to 54 to 67% of maximum WUA provided under existing conditions.

The Proposed Action would increase adult brown trout summer habitat by about 10% in all water year types (Table Attachment D-55). Over the course of the entire year, adult brown trout habitat would increase by approximately 20% in relation to the existing conditions for both water supply conditions. Throughout the year, the Proposed Action would provide more than 95% of maximum available habitat in both normal and dry years (Table Attachment D-56), compared to an average of about 80% of maximum available habitat provided under current conditions in both year types. Brown trout spawning habitat would increase by 9 and 15% in normal and dry years respectively, relative to existing conditions. The Proposed Action would provide an average of 74% of maximum brown trout spawning WUA in all years, as compared with about 65% under existing conditions.

Rainbow and brown trout juvenile and fry habitat respond similarly to the flow changes under the Proposed Action. Juvenile habitat would decrease slightly (less than 10%) relative to the No Action Alternative (Tables Attachment D-54 and D-55). The Proposed Action would provide more than 88% of maximum WUA at all times (Table Attachment D-56), while the existing condition provides at least 96% of maximum WUA at all times. Fry habitat would decrease by about 15% on average, providing about 75% of maximum WUA. Existing conditions provide about 90% of maximum fry habitat in both water supply conditions.

The results above were confirmed in the habitat time series analysis, which showed similar changes in habitat for adult trout rearing habitat, and brown trout spawning habitat (Tables Attachment K-22 through K-27). The TSA median analysis indicates slightly larger median habitat increases for rainbow trout spawning (a 45% increase over existing conditions) relative to the MIF WUA analysis. The increase at the 90% exceedance value is similar to that for dry years in the MIF WUA analysis. The TSA analysis also indicates about a 20% decrease in juvenile habitat for both species. This is about twice the loss indicated in the MIF WUA analysis.

Passage and Stranding

The Proposed Action would result in little potential for additional fish or redd stranding relative to existing conditions. Sufficient flow for upstream passage would be provided under both the Proposed Action and No Action alternatives. Therefore, the Proposed Action would not enhance or adversely affect passage relative to existing conditions.

The likelihood of fish stranding resulting from the changes in flow under the Proposed Action is minimal. In April through July, when young-of-the-year fish are present and vulnerable (primarily June through July), the Proposed Action MIFs decrease from 75 to 72 cfs. This flow change would result in less than a 1% change in wetted perimeter (Table Attachment D-57). Dewatering of rainbow trout redds would not occur because of the Proposed Action, as MIFs are relatively stable during the incubation and emergence period.

In the late spring to summer of Wet and Above Normal Water Years, this subreach would also be subject to the effect of CRM flows, as previously described for the upstream subreaches of the SFSJR, plus the CRM flows for Mono Creek, and other tributaries including Bear Creek (in Wet Water Years). These CRM flows exceed the range of the PHABSIM models and cannot be fully evaluated. In Wet Water Years, the CRM flows resemble (and include) spills that occur under current conditions. Therefore, the Proposed Action would likely have little additional effect relative to existing conditions on fry or rainbow trout redd stranding. In Above Normal Water Years, Florence Lake and Mono Creek generally do not spill, so CRM flows from Florence Lake may have the potential to adversely affect the potential for stranding. CRM flows from Mono Creek may occur sufficiently late in the summer to avoid affecting incubating trout embryos in the redds. Since CRM flows exceed the range of extrapolation of the PHABSIM models, the likely effect cannot be quantitatively analyzed.

The redd stranding analysis indicates that less than 8% of the potential brown trout redd habitat would be likely lost over the range of flow change (62 to 47 cfs) during their spawning and incubation season (Table Attachment D-58). This flow change would occur gradually over a four-month period, so the habitat loss would likely have a greater effect on early spawners, which spawn when flows are higher. The loss of this amount of habitat is likely to have a slight effect on brown trout spawning success.

Temperature

Summer water temperatures in this subreach are suitable for trout under existing conditions. Under existing conditions, water temperatures upstream of Mono Creek that may be stressful to trout are cooled by Mono Creek MIFs.

The Proposed Action, which includes increased MIFs upstream and in Mono Creek, would result in cooler water temperatures in this subreach (Figures 5.2.4.3.3-1 through -4, Figures Attachment F-9 through F-12). As part of the Proposed Action, SCE proposes to monitor water temperatures in the SFSJR as identified in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)) to confirm that water temperatures in this subreach are in compliance with the Basin Plan (CVRWQCB 1998).

Aquatic Life

Fish

Under existing conditions, trout are abundant in this subreach with densities greater than the reference site upstream of Florence Lake. Condition factors average over 1.00 and there are abundant juvenile fish present, indicating successful recruitment. Habitat does not appear to be limiting in this subreach for the current trout populations.

The Proposed Action would provide enhancements to both habitat and temperature. The Proposed Action flows would result in modest habitat enhancement in wetter water years and substantial habitat enhancement in drier water years over the No Action Alternative. These enhancements may provide some benefit to trout populations. Water temperatures under existing conditions are suitable for trout growth and would be cooler under the Proposed Action.

Macroinvertebrates

Under existing conditions, macroinvertebrates, including EPTs, are less abundant than at the reference site. This may be related to a higher level of predation by trout associated with the high total trout density in this subreach. The Proposed Action MIFs may provide some enhancement to this subreach by increasing the stream width and area available for macroinvertebrate production in the summer months, especially in dry water years.

South Fork San Joaquin River from Rattlesnake Creek to San Joaquin River Confluence

Proposed Action

Under existing conditions, temperatures in the lower portion of this reach levels that are not conducive to good trout growth during the summer months in a dry water year with warm air temperatures. Daily mean water temperatures are warmer than suitable for trout in the most downstream portion of the subreach (the lower five miles in July and 0.3 miles in August of a dry, warm year). Under the Proposed Action, flows in this subreach would be greater than the No Action Alternative as a result of the Proposed Action MIFs described in Table 3.1.7-1, and would be similar to those described for the Mono Creek to Rattlesnake Creek subreach above. Under the Proposed Action, temperatures in this subreach would be reduced to levels suitable for trout most of the time. Increased flows also would enhance flow-related habitat, especially in dry years. The Proposed Action is expected to benefit trout populations by providing suitable temperatures for growth, and to a lesser extent, by enhancing habitat.

Habitat Impacts

Flow-related Habitat (WUA)

The effects of the Proposed Action for this subreach would be similar to those described for the Mono Creek to Rattlesnake Creek Reach in the preceding section. Per agreement with the CAWG, habitat was modeled using the same PHABSIM transects and flows used for the Mono Creek to Rattlesnake Creek subreach. SCE has no ability to change the flows between these two subreaches, so the flows in the Rattlesnake Creek to SJR confluence subreach would be the same as those for the upstream subreach, except for minor accretion and inflows contributed by small tributaries unaffected by Project operations. These minor flow differences are highly unlikely to result in different impacts than those described above.

Temperature

Under existing conditions in the summer, water temperatures in this subreach get warm as flow subreaches the confluence with the SJR. During drier water years (Dry and Critical Water Years) with warm air temperatures, such as in 2001, daily mean water temperatures upstream of the SJR confluence exceeded 20°C. This warming is clearly shown in the lower four miles of the subreach for existing conditions for July and August of a dry year with warm meteorology (Figures 5.2.4.2-14, 5.2.4.3.1-3 and 5.2.4.3.1-4. These temperatures are considered unsuitable for trout growth. Daily maximum water temperatures exceeded 22°C in 2001. However, daily maximum water temperatures in this subreach did not exceed 24°C (Table 5.2.4-17).

Proposed Action MIFs would enhance water temperatures in this subreach. The MIFs would result in daily mean water temperatures of less than 20°C throughout the summer with the exception of July of warm, dry years (Figures 5.2.4.3.3-1 through -4). Daily mean water temperatures in drier water years with warm air temperatures were warmer than suitable for trout in the lower five miles in July and 0.3 miles in August under existing MIFs. Under the Proposed Action, water temperatures are predicted to slightly exceed 20°C (reaching up to 20.2°C) only in the lower 0.74 miles during July of warm, drier water years (Figure 5.2.4.3.3-4). Daily maximum water temperatures would be reduced to less than 22°C throughout the subreach at all times (Figures Attachment F-9 through F-12). Therefore, water temperatures would be less than the daily mean target temperature most of the time. The predicted daily mean water temperature in a hot and dry July at the bottom of the subreach would be considered biologically suitable for trout since the difference from 20.0°C is minor and within the uncertainty of the model predictions.

SCE proposes to monitor water temperatures in the SFSJR and in Camp 61 and Mono creeks, as identified in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)) to confirm that the water temperatures in this SFSJR subreach, are in compliance with the Basin Plan (CVRWQCB 1998), when controllable by Project operations. Monthly water temperature profile data also would be collected during the summer months in Florence Lake. In consultation with resource agencies, a Long-Term Operational Water Temperature Control Plan would be developed to meet water temperature targets, when meeting water temperatures is feasibly under Project control. An Interim Water Temperature Control Program (Interim Program) will be prepared by SCE within one year of license acceptance. The Interim Program will contain measures (e.g., increased flow releases) that may be feasibly implemented by SCE to maintain water temperatures below target temperatures, when water temperature is a Project controllable factor. Water temperatures in the SFSJR just above the confluence with the SJR will be monitored during July of the first Dry or Critical Water year[13], and SCE will perform additional modeling regarding the relationship between atmospheric and water conditions. If atmospheric and water conditions indicate daily mean temperatures will likely exceed the 20°C target at the SFSJR/SJR confluence, SCE will undertake real time monitoring of the actual daily mean water temperature at the confluence to confirm the model's predictions. If the water temperatures exceed 20°C, SCE will increase water releases from Mono Creek by an additional three cfs. If the increased water releases do not reduce water temperature to 20°C or less, SCE will continue increasing water releases and monitoring water temperatures at the confluence at least every other day that daily mean water temperatures are predicted to exceed 20°C, until water temperatures are 20°C or less. Once water temperatures are 20°C or less, SCE will cease the additional monitoring and use this information to develop a revised protocol to maintain water temperatures at 20°C or less at the SFSJR/SJR confluence.

Aquatic Life

Fish

Under existing conditions, trout abundance in this subreach is very high. Trout are more abundant here than at the reference site upstream of Florence Lake. Condition factors for these fish average greater than 1.00. In addition, this site has the second highest abundance for total trout and adult trout in the SFSJR, respectively (Section 5.2.4.2 Affected Environment). Physical habitat does not appear to limit the current trout population under existing conditions. Under existing conditions, water temperatures in the lower portion of the subreach are warmer than suitable for trout during dry water years with warm meteorology.

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[13] If daily mean air temperatures monitored during July are cooler than the 20% long-term daily exceedance, the evaluation will be repeated during the next Dry or Critically Water Year.

The Proposed Action MIFs for SFSJR and tributaries would enhance habitat conditions by providing additional physical habitat and suitable water temperatures. Increased physical habitat may provide the potential for future trout population growth. Cooler water temperatures resulting from the Proposed Action would provide an enhancement to this subreach and may be beneficial to fish growth in areas currently affected by warm water temperatures in drier water years.

Macroinvertebrates

Both macroinvertebrate and EPT densities in this subreach were the highest of any site in the SFSJR under existing conditions. Densities were greater than those found at the reference site upstream of Florence Lake. The increased flows of the Proposed Action would decrease water temperatures and may benefit macroinvertebrate habitat in this subreach.

Bear Creek Forebay

Proposed Action

The Proposed Action would increase MIF releases to the Bear Creek bypass reach, and release CRM flows. The Proposed Action would have little effect on forebay operations and therefore, would have little effect on the fishery.

Habitat

Bear Creek Forebay is a moderate-sized impoundment. Under existing conditions, the elevation of the forebay fluctuates very little. The Bear Creek diversion dam generally spills when Florence Lake spills. Upstream migration into Bear Creek from the impoundment is blocked by a steep, bedrock sheet located immediately upstream of the forebay. The Proposed Action, including CRM flows, would have little to no effect on Bear Creek operations. The CRM flows would consist primarily of spills in Wet Water Years, when Florence Lake is spilling so there would be little change in impoundment habitat, as Bear Creek typically spills during this period under current operations.

Temperature

Forebay temperatures are generally cool under existing conditions. Daily mean temperatures did not exceed 20°C and daily maximum temperatures did not exceed 21°C. Cooler water temperatures were present in the deeper portion of the impoundment (SD-D CAWG 5 Water Temperature Monitoring Report, SCE 2004). Little or no change would be expected under the Proposed Action.

Entrainment

Bear Creek Diversion forms an impoundment on Bear Creek and diverts water to the Mono-Bear Siphon, which conveys water to Ward Tunnel. Entrainment mortality through the Ward Tunnel and Portal Powerhouse was discussed for

Florence Lake (Section 5.2.4.2.). Based on flow records at the Bear Creek Conduit, the monthly median flow has an associated intake approach velocity of 0.05 to 1.00 ft/sec, putting it in the low entrainment vulnerability category (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). These velocities are well within the escape capability of both rainbow and brown trout. Under existing conditions, little entrainment loss is expected from this forebay. The Proposed Action would result in little or no change.

Fisheries

The forebay fish community consists of brown trout with a smaller number of rainbow trout. Neither species has been stocked for many years. Since upstream migration into Bear Creek upstream from the impoundment is blocked by a steep, bedrock sheet, this suggests that recruitment to the forebay may occur through downstream movement of fish from upstream areas, or that some upstream passage may be available during high spring flows, when rainbow trout spawn under existing conditions. The Proposed Action would have little effect on forebay operations and therefore, would have little effect on the fishery.

Bear Creek Bypass Reach

Proposed Action

Under existing conditions, fish populations in Bear Creek are very healthy, with one of the highest densities of adult trout observed in any Project stream. However, adult and spawning habitat may be approaching limiting values for brown trout populations. The Proposed Action would increase MIFs in Bear Creek, particularly in drier years (Table 3.1.7-1).

The Proposed Action would provide more habitat for trout, which is expected to benefit trout populations in Bear Creek. The increased flows also may contribute to enhancing temperatures in the SFSJR. Sediment management prescriptions would be implemented to improve sediment transport through this reach, which should increase available pool habitat, reduce spawning gravel embeddedness, and benefit macroinvertebrate production. In addition to the above measures, large woody debris (LWD) accumulating in the Bear Creek Forebay would be moved below the diversion to provide LWD to the downstream reach as habitat elements (LWD Management Plan (SCE 2004a; Volume 4, SD-D (Books 14 and 23)). Fish monitoring in this reach will provide information on population trends.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of nine PHABSIM transects in this reach and was assessed for flows from one to 125 cfs. The flow-habitat relationships for brown trout, the only species present, are shown in Table

Attachment D-59. The instream flows under the Proposed Action would be the same for all water year types for this reach (Table Attachment D-60).

The Proposed Action would increase summer habitat (July through September) for adult brown trout by 49 and 79% in normal and dry years, respectively (Table Attachment D-60). Over the course of the entire year, the increases would be 62 and 105% on average, respectively, for the two water supply conditions. The Proposed Action would provide an average of about 53% of maximum WUA during the summer months and throughout the year (Table Attachment D-61). Under existing conditions, an average of 33 and 26% maximum WUA are provided for normal and dry water supply conditions, respectively. The Proposed Action would increase brown trout spawning habitat by an average of 22% over existing conditions in normal years and 44% in dry years. For brown trout spawning, the Proposed Action would provide 76% of maximum WUA, on average in all years. Under existing conditions, 62% of maximum spawning WUA is provided during normal years, and 53% of maximum WUA during dry years.

Brown trout juvenile summer habitat would increase by 33 and 57% in normal and dry water supply conditions, respectively (Table Attachment D-60) under the Proposed Action. This alternative would provide 88% of maximum WUA (Table Attachment D-61). Over the course of the entire year, the respective habitat increases in normal and dry years would be 43 and 81%, with 86% of maximum available habitat provided on average. Under existing conditions, an average of 60% and 48% of maximum WUA is provided during normal and dry water supply years, respectively. Brown trout fry habitat would increase by about 15% on average during both year types. Under the Proposed Action, 96% of maximum WUA would be provided for fry, as compared with about 83% under existing conditions.

The results above were confirmed in the habitat time series analysis, which showed similar changes in habitat for all lifestages (Tables Attachment K-28 through K-30).

Passage and Stranding

The Proposed Action would not adversely affect fish passage and would result in little potential for increased fish or redd stranding relative to existing conditions.

The Proposed Action would provide passage conditions for trout similar to the No Action Alternative. Sufficient flows for passage through a typical riffle would be provided at all times.

The probability of fish and redd stranding resulting from changes in flow under the Proposed Action would be minor (Table Attachment D-62 and D-63). Flows would be stable during the principal season for fish stranding (April through June, as rainbow trout are not present). During the brown trout spawning and incubation season, flows would decline gradually from 7 cfs in October to 4 cfs in January. The redd stranding analysis shows that this flow change would result in less than a

2% loss of redd area. While the current MIF is stable throughout the spawning and incubation period, this small increase in stranding potential would be minor and unlikely to adversely affect fish populations.

CRM flows are proposed in Wet Water Years. These flows exceed the reasonable extrapolation of the model, but resemble what occurs under current spill conditions. Thus, the CRM flows are not expected to increase fish stranding relative to current conditions.

Temperature

Water temperatures in Bear Creek are cool under existing conditions. Daily mean temperatures did not exceed 17.3°C and daily maximum temperatures did not exceed 19.2°C during 2001, a dry water year with warm air temperatures (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). These temperatures are suitable for brown trout. The Proposed Action would continue to maintain suitable water temperatures for trout.

Aquatic Life

Fish

Under existing conditions, Bear Creek has one of the higher adult trout densities of any stream sampled in the watershed. Densities were high for both total trout and adult trout. Brown trout is the only trout species currently found in the bypass reach. Condition factors were greater than 1.00. Water temperatures were suitable throughout the summer.

Under existing conditions, brown trout in Bear Creek had one of the lowest ratios of habitat per fish of any stream studied. This suggests that brown trout may be approaching or have reached the capacity of existing available habitat. Under the Proposed Action, increased habitat, especially in dry water years, may increase trout abundance. The Proposed CRM flow turnout of the diversion in Wet Water Years provides a continuation of a flow regime that may benefit physical habitat conditions by transporting fine and coarse sediments, but also may adversely affect trout incubation, if brown trout young-of-the-year have not emerged at the time of the release. This would be similar to the No Action alternative, since Bear Creek usually spills during Wet Water Years, generally around the same time as Florence Lake spills into the SFSJR. Transport of LWD from upstream of the diversion to the bypass reach will provide some habitat enhancement.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the monitoring plan, the trout population of Mono Creek would be monitored at years 8, 18, 28 and 38, after the implementation of the proposed enhancement measures, through the remainder of the license period.

Macroinvertebrates

Under existing conditions, the total density of macroinvertebrates in Bear Creek was greatest in the site immediately upstream of the SFSJR, and lowest just downstream of Bear Creek Diversion Dam. EPT densities were greatest upstream of Bear Creek Forebay. Factors affecting macroinvertebrate density are not clear. The increased MIFs under the Proposed Action would likely contribute to increased macroinvertebrate production, since the wetted perimeter of the stream would generally increase by 20 to 25% over that for existing conditions during the summer months. Enhancements to macroinvertebrates are most likely to occur during drier water years when flows are increased the most. Transport of LWD from the forebay to the bypass reach may also contribute to macroinvertebrate enhancement as a source of carbon and as substrate for macroinvertebrates.

Mono Diversion Forebay

Proposed Action

There were no identified aquatic resource issues in Mono Diversion Forebay under existing conditions. However, habitat issues downstream are related to the accumulation of sand and fine sediment in the forebay.

The Proposed Action includes sediment management prescriptions for Mono Creek, including Mono Forebay (Sediment Management Prescription (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)). This plan would involve mechanical sediment removal at a frequency of approximately once every five years, in conjunction with CRM flows in Wet Water Years (Mono Creek Channel Riparian Maintenance Flow Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Upon completion of the sediment removal, the low-level outlet will be closed and a flow will be spilled over the dam, consistent with the CRMF flow condition for Mono Diversion, for at least 24 hours.

Proposed CRM flows in Wet and Above Normal Years, which spill over the diversion dam, may transport wild brown trout and hatchery rainbow trout out of the forebay to Mono Creek downstream. Sediment prescriptions that decrease sediment build up in the impoundment would maintain pool depth (space) for fish and would improve fish habitat within the forebay, as well as benefit the bypass reach. Little or no other change in the impoundment would be expected from the Proposed Action.

Habitat Impacts

Water released from Lake Thomas A. Edison (Vermilion Valley Project, FERC Project No. 2086) flows through Mono Creek to the forebay for diversion through the Mono-Bear Siphon to Ward Tunnel. During peak releases from Lake Edison, retention of water in the forebay may last from one to a few hours. Mono Creek Forebay contains areas of shallow water habitat in its upstream area. The forebay is generally kept full during the summer and fall months. There is no passage barrier between the forebay and the upstream reach. Regular removal of sediment would have a beneficial effect on substrate and habitat in the forebay and minimize potential impacts in the bypass reach downstream. CRM flows would have little effect on the forebay, since flows are likely to be in the range of flows transported to the diversion during normal operations. Little or no effect on habitat, temperature, or the potential for entrainment mortality is expected in the forebay due to other Proposed Action changes.

Temperature

The small Mono Diversion Forebay has a short retention time and water temperatures reflect release temperatures from deep within Lake Thomas A. Edison. Water temperatures are generally very cool throughout the summer with daily maximum temperatures of 18.4°C or less under existing conditions (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). These temperatures are suitable for trout. The Proposed Action would have little or no effect on these water temperatures.

Entrainment

Based on flow records at the Mono Creek Conduit near Mono Hot Springs Gage (USGS gage 11231550) between 1983 and 2002, the monthly median flow has an associated intake approach velocity of 0.05 to 0.92 ft/sec, which categorizes the intake as low for potential fish entrainment (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Trout have a low vulnerability to intake velocities when the intake approach velocities are well within their swimming capability (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). A discussion of potential entrainment and mortality through the Portal Powerhouse is discussed under Affected Environment. Overall, under existing conditions there is a low potential for entrainment through the intake and low potential for mortality. Under the Proposed Action, little or no change is expected.

Fisheries

Under existing conditions, the forebay provides habitat for wild brown trout, which are abundant in the upstream reach. Hatchery rainbow trout may drift into the forebay from where they are stocked upstream. Proposed channel maintenance flows in Wet and Above Normal Water Years, which spill over the diversion dam, may transport fish out of the forebay to Mono Creek downstream. The Proposed Action also includes a sediment management prescription. Sediment management would result in improved fish habitat within the forebay and less likelihood of sediment build up in the bypass reach. Little or no other change is expected from the Proposed Action.

Mono Creek Bypass Reach

Proposed Action

Sedimentation of habitat, including loss of pool depth and embeddedness of gravels, likely has had adverse effects on trout habitat, recruitment, and overwinter survival. Sediment conditions were the most likely limiting factor in this stream during the 2000 to 2002 studies. The Proposed Action implements sediment management prescriptions, in conjunction with CRM flows in Wet Water Years (Section 3.1.7.1), and fine sediment monitoring will be implemented in Mono Creek to determine the of efficacy of those CRM flows. CRM flows also will be released in Above Normal Water Years, which also may contribute to improved sediment transport in the bypass reach. During implementation of the sediment prescription, turbidity will be monitored to determine if modifications to the sediment prescription are warranted. The implementation of the Proposed Action sediment prescriptions, including channel maintenance flows, V* monitoring and source control as part of forebay sediment management prescriptions, should result in substantial enhancement of sediment conditions in this reach (see Section 5.2.3 Geomorphology).

Current MIFs during the fall of dry years are lower than the identified passage flows for trout. However, the actual flows in the reach (based on the USGS record) are usually sufficient to provide passage as a result of the practice of releasing slightly more than the required MIF to maintain compliance. The Proposed Action would increase MIFs in Mono Creek, primarily to increase habitat and to help control temperatures in the SFSJR. Physical habitat for trout would be substantially enhanced by the Proposed Action. The implementation of the sediment management prescriptions and CRM flows also would benefit the macroinvertebrate community. Improvements to sediment conditions and increased MIFs will likely provide beneficial effects to overwinter survival. With the enhancement of sediment conditions, additional habitat may provide the potential for trout population increases. Passage and standing conditions would not become resource issues. Water temperatures would remain favorable for trout.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)).

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of 21 PHABSIM transects, for flows from 5 through 175 cfs, in this reach. The flow-habitat relationships for rainbow and brown trout are shown in Tables Attachment D-64 and D-65. The instream flows under the Proposed Action would be the same for all water year types. The Proposed Action would increase flows by two to three times on average, over current MIFs (Table Attachment D-66).

The Proposed Action would increase adult rainbow trout summer habitat by 44% during normal water supply conditions, and 80% in dry water supply conditions (Table Attachment D-66). Over the course of the entire year, habitat would increase by an average of 65 and 105% in normal and dry years, respectively, over existing conditions. The Proposed Action would provide over 80% of maximum WUA during the summer and 75% of maximum WUA averaged throughout the year (Table Attachment D-68). Current conditions provide an average of 56 and 45% of maximum WUA during the summer of normal and dry years, respectively; and approximately 47 and 37% of maximum WUA on average over the course of the year, respectively, for those same water supply conditions. Under the Proposed Action, the amount of rainbow trout spawning habitat would be 39 and 75% greater than that under current conditions in normal and dry years, respectively. The Proposed Action would provide 99% of maximum WUA for spawning in all years. Current conditions provide an average of 73% of maximum available spawning WUA during normal water supply conditions, and 58% in dry water supply conditions.

The Proposed Action would increase adult brown trout summer habitat by 17% during normal water supply conditions, and 34% during dry water supply conditions (Table Attachment D-67). Over the course of the entire year, adult brown trout habitat would increase by 30% for normal years and 52% for dry years over existing conditions. The Proposed Action would provide 85 to 92% of maximum WUA throughout the year (Table Attachment D-68). This is compared to 53 to 78% of maximum available habitat provided under current conditions in all years. Brown trout spawning habitat would increase by 40% under normal water supply conditions, and 66% under dry water supply conditions, relative to existing conditions. The Proposed Action would provide the maximum brown trout spawning WUA available within the range of flows modeled. Current conditions provide 72% of maximum available WUA in normal years, and an average of 61% in dry years.

Rainbow and brown trout juvenile and fry habitats respond similarly to the flow changes under the Proposed Action. Juvenile habitat would remain similar (within 10%) to that under the No Action Alternative (Tables Attachment D-66 and D-67) providing more than 97% of maximum WUA (Table Attachment D-68). Fry habitat would decrease by about 15% on average. The Proposed Action would provide more than 83% of maximum WUA. Existing conditions provide more than 96% of maximum fry habitat in all water years.

The results described above were confirmed in the time series analysis, which showed changes in median habitat similar to those reported for the MIF WUA analysis for all species and lifestages (Tables Attachment K-31 through K-36). The evaluation of the 90% exceedance habitat indicates that greater habitat increases would be provided for adult and spawning lifestages. Adult habitat would increase by 87 and 47% for rainbow and brown trout, respectively. Spawning habitat would increase by 86 and 57% for the two species, respectively.

Passage and Stranding

The Proposed Action would not adversely affect fish passage and would result in little potential for fish or redd stranding relative to existing conditions. The Proposed Action would nominally improve passage conditions for trout in the fall and winter of dry years. The current MIF during this period is slightly less than the flow required for passage through typical riffles (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)), while the MIFs under the Proposed Action exceed this flow at all times. Over-releases, routinely made to comply with MIF requirements under current operations, actually provide passage flows at all times (CAWG 6, Hydrology, TSRPs (SCE 2004a; Volume 4, SD-D (Books 13 and 23)). Because of this, the Proposed Action would provide little additional benefit for passage.

The probability of fish and redd stranding resulting from the changes in seasonal MIFs under the Proposed Action are minimal. Flows would be stable or increasing during the principal season for fish stranding and rainbow trout spawning and incubation, and stranding would not occur. This is the same as the No Action Alternative. For brown trout spawning and incubation, flows would decrease from 25 to 18 cfs, resulting in less than a 5% loss of spawning habitat (Table Attachment D-70). This is slightly higher than the stranding potential under the No Action Alternative, but is unlikely to affect fish populations.

The Proposed Action includes CRM flows in Wet and Above Normal Water Years. These flows exceed the extrapolation range of the PHABSIM models, and therefore cannot be fully evaluated. Mono Diversion spills infrequently under current conditions, so these CRM flows have the potential to increase stranding of young trout relative to current conditions. The highest flow extrapolated in the PHABSIM model was 175 cfs. Since the timing of the CRM releases would be between July 1 and August 5, after most of the fry have emerged, there would be little effect on incubating fish in redds.

Temperature

Water temperatures in Mono Creek are cool throughout the summer under existing conditions (Section 5.2.4.2 Affected Environment; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily mean water temperatures did not exceed 17°C at any monitoring location (Table CAWG 5 Appendix H-A36 through H-A39; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) and daily maximum water temperatures did not exceed 20°C (Table 5.2.4.2-22). The Proposed Action would likely result in a small reduction in summer water temperatures in the lower portion of Mono Creek due to the higher release flows, which are being made for the purpose of reducing water temperatures in the SFSJR. This is unlikely to result in additional benefit for trout in Mono Creek.

Aquatic Life

Fish

Under existing conditions, trout populations in Mono Creek are low. The ratio of WUA to trout abundance is one of the highest among Project streams. This strongly suggests that physical habitat as derived from depths and velocities are not limiting factors for existing trout populations. Sedimentation of habitats, including loss of pool depth and embeddedness of gravels, likely has adverse effects on trout habitat, over-winter survival, and recruitment, and is the most likely limiting factor in this stream. The implementation of the Proposed Action sediment management prescription, including CRM flows and source control, should result in substantial enhancement of sediment conditions (see Section 5.2.3 Geomorphology). The timing of the Proposed Action CRM flows should minimize disruption of incubating embryos, which takes place earlier in the year, and minimize disruption of brown trout spawning which takes place later in the year. This enhancement would likely improve trout recruitment and result in increased trout abundance. Physical habitat for trout would be substantially enhanced by the Proposed Action and may be beneficial in conjunction with improved sediment conditions. Improvements to sediment conditions and increased MIFs will likely provide beneficial effects to overwinter survival.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the monitoring plan the trout population of Mono Creek would be monitored at years 3, 8, 18, 28 and 38, after the implementation of the proposed enhancement measures through the remainder of the license period.

Macroinvertebrates

Under existing conditions, the densities of total macroinvertebrates and EPTs were highly variable between sampling sites along Mono Creek. Many of the EPT densities were much lower than those found in Bear Creek below Bear Creek Diversion, a nearby stream. Proposed Action MIFs for Mono Creek would result in an average increase of about 20% in summer wetted perimeter. This, plus the reduction in fine sediments due to the proposed CRM flows, would likely result in increased macroinvertebrate production, an enhancement of the macroinvertebrate community. Trout populations could benefit from an increased food supply.

Tombstone, North Slide, and South Slide Creeks

These diversions are currently not in operation and under the Proposed Action would be decommissioned. Under current conditions, only Tombstone Creek supports trout, in the reach below the diversion. Under the Proposed Action, maintaining natural flow to the bypass reach would continue to maintain aquatic habitat conditions in Tombstone, North Slide, and South Slide Creeks. Removal of diversion structures may increase gravel recruitment from these tributaries to the SFSJR, as well as to the Tombstone bypass reach.

Hooper Creek Diversion

Proposed Action

Flow from Hooper Creek is diverted through a 34-inch-diameter pipe to Florence Lake, which is controlled by a head gate (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)); Figure CAWG 9 Appendix A-20). Multiple age classes of rainbow trout that showed signs of rainbow/golden trout hybridization were observed upstream and downstream of the diversion (SCE 2003a). No resource issues were identified for the impoundment behind Hooper Creek Diversion.

The Proposed Action would increase MIF releases to the bypass reach from 2 cfs to 4 cfs during April through June, and from 2 cfs to 3 cfs from July through September. The Proposed Action would implement a sediment management prescription. Sediment would be removed mechanically, when necessary. During each spring of Wet Water Years, the diversion drain gates will be opened to pass sediment for transport downstream.

A decrease in sediment build up in the impoundment would maintain pool depth (space) for fish. The Proposed Action would release higher flows to Hooper Creek below the diversion in the summer months. Overall, the Proposed Action would not result in a change from existing conditions in the impoundment

Habitat Impacts

Sediment management prescriptions would result in a net improvement in habitat conditions in the diversion, the regular replenishment of fine and coarse sediments to the bypass reach, and reduction of potential accumulations in the impoundment.

Entrainment

The potential for entrainment from small diversions was assessed by studying Balsam and Rock Creek diversions as representative of the small diversions in the Project Area. These diversions were selected in consultation with the Combined Aquatic Working Group (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Under existing conditions, there appeared to be little potential for entrainment at small diversions. In the case of Hooper Creek, the intake diverts water to Florence Lake, with no potential for entrainment mortality. The Proposed Action would not result in a change from existing conditions.

Hooper Creek Bypass Reach

Proposed Action

In Hooper Creek, flows for fish passage were identified as a potential resource issue. The Proposed Action would increase MIFs from 2 cfs to 4 cfs during April through June, and from 2 cfs to 3 cfs from July through September. The flow changes are proposed in order to improve passage conditions (an identified resource issue) and enhance spawning habitat for rainbow trout in Hooper Creek. Sediment was identified as a resource issue in Hooper Creek (Attachment C – Limiting Factors). A sediment management prescription is proposed to reduce the risk of fine sediment accumulations in the bypass reach. The Proposed Action is expected to improve conditions for trout and macroinvertebrates in Hooper Creek.

Habitat Impacts

In Hooper Creek, the Proposed Action exceeds the flows identified by the wetted perimeter analysis as being protective of fish and invertebrates, as do the existing MIFs. The Proposed Action provides higher flows during the spawning period, which may facilitate passage through riffles, where passage is restricted by the existing MIF of 2 cfs. The passage analysis indicated that a flow of 2.5 cfs is required to obtain passage through a typical riffle (CAWG 3, Flow-Related Habitat - Upper Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21)) (Table Attachment D-74). The enhanced passage flow of 4 cfs may provide some benefits to upstream movement for rainbow trout in this stream, relative to the No Action Alternative.

Temperature

Water temperatures in Hooper Creek are cool throughout the summer under existing conditions (Section 5.2.4.2 Affected Environment). Daily mean water temperatures in the bypass reach did not exceed 12.9°C, which is cold, but suitable for trout. Little or no change is expected under the Proposed Action.

Aquatic Life

Fish

Under existing conditions, rainbow trout hybrids are abundant both above and below the diversion in Hooper Creek. Densities downstream of the diversion are greater than above the diversion. Condition factors are greater than 1.00 in both locations. Under the Proposed Action, habitat and temperature conditions would remain favorable, and habitat would be enhanced with a small increase in wetted perimeter. Enhanced passage flows may provide some benefit to upstream movement for rainbow trout. The sediment management prescription also would enhance habitat for trout and macroinvertebrates by reducing fine sediment accumulations and replenishing spawning gravels.

Macroinvertebrates

Under existing conditions, macroinvertebrate densities immediately below the diversion are similar to those above the diversion. Densities of total macroinvertebrates and EPTs near the SFSJR confluence are lower. Under the Proposed Action, increased flows and the sediment management prescription in Hooper Creek may provide some benefit to macroinvertebrate production.

Crater Creek Diversion

Flow from Crater Creek under existing conditions is diverted to Florence Lake. Multiple age classes of brook trout were observed upstream and downstream of the diversion, as well as in the diversion channel (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)).

Entrainment

The potential for entrainment from small diversions under existing conditions was studied using Balsam and Rock Creek diversions as representative streams for sampling. These diversions were selected in consultation with the Combined Aquatic Working Group (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). As flow is diverted to Florence Lake, fish diverted from Crater Creek are not subject to turbine mortality. Under the Proposed Action, the diversion would be removed and there would be no potential for fish to be diverted to Florence Lake.

Crater Creek Bypass Reach

Proposed Action

Under the Proposed Action, the Crater Creek Diversion would be removed from service. Flows downstream of the diversion will increase habitat for fish and macroinvertebrates and provide benefits at times when SCE would be diverting under current conditions. Passage conditions would remain similar to those that currently exist. Water temperatures under the Proposed Action are expected to remain suitable for trout at all times. Peak high flows will remain in the channel, which will ensure that high flows will periodically flush any sediment accumulations. These high flows will enhance geomorphic and aquatic resources and riparian resources within Crater Creek.

The level of enhancement may be limited by the availability of flow upstream of the diversion during the drier portion of the year. A late summer and fall habitat bottleneck related to natural base flow levels upstream of the diversion will continue to occur. Upstream passage within Crater Creek will continue to be limited due to numerous structural barriers. Trout would no longer be diverted to Florence Lake from Crater Creek diversion, and there will no longer be trout in the diversion channel, which currently has higher populations of trout than Crater Creek above the diversion.

This may be offset by an increase in trout populations in Crater Creek below the diversion.

Habitat Impacts

Flow-related Habitat

Removing Crater Diversion from service would provide year-round benefits to trout and invertebrates at times when SCE would be diverting under current conditions. A late summer and fall habitat bottleneck related to natural base flow levels upstream of the diversion will continue to occur. Upstream passage within Crater Creek will continue to be limited due to numerous structural barriers, and extensive upstream fish migration is unlikely at any flow.

Temperature

Water temperatures in Crater Creek were cool under existing conditions. Daily mean temperatures did not exceed 18°C at any monitoring station in Crater Creek or the Crater Creek Diversion Channel (Tables CAWG 5 Appendix H-A24 through H-A26; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). These water temperatures are suitable for trout. Temperatures are expected to remain suitable under the Proposed Action.

Aquatic Life

Fish and Macroinvertebrates

Under existing conditions, trout densities are greatest in the Crater Creek diversion channel and lowest downstream of Crater Diversion. Macroinvertebrate densities are greater above the diversion than below. The Proposed Action would provide more favorable habitat conditions for trout and macroinvertebrates in the current bypass reach. The level of enhancement may be limited by the availability of flow upstream of the diversion during the drier portion of the year. Trout would no longer be diverted to Florence Lake through the Crater Creek diversion.

Chinquapin, Camp 62, and Bolsillo Creek Diversions

Flow from Camp 62 Creek is diverted through a slanted borehole to Ward Tunnel (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)); Figure CAWG 9 Appendix A-22). Chinquapin Creek is a tributary of Camp 62 Creek. Flow from Chinquapin Creek also is diverted through a slanted borehole to Ward Tunnel (Figure CAWG 9 Appendix A-23). Flow from Bolsillo Creek is diverted through a vertical borehole into Ward Tunnel. The flow into Ward Tunnel at these three diversions is not controlled by a valve (Figure CAWG 9 Appendix A-24). For each of these intakes, diverted flows must pass over a vertical lip to enter the diversion (borehole). Multiple age classes of brook trout are found upstream and downstream of the diversions on each of these creeks (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)).

Entrainment

Based on using Balsam and Rock Creeks as representative models for the small diversions' entrainment, little entrainment is expected. As discussed for Florence Lake, entrained fish would be transported to Huntington Lake through Portal Powerhouse or an HB valve. Under existing conditions, little mortality is expected (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The Proposed Action would have little or no effect on entrainment at these intakes.

Chinquapin, Camp 62, and Bolsillo Creek Bypass Reaches

Proposed Action

Chinquapin, Camp 62 and Bolsillo creeks are steep, boulder/bedrock streams. The existing MIFs in Chinquapin Creek approximate the flow indicated by wetted perimeter analysis to be protective aquatic habitat, but MIFs are less than the protective flow in Camp 62 and Bolsillo creeks. The most severe habitat bottleneck in these streams likely occurs in the summer and fall when the natural base flow upstream of the diversions drop below the protective flow (as identified by the wetted perimeter study) for several months. During this time, the diversions are turned out (not diverting) and the stream flows are unaffected by the Project. Passage is restricted by frequent structural barriers. Natural summer-fall base flows and fish passage are the factors most likely to constrain fish populations in these bypass reaches. In Bolsillo Creek, the presence of fine sediments also was identified as a resource issue.

On Chinquapin, Camp 62, and Bolsillo creeks, the Proposed Action would provide MIFs that are similar or slightly higher than the existing MIFs for most of the year. In Wet Water Years, these diversions would be turned out between April 1 and June 30, and sediment behind the diversions would be sluiced as part of the sediment management prescriptions. These high flows will enhance geomorphic and aquatic resources in these creeks, particularly in Bolsillo Creek where there is sediment accumulation under existing conditions. Physical removal of sediment from diversions would be implemented, if needed, during the low flow period. In the spring of wet water years, flows in Camp 62 and Bolsillo Creeks would be two to three times the existing MIF, when these flows are available. While these flows will provide benefits, summer and fall habitat would remain the same as under the No Action Alternative, based on naturally low base flows occurring upstream of the diversions. Passage conditions and summer water temperatures are expected to remain about the same as under the No Action Alternative.

Habitat Impacts

Flow-Related Habitat

In Chinquapin, Camp 62, and Bolsillo creeks, the Proposed Action would provide MIFs that are similar or slightly higher than the No Action MIFs for most of the year. In the spring of wet water years, flows in Camp 62 and Bolsillo Creeks would be much greater than the existing MIF, when these flows are available. Late summer and fall natural flows on these creeks are generally lower than the proposed MIF. The low, natural, base flows at these times of the year would impose the most severe habitat restrictions (Attachment C – Limiting Factors). These restrictions would be the same as under the No Action Alternative, since these diversions are generally turned out (not in operation) during these periods. Upstream passage on these streams is also restricted by frequent, natural, structural barriers, so passage conditions would be similar to those under the No Action Alternative. The Proposed Action would provide seasonal benefits relative to the No Action Alternative when the MIFs are available, but the overall effect on trout populations likely would be minimal, as the current natural habitat and passage bottlenecks would continue to exist.

Temperature

Water temperatures for these small streams are cool. Daily mean water temperatures for all three creeks did not exceed 17°C under existing conditions (Tables CAWG 5 Appendix H Tables H-A31 through H-A35; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Under the Proposed Action, little or no change is expected.

Aquatic Life

Fish and Macroinvertebrates

Under existing conditions, fish populations in Camp 62 and Chinquapin Creeks are healthy and abundant. In both creeks, total trout densities below these diversions are greater than above the diversions (reference sites) (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)); Section 5.2.4.2 Affected Environment). In Bolsillo Creek, trout densities are lower below the diversion than above. There are differences in the habitats present above and below the diversion in Bolsillo Creek. There also is a greater amount of fine sediments present below the diversion. Under the Proposed Action, CRM flows would be provided in all three creeks by turning out the diversions during Wet Water Years (see Section 5.2.3 Geomorphology). Sediments behind the diversions would be transported by opening the drain gates during these periods. These flows would improve habitat conditions in Bolsillo Creek and maintain good habitat conditions in the other creeks. The proposed MIFs may provide enhancements to trout and macroinvertebrate habitats. While these flows will provide benefits, summer and fall habitat would remain the same as under the No Action Alternative, due to naturally low flows.

Balsam Forebay

Proposed Action

There is some build up of sediment in Balsam Forebay, which would be addressed by mechanical removal under the sediment management prescription. Turbidity monitoring would be implemented to determine if modifications to the sediment prescription are warranted. Since little change is expected to reservoir habitat, water temperatures, or entrainment, little change is expected in fish populations in the forebay.

Habitat Impacts

Water surface elevation in the forebay varies daily, but generally is higher in the summer than in the winter. The forebay contains suitable habitat for fish, but the small amount of shallow water habitat is indicative of the small size and relatively steep shoreline of the reservoir (CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). There is some build up of sediment in the forebay, which would be addressed by mechanical removal under the sediment management prescription. Under the Proposed Action, little change would be expected to habitat in the forebay.

Temperature

Under existing conditions, Balsam Forebay water temperatures are affected by the movement of water through the forebay including water diverted from Huntington Lake into the forebay, flow diverted from Pitman Creek, and water pumped back from Shaver Lake into the forebay. Although the reservoir can be thermally stratified during the summer, thermal stratification does not occur often, or persist, due to the regular movement of large volumes of water from the forebay through the Eastwood Power Station (Section 5.2.4.2 Affected Environment). Water temperatures may vary considerably. However, water temperatures suitable for trout growth (less than 20°C) are available throughout the summer months. Operations, and therefore temperatures in Balsam Forebay, under the Proposed Action are expected to be similar to existing conditions. There will be no effect under the Proposed Action.

Entrainment

The majority of flow from Balsam Forebay is routed through Eastwood Power Station and discharged to Shaver Lake. Eastwood Power Station also may operate in pumpback mode at night to supplement peak generation during the day (discussed with Shaver Lake, below). Based on flow records at the Eastwood Power Station between 1987 and 2002, the monthly 50% exceedance value flow has an associated intake approach velocity of 0.15 to 0.67 ft/sec, in the low vulnerability category (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Fish species in the forebay include brown trout, rainbow trout, Sacramento sucker, prickly sculpin, kokanee, and smallmouth bass. The relative numbers of fish were considered low to medium (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The Eastwood Power Station has a Francis Reaction pump turbine and a high head of 1,338 feet. However, fish vulnerability to entrainment at the intake is low to medium because intake velocities are low, fish presence near the intake face is low, and fish near the intake are likely to be larger-sized and able to escape the influence of intake velocities (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). In consultation with the CAWG, the Eastwood Power Station was selected for turbine passage sampling. Over 65 million cubic feet of water were sampled over the course of the study and over 292 million cubic feet of water passed through the powerhouse. There were no entrained fish collected at Eastwood Power Station over the course of the study (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Under existing conditions, there was little potential for entrainment and the sampling confirmed that conclusion.

Since no increase in generation flow or change in reservoir elevations are expected under the Proposed Action, no change in low entrainment potential is expected from existing conditions.

Fisheries

Since little change is expected to reservoir habitat, water temperatures, or entrainment, little change is expected in fish populations in the forebay.

Balsam Creek – Forebay to Diversion

Proposed Action

Natural flow in this reach is currently augmented by releases from Balsam Forebay. Existing MIFs are greater than the flow identified by the wetted perimeter analysis as protective of fish and macroinvertebrate habitat during the summer months, and slightly less than this flow in the winter months. However, actual releases made to maintain compliance result in flows that exceed the protective flow at all times. The only factor that appears to be a resource issue in Balsam Creek between the Forebay and the diversion is the steepness of the habitat and frequent, natural, structural passage barriers that limit upstream migration at any flow.

The Proposed Action would increase MIF requirements and would provide flows exceeding those recommended by the wetted perimeter analysis. This would increase habitat for rainbow trout, including overwinter habitat. Although trout and macroinvertebrate populations are abundant in this reach under existing conditions, overall these flows are likely to result in a favorable response. Upstream fish passage would still be a resource issue, due to numerous, natural, structural barriers (waterfalls). Water temperature would remain suitable for trout growth, as it is under current conditions.

Habitat Impacts

Flow-related Habitat

The Proposed Action would result in improved rearing conditions for trout, as it provides flows that exceed the 0.6 cfs flow identified by the wetted perimeter analysis as being protective of fish and invertebrate habitat throughout the year (Table CAWG 3-7, CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). The No Action Alternative MIFs are slightly lower than the flow recommended by the wetted perimeter study for most of the year. The Proposed Action MIFs likely would provide some benefit for rainbow trout spawning and macroinvertebrates, although these benefits cannot be quantified. Upstream migration on Balsam Creek would continue to be limited by the steep, bedrock nature of the channel (Attachment C – Limiting Factors) which prevents migration at any flow.

Temperature

Flows in this reach of Balsam Creek are primarily derived from MIFs released from Balsam Forebay and are cool throughout the summer. Daily mean water temperatures did not exceed 17°C during monitoring (CAWG 5 Appendix H Table H-A70; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). These water temperatures are suitable for trout. Under the Proposed Action, little or no change is expected.

Aquatic Life

Fish and Macroinvertebrates

Trout and macroinvertebrates are abundant in this reach under existing conditions. However, because current MIFs are less than recommended by the wetted perimeter analysis, a favorable response to increased MIFs is likely. Overall, the Proposed Action MIFs are expected to enhance habitat conditions in this reach and result in increased numbers of fish and macroinvertebrates.

Pitman Creek Diversion

Flow from Pitman Creek diversion is diverted to Balsam Forebay and North Fork Stevenson Creek through Tunnel No. 7 (HSB). The diversion has a vertical bore intake into Tunnel 7, and has vertical and horizontal trash grids (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Rainbow trout dominated the sampled fish community upstream of Pitman Creek Diversion, with smaller numbers of brown and brook trout. No resource issues were identified for the impoundment.

Sediment Management Prescriptions would be implemented to avoid future sediment accumulations in the diversion (Sediment Management Prescription (Appendix J, SCE 2007b; Volume 4, SD-H (Book 20)). Sediment would be removed mechanically, when necessary. During each spring of Wet Water Years, the diversion drain gates will be opened to pass sediment for transport downstream.

In the diversion impoundment, no change in effects on resources is expected under the Proposed Action.

Entrainment

Vulnerability of fish to entrainment is considered to be low based on results from Balsam and Rock Creeks (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Because flow diverted from this location passes to Balsam Forebay and North Fork Stevenson Creek directly, without passing through a powerhouse, no mortality is associated with entrainment at this site. No change is expected under the Proposed Action.

Pitman Creek Bypass Reach

Proposed Action

Pitman Creek below the diversion is a steep, bedrock-dominated stream. About half of this reach is plunge pool and step pool habitat with bedrock controls, and this type of habitat is not responsive to changes in flow. Most of the remaining habitat is cascade and bedrock sheet, which provides very limited habitat for fish. Upstream migration through this channel is prohibited by numerous, natural, structural barriers. In spite of these constraints, fish populations are abundant and healthy under current conditions.

The Proposed Action would increase MIFs to meet or exceed the flows recommended by the wetted perimeter and passage analyses. A sediment management prescription would be instituted to avoid sediment accumulations in the reach. The Proposed Action MIFs would enhance habitat for both fish and macroinvertebrates.

Habitat Impacts

Flow-related Habitat

The Proposed Action would increase MIFs in Pitman Creek to exceed the 0.5 cfs flow suggested by the wetted perimeter analysis as protective of fish and macroinvertebrates, and would provide the 2.5 cfs flow in the spring for adequate passage through a typical riffle (Table CAWG 3-7, CAWG 3, Flow-Related Habitat - Lower Basin Wetted Perimeter, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). This would benefit rainbow trout. The No Action MIF does not meet the flows suggested by the wetted perimeter or the passage analysis.

The Proposed Action may provide a slight benefit to fish populations throughout the year. However, fish populations on Pitman Creek are limited by the steep, bedrock nature of the channel (Attachment C – Limiting Factors). This habitat is not responsive to changes in flow. The nature of the channel also restricts upstream passage because of frequent structural passage barriers that would exist even at full natural flows.

Temperature

Observed stream temperatures in the bypass reach of Pitman Creek were cool; daily mean water temperatures did not exceed 19°C at any monitoring station in Pitman Creek under existing conditions (Table CAWG 5 Appendix H-A68 and H-A69; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). This would not change under the Proposed Action.

Aquatic Life

Fish and Macroinvertebrates

Under existing conditions, trout were abundant above and below the diversion. However, trout densities above the diversion are considerably greater than below. This may in large part reflect the structural differences in channel types and habitats (Section 5.2.4.2 Affected Environment), as well as the existing MIFs that are below those recommended by the wetted perimeter analysis. Total macroinvertebrate densities are somewhat variable, with two of the three sites below the diversion having greater densities than above the diversion. EPT densities are greater above the diversion than below under existing conditions.

A sediment management prescription would reduce the accumulation of fine sediments in Pitman Diversion and the bypass reach. The Proposed Action MIFs would enhance habitat for both fish and macroinvertebrates below the diversion. This may result in increased densities of trout and macroinvertebrates, but the potential enhancement is limited by the physical structure and passage barriers in the bypass reach.

North Fork Stevenson Creek

Proposed Action

Current flows in North Fork Stevenson Creek are much higher than that of the original stream. Flows are augmented by Project releases from Tunnel 7 (Huntington-Pitman-Shaver (HPS)) (North Fork Stevenson Creek RM 3.55). Existing MIFs are sufficient to provide fish passage through typical riffles at all times, although natural structural barriers prevent extensive upstream passage in portions of the reach. Resource issues relate to a widening of the channel due to its use as a flow transport reach by SCE prior to the construction of the Eastwood Power Station. This channel may still be occasionally used to convey high flows in the spring, if the Eastwood Power

Station is offline. Trout populations are lower than expected, due to high flow releases in several past years, which adversely affected recruitment. Gravel in this reach is limited in abundance.

The Proposed Action would increase MIFs downstream of the Tunnel 7 outlet over current MIFs, as described in Table 3.1.7-1. The proposed MIFs would enhance fish habitat. The frequency of natural, structural passage barriers that restrict upstream spawning movements and a shortage of gravel in the uppermost portion of the reach were identified as resource issues potentially affecting trout populations. Another factor limiting trout populations is periodic high flows in Stevenson Creek resulting from outages at Eastwood Powerhouse. During outages, SCE may use North Fork Stevenson Creek to convey water from Huntington Lake to Shaver Lake. These high flows, if released during the spring, may adversely affect incubating embryos and subsequent recruitment.

Trout populations are expected to increase in the next few years, as the fish population is currently recovering from large flow events in the recent past that adversely affected recruitment. The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the monitoring plan the trout population of North Fork Stevenson Creek would be monitored at years 8, 18, 28 and 38, after the implementation of the proposed enhancement measures through the remainder of the license period.

Water temperatures would be monitored at the Tunnel 7 outlet and at the SCE Gage 99 (NFSC RM 1.6) for three years, as identified in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)) to confirm that water temperatures, when controllable by Project operations, are in compliance with the Basin Plan (CVRWQCB 1998).

Under the Proposed Action, an increase in wetted perimeter of about 15% during the summer may result in increased macroinvertebrate production over existing conditions.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of 24 PHABSIM transects in this reach and was assessed for flows from three to 80 cfs. The flow-habitat relationships for rainbow and brown trout are shown in Tables provided in Attachment D-81 and D-82. The instream flows under the Proposed Action would be the same for all water year types for this reach. The Proposed Action would increase flows by two to three times on average, relative to current conditions (Table Attachment D-83).

The Proposed Action would increase summer habitat (July through September) for adult rainbow trout by 50% under normal water supply conditions and 66% in dry water supply conditions (Table Attachment D-83). Over the course of the entire year, adult habitat would increase by 55% in normal years and 69% in dry years. The Proposed Alternative would provide 68% of maximum WUA at all times, compared with the 38 to 47% provided under existing conditions (Table Attachment D-85). For rainbow trout spawning, the Proposed Action would increase habitat by 18% over existing conditions in normal years, and by 32% in dry years. The Proposed Action would provide 99% of maximum spawning WUA in all years, compared to the 84 and 75% of maximum available habitat provided under existing conditions in normal and dry years, respectively.

For adult brown trout, summer habitat would increase by 35% in normal years and 46% in dry years, over existing conditions (Table Attachment D-84). Over the course of the entire year, habitat would increase by an average of 38% under normal conditions and 48% in dry years, respectively. The Proposed Action would provide 85% of maximum WUA in both the summer and throughout the year, compared to about 60% provided under existing conditions (Table Attachment D-85). Relative to existing conditions, the Proposed Action would increase brown trout spawning habitat by 6 and 21% on average, in normal and dry years, respectively. The Proposed Action would provide 95% of maximum spawning WUA in all water year types, compared to a maximum WUA of 90 and 79% under existing conditions in normal and dry years, respectively.

Rainbow and brown trout juvenile and fry habitat would respond similarly to the flow changes under the Proposed Action. On average, juvenile habitat would increase by 15 to 30%, both during the summer and throughout the year (Table Attachment D-83 and D-84). Under the Proposed Action, over 97% of maximum WUA would be provided for juveniles, compared to between 75 and 85% of maximum WUA under existing conditions (Table Attachment D-85). Changes in habitat for fry of both species would be negligible, as conditions under the Proposed Action would vary by less than 5% from current conditions. Both alternatives would provide more than 97% of maximum available fry habitat.

The habitat time series analysis indicates that smaller increases in habitat would be provided than the MIF analysis described above (Tables Attachment K-37 through K-42). Under the Proposed Action, the time series analysis shows that the median habitat would be increased by 31% for adult rainbow trout and 20% for adult brown trout, relative to the No Action Alternative. The median habitat for juvenile and spawning life stages would increase by about 10% for both species. The changes in habitat based on the 90% exceedance habitat values are similar to those reported for the WUA analysis above.

Passage and Stranding

The Proposed Action would result in little potential for fish or redd stranding relative to existing conditions.

The passage study identified 2.9 cfs as the flow that would allow fish to migrate upstream past typical riffles within North Fork Stevenson Creek (SD-D CAWG 3 Instream Flow Studies: PHABSIM Report, SCE 2004). The current MIFs provide this flow at all times, so flow-related passage was not considered a resource issue on North Fork Stevenson Creek. The Proposed Action would increase flows throughout the year, but this would not provide a benefit to passage over the No Action Alternative. North Fork Stevenson Creek contains numerous, natural, structural passage barriers, which occur every 1,000 to 2,000 feet on average. These barriers prevent upstream migration.

The probability of fish stranding and redd stranding resulting from changes in flow under the Proposed Action are negligible (Tables Attachment D-86 and D-87). Flows would be stable throughout the year.

Temperature

Under existing conditions, water temperatures in this stream are cool throughout the summer. Daily mean water temperatures did not exceed 18°C at any monitoring station in North Fork Stevenson Creek (Table CAWG 5 Appendix H-A76 and H-A77; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Water temperatures are suitable for trout under existing conditions. The Proposed Action MIFs would result in slightly cooler water temperatures in the lower portion of the reach during summer months due to higher flows, producing a slight enhancement.

As part of the Proposed Action, water temperatures would be monitored at the Tunnel 7 outlet and at the SCE Gage 99 (NFSC RM 1.6) for three years, as identified in the Temperature Monitoring and Management Plan (Temperature Monitoring and Management Plan (SCE 2007a; Volume 4, SD-G (Books 19 and 24)). This will confirm that water temperatures, when controllable by Project operations, are in compliance with the Basin Plan (CVRWQCB 1998).

Aquatic Life

Fish

The proposed MIFs would enhance fish habitat. Trout populations are expected to increase in the next few years, as the population is currently recovering from large flow events in the recent past that adversely affected recruitment. The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Trends in the trout population in North Fork Stevenson Creek will be monitored to evaluate the effect of enhancement measures. Water temperatures will also be monitored to verify that summer water temperatures, when controllable by Project operations, are in compliance with the Basin Plan.

Macroinvertebrates

Under existing conditions, total macroinvertebrate and EPT densities in the augmented reach of North Fork Stevenson Creek are similar to or greater than those above the Tunnel 7 outlet, with the exception of the site immediately downstream of the outlet. This may, in part, be a response to the source water from deep in Huntington Lake that is released at the outlet. Under the Proposed Action, an increase in wetted perimeter of about 15% during the summer may result in increased macroinvertebrate production over existing conditions.

Shaver Lake

Under the Proposed Action, there would be little change in reservoir operations. Therefore, there would be little or no change to fish habitat, water temperatures, or potential for entrainment.

Habitat Impacts

Under existing conditions, water surface elevations usually are lowest in the spring and highest in the summer, typically around July. The relatively large amount of shallow habitat available at most reservoir elevations is indicative of the shallow depth and large size of the reservoir. Under the Proposed Action, there would be little change in reservoir volumes and elevations over time. Therefore, the Proposed Action would have little effect on lake habitat.

Temperature

Flows entering Shaver Lake influence water temperatures. Flows may enter from North Fork Stevenson Creek (discussed above), Stevenson Creek (upstream of Shaver Lake), and Eastwood Power Station, as well as from minor creeks and local area runoff. During the spring, thermal gradients are present in the upper depths of the lake. Thermal stratification usually occurs during the summer, with mixing of layers commencing in September. Under existing conditions, water temperatures suitable for trout growth (less than 20°C) were always available in Shaver Lake. Warm water temperatures suitable for warmwater fish also were available. When thermally stratified, the upper layer ranged from 16.1°C (May) to 21.1°C (July) and the deeper layer ranged from 7.6°C (May) to 13.6°C (July) in 2001 (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Under the Proposed Action, there would be little change in operations. Therefore, the Proposed Action would have little effect on lake temperatures.

Entrainment

Water from Shaver Lake not released to Stevenson Creek is diverted through Tunnel 5 to Big Creek Powerhouse 2A or may be pumped up to Balsam Forebay for later generation (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Powerhouse 2A has a Pelton Impulse turbine and a high head of 2,418 feet; therefore, if fish were entrained here, the potential for turbine mortality would be high. However, fish vulnerability to entrainment at the intake was assessed as low because calculated intake velocities are low and fish presence near the intake face was low (Table CAWG 9-7; CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The intake to Powerhouse 2A is at the bottom of the dam, in deep water. Low fish densities were found at deep depths near the intake, and these fish are likely to be large, with strong swimming capabilities. The large cross-sectional area of the intake results in low approach velocities. Based on flow records at the Big Creek Powerhouse 2A, the maximum monthly 50% exceedance value of associated intake approach velocity was calculated as 0.11 ft/sec in June through August (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). These very low approach velocities put this intake in the category of very low risk for vulnerability to entrainment. This was confirmed by sampling in the Powerhouse 2A tailrace. Under existing conditions, there was little potential for entrainment losses associated with diversion through Tunnel 5 and Powerhouse 2A.

Eastwood Power Station also may operate in pumpback mode at night to supplement peak generation during the day. The water pumped from Shaver Lake passes through Eastwood Power Station Tunnel to Balsam Forebay. Detailed pumpback studies were conducted in 1991-1992 (SCE 1992) and 1997-1998 (SCE 2005). The majority of fish entrained were small juveniles and 61% of the fish were non-game species. Juvenile green sunfish accounted for about 31% of the total, while larval prickly sculpin accounted for approximately 24%. Juvenile smallmouth bass and adult kokanee represented 17 and 10% of the total loss, respectively. Many of the adult kokanee collected included spawned out fish and carcasses. Adult rainbow trout accounted for about 5% of the total loss estimate. The losses due to pumpback entrainment represent a small fraction of the reproductive potential for those species in Shaver Lake. It was concluded that the losses could not be considered significant to the maintenance of fish populations in Shaver Lake.

The Proposed Action would result in little or no change in operations or entrainment effects as compared with existing conditions (No Action Alternative).

Reservoir Fisheries

Fish populations in Shaver Lake consist of a combination of stocked and wild fish. Rainbow trout and kokanee are of hatchery origin. Sacramento sucker, smallmouth bass, bluegill, crappie, and carp, among other species, are self-sustaining. Under existing conditions, Shaver Lake supports these species and a large recreational fishery. With the Proposed Action, little change is expected to reservoir habitat, water temperatures, or entrainment, and therefore, little change is expected in reservoir fisheries.

Powerhouse 8 Forebay (Dam 5)

Big Creek Powerhouse 8 Forebay is a relatively small water body (49 acre-feet). Dam 5 impounds water from Big Creek and the discharge from Powerhouse 2/2A. Water from the Dam 5 forebay is released to Big Creek below Dam 5 or diverted into an intake for Big Creek Powerhouse 8. Water surface elevation does not normally fluctuate. The intake to Tunnel 8 is near the bottom of the impoundment. No change in operations is expected under the Proposed Action. Sediment in the forebay would be managed under a sediment management prescription. This would include mechanical removal and flushing of sediments. Sediment management would maintain habitat conditions in the forebay by maintaining pool depth (space for fish).

Temperature

Under existing conditions, Big Creek Powerhouse 2/2A tailrace, provides cool water inflow to the forebay throughout the summer months. Monthly mean water temperatures in the forebay did not exceed 17.7°C during either year of monitoring and temperatures were generally cooler (Section 5.2.4.2 Affected Environment; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). These temperatures are suitable for trout. Little or no change in water temperature is expected under the Proposed Action.

Entrainment

Almost all water flowing into the forebay derives from Big Creek Powerhouses 2/2A discharge. Due to the principal source of flow and the small size of the forebay, the vast majority of flow has already passed through at least one powerhouse, and fish entrained with the flow would have experienced mortality from that source, if present. Relative numbers of additional fish vulnerable to entrainment in the source waterbody is low. Big Creek Powerhouse 8 has a Francis Vertical Reaction turbine and a head of 713 feet. If fish were entrained, the potential for turbine mortality could be high (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Based on flow records at Big Creek Powerhouse 8, the associated monthly 50% exceedance value of intake approach velocities ranged from 0.48 to 1.04 ft/sec, with the highest monthly value in July (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). These velocities are within the swimming capabilities of resident trout in the forebay. Fish presence near the intake face is rated low and overall fish vulnerability to entrainment at the intake and corresponding mortality at Powerhouse 8 is low (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Under the Proposed Action, this is not expected to change.

Big Creek Dam 5 to Powerhouse 8 Bypass Reach

Proposed Action

The principal resource issues in this reach are warm water temperatures, upstream migration in the fall of dry years, overwinter flows in dry years, and periodic (about once every seven years) sedimentation when the impoundment is drained for tunnel inspections. Despite these resource issues, trout density under existing conditions is similar to that of reference streams.

The Proposed Action would increase MIFs below Dam 5 (Table 3.1.7-1). It also would implement a sediment management prescription that would control sedimentation of downstream habitat when the impoundment is drained for tunnel inspections. Implementation of a sediment management prescription would improve habitat for fish and macroinvertebrates. Sediment is relatively abundant under current conditions and the Proposed Action would reduce periodic deposits of sediment related to tunnel walks and maintenance activities (Section 5.2.3). The proposed MIFs would maintain cooler summer water temperatures in the lower portion of the reach, which at times are warmer than suitable for trout growth in dry water years with warm air temperatures. These flows and the sediment management prescription would substantially increase overwinter habitat in drier water years for rainbow and brown trout, and may contribute to increased overwinter survival. Passage conditions would improve in December through March of drier years, when current MIFs are less than the 2 cfs the passage analysis indicated is needed for passage through typical riffles. However, numerous structural barriers would continue to restrict upstream movements. The MIFs would enhance habitat throughout the year.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007a; Volume 4, SD-G (Book 19)). Under the plan, the trout population of Mono Creek would be monitored at years 8, 18, 28 and 38, after the implementation of the proposed enhancement measures.

As part of the Proposed Action, water temperatures would be monitored in the bypass reach, as identified in the Temperature Monitoring and Management Program (SCE 2007a; Volume 4, SD-G (Books 19 and 24) to confirm that water temperatures, when controllable by Project operations, are in compliance with the Basin Plan (CVRWQCB 1998).

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of 20 PHABSIM transects in this reach at flows ranging from one to 100 cfs. The flow-habitat relationships for rainbow and brown trout are shown in Tables provided in Attachment D-88 and D-89. The instream flows under the Proposed Action would be the same for all water year types for the Dam 5 to Powerhouse 8 bypass reach. The Proposed Action would increase flows by three to six times on average relative to current conditions (Table Attachment D-90).

The Proposed Action would increase summer habitat (July through September) for adult rainbow trout by 45% in normal years and 57% in dry years (Table Attachment D-90). Over the course of the entire year, adult habitat would be increased by 39% in normal and 52% in dry water supply conditions. This action would provide 73% of maximum WUA during the summer months and an average of 68% for the full year (Table Attachment D-92). Under existing conditions, MIFs provide 41 to 50% of maximum WUA under normal and dry conditions, respectively. For rainbow trout spawning, the Proposed Action would more than double existing habitat in normal years and more than triple it during dry water years. The Proposed Action would provide 90% of maximum spawning WUA in all water years, compared to a maximum of 34% of maximum WUA provided under existing conditions.

Adult brown trout habitat would increase by about 30% under normal water supply conditions relative to the existing conditions, during the summer and averaged throughout the year (Table Attachment D-91). During dry water supply conditions, the habitat increase would average 40% over the course of the entire year, as well as during the summer. The Proposed Action would provide at least 80% of maximum WUA at all times, and nearly 90% during the summer, as compared with the 57 to about 65%, respectively, currently provided (Table Attachment D-92). Brown trout spawning habitat would be increased by 70 and 136% on average, in normal and dry years, respectively, relative to existing conditions. The Proposed Action would provide approximately 85% of maximum spawning WUA in both water supply conditions. This is compared with an average of 50 and 37% of maximum available habitat in normal and dry years, respectively, under spawning existing conditions.

Rainbow and brown trout juvenile and fry habitat would respond similarly to the flow changes under the Proposed Action. Juvenile habitat would increase by 14 to 29% during the summer months, and 16 to 34% on average throughout the year (Table Attachment D-90 and D-91). Nearly 100% of maximum WUA would be provided for juvenile trout, compared with 67 to 84% of maximum WUA under existing conditions (Table Attachment D-92). Under the Proposed Action, fry habitat would remain similar (maximum difference of 8%) to that provided under existing conditions, with more than 92% of maximum available habitat provided under both alternatives.

The results above were confirmed by the habitat time series analysis for adult and juvenile lifestages and for rainbow trout spawning (Tables Attachment K-43 through K-48). Somewhat smaller increases in median brown trout spawning habitat were obtained, with an increase of 47% at the median and a 104% increase at the 90% exceedance value.

Passage and Stranding

The Proposed Action would have a minor effect on fish passage and would result in little potential for fish or redd stranding relative to existing conditions.

The Proposed Action would improve passage conditions for trout in December through March of dry years, when current MIFs are less than the 2 cfs needed for upstream passage through typical riffles (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). At other times, the Proposed Action would provide similar conditions for passage as occur under existing conditions.

Fish and rainbow trout redd stranding would not occur because of changing MIFs under the Proposed Action (Table Attachment D-93 and -94). Flows would be stable during the principal season for fish stranding and rainbow trout spawning and incubation. For brown trout spawning and incubation, flows would decrease from 8 to 7 cfs. This would result in the potential loss of less than 8% of the starting spawning area. This is greater than the loss that would be anticipated under the No Action Alternative, but unlikely to substantially affect the population.

Temperature

Water temperatures in Big Creek directly downstream of Dam 5 are affected by releases from Powerhouse 2/2A. Under existing conditions, water temperatures increased from Dam 5 to upstream of Big Creek Powerhouse 8, where powerhouse outflows again provided cool water. Daily mean water temperatures did not exceed 20°C at the site downstream of Dam 5, but exceeded 20°C at the monitoring station upstream of Powerhouse 8 for 11 days in 2001 (CAWG 5 Appendix H Table H-A51 through HA53; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)). Daily maximum water temperatures were 18.1°C or less in the upstream portion of the reach, and 23.6°C or less in the downstream portion of the reach, exceeding 23°C for four days and 22°C for 24 days in 2001, a dry water year (Table 5.2.4-31). Under existing conditions for a dry year with warm air temperatures, daily mean water temperatures frequently exceeded those desirable for trout growth in the lower portion of the reach. Daily maximum water temperatures infrequently approached those stressful for trout. The Proposed Action would enhance water temperatures for trout in this reach. The Proposed Action MIFs were simulated using the water temperature model developed for this reach (CAWG 5, Water Temperature Modeling, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18 and 24)). As shown in Figures 5.2.4.3.3-5 through 5.2.4.3.3-8, daily mean temperatures would be reduced under the Proposed Action to less than 17°C during the summer months of years with dry and warm meteorology. Daily maximum temperatures (Figures Attachment F-13 through F-16) would be reduced to less than 20°C.

As part of the Proposed Action, water temperatures would be monitored in Big Creek downstream of Dam 5 and upstream of Powerhouse 8 for three years, as identified in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007; Volume 4, SD-G (Books 19 and 24)) to confirm that water temperatures, when controllable by Project operations, are in compliance with the Basin Plan (CVRWQCB 1998). In consultation with resource agencies, a Long-Term Operational Water Temperature Control Plan would be developed to meet water temperature targets, when water temperatures are feasibly under Project control.

Aquatic Life

Fish

Under existing conditions, trout populations in this reach are abundant. There were young-of-the-year fish present, indicating successful reproduction under existing conditions. Due to the prevalence of shallow water habitats and sediment, drier year winter flows may be lower than desirable for overwintering under existing conditions. Water temperatures under existing conditions are warmer than desirable for trout in the lower portion of the reach. In addition, existing operations in this reach may contribute to periodic episodes of sedimentation (Section 5.2.3 Geomorphology). Excessive sedimentation generally has an adverse effect on fish in periods other than winter, as well.

The Proposed Action would enhance habitat throughout the year, especially in dry water years. The Proposed Action would substantially increase overwinter habitat for rainbow and brown trout in dry water years. This enhancement may contribute to increased overwinter survival. The Proposed Action would enhance water temperatures in the lower portion of the reach, resulting in temperatures suitable for trout throughout the summer in all water year types. This may be beneficial to trout in the lower portion of the bypass reach.

The Proposed Action includes sediment management prescriptions for this reach (Section 5.2.3 Geomorphology) that would control sediment releases and avoid excessive sedimentation. The implementation of sediment prescriptions may have some short-term adverse effects due to turbidity, but these are far outweighed by the benefits of reduced sediment build up in the channel. The implementation of these prescriptions would enhance habitat for fish and macroinvertebrates, which serve as their food. Trout populations in this reach of Big Creek will be monitored over the length of the license to document trends.

Macroinvertebrates

Under existing conditions, total macroinvertebrate and EPT densities are relatively high. Proposed Action MIFs would result in increased flow and a summer increase of wetted perimeter of about 15%, likely increasing macroinvertebrate production. Reducing sedimentation of substrates also would contribute to increased production of macroinvertebrates.

Stevenson Creek

Proposed Action

Availability of spawning habitat and passage flows were identified as potential resource issues for rainbow trout in Stevenson Creek. The Proposed Action for this reach would increase MIFs throughout the year, as described in Table 3.1.7-1. These flows address passage flows and spawning habitat for trout in the lower portion of the reach, which under existing conditions have been identified as potential resource issues. The Proposed Action MIFs would enhance passage flows during November through April, when pre-spawning movement of rainbow trout is likely to occur. The enhancement of passage and spawning habitat should contribute to increased recruitment success and trout abundance. However, natural structural passage barriers along this stream prevent migrations longer than 1,000 to 2,000 feet, on average, at any flow. Proposed Action increased MIFs would increase the wetted perimeter of the stream by about 10% and would likely result in additional macroinvertebrate production. Proposed MIFs would decrease water temperatures, which are already suitable for trout under existing conditions.

The Proposed Action includes a Fish Monitoring Plan (Fish Monitoring Plan (SCE 2007; Volume 4, SD-G (Book 19)). Under the monitoring plan the trout population of Mono Creek would be monitored at years 8, 18, 28 and 38, after the implementation of the proposed enhancement measures, through the remainder of the license period.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-related habitat was evaluated based upon models of 23 PHABSIM transects in this reach and was assessed for flows from two to 125 cfs. The flow-habitat relationships for rainbow trout, the only species present, are shown in Table Attachment D-95. The instream flows under the Proposed Action would be the same for all water year types for the Stevenson Creek Reach. The Proposed Action would increase MIFs by an average of 164%, relative to the current MIFs (Table Attachment D-96).

MIFs under the existing license are identical for all water year types. The Proposed Action MIFs would increase adult rainbow trout habitat by 54% in summer (July through September), and an average of 52% over the entire year (Table Attachment D-96). This alternative would provide 64% of maximum WUA during the summer months and 60% for the entire year (Table Attachment D-97). The current MIFs provide about 40% of maximum adult WUA at all times. Under the Proposed Action, the amount of rainbow trout spawning habitat would be nearly five times greater than under existing conditions, and would provide nearly 90% of maximum spawning WUA. Only 18% of maximum spawning WUA is provided under existing conditions.

Juvenile rainbow trout habitat would increase by about 15% during the summer months, and on average throughout the year (Table Attachment D-96). Nearly 100% of maximum WUA would be provided for juvenile trout, compared to an average of 85% of maximum WUA under existing conditions (Table Attachment D-97). Under the Proposed Action, habitat for rainbow trout fry would decrease by 9% on average. More than 90% of maximum available habitat would be provided under the Proposed Action, as compared with 100% provided for fry under current MIFs.

The time series analysis found that smaller habitat increases would be provided than those indicated by the MIF analysis above (Tables Attachment K-49 through K–51). The time series analysis shows that the median habitat under the Proposed Action would increase by 18% for adult rainbow trout relative to the No Action Alternative, and by 7% for juveniles. Spawning habitat would be more than three times greater under the Proposed Action. The evaluation of the 90% exceedance habitat provides similar results to the WUA analysis described above.

Passage and Stranding

The Proposed Action would result in little potential for fish or redd stranding relative to existing conditions.

The Proposed Action would provide sufficient flows for upstream passage at typical riffles at all times. This would represent a benefit relative to existing MIFs, which do not provide the 4.25 cfs needed for passage through typical riffles. However, there are numerous, natural, structural barriers on Stevenson Creek. These structural barriers prevent substantial upstream migrations at any flow.

The likelihood of fish stranding and redd stranding resulting from the changes in flow under both the Proposed Action and the No Action alternatives are negligible (Table Attachment D-98 and D-99). Under the Proposed Action, the MIF decreases from 10 to 8 cfs between June and July. This change would result in a 3% change in wetted perimeter. MIFs under the No Action Alternative are stable at this time, so no stranding is likely to occur. The Proposed Action results in a slight increase in stranding potential over the current condition, but is unlikely to affect the trout population. During the rainbow trout spawning and incubation season, flows are stable under current conditions and decrease from 10 to 8 cfs under the Proposed Action. All potential spawning habitat would be retained over this flow change, so no stranding would be expected to occur from changes in MIF under either scenario.

Temperature

Under existing conditions during the summer, water temperatures in Stevenson Creek at the release point of Shaver Dam were cold when Shaver Lake was stratified and became warmer as the water flowed downstream. After thermal stratification in Shaver Lake breaks down and water begins to mix, the release water temperatures are warmer at the release point. Water temperatures were suitable for trout growth. Daily mean water temperatures did not exceed 20°C at any monitoring station in this bypass reach (CAWG 5 Appendix H Tables H-A75, H-A78, and H-A79; CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) and daily maximum temperatures did not exceed 22°C (Table 5.2.4-32). The Proposed Action would result in less warming of stream temperatures during the summer months as compared to the No Action alternative (existing case) (Figures 5.2.4.3.3-9 through -12, Figures Attachment F-

17 through F-20). Since existing water temperatures are suitable for trout, there would be relatively little additional benefit from cooler temperatures.

Aquatic Life

Fish

Under existing conditions, rainbow trout are relatively abundant in Stevenson Creek, except for the Rosgen A channel segment in the lower portion of the reach. Passage flows and spawning habitat have been identified as potential resource issues in this reach under existing conditions. The Proposed Action MIFs enhance passage flows during November through April, when pre-spawning movement of rainbow trout is likely to occur. Spawning habitat would increase by 334%, providing a substantial enhancement of this habitat. The enhancement of both passage and spawning habitat should contribute to increased recruitment success and trout abundance. Fish population trends will be monitored in Stevenson Creek to document the results of enhancement measures.

Macroinvertebrates

Under existing conditions, macroinvertebrate densities were relatively high, but variable in this reach. Proposed Action increased MIFs would increase the wetted perimeter of the stream by about 10% (Table Attachment D-98) and would likely result in additional macroinvertebrate production.

5.2.4.3.4 Big Creek No. 3 (FERC Project No. 120)

<u>Project Effects on Project Waters</u>

The following sections describe how the Proposed Action will affect conditions for aquatic resources in each water body affected by the operation of Project 120 and how these proposed changes address the identified resource issues. The discussion of each reach begins with a summary of the Proposed Action and a summary of effects. This is followed by a more detailed description of effects.

Powerhouse 3 Forebay (Dam 6)

Proposed Action

No aquatic resource issues were identified in the forebay. The Proposed Action would increase MIF requirements to the bypass reach between Dam 6 and Redinger Lake (Stevenson Reach). The Proposed Action would include sediment management prescriptions to reduce sediment build up in the Powerhouse 3 Forebay, thereby maintaining pool depth (space) for fish habitat.

Habitat Impacts

Powerhouse 3 Forebay is a medium-sized impoundment that experiences relatively little fluctuation in water surface elevation over the course of the year under existing conditions. There would be little or no change under the Proposed Action.

Temperature

Water temperatures in the forebay are dominated by the temperatures of inflows from Mammoth Pool Powerhouse and Powerhouse 8. Under existing conditions, water temperatures are generally cool and suitable for trout (daily mean water temperatures of 20°C or less). After thermal stratification breaks down in Mammoth Pool Reservoir (upstream), water temperatures in mid-depth and shallower depths of the Powerhouse 3 Forebay increase, reflecting mixed water temperatures in the upstream reservoirs. Water temperatures reached 20°C in the upper layer of the Powerhouse 3 Forebay by the end of August in 2001, a dry and warm year. However, suitable water temperatures for trout remain available in the lower depths of the impoundment under existing conditions (CAWG 5, Water Temperature Monitoring, TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Under the Proposed Action, little change is expected. During the course of normal operations in drier water years, the discharge of proportionately greater amounts of water from Mammoth Pool Powerhouse than Powerhouse 8 in late August or September could result in warmer water temperatures occurring earlier, with Mammoth Pool Powerhouse discharge dominating temperatures in the forebay. Accelerated depletion of cool hypolimnetic water in Mammoth Pool Reservoir (upstream) could occur under the Proposed Action, which would result in warmer water temperatures in the Powerhouse 3 Forebay earlier than under existing conditions. However, this would be related to impacts of the Proposed Action on the Mammoth Pool Project. While this may affect releases and downstream temperatures in the Stevenson Reach of the SJR, it should have relatively little effect on fish in the forebay, since some cool water from discharges from Big Creek and Big Creek Powerhouse 8 would remain available for trout.

Entrainment

Inflow to the Big Creek Powerhouse 3 Forebay includes flows from the SJR and Big Creek. During much of the year, most of the inflow is from the Mammoth Pool Powerhouse tailrace and the Big Creek Powerhouse 8 tailrace. Fish species collected in the forebay during sampling in 2002 included Sacramento sucker (79%), brown trout (15%), and rainbow trout (6%). The relative numbers of fish in the forebay were low. In addition, almost all flow passing through the Powerhouse 3 turbines has previously passed through one or more other powerhouses. Very few if any fish would be expected to be delivered from the Mammoth Pool Powerhouse, based on sampling results (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). Sampling of the powerhouses on Big Creek also showed that few, if any fish would be expected to be transported from that source.

Fish passing through the Big Creek powerhouses would have passed through one or more high-head impeller turbines, which are associated with high mortality. Therefore, the relative numbers of additional viable fish vulnerable to entrainment is low. The intake to Tunnel 3, which diverts water to Powerhouse 3, is located deep in the forebay (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)). The depth of the intake results in reduced exposure of fish to the moderate to high intake velocities. Overall fish vulnerability to entrainment at the intake is low under existing conditions (CAWG 9, Entrainment, TSRPs (SCE 2004b; Volume 4, SD-E (Books 18, 24 and 26)); Table CAWG 9-8). The Proposed Action would result in little or no change to this.

Aquatic Life

Powerhouse 3 Forebay is a medium-sized impoundment that experiences relatively little fluctuation in water surface elevation over the course of the year under existing conditions. Water temperatures in the forebay are dominated by the temperatures of discharges from Mammoth Pool Powerhouse and Powerhouse 8. Under existing conditions, water temperatures are generally cool and suitable for trout (daily mean water temperatures of 20°C or less) and fish vulnerability to entrainment at the intake is low. There would be little or no change under the Proposed Action.

Proposed sediment prescriptions would reduce sediment build up in the impoundment, thereby maintaining pool depth (space) for fish habitat. There would be short-term impacts due to turbidity during initial sediment management activities prior to spill and the presence of higher background turbidities.

San Joaquin River Dam 6 to Redinger Lake

Proposed Action

The Proposed Action would increase MIF requirements below Dam 6 to the bypass reach (Stevenson Reach). MIFs would increase by 6.7 to more than 26 times for individual months, and would be the same for all water year types (Table 3.1.7-1). The Proposed Action MIFs are intended to produce compliance with the Basin Plan requirement to protect COLD (coldwater) fish habitat, when and where temperatures in the bypass reach are practically controllable by the Project. The Basin Plan does not recognize the conflict between temperature preferences of cold water game fish and sensitive transition zone species such as hardhead. The reduction of summer water temperatures from those present under existing conditions may be considered an adverse impact to hardhead.

The temperature monitoring and management plan (Temperature Monitoring and Management Plan (SCE 2007; Volume 4, SD-G (Books 19 and 24)) would implement the use telemetry to monitor summer water temperatures and would release additional flow, if needed, to meet temperature targets when temperature is a Project controllable factor. Under the temperature monitoring plan, the lower portion of the reach would be studied to evaluate whether a change in classification is justified to manage water temperatures and habitat conditions for hardhead in preference to trout.

A resource issue raised by the resource agencies is the need for increased adult habitat for hardhead and Sacramento pikeminnow. The Proposed Action would increase flow-related habitat for both trout and native transition zone species. Under the Proposed Action, decreased water temperatures may facilitate increases in trout populations for which increased physical habitat may be beneficial.

Fish monitoring would take place under the fish monitoring plan (Fish Monitoring Plan (SCE 2007; Volume 4, SD-G (Book 19)) to assess trends in fish populations. This would be supplemented by additional sampling during the first five years focused on hardhead, Sacramento pikeminnow, and Sacramento sucker under the temperature monitoring plan.

Sediment prescriptions would be implemented. Sediment removal would take place by mechanical means in the forebay. Sediment pass-through at Dam 6 would move sediments downstream and would take place at five-year intervals. Following these activities, the stream would be hydraulically flushed for at least 24 hours with flows that are at least 3,000 cfs (see Section 5.2.3.3). This would benefit aquatic habitat by reducing the potential for long-term sediment accumulation in the downstream channel and releasing spawning gravels to the bypass reach.

Higher MIFs from Dam 6 and Stevenson Creek would likely result in some enhancement of macroinvertebrate populations.

Habitat Impacts

Flow-related Habitat (WUA)

Flow-habitat relationships (Tables Attachment D-144 through D-148) for the Dam 6 to Powerhouse No. 3 bypass Reach (Stevenson Reach) were determined based upon models of 10 PHABSIM transects for flows from three to 350 cfs (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)).

The Proposed Action would increase adult rainbow trout habitat by 74% during the summer, averaging 66% over existing conditions for the entire year (Table Attachment D-149). The Proposed Action would provide 76% of Maximum WUA during the summer, and over 60 of maximum WUA over the entire year (Table Attachment D-151). Currently, 44% of maximum WUA is available for adult rainbow trout.

Under the Proposed Action, rainbow trout spawning habitat would be about five times greater than under existing conditions, and would provide the maximum spawning WUA of any flow modeled (Tables Attachment D-149 and -D151). Under existing conditions 18% of maximum WUA is available for spawning.

For brown trout, the habitat increase under the Proposed Action would provide about 50% more habitat than is provided under existing conditions, both in the summer and over the course of the entire year (Table Attachment D-150). The Proposed Action would provide 87% of maximum habitat during the summer and more than 73% of maximum available habitat throughout the year (Table Attachment D-151). Under existing conditions, 56% of maximum available habitat is provided in both summer and throughout the year (Table Attachment D-151).

Brown trout spawning habitat (October and December) would increase by over five times, on average, under the Proposed Action (Table Attachment D-150), relative to existing conditions, and provide an average 81% of maximum WUA. Under existing conditions, 15% of maximum WUA is available for brown trout spawning.

Under the Proposed Action, juvenile trout habitat would increase by about 30% throughout the year, providing more than 93% of maximum available habitat for both trout species throughout the year.

The Proposed Action MIFs would provide a similar amount of fry habitat for both rainbow and brown trout. About 90% of maximum fry WUA is provided under both the Proposed Action and existing conditions.

The Proposed Action MIFs would increase summer habitat for adult hardhead by 42%. Over the course of the year, the average increase in habitat would be 38% (Table Attachment D-153). This alternative would provide between 70 and 87% of maximum WUA, while 58% of maximum WUA is provided under existing conditions (Table Attachment D-155).

For juvenile hardhead, the Proposed Action would increase summer habitat by 25% (Table Attachment D-153), providing over 97% of maximum WUA. The habitat increase would average 23% throughout the year, providing at least 90% of maximum WUA. Current MIFs provide 78% of maximum available juvenile hardhead habitat throughout the year.

Habitat for adult Sacramento pikeminnow would be increased by 29% during the summer, with an overall increase of 27% (Table Attachment D-152). The Proposed Action would provide at least 90% of maximum available habitat at all times (Table Attachment D-155). Under current conditions, 76% of maximum WUA is provided.

The Proposed Action would increase Sacramento sucker adult habitat by 54% during the summer, averaging an increase of 49% over the entire year (Table Attachment D-154). These represent 61 to 81% of maximum WUA, while 48% of maximum available habitat is currently provided (Table Attachment D-155).

For juvenile Sacramento pikeminnow and Sacramento suckers, habitat under the Proposed Action would increase, but remain within about 10% of that provided under existing conditions (Tables Attachment D-152 and D-154). Both the

Proposed Action and existing conditions would provide more than 90% of maximum WUA.

Habitat Time Series Analysis

The habitat time series analysis indicated that median habitat values were quite similar to results from the MIF analysis for all species and lifestages (Tables Attachment K-52 through K-63). The amount of habitat exceeded 90% of the time shows smaller increases for all species and lifestages. The amount of habitat exceeded 90% of the time would increase by 23 to 36% relative to existing conditions for all trout rearing lifestages, and by over 350% for spawning under the Proposed Action relative to the No Action Alternative. The 90% exceedance habitat would increase by 15% for juvenile hardhead, and 5% for juvenile Sacramento sucker and Sacramento pikeminnow. The 90% exceedance habitat would increase by 18 to 26% for adults of the native transition zone species, relative to existing conditions.

Passage and Stranding

Under the Proposed Action, the MIFs at all times exceed the 6 cfs needed to provide passage (CAWG 3, Instream Flow Studies – PHABSIM, TSRPs (SCE 2003; Volume 4, SD-D (Books 11 and 23)). Therefore, trout (and other fish species) would be able to move freely up and downstream. This represents an enhancement to passage relative to existing conditions.

The potential for fish stranding is low during May through July, when young-of-the-year fish are abundant and fish stranding is most likely to occur. The stranding analysis (Attachment A3 - Stranding Report) shows that decreasing flows from 80 to 60 cfs would result in a loss in wetted perimeter of about 3% (Table Attachment D-156).

Stranding of rainbow trout redds would not result from the Proposed Action MIFs, as during this period, MIFs are stable or increasing. This is also true for adhesive eggs of native transition zone species (hardhead, pikeminnow, and sucker). During the brown trout spawning season of October to December, MIFs would drop from 50 cfs in October to 25 cfs in November to 20 cfs in December. The change from 50 to 25 cfs would result in the retention of between 86% and 97% of the starting habitat, with the actual value being near the high end of this range (Attachment E - Stranding Report (Table Attachment D-157). The 25 to 20 cfs flow change would result in the retention of over 98% of the spawning habitat. The over-all change from October to December would result in retention of 86 to 94% of the starting habitat in October. This represents a potential increase in redd stranding mortality relative to the No Action Alternative, where flows during this period are stable.

Temperature

Under existing conditions, water temperatures released at Dam 6 are generally cool throughout the summer and suitable for trout. Water heats up as it flows downstream to the confluence of Stevenson Creek, reaching temperatures favorable for hardhead and other native transition zone fish in the lower portion of the reach. However, these temperatures are considered unsuitably warm for trout. In dry years, as thermal mixing begins in Mammoth Pool Reservoir upstream, flows reaching Dam 6 are warm. In September of dry and warm water years, daily mean water temperatures reach 20°C throughout most of the reach below Dam 6, regardless of amount of flow released at Dam 6. In general, with the exception of dry and warm Septembers, under existing conditions summer water temperatures are suitable for trout in the upper portion of the bypass reach, but unsuitable in the lower portion. For native transition zone fish, summer water temperatures may be unsuitably cool in the upper portion of the reach, but favorable in the lower portion of the reach. The distribution of hardhead observed in this reach (CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) corresponds to portions of the reach with suitable summer temperatures.

The Proposed Action MIFs would result in substantial cooling of this reach with water temperatures below 20°C during periods other than September (or late August) of dry and warm years, described above (Figures 5.2.4.3.4-1 through -4, also see Attachment G – Temperature Tables). In September of dry water years with hot air temperatures, daily mean temperatures would range from 20.1 to 20.7°C. Daily maximum temperatures would be less than 22°C except in September of a hot and dry water year (Figures Attachment F-21 through F-24). At that time, water temperatures upstream of Powerhouse 3 would be less than 22°C except for the last 0.4 miles, where water temperatures would reach up to 22.2°C (Tables Attachment G-31 and G-32). In this case, there would be less than 1.1°C warming in the reach, which is consistent with the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007; Volume 4, SD-G (Books 19 and 24)). The cooler temperatures would benefit trout but may be cooler than suitable, and potentially detrimental, to native transition zone fish species.

The Proposed Action is intended to produce compliance with the Basin Plan requirement to protect COLD water fish habitat, where practically controllable. The Basin Plan does not recognize the conflict between temperature preferences of cold water game fish and sensitive transition zone species such as hardhead. As part of the Proposed Action, the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007; Volume 4, SD-G (Books 19 and 24)) would direct SCE to conduct studies to determine if a change in beneficial use designation is warranted, based on the reach containing a native transition zone fish assembly and the need to maintain water temperature conditions appropriate to that fish community in the lower portion of the reach.

As part of the Proposed Action, water temperatures would be monitored as discussed in the Temperature Monitoring and Management Program (Temperature Monitoring and Management Plan (SCE 2007; Volume 4, SD-G (Books 19 and 24)) to confirm that effects predicted by water temperature modeling occur in the stream, and to maintain compliance with the Basin Plan (CVRWQCB 1998), when water temperatures are a Project controllable factor. Telemetry would be used to monitor real-time water temperatures in the bypass reach and flow releases from Dam 6 would be adjusted to maintain water temperature targets in compliance with the Basin Plan. A Long-Term Operational Water Temperature Control Plan would be developed to meet water temperature targets, when water temperature control is feasible and under Project control.

Aquatic Life

Fish

Under existing conditions, water temperatures are suitable for trout in the upper portion of the reach, but not in the lower portion. The Proposed Action would result in temperatures throughout the reach becoming suitable for trout during the summer months. The Proposed Action would result in enhanced physical habitat for both trout and native transition zone species. The increased flows would greatly increase available spawning habitat for both rainbow and brown trout with minor potential for redd loss due to stranding for brown trout and none for rainbow trout. The increased flows would permit fish passage throughout the reach.

The Proposed Action MIFs would increase habitat for native transition zone species. Sacramento pikeminnow and hardhead dominate the sampled fish community in the lower portion of the reach under current conditions. Under the Proposed Action, habitat would increase for both juvenile and adult hardhead. Juvenile hardhead rear in this reach for extended periods. Adult hardhead apparently ascend to this reach from Redinger Lake to spawn, but do not remain through the summer. Increased adult hardhead habitat may result in increased use by adult hardhead during the summer months. Higher flows would result in improved passage and may enhance access to upstream areas for hardhead and other native transition zone fish.

The Proposed Action would include sediment prescriptions to reduce sediment build up in the Powerhouse 3 Forebay through mechanical removal and to pass some material through Dam 6 to the bypass reach during spill to maintain transport of materials. Dam 6 spills every Wet and Above Normal water year. This would have a beneficial effect in avoiding adverse effects to habitat conditions in the forebay and bypass reach. There would be short-term impacts due to turbidity during initial sediment management activities prior to spill and the presence of higher background turbidities.

The reduction of summer water temperatures in the lower portion of the bypass reach from those present under existing conditions may have an adverse impact to hardhead. Summer water temperatures would be reduced to substantially less than 20°C in much of the reach. These temperatures are lower than optimal temperatures for hardhead, which are in the range of 24°C to 28°C (Moyle 2002). Moyle states that most streams that contain hardhead have summer temperatures in excess of 20°C, and for example, that in the Pit River hardhead generally selected the warmest temperatures available. The distribution of hardhead in the Horseshoe Bend Reach of the SJR suggests a similar selection of warmer conditions (SCE 1995). However, potential adverse impacts to hardhead will be evaluated under the Temperature Monitoring and Management Program, and if indicated by the results, SCE will apply to amend the Basin Plan in the lower portion of the reach to protect and enhance water temperatures and habitat for hardhead and other members of the native transition zone assemblage.

The extent that enhancement of habitat and changes to water temperatures affect changes in fish populations is not known. Under existing conditions, trout abundance is low throughout the reach, including in the upper portion of the reach where habitat is currently available and temperatures are suitable. As in the Mammoth Pool bypass reach upstream, the fish community in the upper portion of the reach is dominated by Sacramento sucker. The potential exists that the Sacramento sucker may represent a more successful competitor than trout. The fish monitoring plan would provide information on fish community trends over the course of the license.

Macroinvertebrates

Under existing MIFs, macroinvertebrates are abundant and have greater EPT and overall densities than the reference site upstream of Mammoth Pool Reservoir. Highest densities occur downstream of Dam 6 and the confluence with Stevenson Creek. Under the Proposed Action, higher MIFs from Dam 6 and Stevenson Creek would likely result in some enhancement of macroinvertebrate populations.

5.2.4.4 Unavoidable Adverse Impacts of Proposed Action

Operation of the four Big Creek ALP Projects under the Proposed Action would not result in any unavoidable adverse impacts. The Proposed Action is specifically comprised of measures to enhance habitat and other conditions to benefit fish and other aquatic life. The temperature and fish monitoring programs instituted as part of the Proposed Action, in consultation with the State Water Board and other resource agencies, will provide information on the efficacy of the Proposed Action. The Temperature Monitoring and Management Plan provides for modification of flow releases in the bypass reaches, if the Proposed Action fails to maintain temperature criteria, when temperatures are a Project controllable factor.

TABLES

Table 5.2.4.1-1. The Status of Fish Species of Waters in the Big Creek System.

Common Name	Scientific Name	Status	Special Status
Hardhead	*Mylopharodon conocephalus*	N	CSC, USFS
Sacramento pikeminnow	*Ptychocheilus grandis*	N	
Sacramento sucker	*Catostomus occidentalus*	N	
Rainbow trout	*Oncorhynchus mykiss*	N/I[1]	
Golden trout	*Oncorhynchus mykiss aguabonita*	N/I	FSC, CSC[2]
Brown trout	*Salmo trutta*	I	
Brook trout	*Salvelinus fontinalis*	I	
Prickly sculpin	*Cottus asper*	N	
Kokanee	*Oncorhynchus nerka*	I	
Bluegill	*Lepomis macrochirus*	I	
Crappie	*Pomoxis spp.*	I	
Smallmouth bass	*Micropterus dolomieui*	I	
Carp	*Cyprinus carpio*	I	

Legend:

N = Native

I = Introduced

FSC = Federal Species of Concern

CSC = California Species of Special Concern

USFS = Sensitive Species

[1] Rainbow trout are native to California, and were historically absent from the upper-most reaches of the South Fork San Joaquin River. Spawning anadromous rainbow trout (steelhead) may have migrated up the San Joaquin River into the lower reaches of the Project area prior to the installation of dams. Stocking of rainbow trout into the Project area included a variety of genetic strains of fish, including Kamloops, B.C., Whitney, and Coleman.

[2] The special status of golden trout is only applicable to populations in their native range, the South Fork Kern River. The Project Area is outside of its native range.

Table 5.2.4.2-1. Species Captured in Mammoth Pool Reservoir, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Species	Number Captured	CPUE (No./Hour)	Percent of Total	Mean Condition Factor
Brown trout	12	0.04	71	1.10
Rainbow trout	5	0.02	29	1.33
Crayfish	654	0.44	-	-

Table 5.2.4.2-2. Habitat Type Relative Frequencies for Reaches of the San Joaquin River Mammoth Pool Dam to Dam 6. Source: CAWG 1, Characterize Stream and Reservoir Habitats, 2002 FTSR (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Mammoth Pool Project Area.

Habitat Types[1]	SJR Mammoth Reach	Rock Creek Above Diversion	Rock Creek Below Diversion	Ross Creek Above Diversion	Ross Creek Below Diversion
Low Gradient Riffle	1.6%			2.1%	
High Gradient Riffle	12.2%			2.3%	
Cascade	1.2%	36.9%	9.7%	18.1%	11.8%
Bedrock Sheet		8.7%	30.2%	6.6%	9.7%
Pocket Water	5.6%		2.2%		
Run	4.8%				
Step Run	2.3%				
Trench Chute				7.1%	
Main Channel Pool	10.9%	9.4%		11.2%	
Lateral Scour Pool	29.6%				3.9%
Corner Pool	1.4%				
Dammed Pool		8.7%	3.4%		
Step Pool	30.1%	36.3%	9.9%	50.7%	41.3%
Plunge Pool	0.2%		7.6%	2.0%	
Dry					33.3%
Not Available			37.1%		

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-3. Daily Maximum Water Temperature Exceedances San Joaquin River Mammoth Reach (Mammoth Pool Dam to Dam 6), 2000 and 2001.

San Joaquin River Downstream of Mammoth Pool

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	1	0	0	0	0	0	0	15	0	0	0	0	0	0	0	25
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	4	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	1	0	0	0	0	0	0	30	26	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	28

San Joaquin River Upstream of Rock Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	5	9	2	0	0	0	0	0	24
July	11	2	0	0	0	0	0	25	7	0	0	0	0	0	0	31
August	13	5	1	0	0	0	0	31	17	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	7	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	19

San Joaquin River Upstream of Ross Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	31
June	3	3	0	0	0	0	0	3	26	23	16	6	2	0	0	30
July	25	22	11	2	0	0	0	25	31	31	28	13	4	0	0	31
August	31	27	20	8	4	0	0	31	31	27	26	13	2	0	0	31
Sept	9	5	0	0	0	0	0	30	22	6	4	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31

San Joaquin River Upstream of Mammoth Pool Powerhouse

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	31
June	3	1	0	0	0	0	0	3	26	21	14	5	0	0	0	30
July	5	5	2	1	1	1	1	5	31	31	21	12	2	0	0	31
August	14	14	10	2	1	0	0	14	31	27	25	9	1	0	0	31
Sept	11	3	1	0	0	0	0	15	18	5	2	0	0	0	0	30
October	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	31

Table 5.2.4.2-4. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Mammoth Pool Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
San Joaquin River, Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse, RM 18.3 to 26.7)	Upper Site B Channel	Brown trout	79-215	11	125	2.0	1.09	241	4.1	112	68
		Rainbow trout	59-210	10	116	2.1	1.69				
		Sacramento Sucker	50-410	15	523	29.3	1.33				
	Lower Site B Channel	Brown trout	55-438	13	52	4.7	1.18	436	17.2	172	153
		Rainbow trout	46-203	19	384	12.5	2.25				
		Sacramento Sucker	23-335	135	1,215	35.7	1.65				
	Reach Average	Trout						338.5	10.7	142	
Rock Creek	Above Diversion Aa+ Channel	Brown trout	43-305	84	930	91.5	1.31	1,170	121.2	441	1,140
		Rainbow trout	90-200	22	241	29.5	1.19				
	Below Diversion Aa+ Channel	Brown trout	67-277	39	481	42.4	1.30	913	71.4	296	711
		Rainbow trout	67-332	35	432	29.0	1.46				
Ross Creek[3]	Above Diversion	No fish sampling	-	-	-	-	-	-	-	-	-
	Below Diversion	No fish sampling	-	-	-	-	-	-	-	-	-

[1] See text for description of reaches.

[2] Includes all life history stages.

[3] Ross Creek was not sampled because much of it goes dry during the summer.

Table 5.2.4.2-5. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the Mammoth Pool Project Area in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Stream	Site[1]	River Mile	Mean Density (No./Square Meter)	Mean EPT[2] Density (No./Square Meter)
San Joaquin River Above Mammoth Pool Reservoir (reference site)	Site AM	(RM 34.55)	942	310
San Joaquin River Mammoth Reach	Site BM 4	(RM 26.20)	2556	472
	Site BM 3	(RM 22.85)	1219	257
	Site BM 2	(RM 22.10)	1616	517
	Site BM 1	(RM 18.40)	1496	528
Rock Creek	Site AD	(RM 0.55)	3774	1846
	Site BD 2	(RM 0.40)	22696	2552
	Site BD 1	(RM 0.05)	3565	822

[1] AM is a reference site, AD = above diversion, BD = below diversion.
[2] EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).

Table 5.2.4.2-6. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for Rock Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-E (Books 14 and 23)).

Rock Creek Diversion (Maximum)

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	**20°C**	**21°C**	**22°C**	**23°C**	**24°C**	**25°C**	**26°C**		**20°C**	**21°C**	**22°C**	**23°C**	**24°C**	**25°C**	**26°C**	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	11	1	0	0	0	0	0	15	3	0	0	0	0	0	0	29
July	2	1	0	0	0	0	0	31	7	6	2	0	0	0	0	7
August	10	5	0	0	0	0	0	31	27	19	7	1	0	0	0	31
Sept	0	0	0	0	0	0	0	30	1	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	12

Rock Creek Upstream of San Joaquin River (Maximum)

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	**20°C**	**21°C**	**22°C**	**23°C**	**24°C**	**25°C**	**26°C**		**20°C**	**21°C**	**22°C**	**23°C**	**24°C**	**25°C**	**26°C**	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	15	6	0	0	0	0	0	15	21	18	15	5	0	0	0	24
July	15	1	0	0	0	0	0	31	31	23	9	3	0	0	0	31
August	7	6	1	0	0	0	0	31	23	9	2	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	1	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	28

Table 5.2.4.2-7. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for Ross Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004b; Volume 4, SD-E (Books 14 and 23)).

Ross Creek Diversion (Maximum)

	Number of Days in 2000 Maximum Water Temperature Recorded Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Recorded Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	11	7	6	0	0	0	0	31
June	9	9	9	3	0	0	0	9	27	25	19	11	7	3	1	30
July	29	25	21	14	5	2	0	31	24	24	24	17	11	5	1	24
August	31	30	27	20	10	2	0	31	0	0	0	0	0	0	0	0
Sept	1	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ross Creek Upstream of San Joaquin River (Maximum)

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	26	26	21	19	17	14	12	31
June	0	0	0	0	0	0	0	9	30	30	30	29	29	29	27	30
July	0	0	0	0	0	0	0	2	17	17	17	16	14	11	11	17
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0

Table 5.2.4.2-8. Species Captured in Huntington Lake and Powerhouse 2 Forebay (Dam 4), 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Species	Number Captured	CPUE (No./Hour)	Percent of Total*	Mean Condition Factor**
Huntington Lake				
Species Collected with Gill Nets				
Brown trout	7	0.03	11	2.28
Rainbow trout	1	0.00	5	1.97
Kokanee	2	0.01	5	2.94
Sacramento Sucker	10	0.04	39	-
Species Collected with Trap Nets				
Rainbow trout	2	0.02		
Kokanee	1	0.01		
Sacramento Sucker	15	0.11		
Prickly Sculpin	15	0.11	40	-
Species Collected with Minnow Traps				
Prickly Sculpin	11	0.01		
Powerhouse 2 Forebay (Dam 4)				
Species Collected with Gill Nets				
Brown trout	8	0.17	21	1.24
Rainbow trout	11	0.23	46	1.47
Species Collected with Trap Nets				
Prickly Sculpin	2	0.01	33	-
Species Collected with Electrofisher				
Brown trout	1	-		
Rainbow trout	19	-		
Prickly Sculpin	12	-		

* For each species and site regardless of collection method.
** Mean condition factor for individual fish species may include data from fish collected by more than one collection method.

Table 5.2.4.2-9. Habitat Type Relative Frequencies for Reaches of the Big Creek Nos. 1 and 2 Project Area. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Habitat Types[1]	Big Creek PH 1 to Dam 1	Big Creek PH 2 to Dam 4	Balsam Creek Below Diversion	Adit No. 8 Creek	Ely Creek Above Diversion	Ely Creek Below Diversion
Low Gradient Riffle				0.3%		
High Gradient Riffle	3.7%	7.5%	11.9%	6.0%		7.6%
Cascade	23.2%	19.2%	9.9%	20.7%	34.7%	2.8%
Bedrock Sheet	0.5%	2.8%	21.5%		36.4%	
Pocket Water	5.3%	2.3%				
Run	12.4%	0.7%	1.7%	3.9%	2.2%	2.0%
Step Run	8.7%	0.6%	8.3%	13.3%	8.5%	11.2%
Glide	0.4%	0.4%		0.5%		
Trench Chute	0.3%	1.8%	3.8%			0.8%
Main Channel Pool	4.2%	9.4%	0.4%	0.6%		0.6%
Secondary Channel Pool						
Channel Confluence Pool						
Lateral Scour Pool	1.4%	3.8%	0.8%		0.5%	
Corner Pool	0.6%					
Dammed Pool		0.4%	2.4%		0.7%	1.0%
Step Pool	18.0%	42.0%	32.8%	10.1%		7.7%
Backwater Pool	0.1%					
Plunge Pool	2.7%	9.1%	5.3%	2.6%	17.0%	0.9%
Dry				42.0%		45.7%
Road-Crossing			1.1%			0.7%
Flume						
Concrete Box Culvert						0.3%
Not Available	34.1%					18.6%

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-10. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 1 and 2 Project Area (Big Creek, Huntington Lake to PH 1/Dam 4). Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Big Creek Downstream of Dam 1

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
June	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	14

Big Creek Canyon

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
June	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	14

Big Creek Upstream of Big Creek Powerhouse 1

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	30

Table 5.2.4.2-11. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Big Creek Nos. 1 & 2 Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
Big Creek, Dam 1 (Huntington Lake) to Powerhouse 1	B Channel	Brown trout	99-190	16	320	16.0	0.92	320	16.0	220	318
	G Channel	Brown trout	65-199	44	648	50.9	1.17	648	50.9	294	842
		Prickly Sculpin	94	1	14	0.5	-				
	A Channel	Brown trout	49-222	72	1214	[3]	[3]	1214	[3]	624	1836
	Aa+ Channel	Brown trout	78-305	43	497	117.6	1.42	497	117.6	355	1128
	Reach Average	Trout	-	-	-	-	-	670	61.5	373	1031
Big Creek, Dam 4 to Powerhouse 2	A Channel	Brown trout	76-260	25	363	[3]	[3]	726	[3]	274	611
		Rainbow trout	79-200	26	363	[3]	[3]				
	Reach Average	Trout	-	-	-	-	-	726	[3]	274	611
Balsam Creek	Below Diversion Aa+ Channel	Rainbow trout	169	1	12	2.3	2.07	12	2.3	12	33
Adit No. 8 Creek	Below Diversion Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
Ely Creek	Above Diversion Aa+ Channel	Rainbow trout	155-235	15	190	133.9	1.25	190	133.9	190	1605
	Below Diversion Aa+ Channel	Rainbow trout	23-205	26	266	76.7	1.38	368	108.1	204	1258
		Golden x Rainbow trout hybrids	99-175	10	102	31.4					

[1] See text for description of reaches.

[2] Includes all life history stages.

[3] Biomass could not be calculated due to equipment malfunction.

Table 5.2.4.2-12. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the Big Creek Nos. 1 & 2 Project Area in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Stream	Site[1]	Location	Mean Density (No./Square Meter)	Mean EPT[2] Density (No./Square Meter)
Big Creek, Powerhouse 1 to Dam 1 (Huntington Lake)	Site 3	0.05 mi[3]	3139	637
	Site 2	2.0 mi[3]	1208	702
	Site 1	3.5 mi[3]	12807	2557
	Site B[4]	1.1 mi[3]	3509	2336
Big Creek, Powerhouse 2 to Dam 4	Site 3	0.05 mi[5]	4905	1851
	Site 2	1.1 mi[5]	2583	1257
	Site 1	3.9 mi[5]	6155	3026
Balsam Creek	Site AD	0.8 mi[6]	5271	3429
	Site BD 2	0.5 mi[6]	1468	976
	Site BD 1	0.1 mi[6]	1847	1074
Adit No. 8 Creek	Site 2	0.9 mi[6]	304	42
	Site 1	0.4 mi[6]	215	191
Ely Creek	Site AD	1.2 mi[6]	8181	2583
	Site BD 3	0.6 mi[6]	1974	65
	Site BD 2	0.45 mi[6]	485	32
	Site BD 1	0.2 mi[6]	535	504

[1] AD = above diversion, BD = below diversion.
[2] EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).
[3] Location relative to Dam 1 (downstream).
[4] Site B was sampled in Rosgen Level I B type channel in the upper portion of the reach. Sites 3 through 1 were located in Rosgen Level I Aa+ type channel.
[5] Location relative to Dam 4 (downstream).
[6] Location relative to Big Creek (upstream).

Table 5.2.4.2-13. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 1 and 2 Project Areas (Big Creek, Dam 4 to PH 2/2A/Dam 5). Source: C CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Big Creek Downstream of Dam 4

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	3	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	30

Big Creek Upstream of Balsam Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	15	8	3	0	0	0	0	30
July	2	0	0	0	0	0	0	31	31	27	16	6	2	0	0	31
August	1	0	0	0	0	0	0	31	25	19	11	3	0	0	0	31
Sept	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	30

Big Creek Upstream of Big Creek Powerhouse 2

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	4	0	0	0	0	0	0	30
July	7	1	0	0	0	0	0	31	15	8	0	0	0	0	0	31
August	7	1	1	0	0	0	0	31	16	6	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	31

Table 5.2.4.2-14. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 1 and 2 Project Areas (Big Creek Tributaries). Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Balsam Creek Upstream of Big Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:					Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:					Days Monitored	Number of Days in 2002 Maximum Water Temperature Exceeds:					Days Monitored
Month	20°C	21°C	22°C	23°C	24°C		20°C	21°C	22°C	23°C	24°C		20°C	21°C	22°C	23°C	24°C	
May	0	0	0	0	0	6	0	0	0	0	0	31	0	0	0	0	0	7
June	0	0	0	0	0	30	0	0	0	0	0	30	1	0	0	0	0	30
July	0	0	0	0	0	31	1	0	0	0	0	31	15	4	0	0	0	31
August	0	0	0	0	0	31	0	0	0	0	0	31	0	0	0	0	0	31
Sept	0	0	0	0	0	30	0	0	0	0	0	30	0	0	0	0	0	30
October	0	0	0	0	0	26	0	0	0	0	0	30	0	0	0	0	0	29

Ely Creek Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	5
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0

Ely Creek Upstream of Big Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	1	1	0	0	0	0	0	31
August	3	0	0	0	0	0	0	31	10	9	8	4	3	2	0	17
Sept	0	0	0	0	0	0	0	30	7	6	5	2	1	1	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	31

Table 5.2.4.2-15. Species Captured in Reservoirs and Impoundments within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Species	Number Captured	CPUE (No./Hour)	Percent of Total*	Mean Condition Factor**
Florence Lake				
Species Collected with Gill Nets				
Brown trout	39	0.14	100	1.47
Species Collected with Minnow Traps				
Brown trout	2	< 0.01		
Bear Diversion Forebay				
Species Collected with Gill Nets				
Brown trout	39	0.44	93	1.38
Rainbow trout	1	0.01	7	0.85
Species Collected with Electrofisher				
Brown trout	11	-		
Rainbow trout	3	-		
Mono Diversion Forebay				
Species Collected with Gill Nets				
Brown trout	7	0.11	24	1.41
Rainbow trout***	38	0.62	76	2.19
Species Collected with Electrofisher				
Brown trout	5	-		
Big Creek Powerhouse 8 Forebay (Dam 5)				
Species Collected with Gill Nets				
Brown trout	10	0.21	84	1.34
Rainbow trout	1	0.02	8	1.85
Prickly Sculpin	1	0.02	8	-

* For each species and site regardless of collection method.
** Mean condition factor for individual fish species may include data from fish collected by more than one collection method.
*** All fish were determined to be of hatchery origin.

Table 5.2.4.2-15. Species Captured in Reservoirs and Impoundments within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) (continued).

Balsam Meadow Forebay				
Species Collected with Gill Nets				
Brown trout	3	0.02	2	1.14
Rainbow trout	7	0.06	7	1.19
Kokanee	43	0.35	28	1.31
Smallmouth Bass	1	0.01	3	-
Sacramento Sucker	23	0.19	19	-
Species Collected with Trap Nets				
Rainbow trout	3	0.02	-	-
Sacramento Sucker	6	0.04	-	-
Prickly Sculpin	64	0.42	41	-
Species Collected with Electrofisher				
Smallmouth Bass	3	-	-	-
Shaver Lake				
Species Collected with Gill Nets				
Rainbow trout***	24	0.08	37	1.27
Kokanee	13	0.05	19	1.83
Smallmouth Bass	12	0.04	27	-
Sacramento Sucker	2	0.01	3	-
Carp	1	0.00	1	-
Species Collected with Trap Nets				
Smallmouth Bass	6	0.04	-	-
Bluegill	4	0.03	6	-
Crappie	3	0.02	4	-
Unidentified Centrarchid	2	0.01	3	-
Species Collected with Traps				
Crayfish	38	0.05	-	-

* Species composition for all species collected in respective reservoirs.
** Mean condition factor for all individual fish species collected in respective reservoirs.
*** All fish were determined to be of hatchery origin.

Table 5.2.4.2-16. Habitat Type Relative Frequencies for Reaches of the South Fork San Joaquin River. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	Florence Lake to Bear Creek	Bear Creek to Mono Crossing	Mono Crossing to Rattlesnake Crossing	Rattlesnake Crossing to Hoffman Creek	Hoffman Creek to SJR Confluence
Low Gradient Riffle	2.8%	18.7%	13.3%	3.1%	10.2%[2]
High Gradient Riffle	13.4%	8.9%	15.6%	22.9%	
Cascade	2.5%	0.7%	1.2%	3.4%	15.1%
Bedrock Sheet		0.4%			
Pocket Water	11.7%	8.0%	10.3%	14.0%	15.2%
Run	20.7%	13.8%	1.9%	1.5%	9.9%
Step Run	14.1%	1.6%	3.2%	7.1%	
Glide	3.2%				
Trench Chute					
Main Channel Pool	10.0%	2.7%	0.3%	2.3%	17.3%
Secondary Channel Pool	1.1%				
Channel Confluence Pool	1.3%				
Lateral Scour Pool	14.5%	39.1%	26.1%	14.3%	
Corner Pool	0.5%	0.6%	1.9%	0.6%	1.6%
Dammed Pool	0.4%				30.0%
Step Pool	3.1%	5.5%	26.3%	30.5%	
Backwater Pool	0.5%			0.3%	
Plunge Pool	0.1%				0.6%
Dry					
Road-Crossing					
Flume					
Concrete Box Culvert					
Not Available					

[1] USFWS Region 5 habitat types (McCain et al. 1990).
[2] Habitat type is likely to be Low Gradient Riffle, but could not be verified from aerial survey.

Table 5.2.4.2-17. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South Fork San Joaquin River Downstream of Florence Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

South Fork San Joaquin River Downstream of Florence Lake

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	24
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22

South Fork San Joaquin River Downstream of Jackass Meadow

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

South Fork San Joaquin River Upstream of Hooper Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

Table 5.2.4.2-17. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South Fork San Joaquin River Downstream of Florence Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

South Fork San Joaquin River Upstream of Crater Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	18	1	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	2	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	6	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	22

South Fork San Joaquin River Upstream of Bear Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	14	3	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	3	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	13

South Fork San Joaquin River Upstream of Mono Hot Springs

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	29	1	0	0	0	0	0	0	3
July	0	0	0	0	0	0	0	31	5	0	0	0	0	0	0	31
August	1	0	0	0	0	0	0	31	9	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	27

Table 5.2.4.2-17. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South Fork San Joaquin River Downstream of Florence Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

South Fork San Joaquin River Upstream of Camp 62 Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
June	0	0	0	0	0	0	0	29	9	3	0	0	0	0	0	30
July	2	0	0	0	0	0	0	31	11	4	0	0	0	0	0	31
August	2	0	0	0	0	0	0	31	22	7	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

South Fork San Joaquin River Upstream of Bolsillo Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
June	0	0	0	0	0	0	0	29	8	3	0	0	0	0	0	30
July	1	0	0	0	0	0	0	31	11	5	0	0	0	0	0	31
August	1	0	0	0	0	0	0	31	22	4	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

South Fork San Joaquin River Upstream of Camp 61 Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	9
June	0	0	0	0	0	0	0	4	25	16	8	3	0	0	0	30
July	22	13	0	0	0	0	0	31	21	16	10	5	0	0	0	25
August	13	5	0	0	0	0	0	31	29	25	19	6	0	0	0	31
Sept	0	0	0	0	0	0	0	30	2	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

Table 5.2.4.2-17. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South Fork San Joaquin River Downstream of Florence Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

South Fork San Joaquin River Upstream of Mono Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	9
June	0	0	0	0	0	0	0	4	27	20	9	3	0	0	0	30
July	23	19	1	0	0	0	0	31	26	20	11	5	0	0	0	31
August	18	7	3	0	0	0	0	31	29	26	19	4	0	0	0	31
Sept	0	0	0	0	0	0	0	30	3	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

South Fork San Joaquin River Upstream of Warm Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	18
July	0	0	0	0	0	0	0	0	13	2	0	0	0	0	0	31
August	0	0	0	0	0	0	0	0	23	4	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23

South Fork San Joaquin River Upstream of Rattlesnake Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	4	5	0	0	0	0	0	0	30
July	1	0	0	0	0	0	0	31	13	2	1	0	0	0	0	31
August	0	0	0	0	0	0	0	13	21	6	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	24

Table 5.2.4.2-17. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South Fork San Joaquin River Downstream of Florence Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

South Fork San Joaquin River Upstream of Hoffman Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	31
August	1	0	0	0	0	0	0	24	23	5	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	25

South Fork San Joaquin River Upstream of San Joaquin River Confluence

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	30
July	0	0	0	0	0	0	0	0	30	12	6	0	0	0	0	31
August	12	0	0	0	0	0	0	22	26	22	9	1	0	0	0	31
Sept	0	0	0	0	0	0	0	30	3	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31

Table 5.2.4.2-18. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
SFSJR, Upstream of Florence Lake	B Channel	Brown trout	58-300	16	206	-[3]	-	206	-[3]	158	172
SFSJR, Florence Lake to Bear Creek	B Channel	Brown trout	61-226	51	522	35.1	1.37	696	48.1	480	656
		Rainbow trout	108-268	12	174	13.0	1.31				
	C Channel	Brown trout	53-241	21	303	11.1	1.45	324	13.1	108	111
		Rainbow trout	168-208	2	21	2.0	1.84				
	Reach Average	Trout	-	-	-	-	-	510	30.6	294	384
SFSJR, Bear Creek to Mono Crossing	G Channel	Brown trout	64-198	22	306	8.6	1.38	338	9.0	111	95
		Rainbow trout	62-138	3	32	0.4	1.44				
	C Channel	Brown trout	86-232	14	226	9.3	1.35	858	16.0	387	234
		Rainbow trout	58-204	15	632	6.7	1.60				
	B Channel	Brown trout	83-260	15	220	8.3	1.32	920	32.2	647	361
		Rainbow trout	60-280	8	700	23.9	1.31				
	Reach Average	Trout	-	-	-	-	-	705	19.1	382	230
SFSJR, Mono Crossing to Rattlesnake Crossing	B Channel	Brown trout	83-217	29	350	4.7	1.24	1334	10.5	301	150
		Rainbow trout	48-225	59	984	5.8	1.38				
SFSJR, Rattlesnake Crossing to the SJR Confluence	G Channel	Brown trout	90-210	17	385	10.2	1.27	1222	19.5	616	420
		Rainbow trout	58-203	29	837	9.3	1.43				

[1] See text for description of reaches.
[2] Includes all life history stages.
[3] Biomass could not be calculated due to equipment malfunction.

Table 5.2.4.2-18. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) (continued).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
Tombstone Creek, Above Diversion	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
Tombstone Creek, Below Diversion	Aa+ Channel	Brown trout	43-414	37	416	188.4	1.28	416	188.4	225	1600
	C/E Channel	No Fish	-	-	-	-	-	-	-	-	-
South Slide Creek, Above Diversion	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
South Slide Creek, Below Diversion	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
North Slide Creek, Above Diversion	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
North Slide Creek, Below Diversion	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
Hooper Creek, Above Diversion	Aa+ Channel	Golden x Rainbow trout	91-230	13	663	71.3	1.23	663	71.3	306	936
Hooper Creek, Below Diversion	Aa+ Channel	Golden x Rainbow trout	70-230	68	962	124.9	1.31	962	124.9	368	1617
Crater Creek, Above Diversion	Aa+ Channel	Brook trout	49-179	26	547	21.2	1.46	547	21.2	105	288
Crater Creek, Below Diversion	Aa+ Channel	Brook trout	49-171	21	276	29.8	1.05	276	29.8	39	274
	C Channel	No Fish	-	-	-	-	-	-	-	-	-
Crater Creek, Diversion Channel	Aa+ Channel	Brook trout	47-191	80	1193	81.4	1.33	1193	81.4	253	823
Bear Creek, Above Diversion	B Channel	Brown trout	65-225	43	470	18.6	1.20	470	18.6	208	227
Bear Creek, Below Diversion	A Channel	Brown trout	63-292	110	1406	131.3	1.23	1406	131.3	600	1372

[1] See text for description of reaches.
[2] Includes all life history stages.
[3] Biomass could not be calculated due to equipment malfunction.

Table 5.2.4.2-18. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) (continued).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
Camp 62 Creek, Above Diversion	Aa+ Channel	Brook trout	42-202	87	945	152.3	1.21	945	152.3	315	1976
Camp 62 Creek, Below Diversion	Aa+ Channel	Brook trout	44-228	92	1162	124.4	1.21	1162	124.4	215	1253
Chinquapin Creek, Above Diversion	Aa+ Channel	Brook trout	48-190	31	665	122.3	1.35	665	122.3	236	1935
Chinquapin Creek, Below Diversion	Aa+ Channel	Brook trout	43-199	176	2034	215.8	1.01	2034	215.8	173	1116
Bolsillo Creek, Above Diversion	B Channel	Brook trout	44-205	195	2187	431.9	1.11	2187	431.9	538	5047
Bolsillo Creek, Below Diversion	Aa+ Channel	Brook trout	70-166	15	143	22.6	1.22	143	22.6	29	217
	B Channel	Brook trout	43-191	135	1509	216.5	1.24	1509	216.5	257	2109
	Reach Average	Trout	-	-	-	-	-	826	119.6	143	1163
Mono Creek, Below Diversion	B Channel	Brown trout	65-180	6	64	3.3	1.11	75	4.2	32	57
		Rainbow trout	168	1	11	0.9	-				
Big Creek, Dam 5 to Powerhouse 8	A Channel	Brown trout	75-238	42	602	[3]	-	1532	-	124	195
		Rainbow trout	54-178	79	930	[3]	-				
	Aa+ Channel	Brown trout	95-194	11	160	[3]	-	929	-	223	462
		Rainbow trout	73-202	51	769	[3]	-				
	Reach Average	Trout	-	-	-	-	-	1231	4.2	173	329
Balsam Creek, Above Diversion	Aa+ Channel	Rainbow trout	41-262	112	1335	171.6	1.56	1335	171.6	248	1505
Pitman Creek, Above Diversion	B Channel	Brown trout	70-294	28	338	45.4	1.12	1486	104.2	539	1244
		Rainbow trout	46-264	96	1066	57.3	1.20				
		Brook trout	60-170	8	82	1.5	1.00				

[1] See text for description of reaches.

[2] Includes all life history stages.

[3] Biomass could not be calculated due to equipment malfunction.

Table 5.2.4.2-18. Fish Species Capture Totals, Estimated Density, Biomass and Condition Factor in Streams within the Big Creek 2A, 8 and Eastwood Project Area, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)) (continued).

Project Reach[1]	Sampled Reach (Rosgen Channel Type)	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[2]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[2]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
Pitman Creek, Below Diversion	B Channel	Brown trout	175-182	2	22	3.2	1.23	657	42.4	175	407
		Rainbow trout	36-179	56	613	38.2	1.71				
		Brook trout	121-132	2	22	1.0	1.06				
	Aa+ Channel	Rainbow trout	47-187	114	1647	77.5	1.45	1647	77.5	274	916
	Reach Average	Trout	-	-	-	-	-	1152	60.0	225	662
North Fork Stevenson Creek, Upstream of Tunnel 7 Outlet	Aa+ Channel	No Fish	-	-	-	-	-	-	-	-	-
North Fork Stevenson Creek, Downstream of Tunnel 7 Outlet	Aa+ Channel	Golden x Rainbow trout	86-188	48	583	9.0	0.98	583	9.0	109	91
	G Channel	Brown trout	40-237	28	305	43.7	1.23	526	58.5	280	637
		Rainbow trout	101-175	20	210	13.5	1.27				
		Golden x Rainbow trout	168	1	11	1.3	1.35				
		Sacramento Sucker	342	1	11	13.5	-				
	C Channel	Brown trout	38-208	39	430	33.2	1.39	744	63.0	108	546
		Rainbow trout	35-218	30	314	29.8	1.27				
		Sacramento Sucker	237-331	4	42	65.9	-				
	Reach Average	Trout	-	-	-	-	-	618	43.5	166	425
Stevenson Creek, Downstream of Shaver Lake Dam	B Channel	Rainbow trout	42-165	62	751	52.3	1.04	751	52.3	170	639
	Aa+ Channel	Rainbow trout	43-193	73	966	74.9	1.34	966	74.9	238	779
	A Channel	Rainbow trout	95-195	9	128	0.0	1.18	128	-	100	240
	Reach Average	Trout	-	-	-	-	-	615	63.6	169	553

[1] See text for description of reaches.

[2] Includes all life history stages.

[3] Biomass could not be calculated due to equipment malfunction.

Table 5.2.4.2-19. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the Big Creek 2A, 8 and Eastwood Project Area in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Stream	Site[1]	Location	Mean Density (No./Square Meter)	Mean EPT[2] Density (No./Square Meter)
South Fork San Joaquin River	Site 9[3]	30.65 mi[4]	2724	539
	Site 8	26.90 mi[4]	6458	1399
	Site 7	25.60 mi[4]	6392	2646
	Site 6	23.75 mi[4]	6339	3442
	Site 5	21.40 mi[4]	5403	1761
	Site 4	19.70 mi[4]	3431	865
	Site 3	16.95 mi[4]	2412	399
	Site 2	15.40 mi[4]	1684	269
	Site 1	0.80 mi[4]	6997	3394
Bear Creek	Site AD	1.80 mi[5]	3185	1681
	Site BD 2	1.50 mi[5]	2139	929
	Site BD 1	0.05 mi[5]	3345	1152
Mono Creek	Site BD 4	5.70 mi[5]	2526	848
	Site BD 3	4.90 mi[5]	911	552
	Site BD 2	1.30 mi[5]	2617	625
	Site BD 1	0.40 mi[5]	845	298
Tombstone Creek	Site AD	1.15 mi[5]	2652	1524
	Site BD 2	0.95 mi[5]	1883	987
	Site BD 1	0.70 mi[5]	8393	2140
North Slide Creek	Site AD	0.35 mi[5]	4827	1826
	Site BD 2	0.25 mi[5]	299	18
	Site BD 1	0.05 mi[5]	3108	602

[1] AD = above diversion, BD = below diversion.
[2] EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).
[3] Upstream of Florence Lake
[4] Location (upstream) relative to the confluence with San Joaquin River.
[5] Location (upstream) relative to the confluence with South Fork San Joaquin River.
[6] Location (upstream) relative to the confluence with Big Creek.
[7] Location (upstream) relative to previous confluence with Stevenson Creek now within Shaver Lake.
[8] AO = above outlet, BO = below outlet.

Table 5.2.4.2-19. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the Big Creek 2A, 8 and Eastwood Project Area in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)) (continued).

Stream	Site[1]	Location	Mean Density (No./Square Meter)	Mean EPT[2] Density (No./Square Meter)
South Slide Creek	Site AD	0.40 mi[5]	3047	1090
	Site BD 2	0.05 mi[5]	2119	620
Hooper Creek	Site AD	0.70 mi[5]	3120	1276
	Site BD 2	0.55 mi[5]	2214	1395
	Site BD 1	0.05 mi[5]	1012	441
Crater Creek	Site AD	3.10 mi[5]	11797	2239
	Site BD 3	2.40 mi[5]	5989	1154
Chinquapin Creek	Site AD	0.95 mi[5]	4204	2047
	Site BD 2	0.60 mi[5]	1463	637
	Site BD 1	0.35 mi[5]	9731	746
Camp 62 Creek	Site AD	1.40 mi[5]	1567	964
	Site BD 2	1.20 mi[5]	1625	915
	Site BD 1	0.05 mi[5]	2736	1041
Bolsillo Creek	Site AD	1.65 mi[5]	1943	1203
	Site BD 2	1.30 mi[5]	2795	1329
	Site BD 1	0.70 mi[5]	380	131
Pitman Creek	Site AD	1.65 mi[6]	7157	2990
	Site BD 2	1.45 mi[6]	2954	1392
	Site BD 1	1.30 mi[6]	8039	1799
	Site BD 0	0.20 mi[6]	7760	1090

[1] AD = above diversion, BD = below diversion.
[2] EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).
[3] Upstream of Florence Lake
[4] Location (upstream) relative to the confluence with San Joaquin River.
[5] Location (upstream) relative to the confluence with South Fork San Joaquin River.
[6] Location (upstream) relative to the confluence with Big Creek.
[7] Location (upstream) relative to previous confluence with Stevenson Creek now within Shaver Lake.
[8] AO = above outlet, BO = below outlet.

Table 5.2.4.2-19. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the Big Creek 2A, 8 and Eastwood Project Area in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)) (continued).

Stream	Site[1]	Location	Mean Density (No./Square Meter)	Mean EPT[2] Density (No./Square Meter)
North Fork Stevenson Creek	Site AO[8]	3.60 mi[7]	5418	2142
	Site BO 3[8]	3.45 mi[7]	3087	413
	Site BO 2[8]	2.75 mi[7]	5973	2801
	Site BO 1[8]	1.35 mi[7]	8244	3986
Big Creek Dam 5 to PH 8	Site 2	1.55 mi[4]	5330	1806
	Site 1	0.55 mi[4]	5907	1526
Stevenson Creek	Site 5	3.95 mi[4]	3938	1502
	Site 4	2.60 mi[4]	28847	9042
	Site 3	2.40 mi[4]	2644	792
	Site 2	2.10 mi[4]	6476	1171
	Site 1	0.80 mi[4]	4937	1384

1 AD = above diversion, BD = below diversion.
2 EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).
3 Upstream of Florence Lake
4 Location (upstream) relative to the confluence with San Joaquin River.
5 Location (upstream) relative to the confluence with South Fork San Joaquin River.
6 Location (upstream) relative to the confluence with Big Creek.
7 Location (upstream) relative to previous confluence with Stevenson Creek now within Shaver Lake.
8 AO = above outlet, BO = below outlet.

Table 5.2.4.2-20. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Bear Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Bear Creek Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	20
July	0	0	0	0	0	0	0	31	1	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	18	2	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	11

Bear Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	20
July	0	0	0	0	0	0	0	31	1	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	24	6	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	26
October	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0

Bear Creek Downstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
July	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	31

Table 5.2.4.2-20. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Bear Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

Bear Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	13

Table 5.2.4.2-21. Habitat Type Relative Frequencies for Reaches of the Bear and Mono Creeks. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	Bear Creek Above Diversion	Bear Creek Below Diversion	Mono Creek Below Diversion[2]
Low Gradient Riffle	23.5%		4.4%
High Gradient Riffle	26.5%	30.3%	6.9%
Cascade		1.5%	9.6%
Bedrock Sheet		0.9%	
Pocket Water			7.0%
Run	13.9%	0.4%	7.0%
Step Run	23.0%	2.7%	30.7%
Glide			0.5%
Trench Chute			0.3%
Main Channel Pool			6.0%
Secondary Channel Pool			0.5%
Channel Confluence Pool			
Lateral Scour Pool	13.0%	6.6%	12.1%
Corner Pool			
Dammed Pool			0.7%
Step Pool		57.2%	14.0%
Backwater Pool			0.1%
Plunge Pool		0.4%	0.2%
Dry			
Road-Crossing			
Flume			
Concrete Box Culvert			
Not Available			

[1] USFWS Region 5 habitat types (McCain et al. 1990).
[2] Mono Creek upstream of the forebay was addressed as part of the relicensing of the Vermilion Valley Hydroelectric Project (Southern California Edison Company, Vermilion Valley Hydroelectric Project (FERC Project No. 2086) Final Application for New License for Minor Project – Existing Dam, Exhibit E, Volume 2, Section 2.4 [SCE 2001b]).

Table 5.2.4.2-22. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Mono Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Mono Creek Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
5.2.4.1 Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	20
July	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	11

Mono Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
5.2.4.2 Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	20
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	10

Mono Creek Downstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
5.2.4.3 Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	20
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	3
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	20

Table 5.2.4.2-22. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Mono Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

Mono Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
5.2.4.4 Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
June	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

Table 5.2.4.2-23. Habitat Type Relative Frequencies for Reaches of North-side Small Tributaries to the South Fork San Joaquin River. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	Tombstone Creek Above Diversion	Tombstone Creek Below Diversion	North Slide Creek	South Slide Creek	Hooper Creek Above Diversion	Hooper Creek Below Diversion
Low Gradient Riffle		0.9%			3.5%	1.1%
High Gradient Riffle	9.3%	3.2%	13.1%	7.2%	7.0%	15.1%
Cascade	51.0%	9.7%	71.9%	33.8%	6.5%	66.5%
Bedrock Sheet	9.6%	4.9%		17.1%	80.8%	7.5%
Pocket Water						
Run	2.9%	37.5%		1.0%		1.6%
Step Run	19.7%	21.6%	6.9%	37.0%		
Glide						
Trench Chute						
Main Channel Pool	2.3%	14.0%				0.7%
Secondary Channel Pool						
Channel Confluence Pool						
Lateral Scour Pool					2.1%	5.9%
Corner Pool		0.3%				
Dammed Pool						1.6%
Step Pool	5.1%	7.3%				
Backwater Pool						
Plunge Pool		0.5%				
Dry			5.5%			
Road-Crossing			2.6%	3.8%		
Flume						
Concrete Box Culvert						
Not Available						

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-24. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - North-side Small Tributaries of the South Fork San Joaquin River. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Tombstone Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	16
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0

South Slide Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23
August	1	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0
Sept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

North Slide Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

Hooper Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

Table 5.2.4.2-24. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - North-side Small Tributaries of the South Fork San Joaquin River. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

Hooper Creek Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22

Hooper Creek Downstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

Hooper Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22

Table 5.2.4.2-25. Habitat Type Relative Frequencies for Reaches of the South-side Small Tributaries to the South Fork San Joaquin River. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	Crater Creek Above Diversion	Crater Creek Below Diversion	Crater Creek Diversion Channel	Chinquapin Creek Above Diversion	Chinquapin Creek Below Diversion	Camp 62 Creek Above Diversion	Camp 62 Creek Below Diversion	Bolsillo Creek Above Diversion	Bolsillo Creek Below Diversion
Low Gradient Riffle		0.1%	1.9%		0.8%		9.4%		0.3%
High Gradient Riffle		10.9%	2.6%		4.9%	14.2%	16.7%	1.2%	
Cascade	76.7%	25.3%	22.6%		13.4%	52.0%	10.9%	22.6%	18.5%
Bedrock Sheet		10.7%	32.1%		1.7%		1.3%		11.0%
Pocket Water									
Run		9.6%	2.0%		3.2%		1.8%		1.2%
Step Run	21.7%	13.1%	27.5%		34.3%	6.8%	6.8%	28.3%	25.0%
Glide		0.3%							
Trench Chute									
Main Channel Pool		1.0%	1.4%		3.7%				
Secondary Channel Pool									
Channel Confluence Pool							0.3%		
Lateral Scour Pool	1.6%	8.9%	0.8%		0.2%		7.5%	2.6%	
Corner Pool		0.5%					1.4%		
Dammed Pool		0.4%			0.5%				1.1%
Step Pool		18.4%	6.5%	100	32.3%	27.0%	33.2%	45.4%	39.6%
Backwater Pool			0.2%				0.2%		
Plunge Pool		0.7%	0.1%		4.0%		9.5%		0.1%
Dry							1.1%		3.2%
Road-Crossing		0.1%	0.9%		0.9%		0.2%		
Flume			1.4%						
Concrete Box Culvert									
Not Available									

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-26. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South-side Small Tributaries of the South Fork San Joaquin River. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Crater Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	27

Crater Diversion Inflow to Florence Lake

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	28	3	3	2	2	1	1	0	26
August	7	6	1	0	0	0	0	17	0	0	0	0	0	0	0	0
Sept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Crater Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	23
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	22

Chinquapin Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
June	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	13

Table 5.2.4.2-26. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - South-side Small Tributaries of the South Fork San Joaquin River. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)) (continued).

Camp 62 Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
June	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	13

Camp 62 Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
June	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

Bolsillo Creek Upstream of Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
June	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	13

Bolsillo Creek Upstream of South Fork San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
June	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	23

Table 5.2.4.2-27. Habitat Type Relative Frequencies for Reaches of Tributaries to Big Creek. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	Pitman Creek Above Diversion	Pitman Creek Below Diversion	Balsam Creek Forebay to Diversion
Low Gradient Riffle			
High Gradient Riffle	4.1%		15.0%
Cascade	2.7%	35.2%	4.9%
Bedrock Sheet	8.3%	8.5%	8.4%
Pocket Water	11.7%	3.2%	
Run	8.4%	0.6%	11.7%
Step Run			8.2%
Glide	16.3%	0.3%	
Trench Chute		1.5%	4.2%
Main Channel Pool	4.4%	0.7%	1.9%
Secondary Channel Pool			
Channel Confluence Pool			
Lateral Scour Pool	3.5%		0.9%
Corner Pool			
Dammed Pool		4.7%	2.7%
Step Pool	40.6%	40.0%	31.6%
Backwater Pool			
Plunge Pool		5.2%	10.6%
Dry			
Road-Crossing			
Flume			
Concrete Box Culvert			
Not Available			

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-28. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Diverted Tributaries to Big Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Pitman Conduit Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
June	2	0	0	0	0	0	0	17	0	0	0	0	0	0	0	30
July	4	2	0	0	0	0	0	31	11	3	0	0	0	0	0	31
August	13	6	1	0	0	0	0	31	14	7	1	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	26

Pitman Creek Upstream of Big Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	31

Balsam Creek Diversion

	Number of Days in 2000 Maximum Water Temperature Exceeds:					Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:					Days Monitored	Number of Days in 2002 Maximum Water Temperature Exceeds:					Days Monitored
Month	20°C	21°C	22°C	23°C	24°C		20°C	21°C	22°C	23°C	24°C		20°C	21°C	22°C	23°C	24°C	
May	0	0	0	0	0	6	0	0	0	0	0	31	0	0	0	0	0	7
June	0	0	0	0	0	30	0	0	0	0	0	30	0	0	0	0	0	30
July	0	0	0	0	0	19	0	0	0	0	0	31	0	0	0	0	0	31
August	0	0	0	0	0	16	0	0	0	0	0	31	0	0	0	0	0	31
Sept	0	0	0	0	0	30	0	0	0	0	0	30	0	0	0	0	0	30
October	0	0	0	0	0	26	0	0	0	0	0	30	0	0	0	0	0	29

Table 5.2.4.2-29. Habitat Type Relative Frequencies for Reaches of the North Fork Stevenson Creek, Big Creek, and Stevenson Creek (Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)). Big Creek Nos. 2A, 8, and Eastwood Project Area.

Habitat Types[1]	North Fork Stevenson Creek Above Outlet	North Fork Stevenson Creek Below Outlet	Big Creek Dam 5 to Powerhouse 8	Stevenson Creek
Low Gradient Riffle		1.0%	0.2%	0.3%
High Gradient Riffle		10.0%	6.2%	5.2%
Cascade	29.4%	22.5%	11.3%	29.6%
Bedrock Sheet	38.6%	8.8%	2.8%	3.1%
Pocket Water		0.7%		1.3%
Run		1.9%	1.6%	0.8%
Step Run		12.4%	1.1%	4.3%
Glide				
Trench Chute		1.6%	0.5%	3.2%
Main Channel Pool	3.8%	5.1%	10.6%	9.9%
Secondary Channel Pool				
Channel Confluence Pool				
Lateral Scour Pool		2.8%	11.9%	2.6%
Corner Pool				0.1%
Dammed Pool				0.4%
Step Pool	19.6%	31.7%	46.3%	32.6%
Backwater Pool		0.3%		
Plunge Pool	8.6%	1.3%	7.4%	6.5%
Dry				
Road-Crossing				
Flume				
Concrete Box Culvert				0.3%
Not Available				

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-30. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - North Fork Stevenson Creek. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

North Fork Stevenson Creek Downstream of Tunnel 7

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	27
October	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0

North Fork Stevenson Creek Upstream of Shaver Lake

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	12	1	0	0	0	0	0	30	0	0	0	0	0	0	0	30
July	6	0	0	0	0	0	0	31	3	0	0	0	0	0	0	31
August	5	0	0	0	0	0	0	31	4	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	26

Table 5.2.4.2-31. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Big Creek, Dam 5 to Powerhouse 8/SJR. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Big Creek Downstream of Dam 5

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	31

Big Creek Upstream of Big Creek Powerhouse 8

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	31
June	9	7	0	0	0	0	0	10	17	5	1	0	0	0	0	30
July	2	0	0	0	0	0	0	31	31	21	13	2	0	0	0	31
August	9	3	0	0	0	0	0	31	27	25	10	2	0	0	0	31
Sept	0	0	0	0	0	0	0	22	5	3	0	0	0	0	0	30
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31

Table 5.2.4.2-32. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek Nos. 2A, 8, and Eastwood Project Areas - Stevenson Creek below Shaver Lake. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

Stevenson Creek Downstream of Shaver Dam

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	26

Stevenson Creek at Railroad Grade Road

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	30

Stevenson Creek Upstream of San Joaquin River

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	4	0	0	0	0	0	0	10	1	0	0	0	0	0	0	30
July	1	0	0	0	0	0	0	31	10	5	0	0	0	0	0	31
August	5	2	0	0	0	0	0	31	2	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	31

Table 5.2.4.2-33. Species Captured in Dam 6 Forebay, 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 9 and 21)).

Species	Number Captured	CPUE (No./Hour)	Percent of Total*	Mean Condition Factor
Species Collected with Gill Nets				
Brown trout	11	0.14	15	1.11
Rainbow trout	4	0.05	6	1.36
Sacramento Sucker	56	0.72	79	-
Species Collected by Electrofishing				
Sacramento Sucker	9	-		

* For each species and site regardless of collection method.

Table 5.2.4.2-34. Habitat Type Relative Frequencies for San Joaquin River Stevenson Reach (SJR, Dam 6 to PH 3/Redinger Lake) Big Creek No. 3 Project Area. Source: CAWG 1, Characterize Stream and Reservoir Habitats, TSRPs (SCE 2003; SCE 2004a; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

Habitat Types[1]	**San Joaquin River-Stevenson Reach**
Low Gradient Riffle	0.1%
High Gradient Riffle	9.6%
Cascade	3.3%
Bedrock Sheet	
Pocket Water	13.4%
Run	
Step Run	0.2%
Trench Chute	
Main Channel Pool	21.0%
Lateral Scour Pool	12.3%
Corner Pool	
Dammed Pool	0.2%
Step Pool	39.8%
Plunge Pool	0.2%
Dry	
Not Available	

[1] USFWS Region 5 habitat types (McCain et al. 1990).

Table 5.2.4.2-35. Daily Maximum Water Temperature Exceedances, 2000 and 2001 for the Big Creek No. 3 Project Area. Source: CAWG 5, Water Temperature Monitoring TSRPs (SCE 2004a; Volume 4, SD-D (Books 12 and 23)).

San Joaquin River Downstream of Dam 6

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31

San Joaquin River Upstream of Stevenson Creek

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	31
June	0	0	0	0	0	0	0	7	20	14	7	2	0	0	0	30
July	8	3	0	0	0	0	0	21	31	31	31	18	3	0	0	31
August	12	4	0	0	0	0	0	31	31	29	25	10	0	0	0	31
Sept	4	0	0	0	0	0	0	30	19	7	2	0	0	0	0	30
October	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	31

San Joaquin River Downstream of Big Creek Powerhouse 3

	Number of Days in 2000 Maximum Water Temperature Exceeds:							Days Monitored	Number of Days in 2001 Maximum Water Temperature Exceeds:							Days Monitored
Month	20°C	21°C	22°C	23°C	24°C	25°C	26°C		20°C	21°C	22°C	23°C	24°C	25°C	26°C	
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
June	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	30
July	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
August	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31
Sept	0	0	0	0	0	0	0	30	1	0	0	0	0	0	0	30
October	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	31

Table 5.2.4.2-36. Fish Species Capture Totals, Estimated Density, Biomass and Fish Condition in Big Creek No. 3 Project Area, San Joaquin River Stevenson Reach (SJR, Dam 6 to PH 3/Redinger Lake) 2002. Source: CAWG 7, Characterize Fish Populations, TSRPs (SCE 2003; Volume 4, SD-C (Books 8 and 21)).

Project Reach	Sampled Reach	Sampled Fish Species	Size Range (mm)	Number of Fish Captured	Total Fish Density Estimate (fish/km)[1]	Biomass Estimate (kg/ha)	Mean Condition Factor	Total Trout Density Estimate (fish/km)[1]	Trout Biomass (kg/ha)	Adult Trout Density (fish/km)	Adult Trout Density (fish/ha)
San Joaquin River, Stevenson Reach (Dam 6 to Powerhouse No. 3, RM 17.0 to 11.2)	Upper Site G Channel	Brown trout	98	1	7	0.1	1.22	107	0.4	10	8
		Rainbow trout	54-78	4	100	0.3	1.35				
		Sacramento Sucker	38-229	36	514	3.6	1.62				
		Prickly Sculpin	42-105	5	43	0.2	-				
		Sacramento Pikeminnow	75-150	1	-	-	-				
	Lower Site G Channel	Brown trout	87	1	7	0.0	1.16	7	0.1	0	0
		Hardhead	42-163	30	295	2.2	0.97				
		Sacramento Pikeminnow	29-191	41	597	4.6	0.83				
		Sacramento Sucker	195-301	2	15	2.5	1.41				
	Reach Average	Trout						57	0.3	5	4

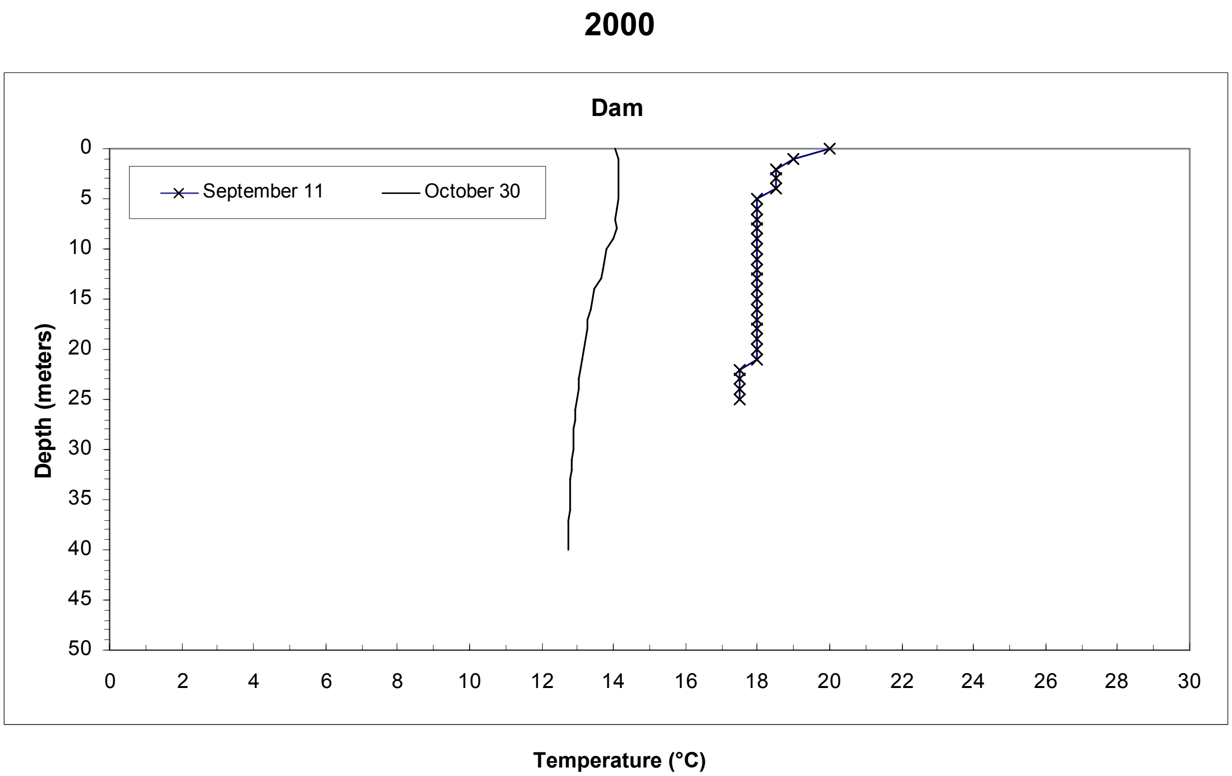
[1] Includes all life history stages.

Table 5.2.4.2-37. Benthic Macroinvertebrate Densities of Samples Collected in the Streams of the San Joaquin River Stevenson Reach (SJR, Dam 6 to PH 3/Redinger Lake) in Fall, 2002. Source: CAWG 10, Macroinvertebrates 2003 TSRPs (SCE 2004a; Volume 4, SD-D (Books 14 and 23)).

Stream	Site	Location Relative to Dam 6 (downstream)	Mean Density (No./Square Meter)	Mean EPT[1] Density (No./Square Meter)
San Joaquin River Stevenson Reach	Site SR 4	0.2 mi	6703	1617
	Site SR 3	1.7 mi	1693	307
	Site SR 2	3.6 mi	11466	2150
	Site SR 1	5.3 mi	2215	297

[1] EPT = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies).

FIGURES



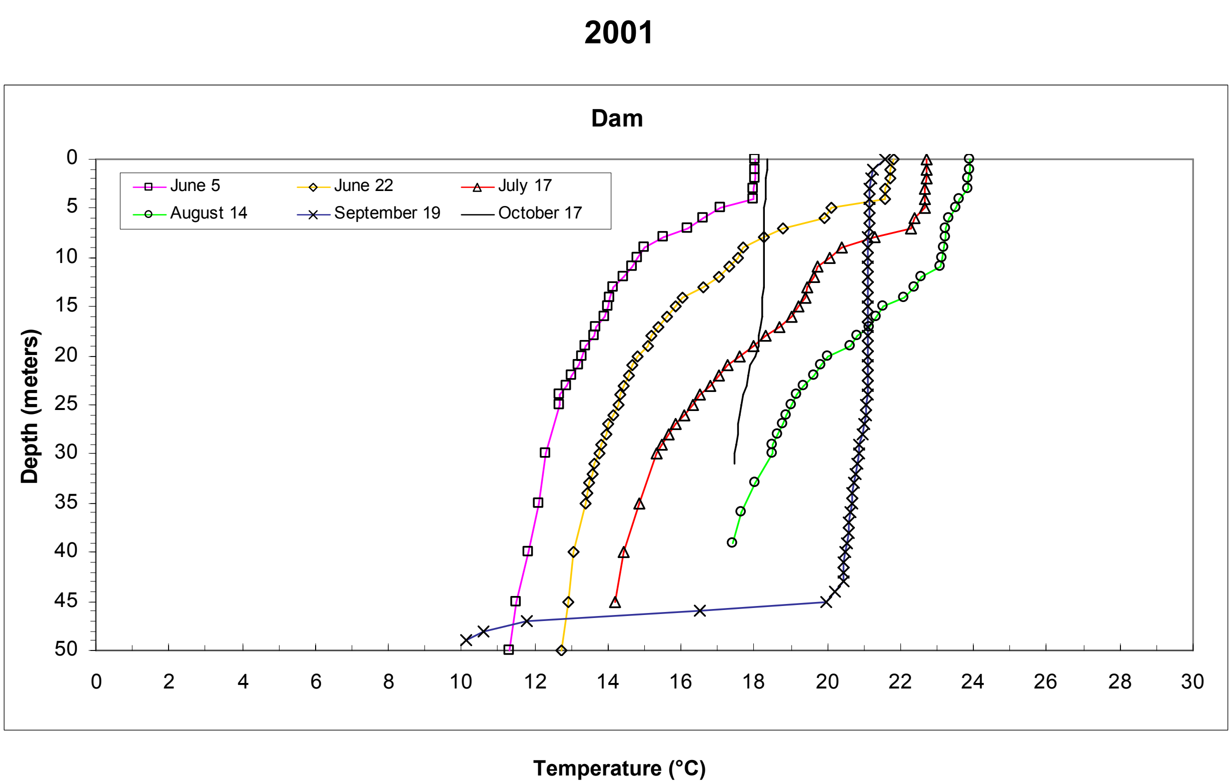
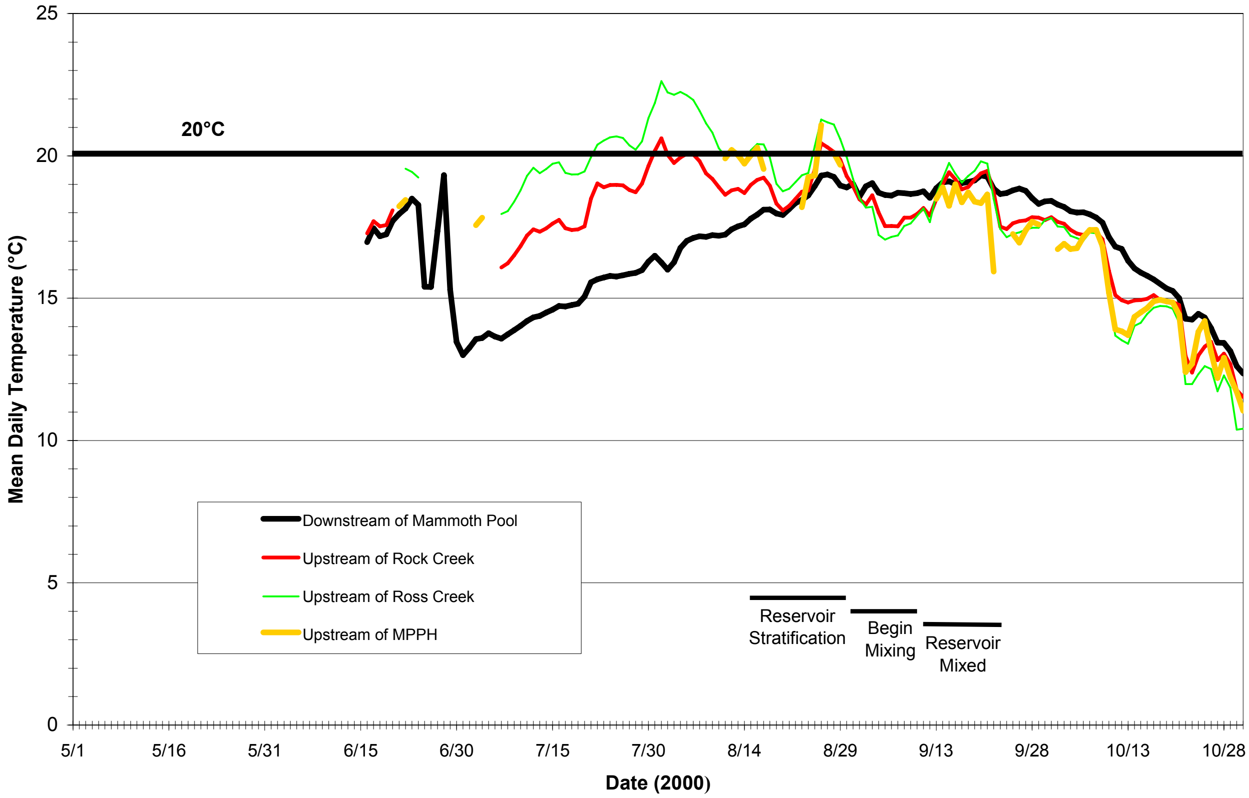


Figure 5.2.4.2-1. Mammoth Pool Reservoir Water Temperature Profiles, 2000 and 2001.



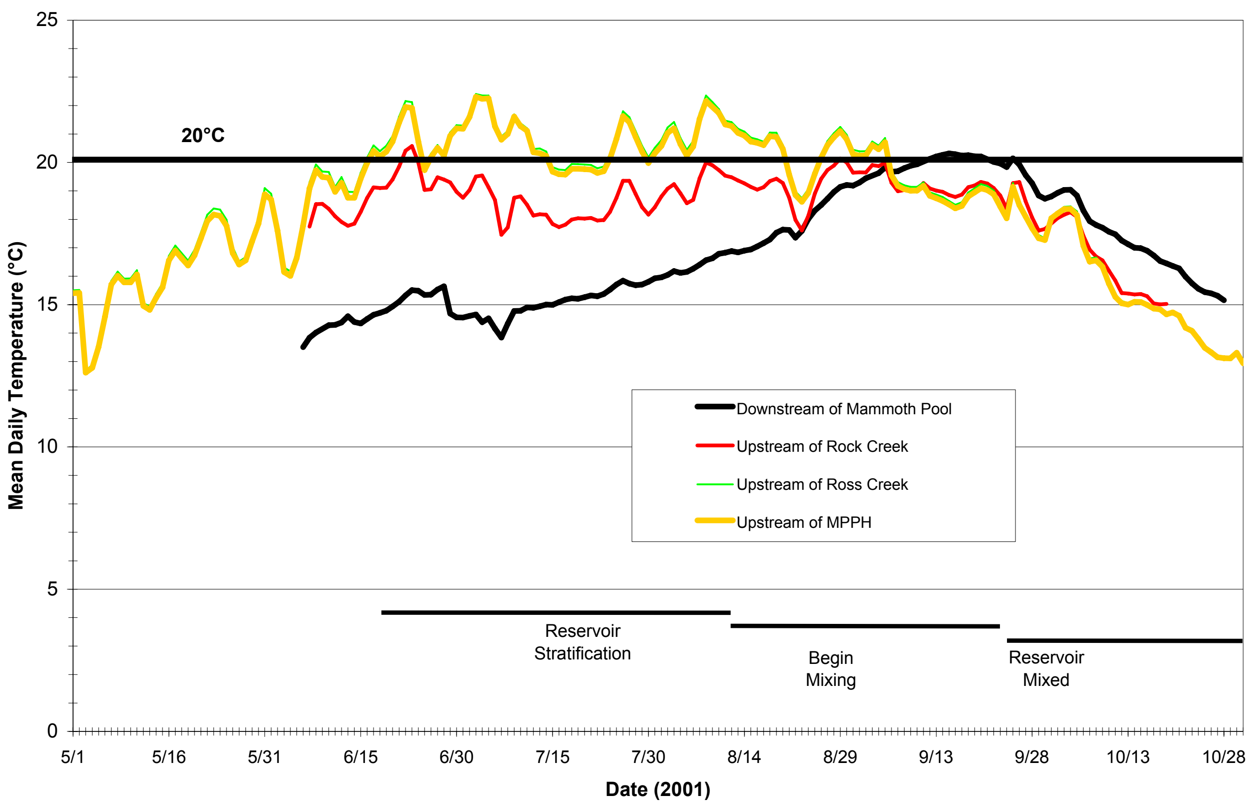
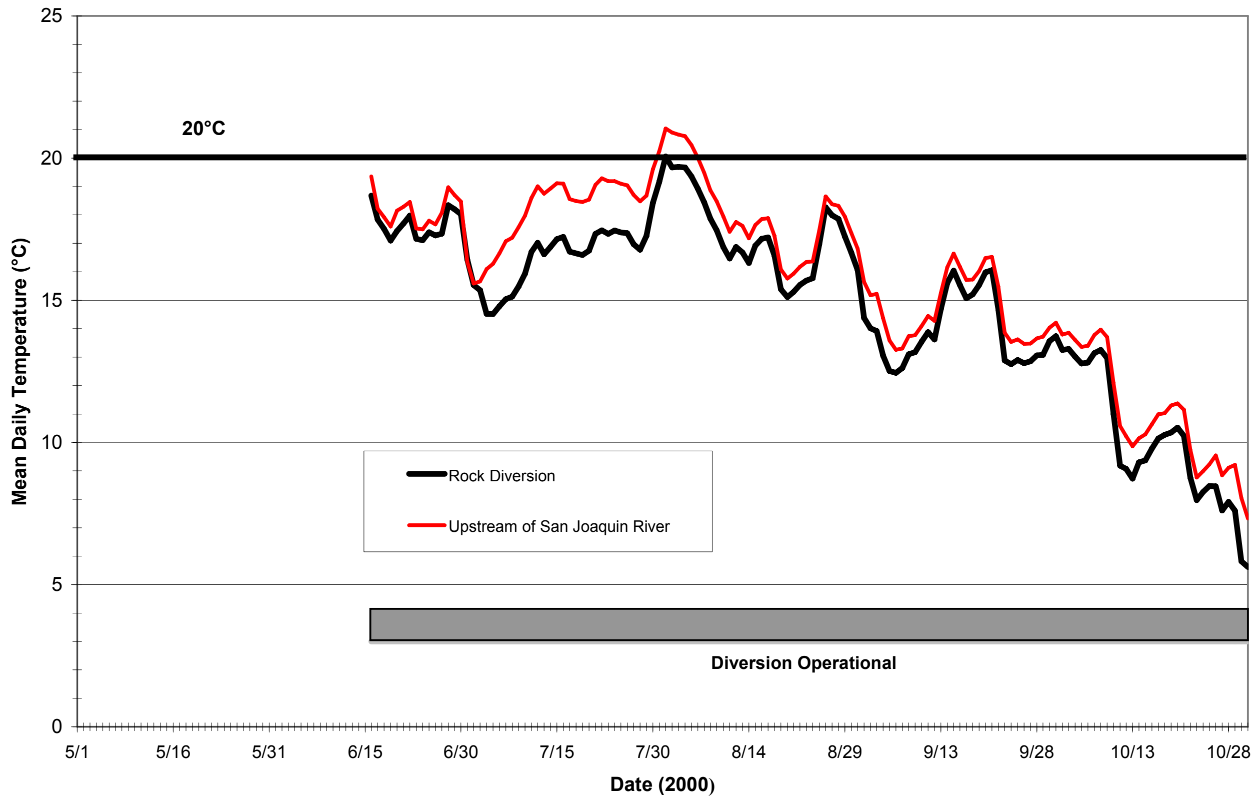


Figure 5.2.4.2-2. San Joaquin River Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse/Dam 6) Mean Daily Water Temperatures, 2000 and 2001.



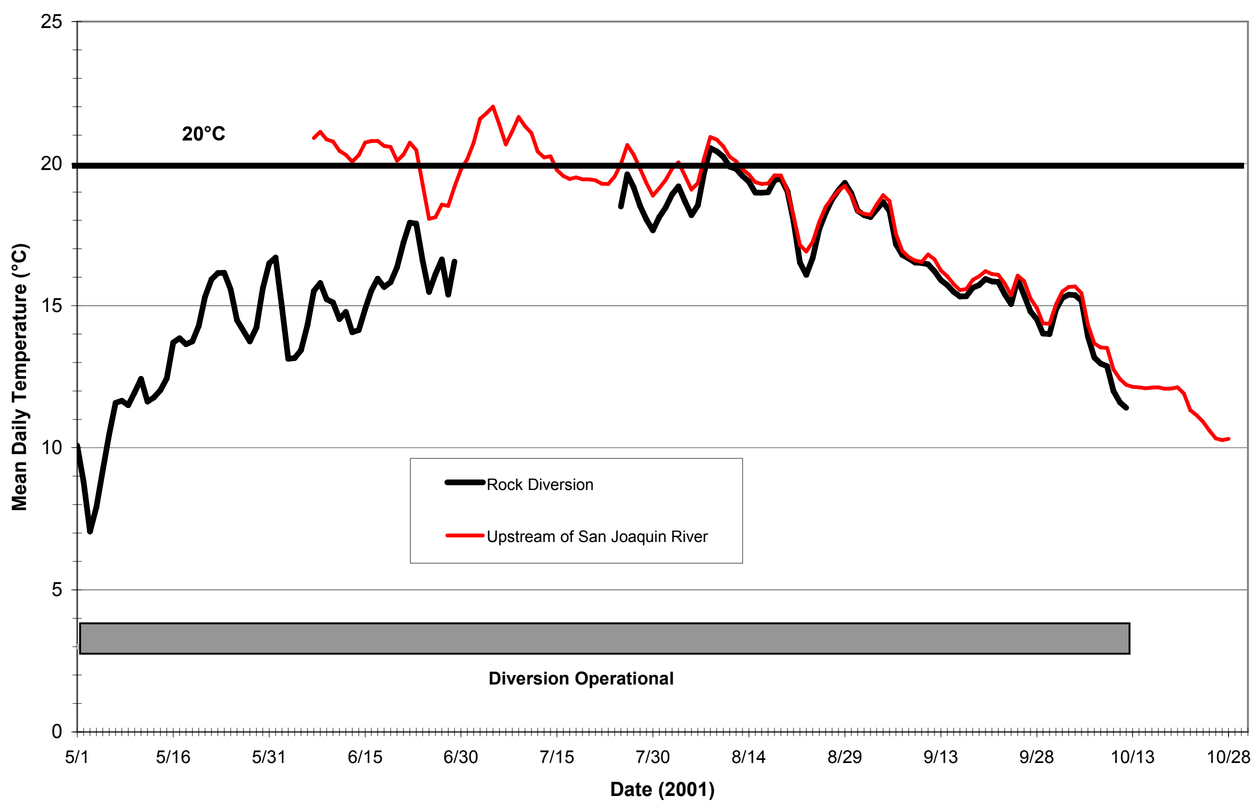


Figure 5.2.4.2-3. Rock Creek Mean Daily Water Temperatures, 2000 and 2001.

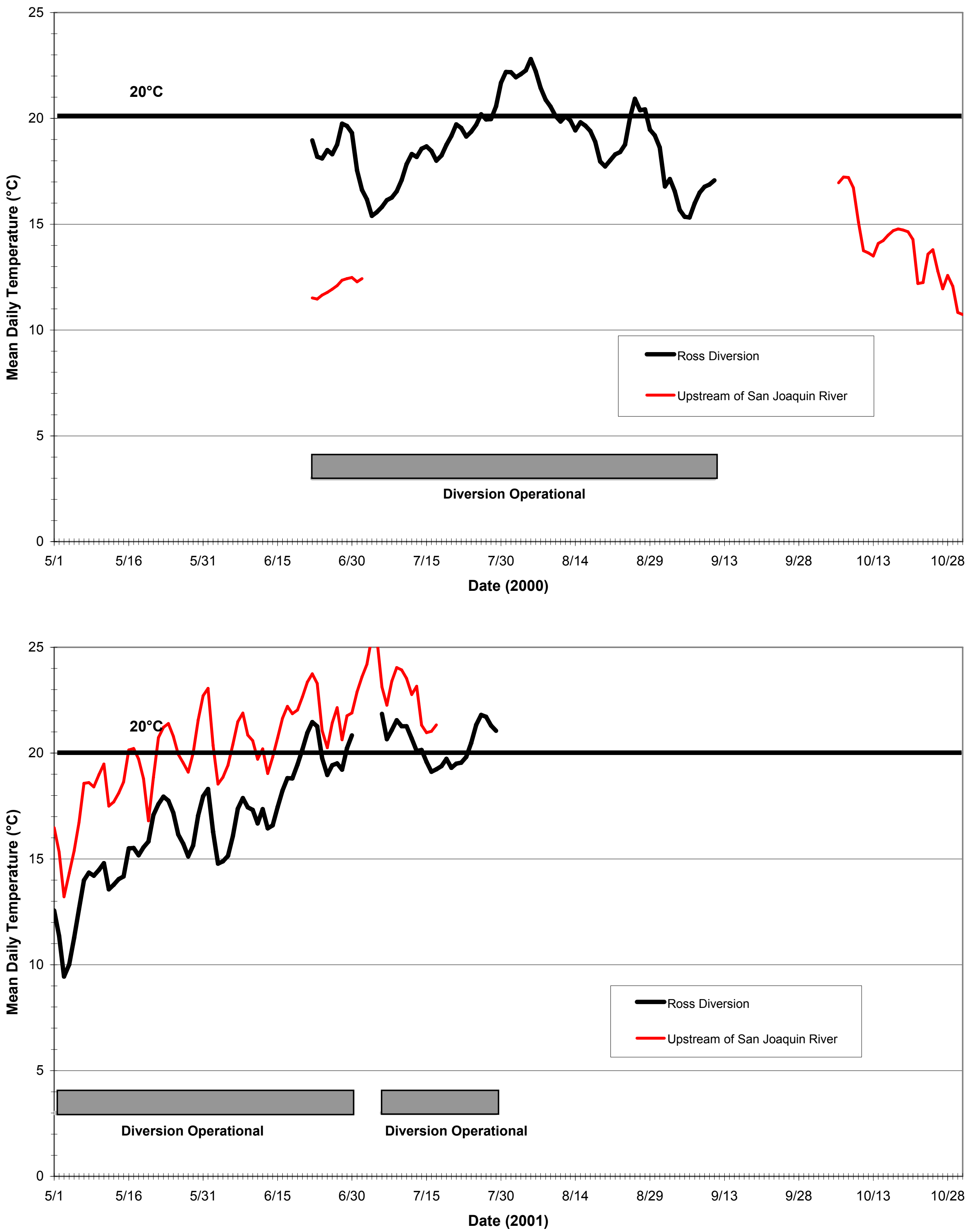
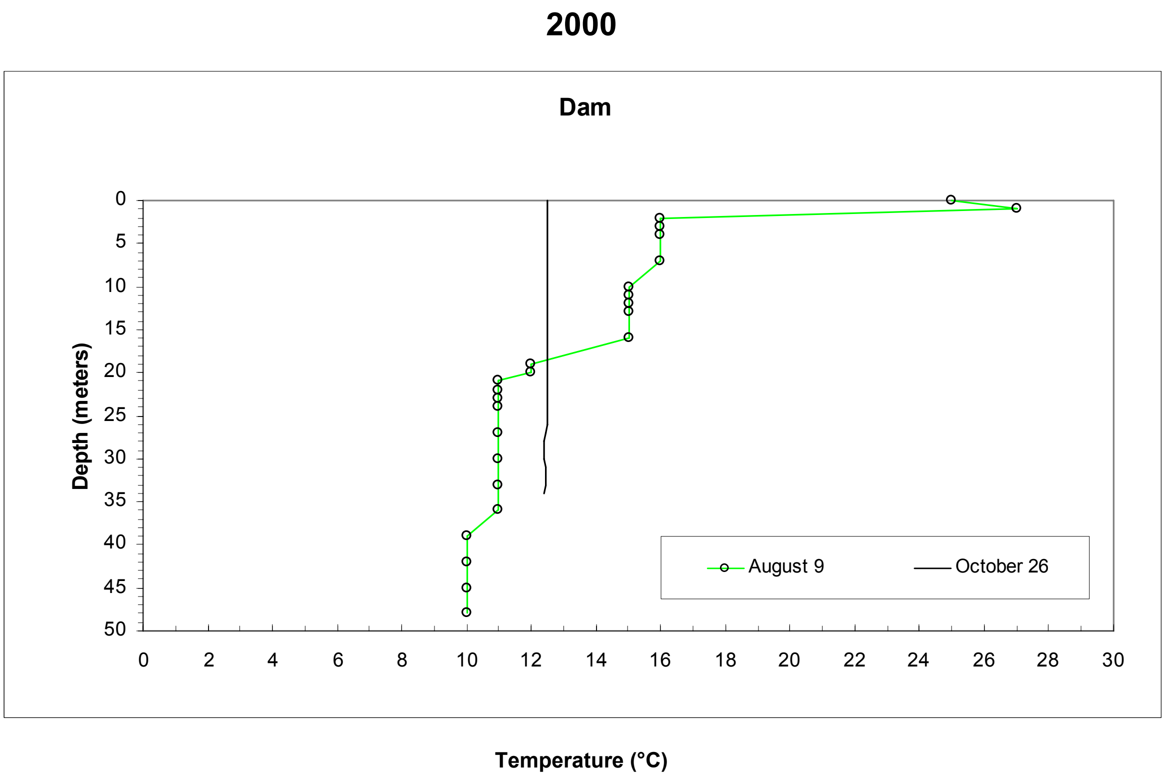


Figure 5.2.4.2-4. Ross Creek Mean Daily Water Temperatures, 2000 and 2001.



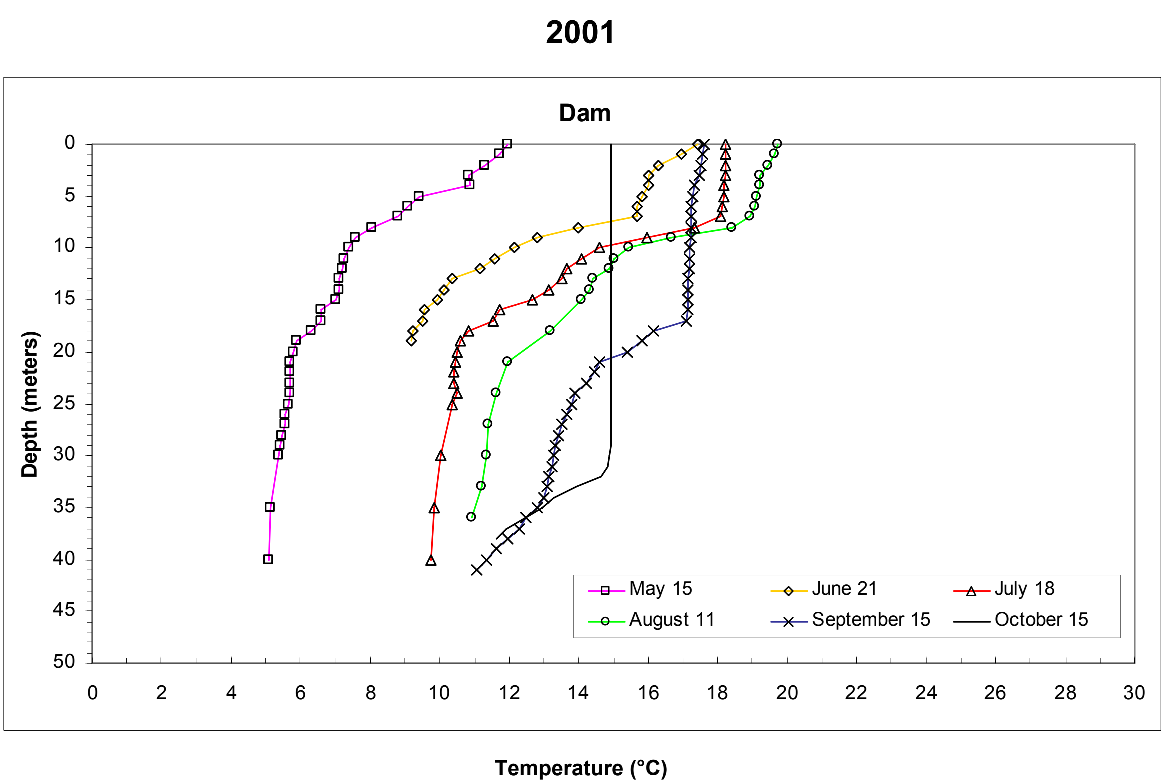


Figure 5.2.4.2-5. Huntington Lake Water Temperature Profiles, 2000 and 2001.

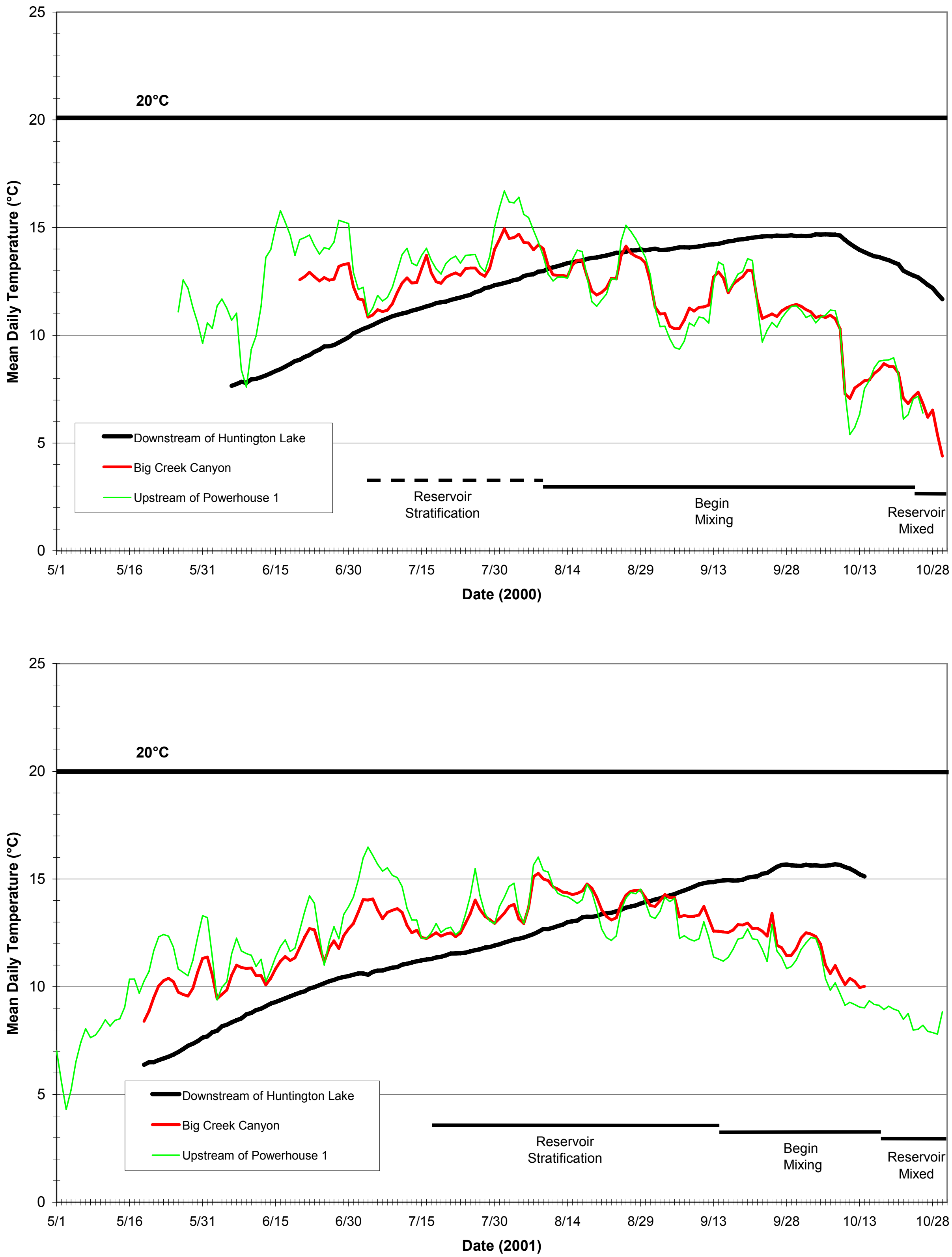


Figure 5.2.4.2-6. Big Creek, Huntington Lake to Powerhouse 1/Dam 4 Mean Daily Water Temperatures, 2000 and 2001.

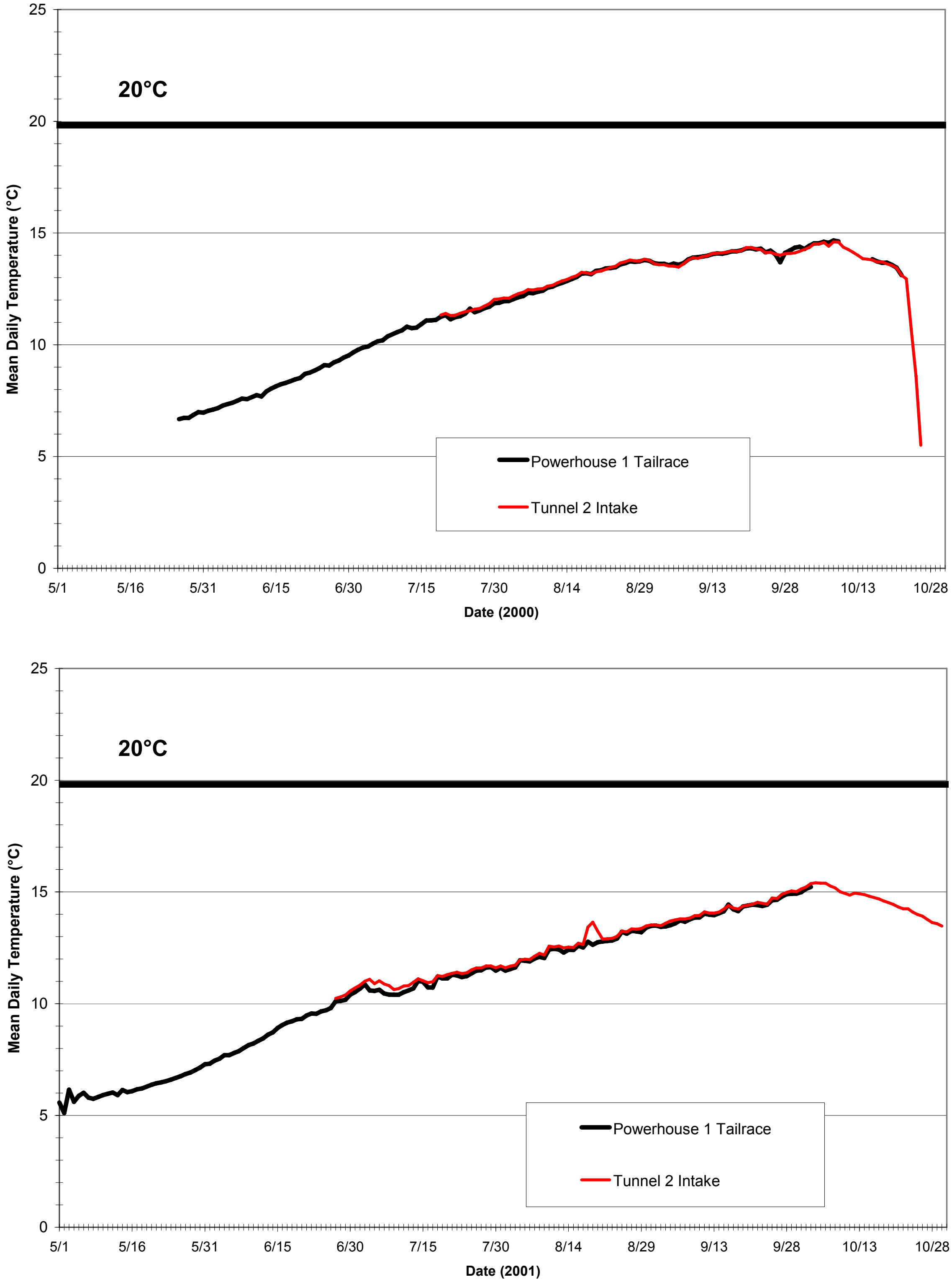
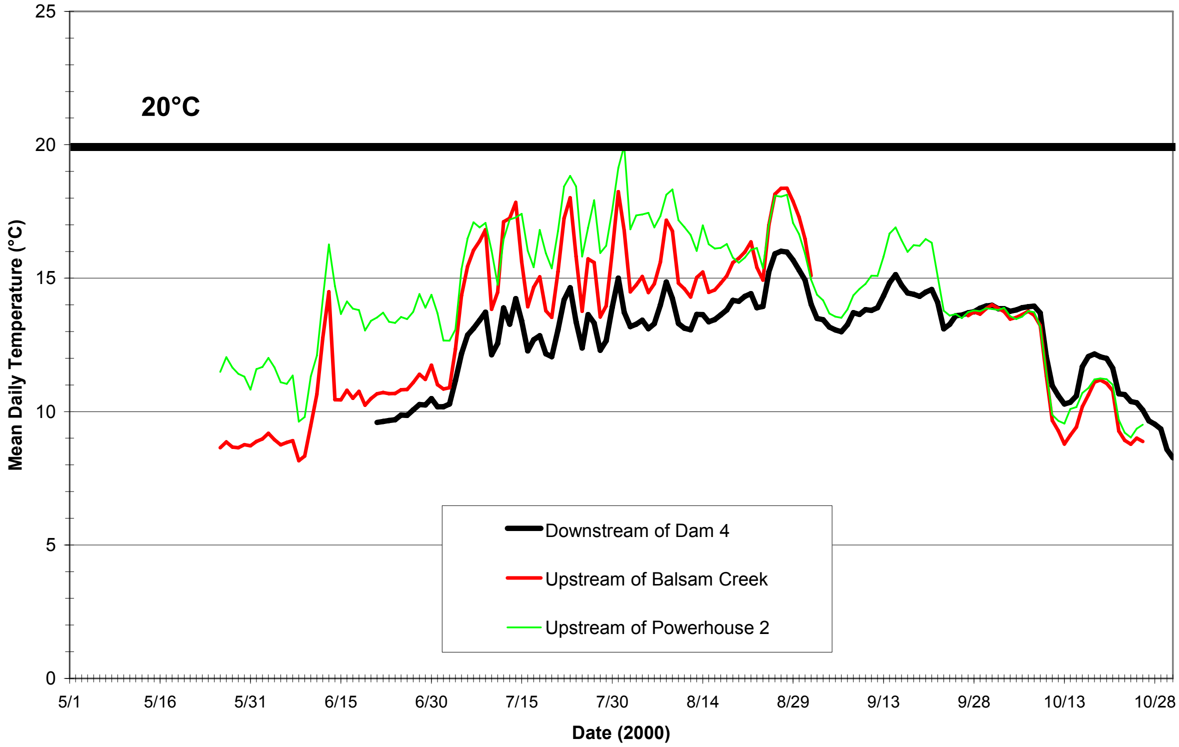


Figure 5.2.4.2-7. Big Creek Nos. 1 & 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Big Creek Powerhouse 2 Forebay (Dam 4).



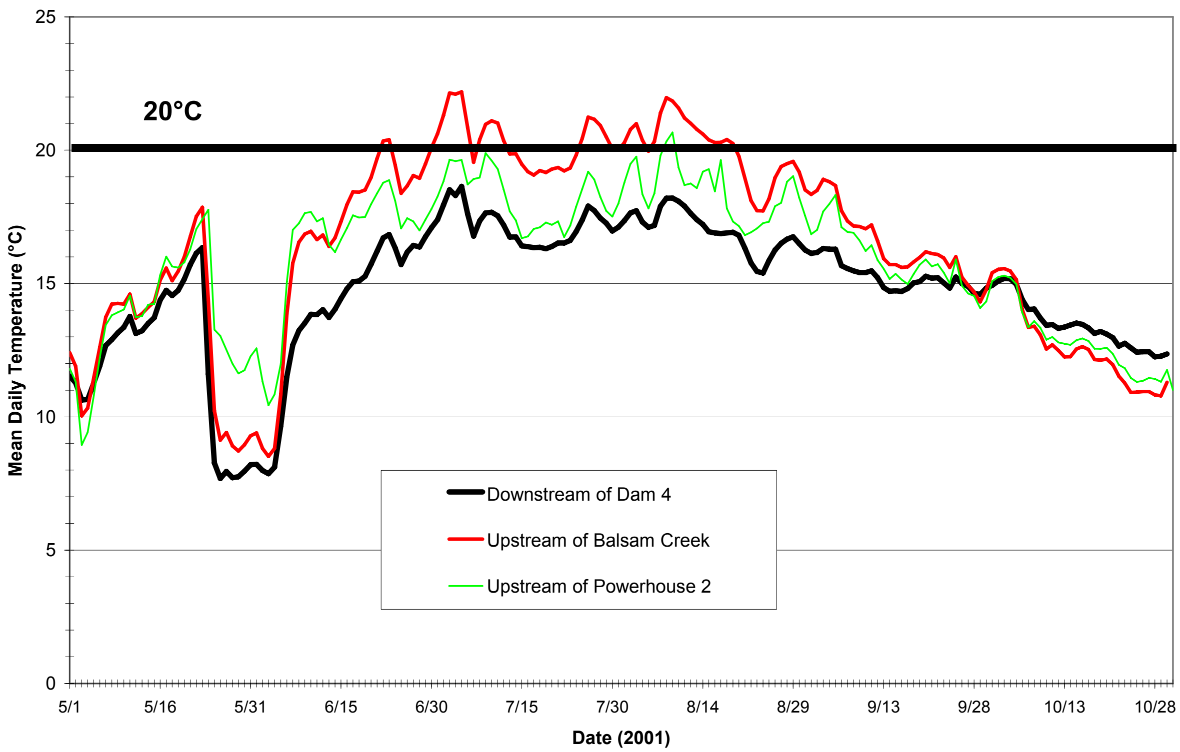


Figure 5.2.4.2-8. Big Creek, Dam 4 to Powerhouse 2/2A/Dam 5 Mean Daily Water Temperatures, 2000 and 2001.

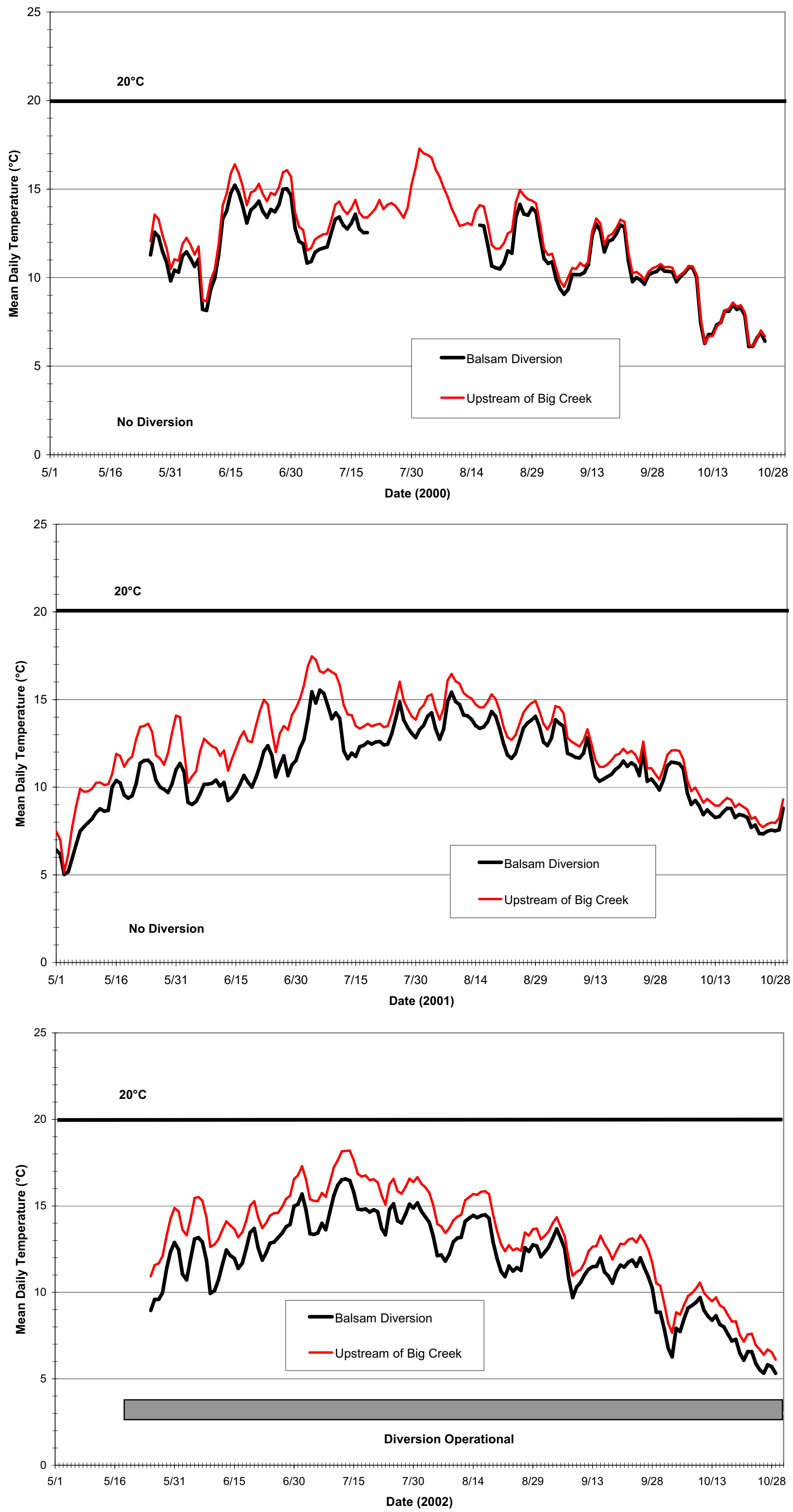
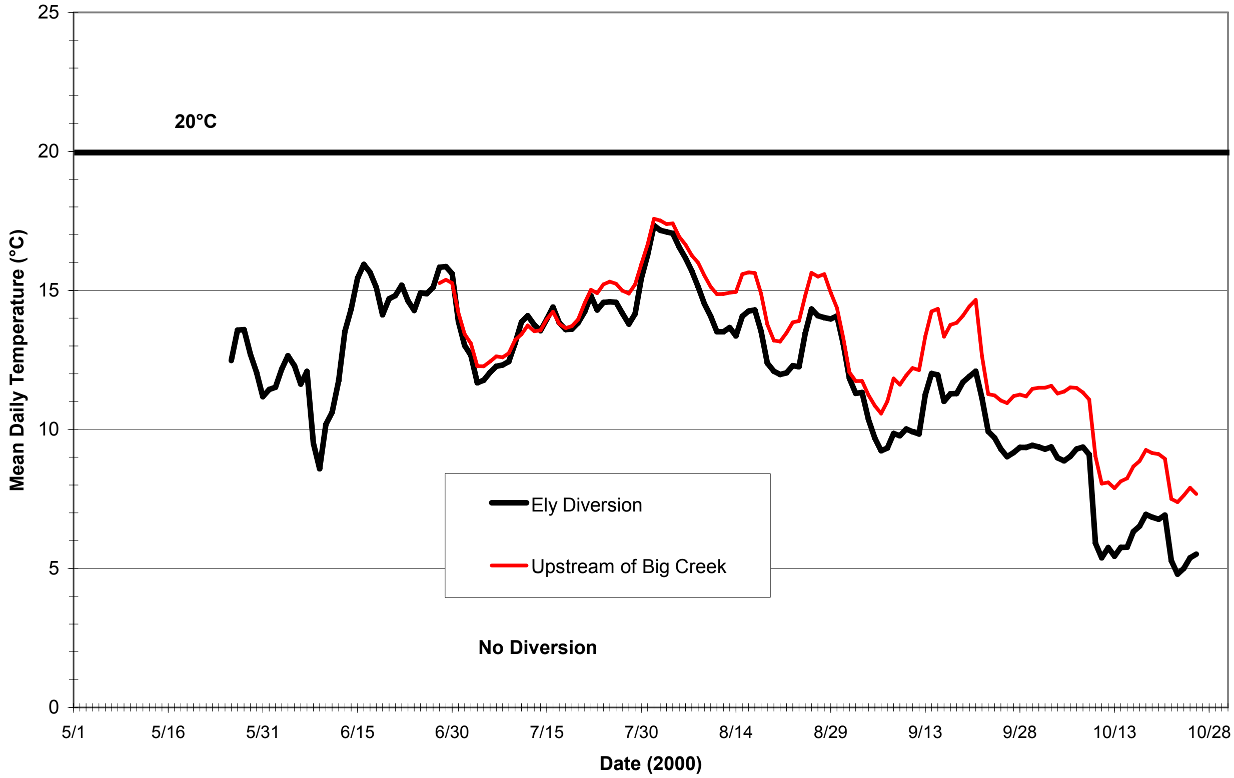


Figure 5.2.4.2-9. Big Creek Nos. 1 & 2 Project Areas Mean Daily Water Temperatures, 2000, 2001 and 2002. Balsam Creek.



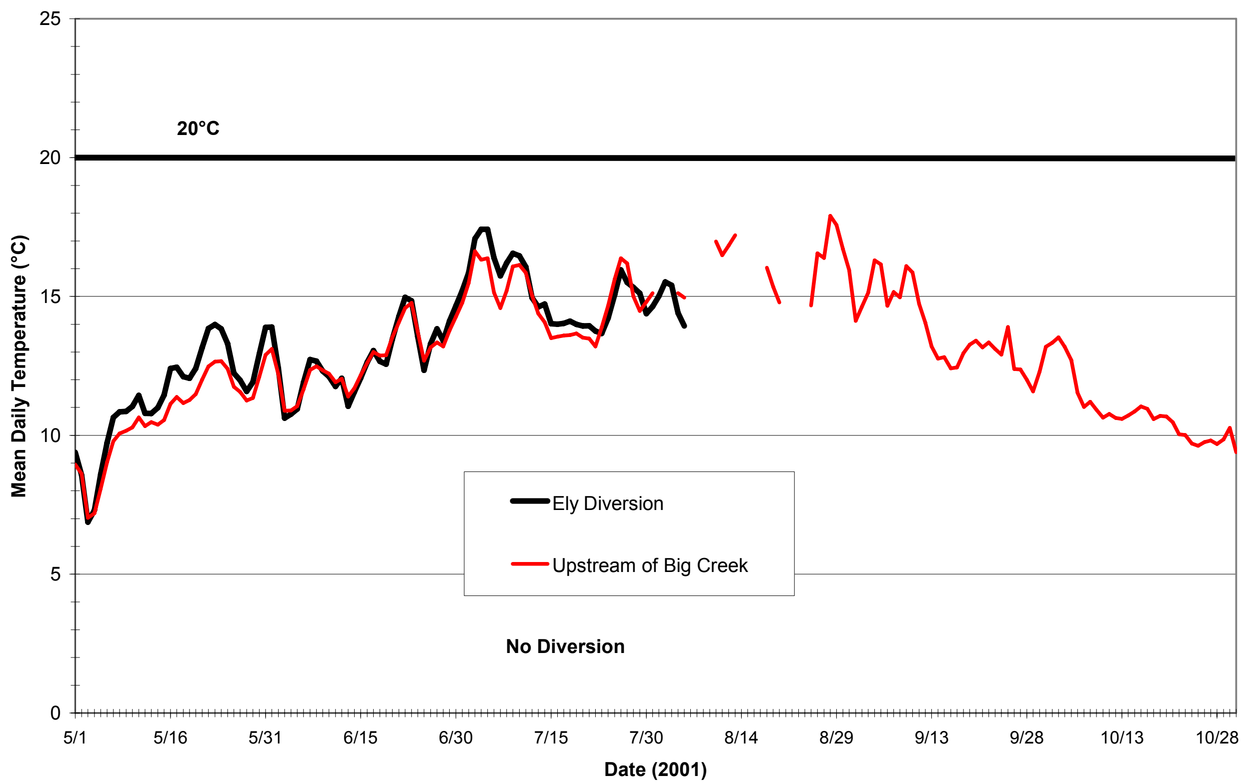
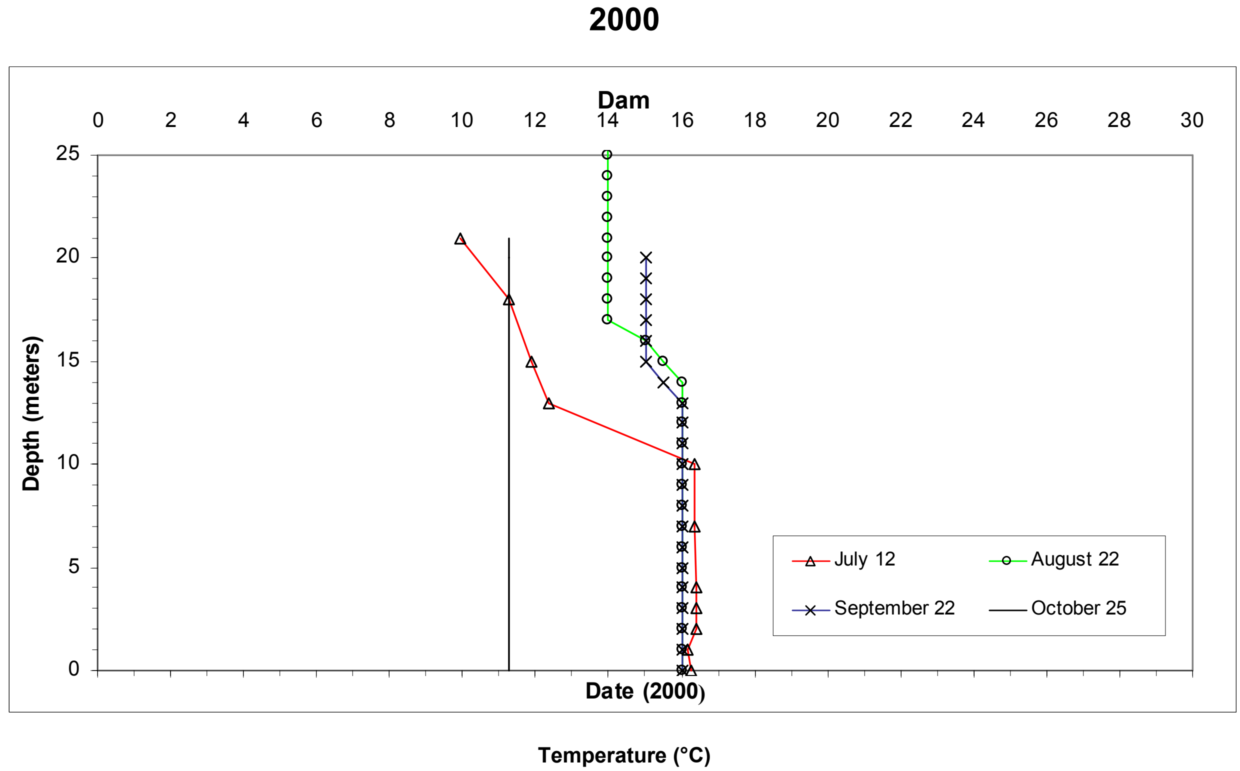


Figure 5.2.4.2-10. Big Creek Nos. 1 & 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Ely Creek.



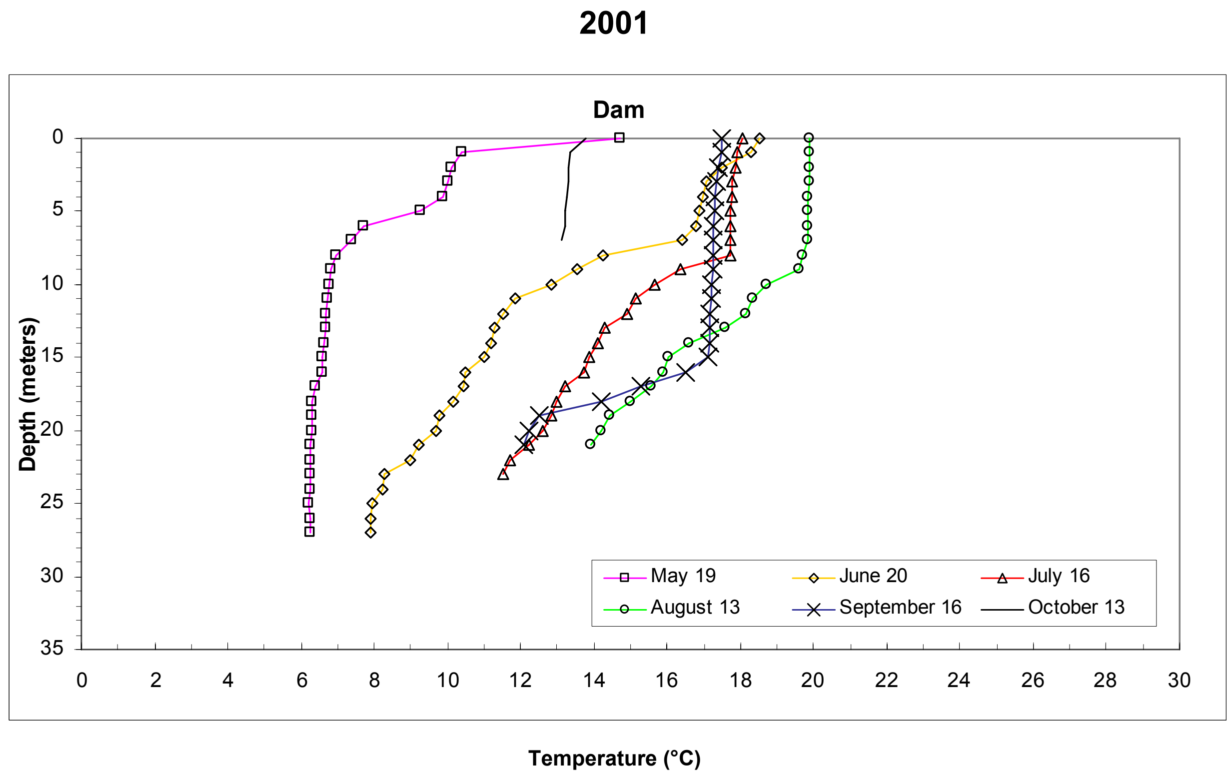


Figure 5.2.4.2-11. Florence Lake Water Temperature Profiles, 2000 and 2001.

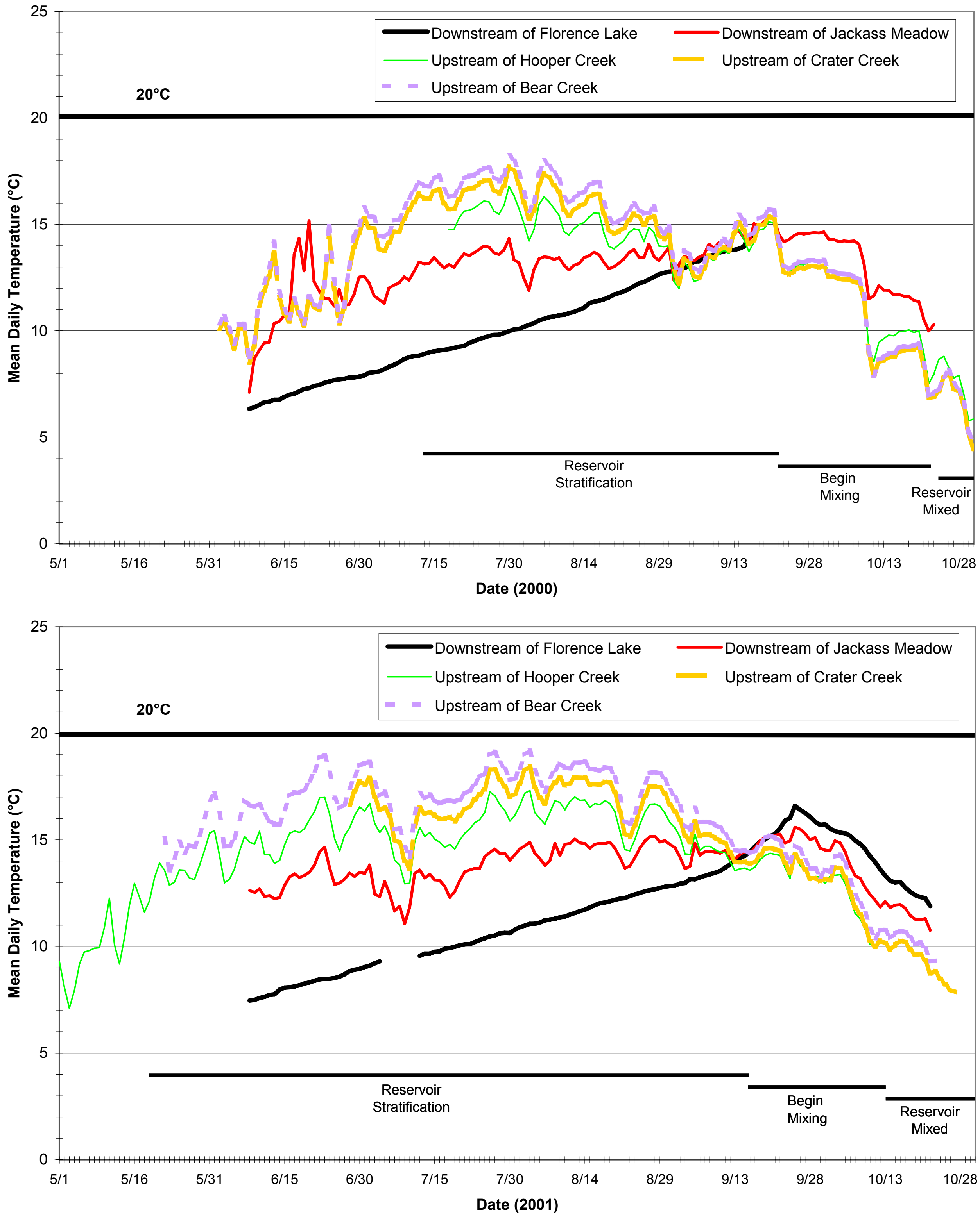
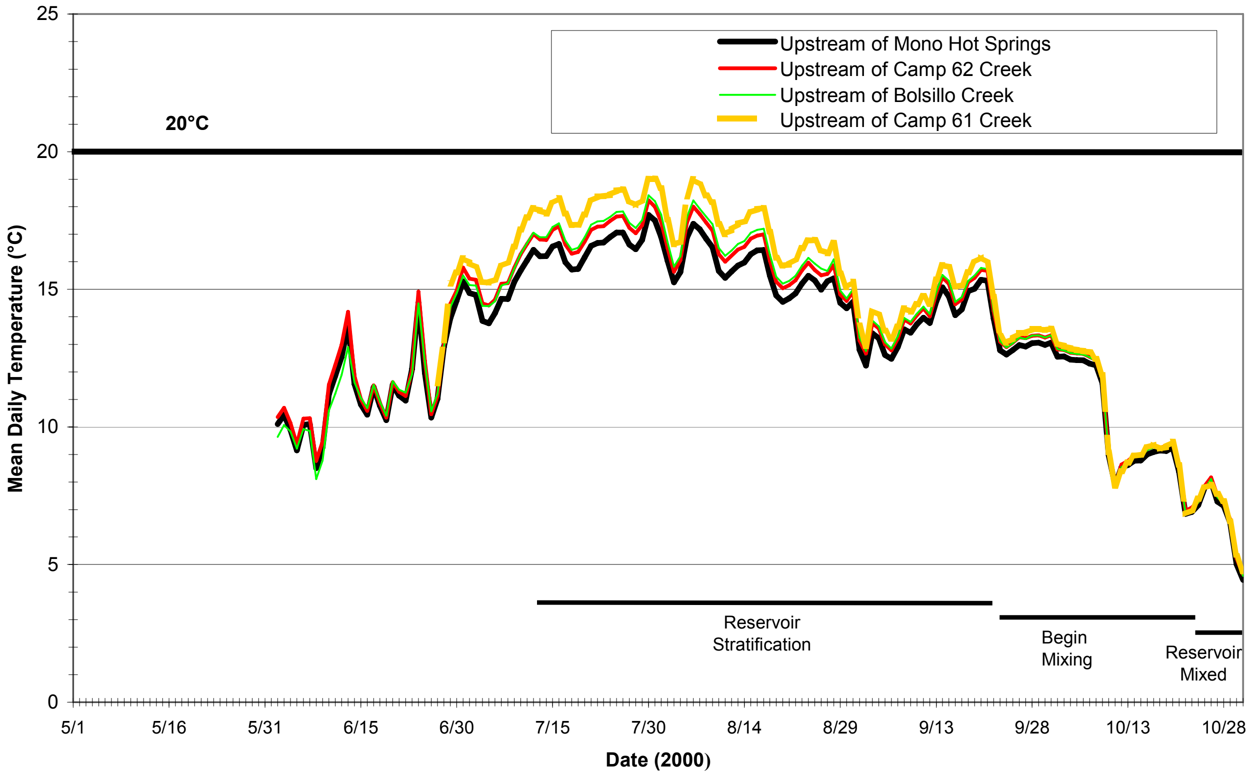


Figure 5.2.4.2-12. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. South Fork San Joaquin River Florence Lake to Upstream of Bear Creek.



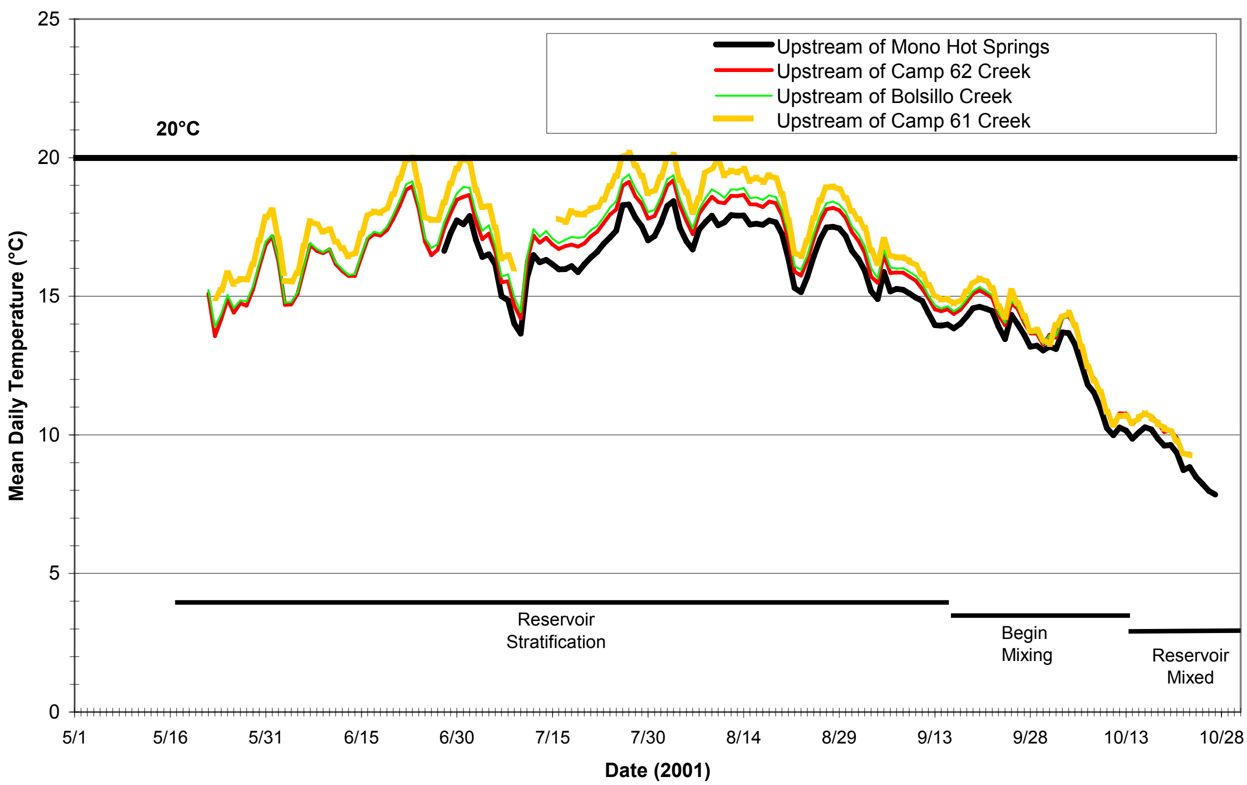


Figure 5.2.4.2-13. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. South Fork San Joaquin River Bear Creek to Upstream of Mono Creek.

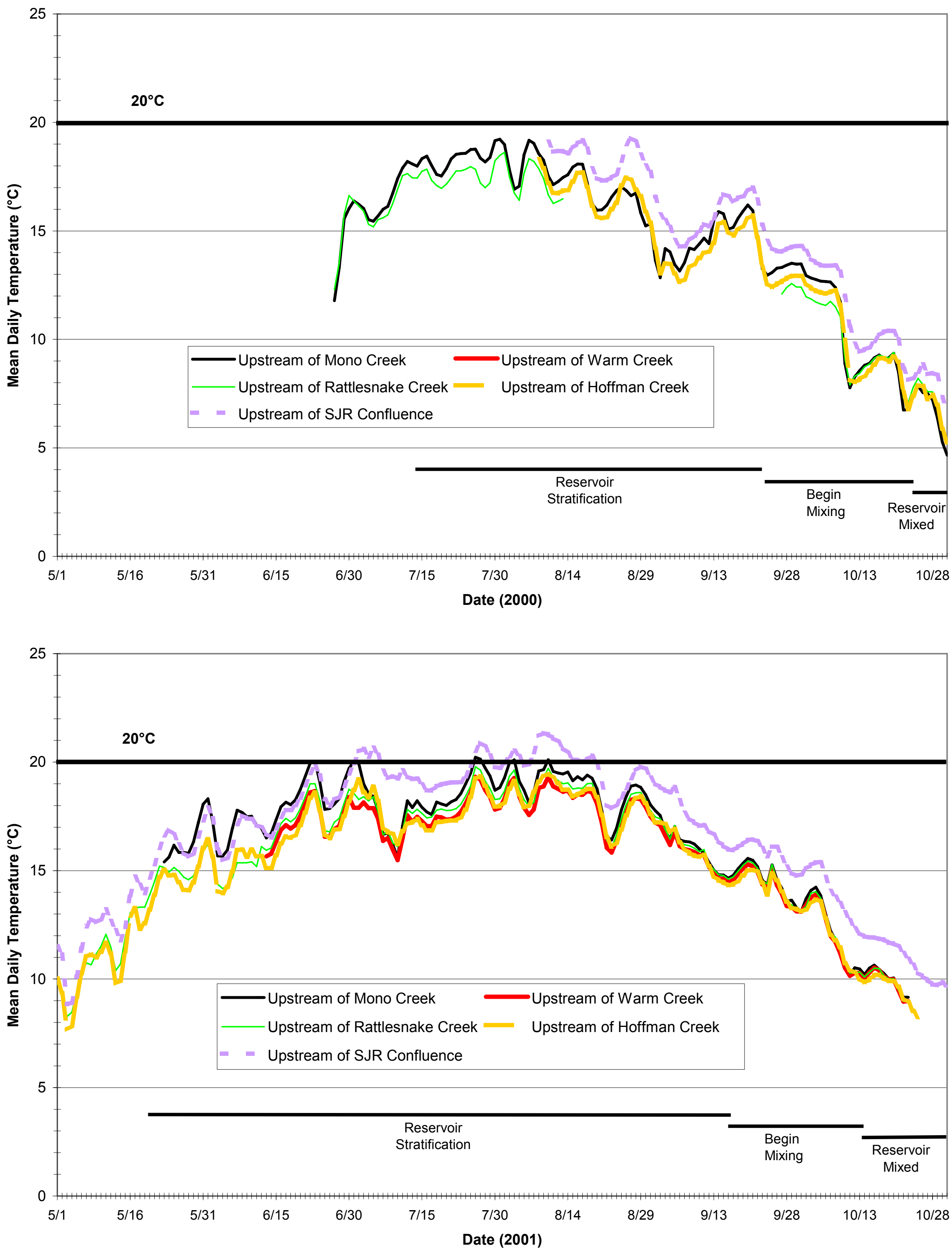
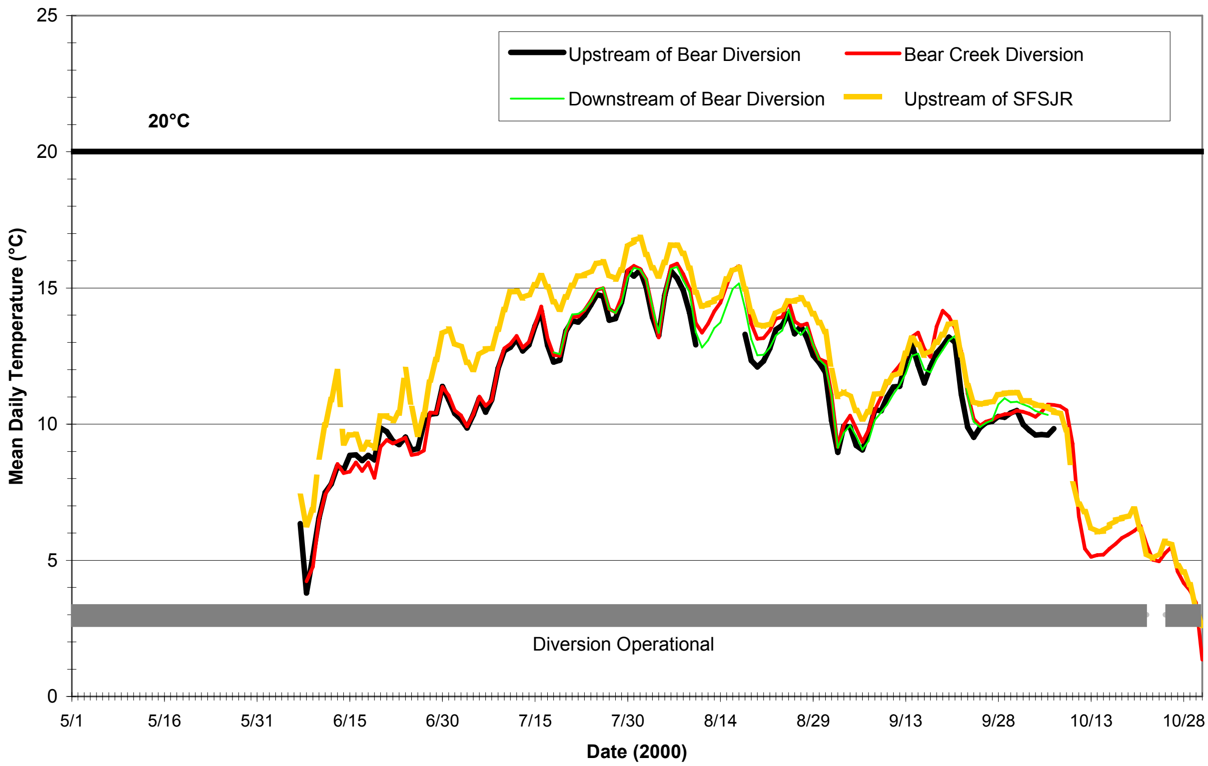


Figure 5.2.4.2-14. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. South Fork San Joaquin River Mono Creek to Upstream of San Joaquin River Confluence.



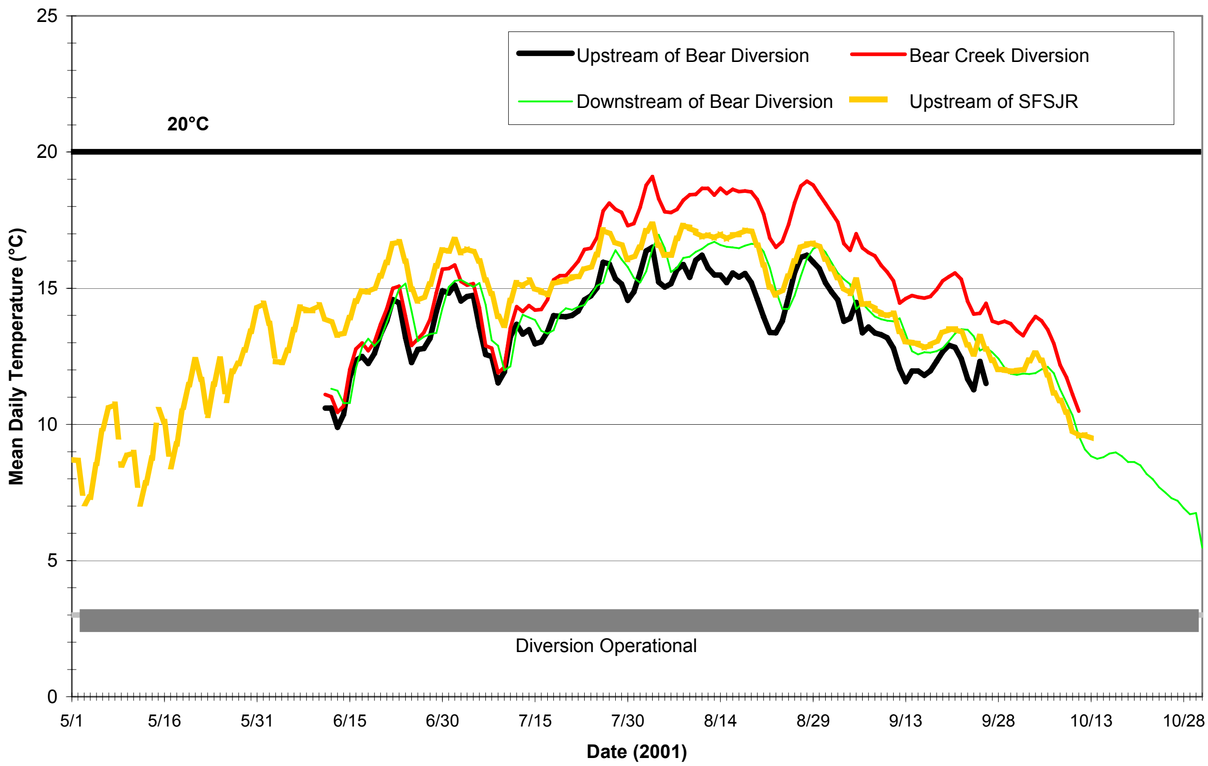
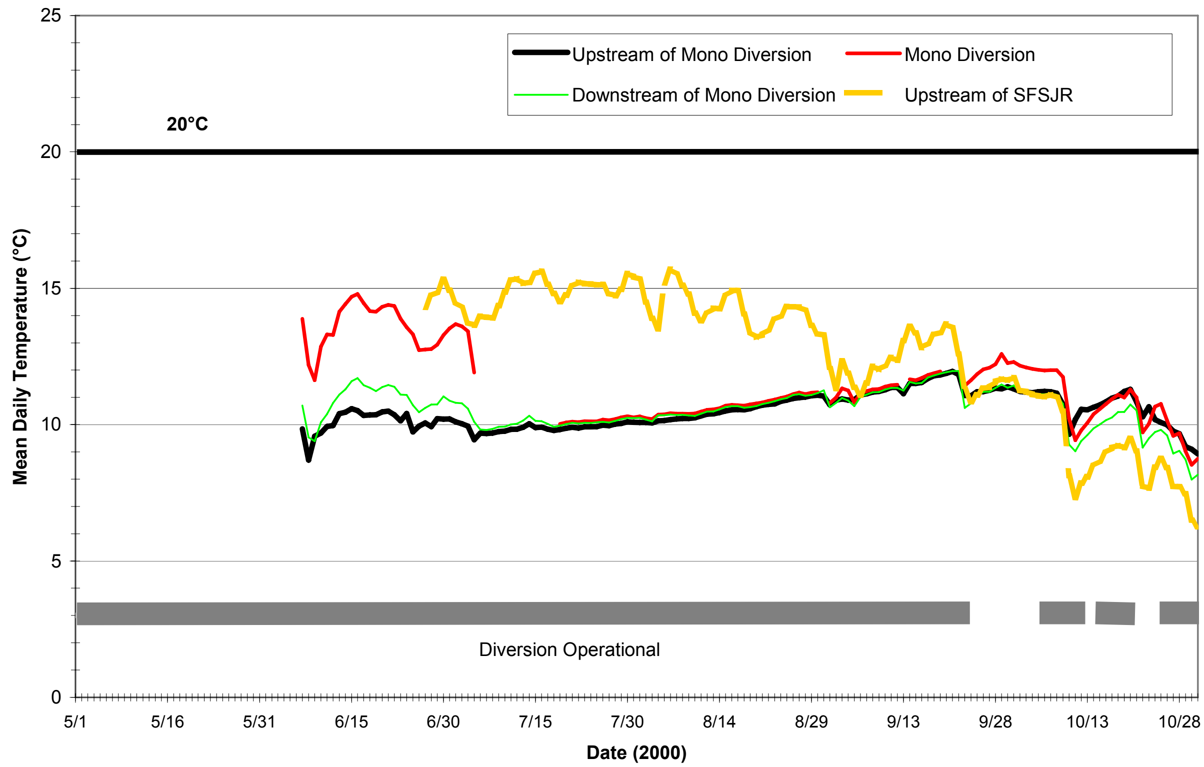


Figure 5.2.4.2-15. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Bear Creek.



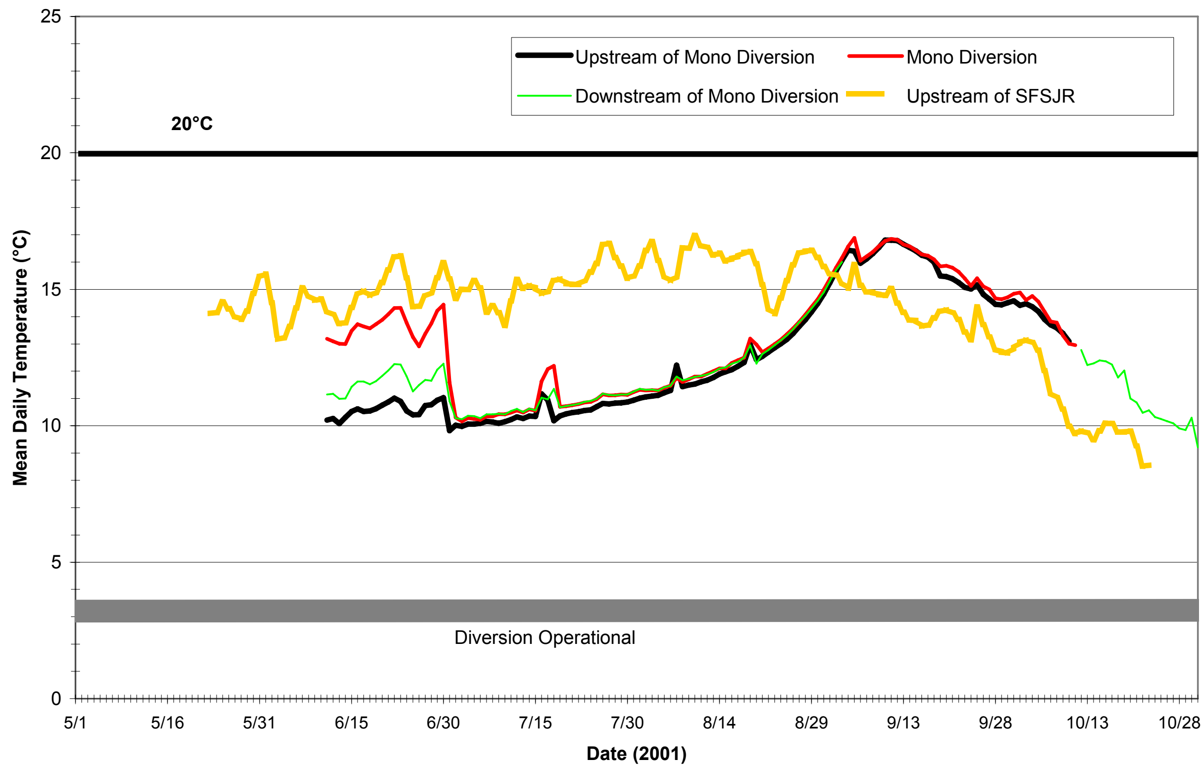


Figure 5.2.4.2-16. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Mono Creek.

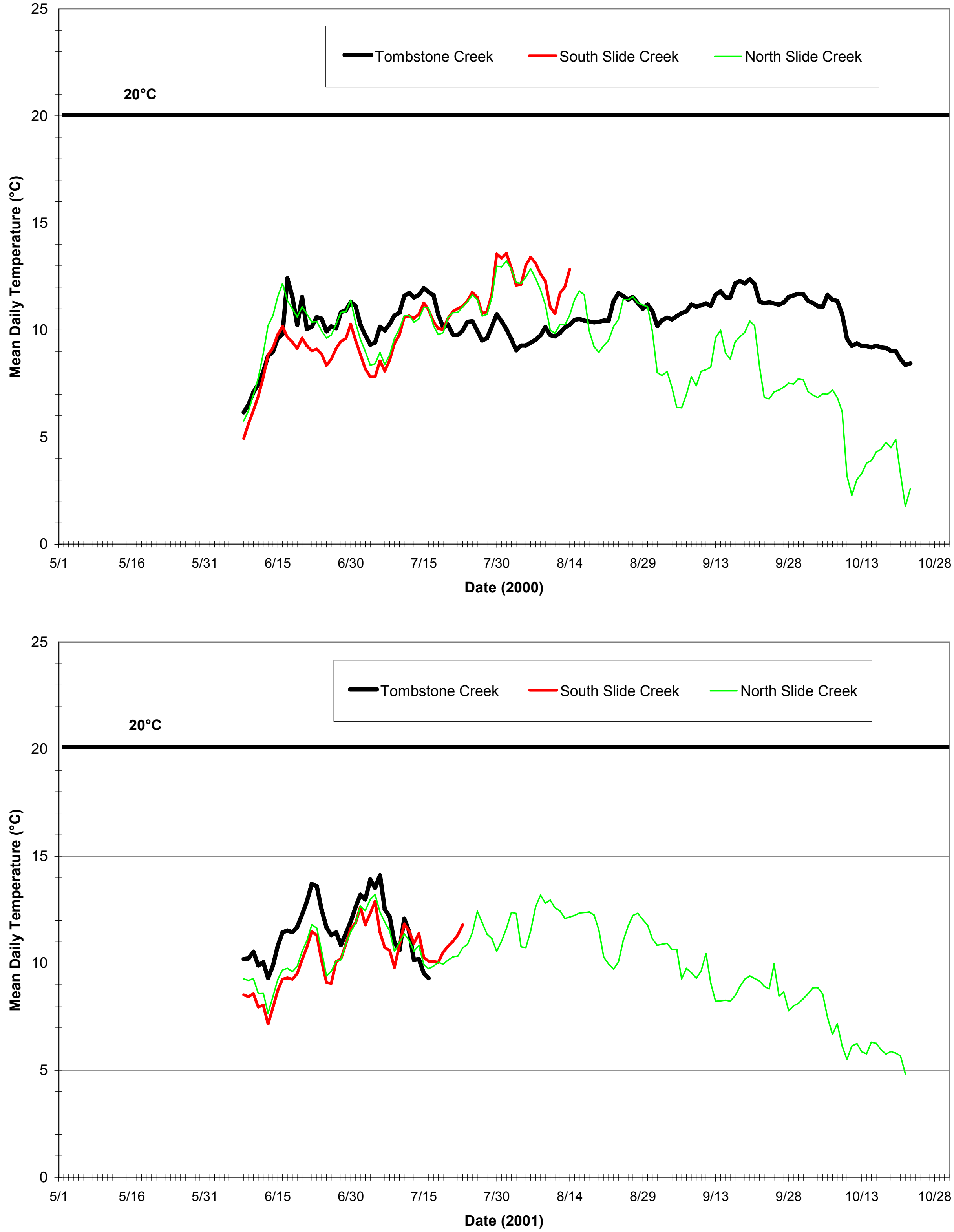
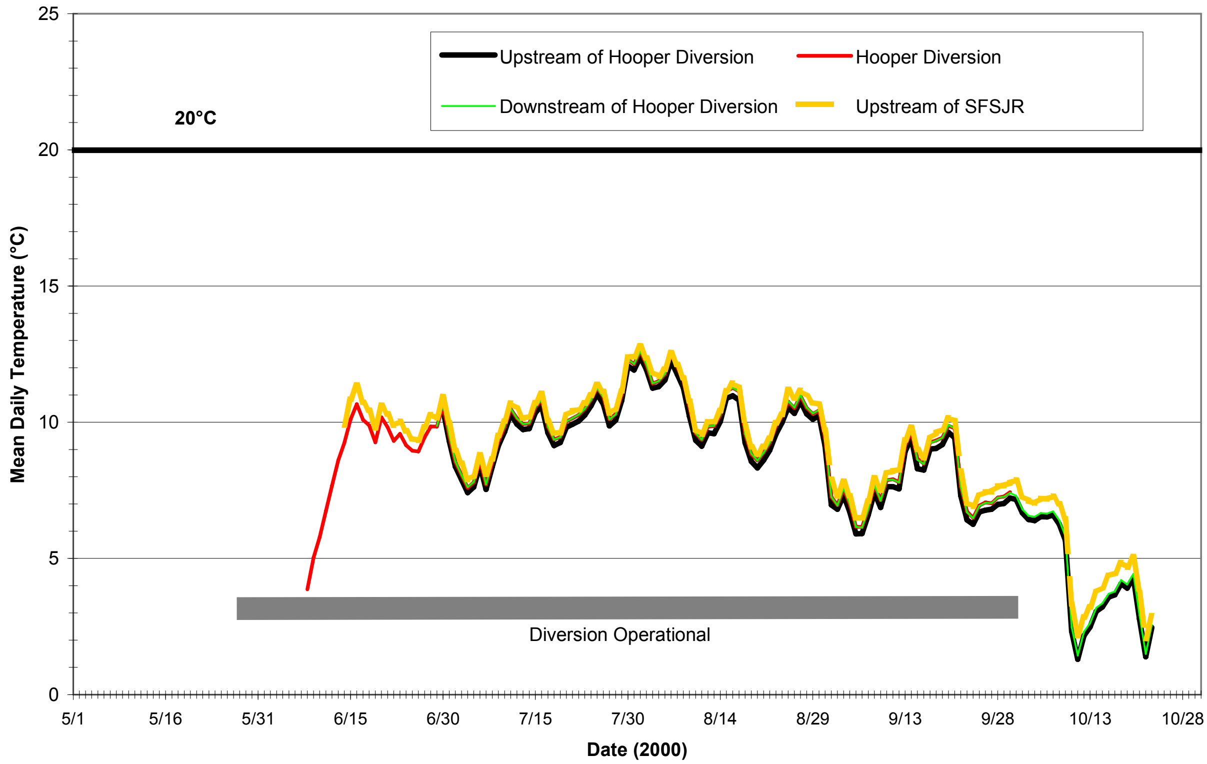


Figure 5.2.4.2-17. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. South Fork San Joaquin River Diverted (Non-Operational) Tributaries.



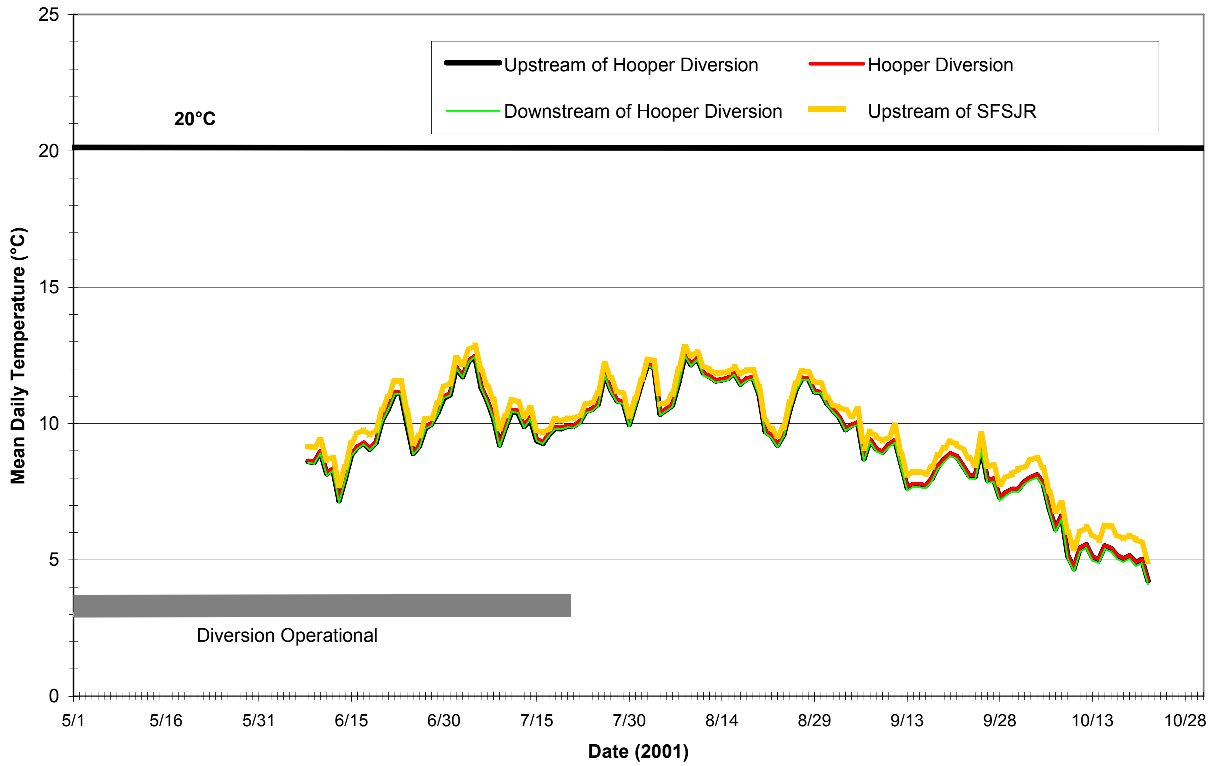
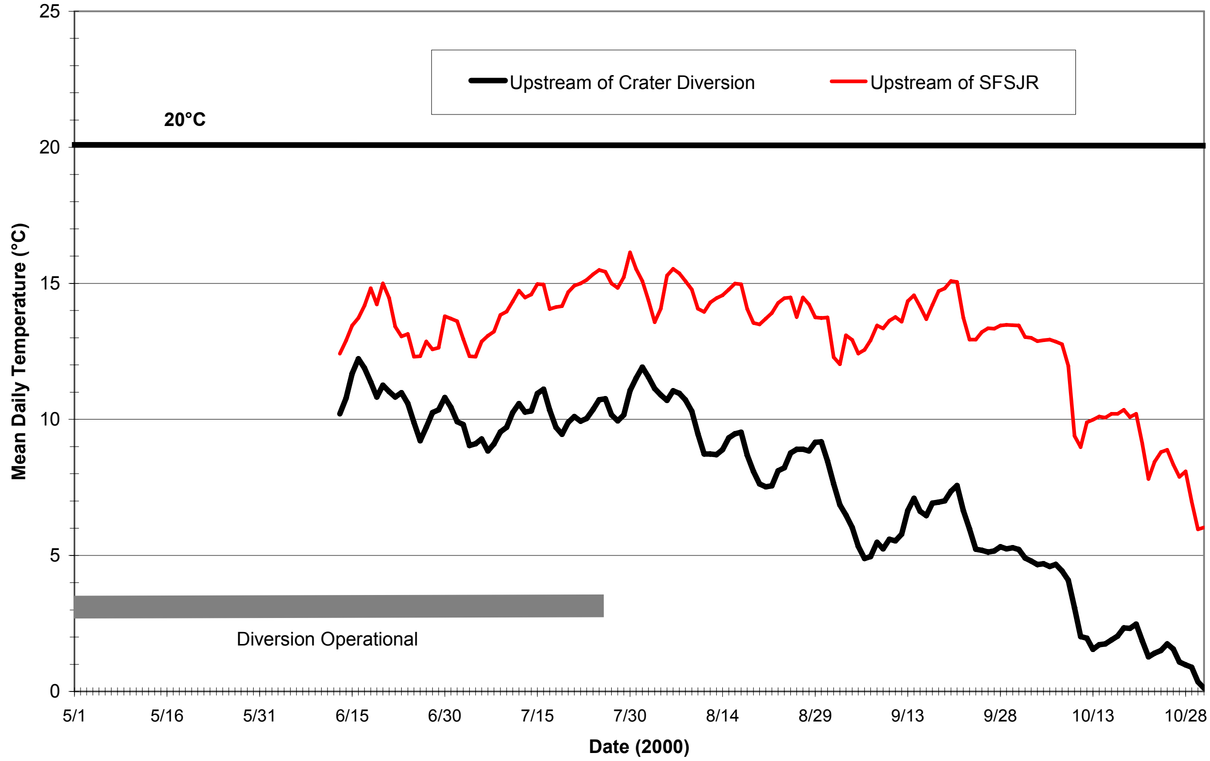


Figure 5.2.4.2-18. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Hooper Creek.



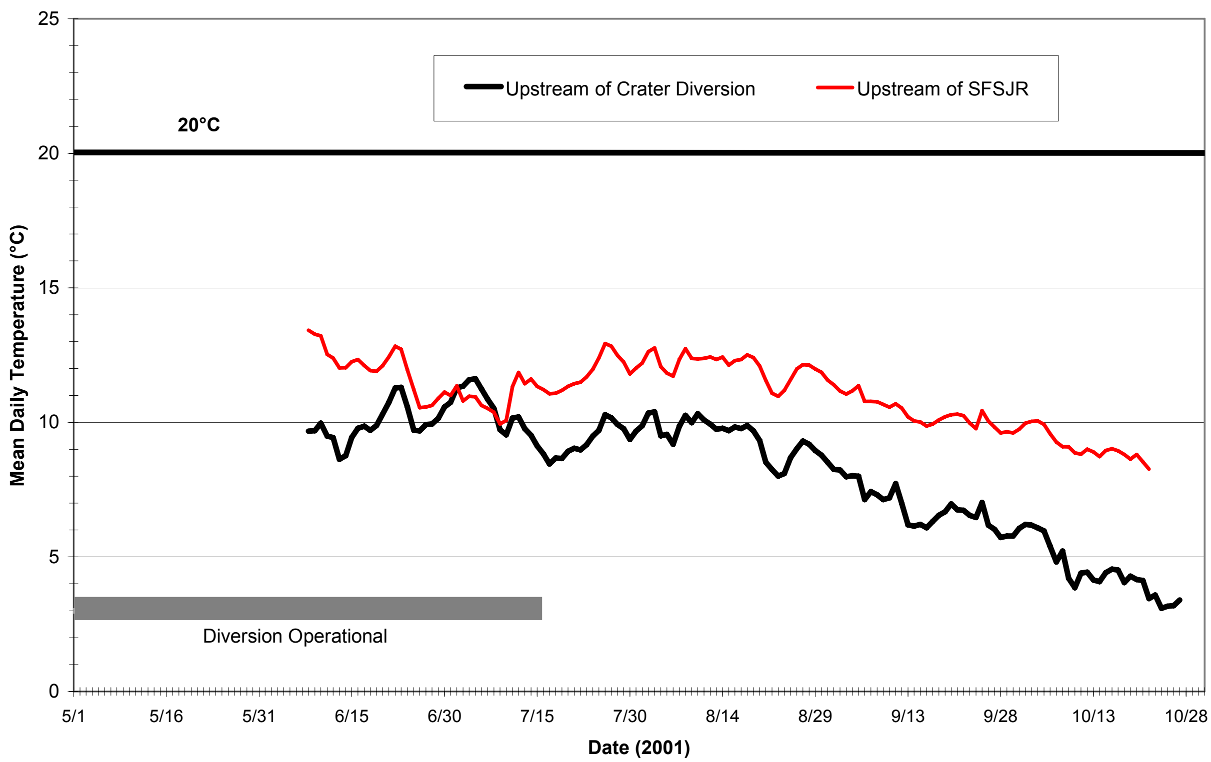
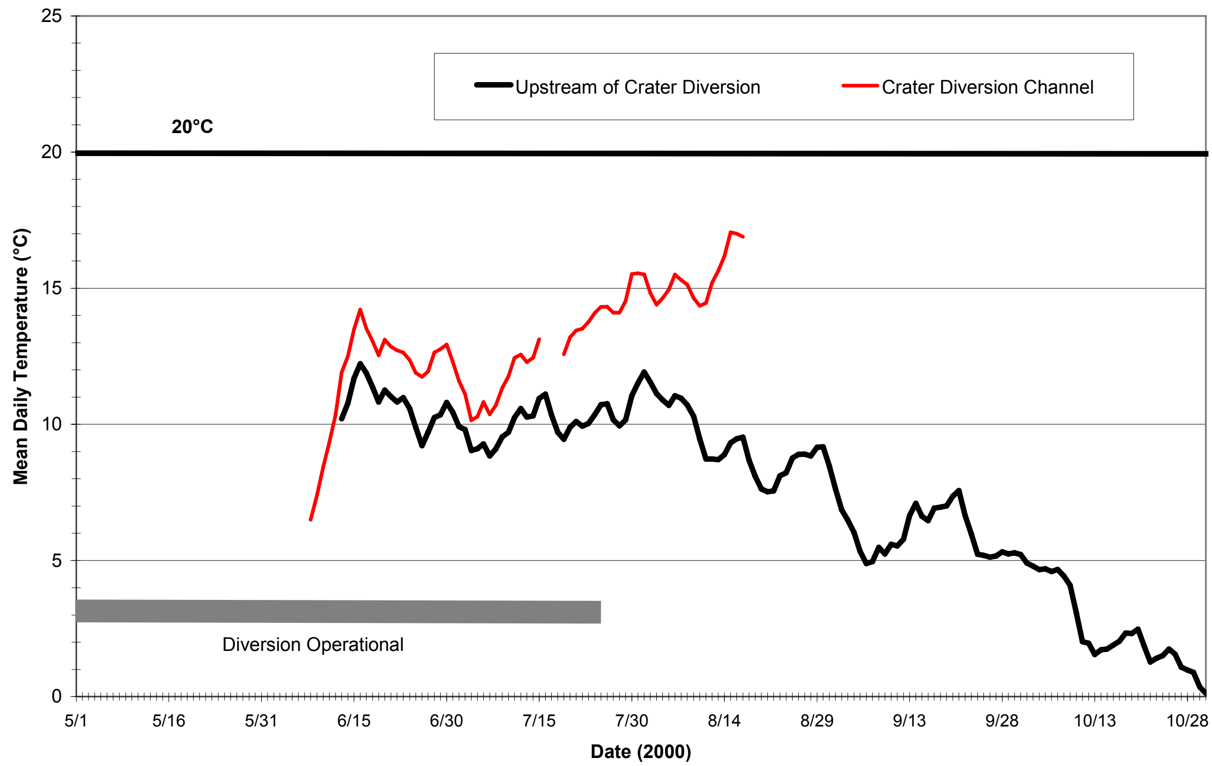


Figure 5.2.4.2-19. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Crater Creek.



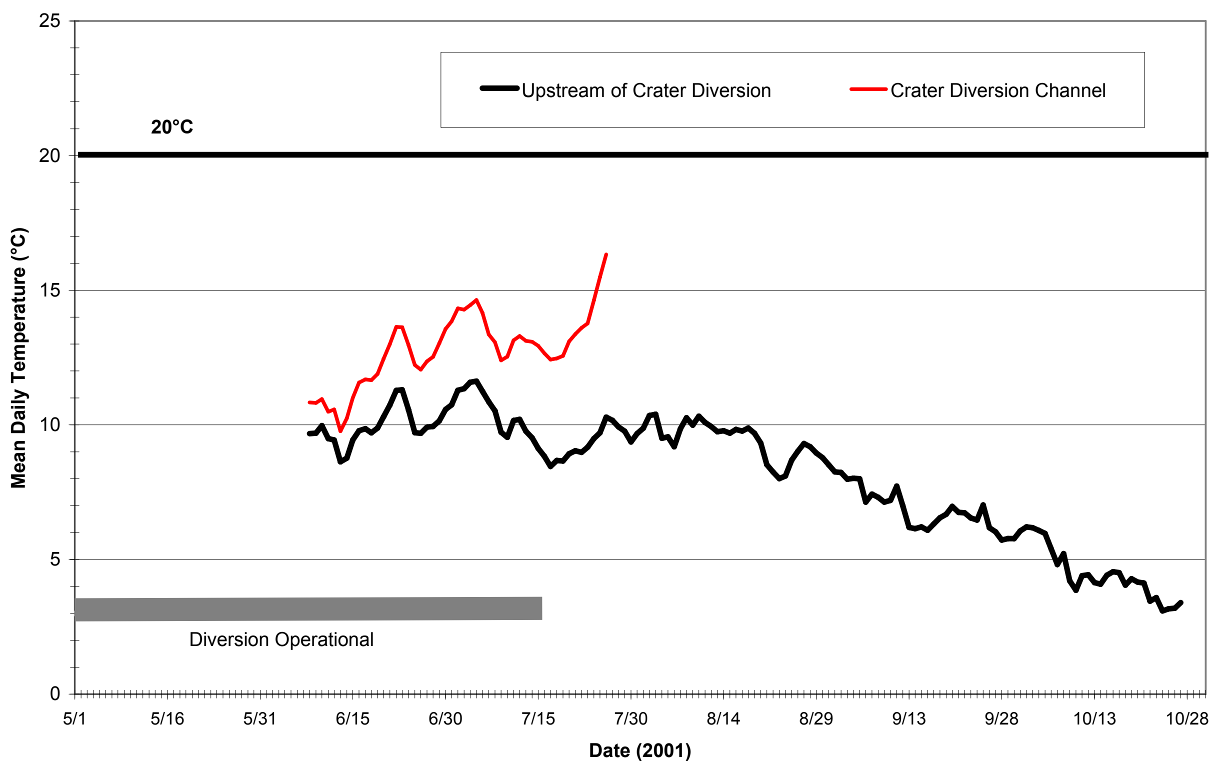


Figure 5.2.4.2-20. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Crater Creek Diversion Channel.

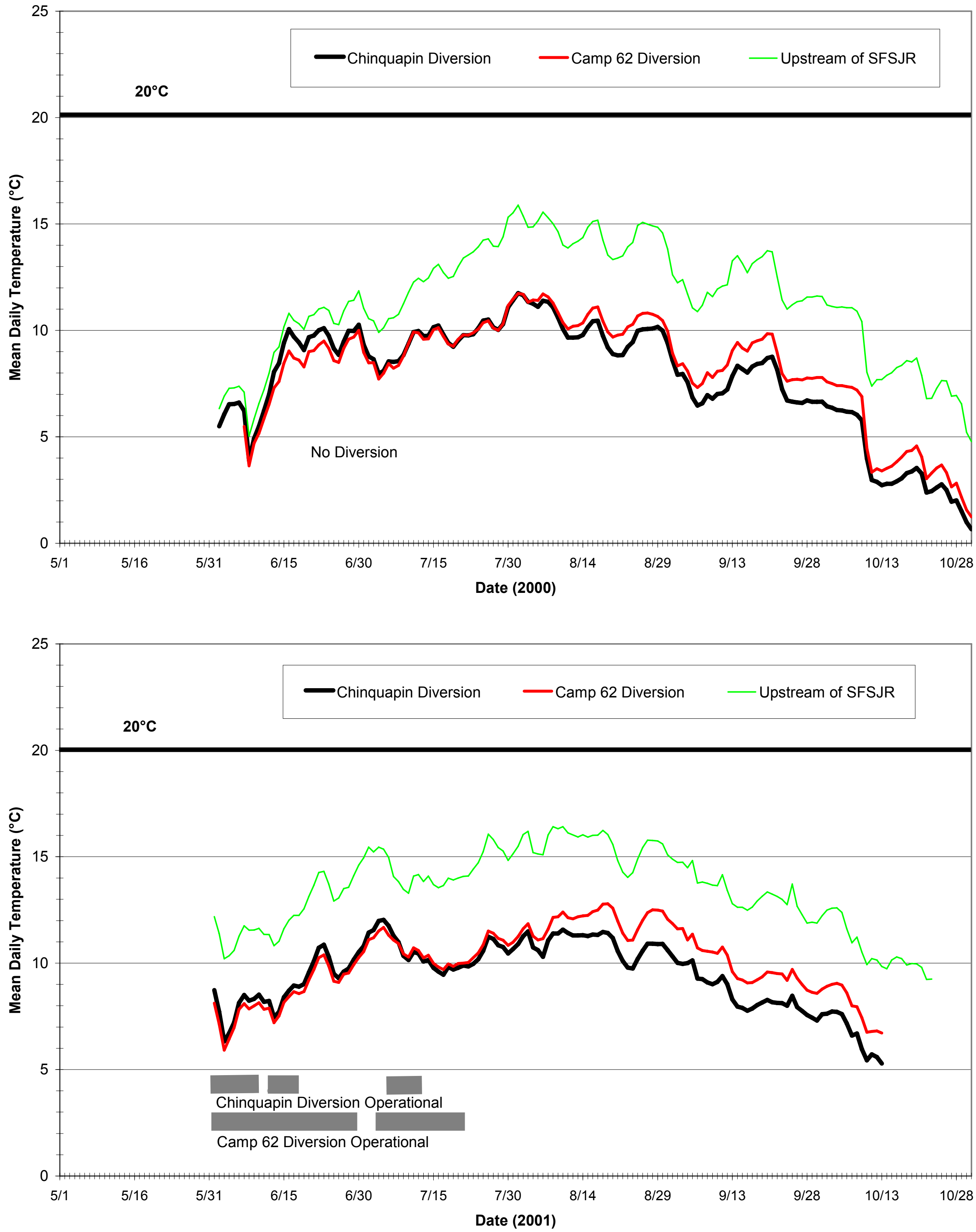
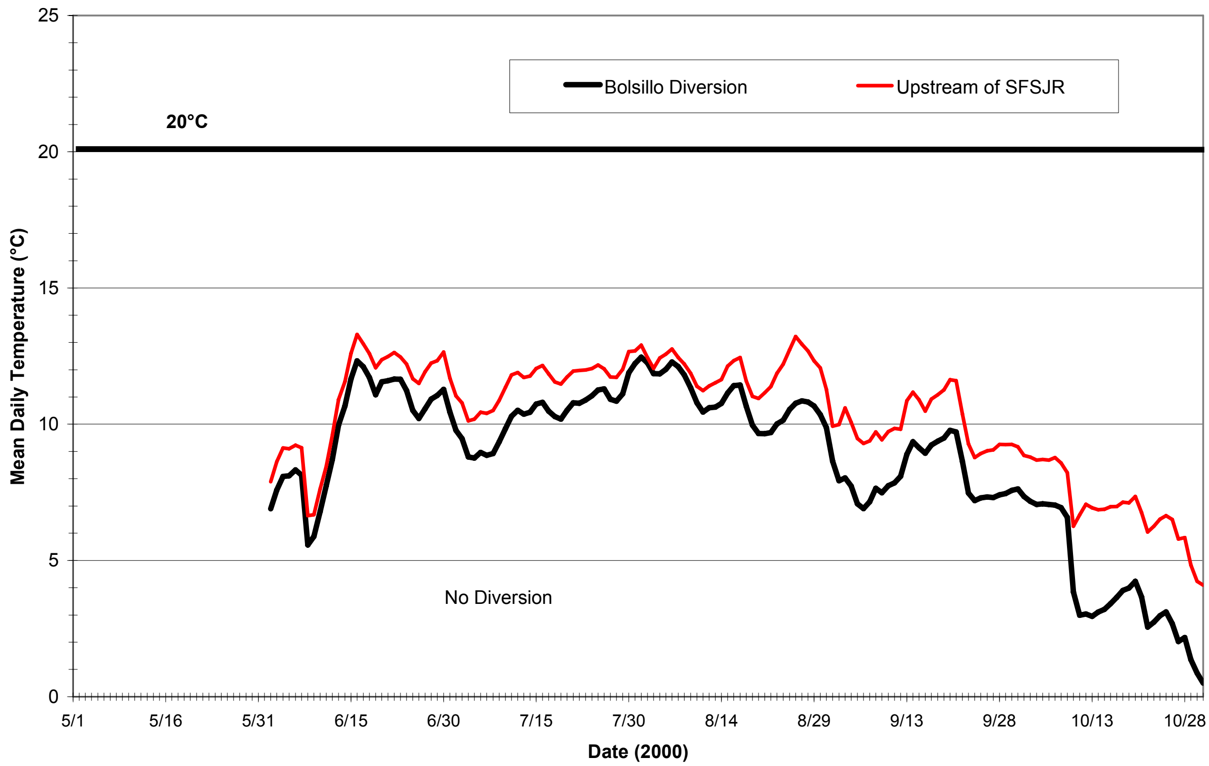


Figure 5.2.4.2-21. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Camp 62 and Chinquapin Creek.



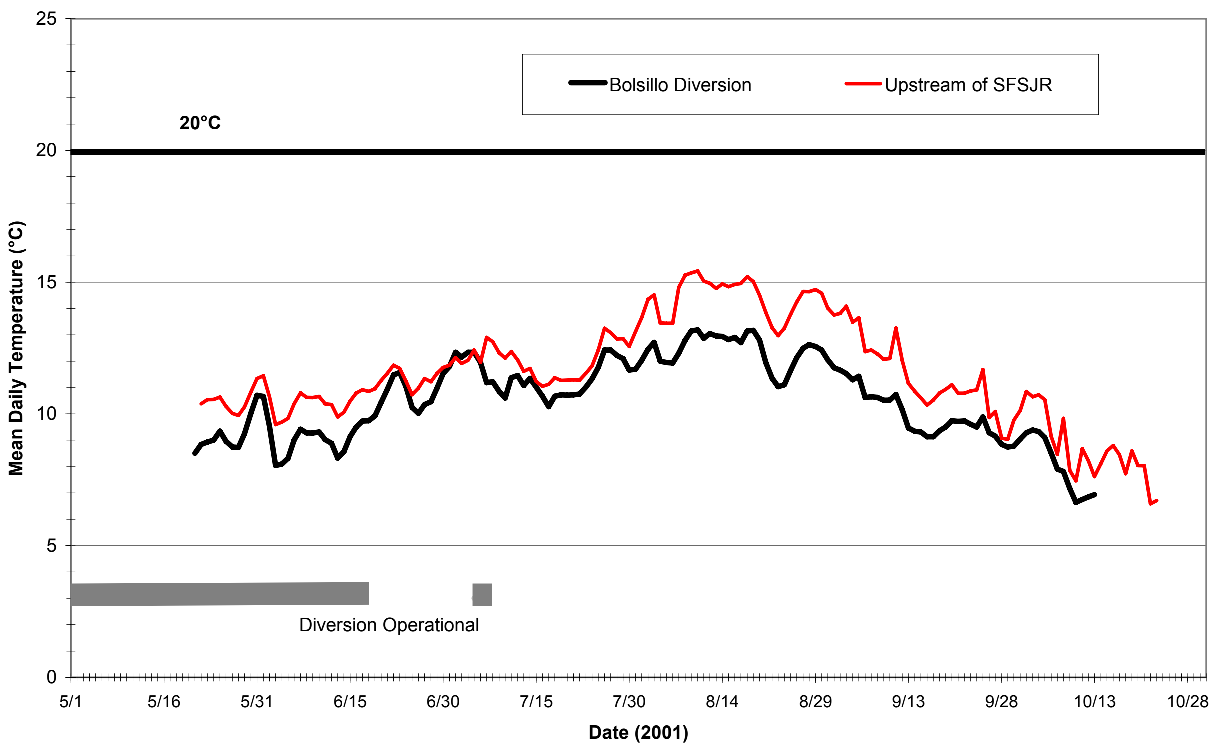


Figure 5.2.4.2-22. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Bolsillo Creek.

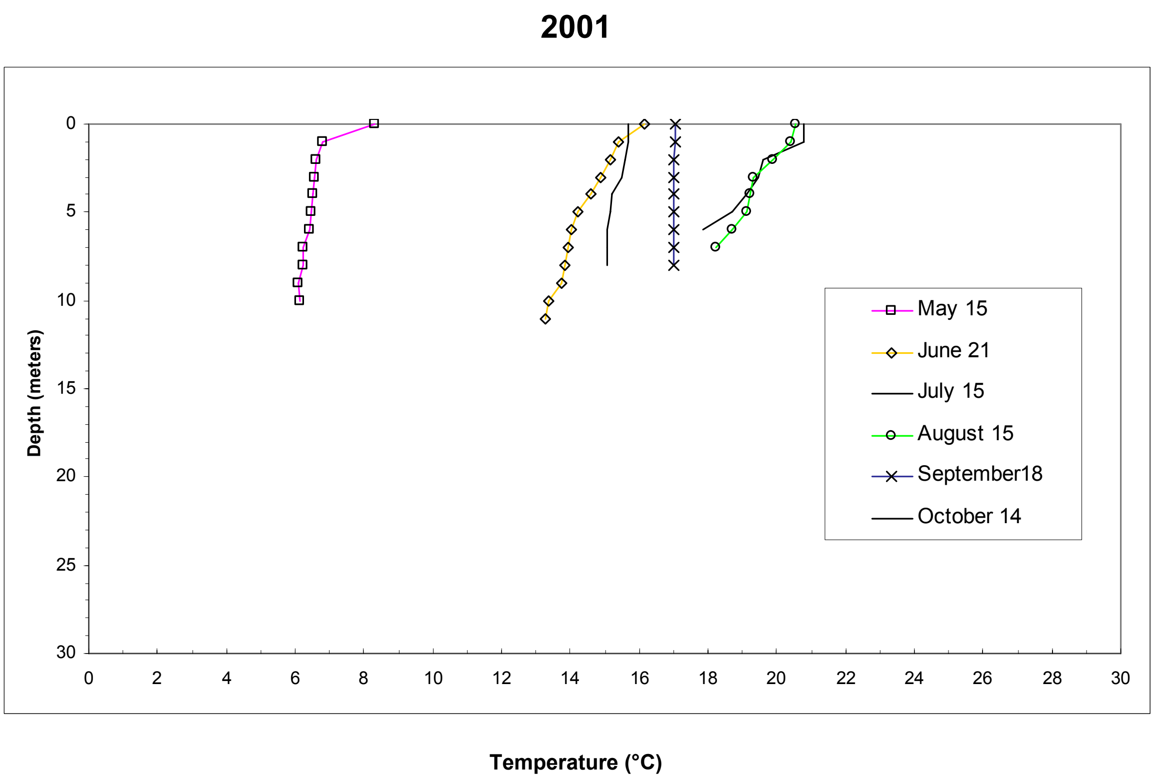
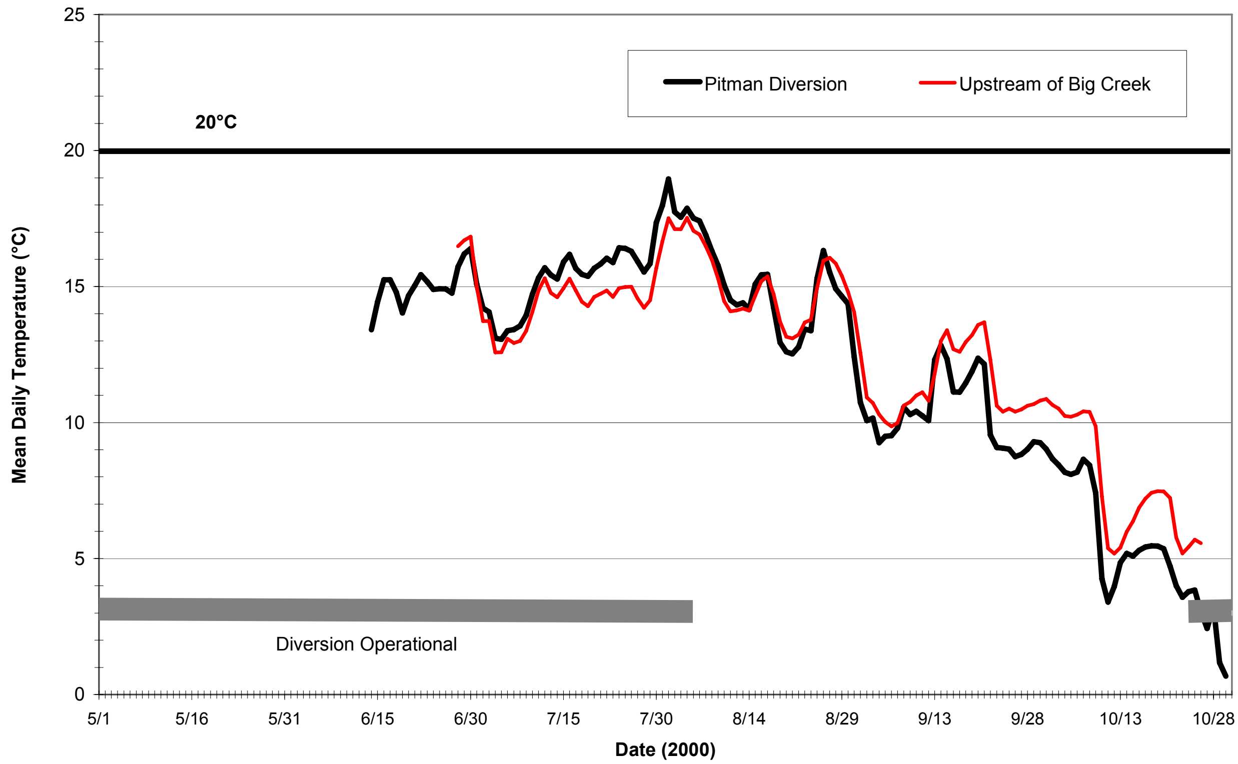


Figure 5.2.4.2-23. Balsam Meadow Forebay Water Temperature Profile, 2001.



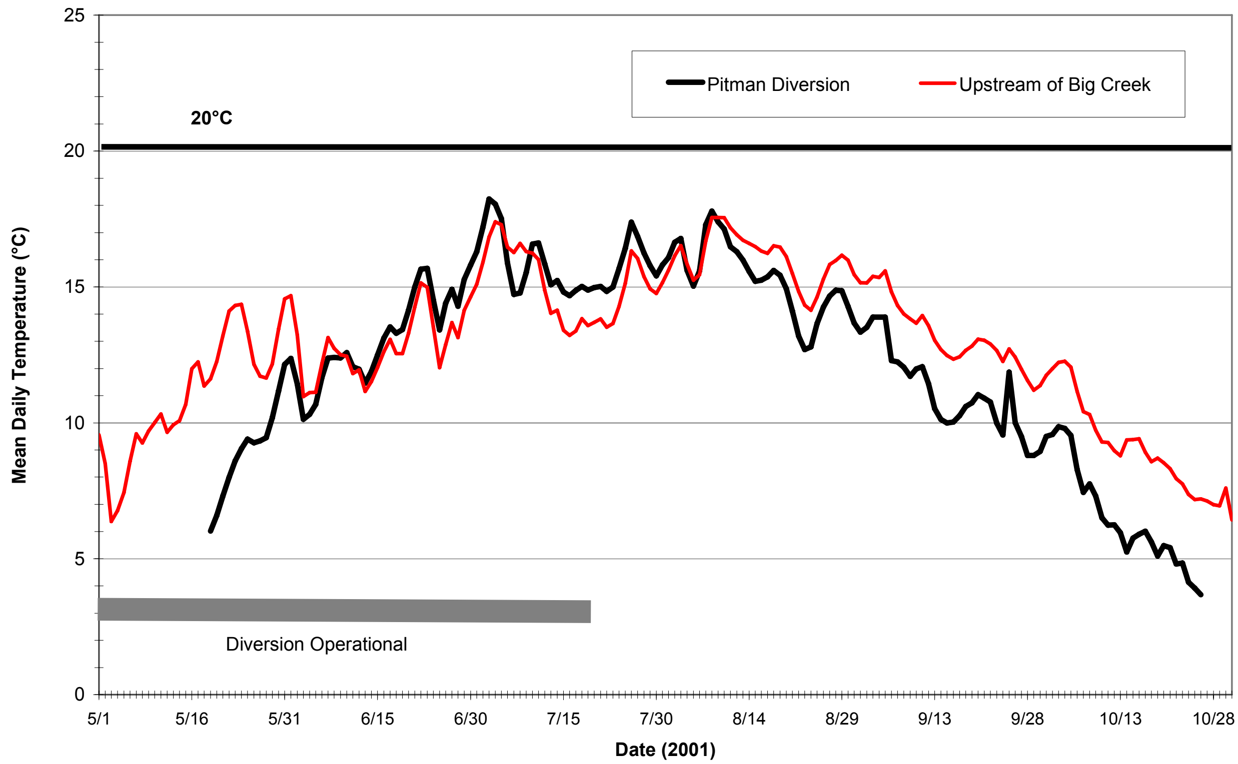


Figure 5.2.4.2-24. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Pitman Creek.

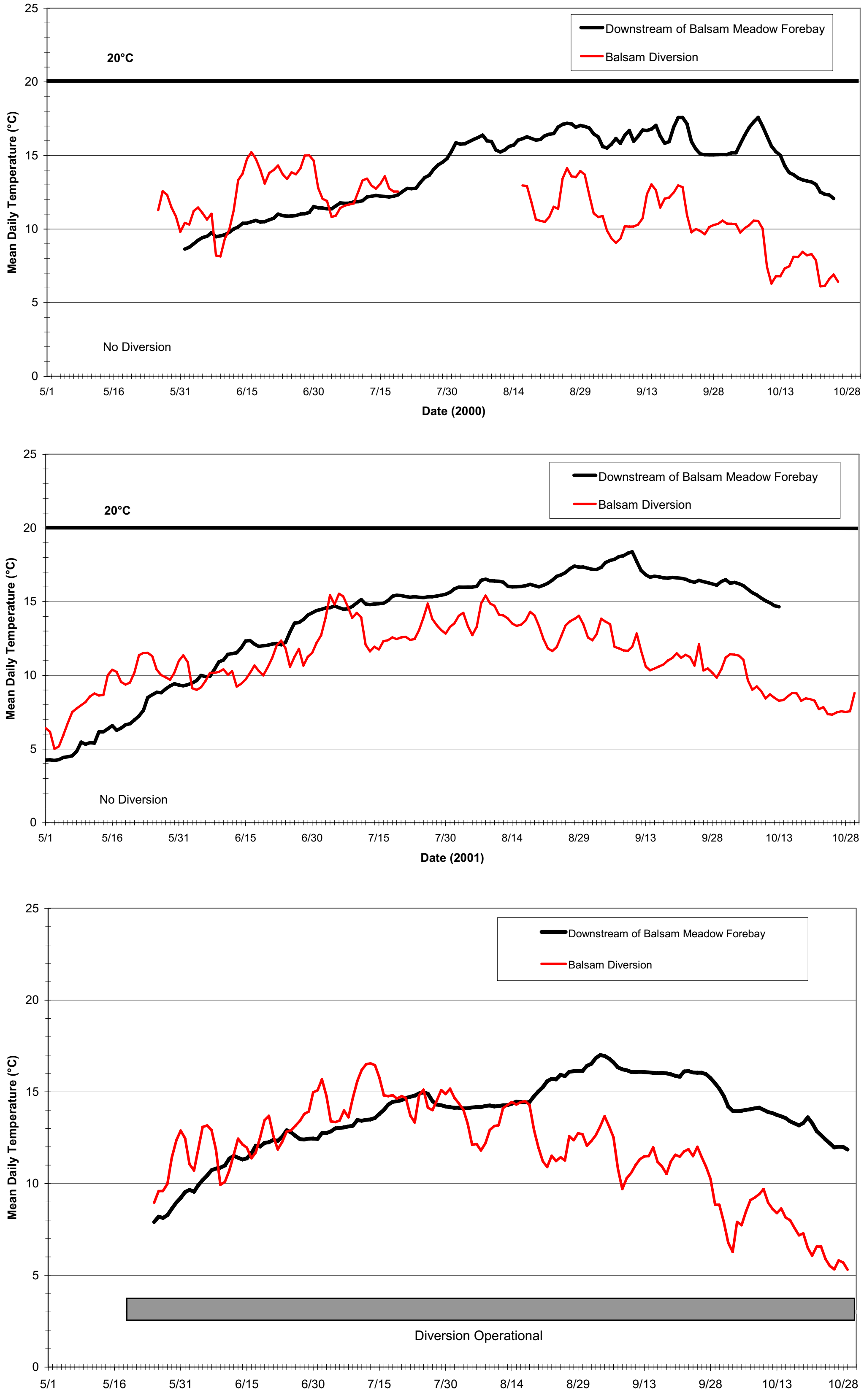
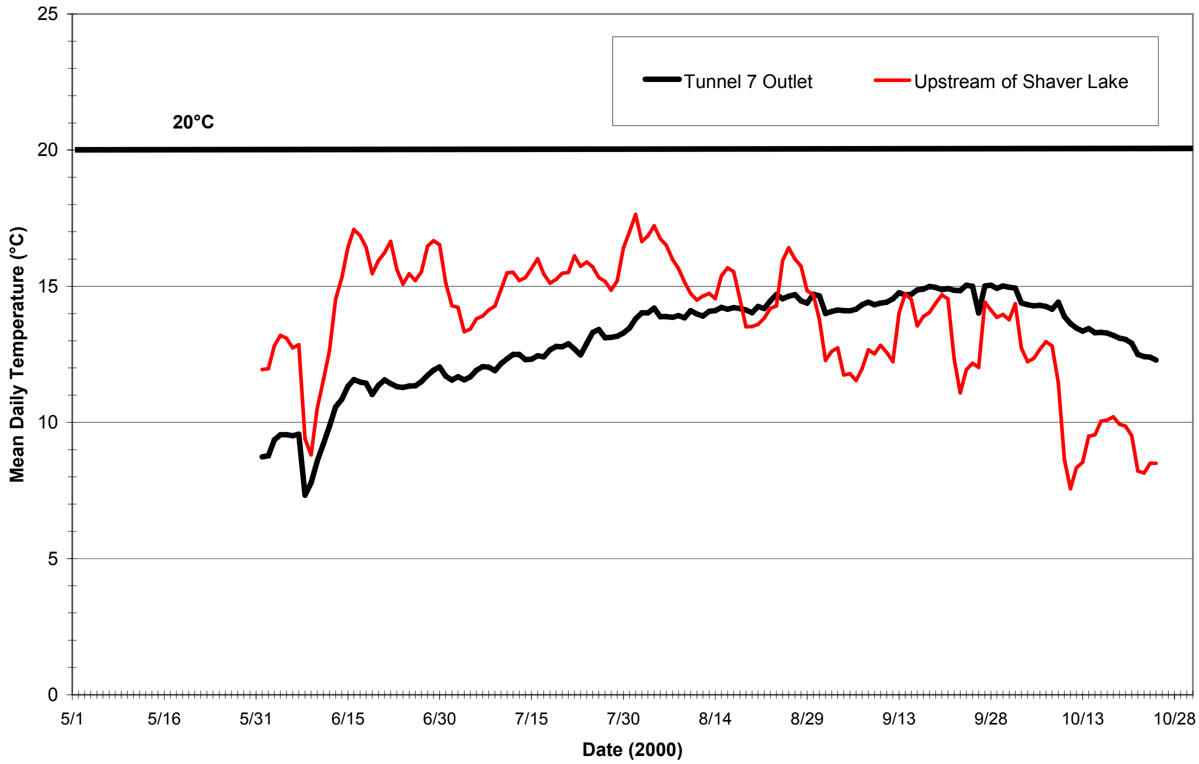


Figure 5.2.4.2-25. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000, 2001 and 2002. Balsam Creek.



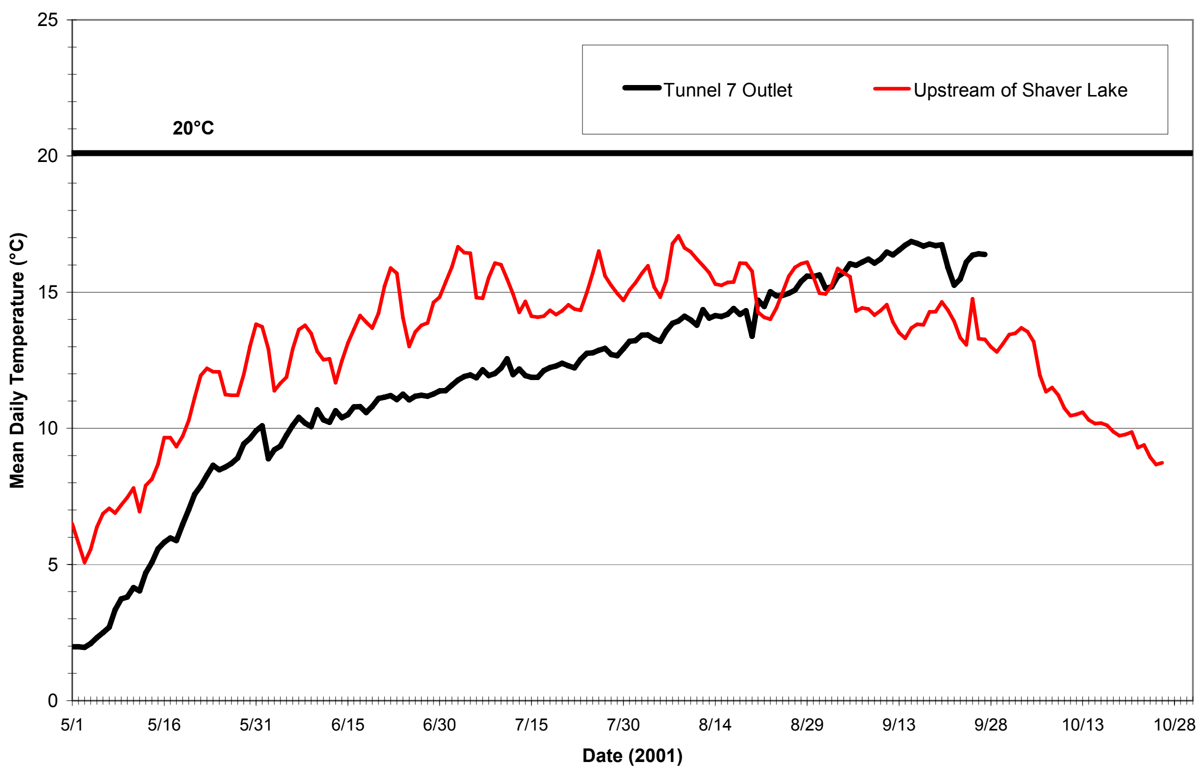
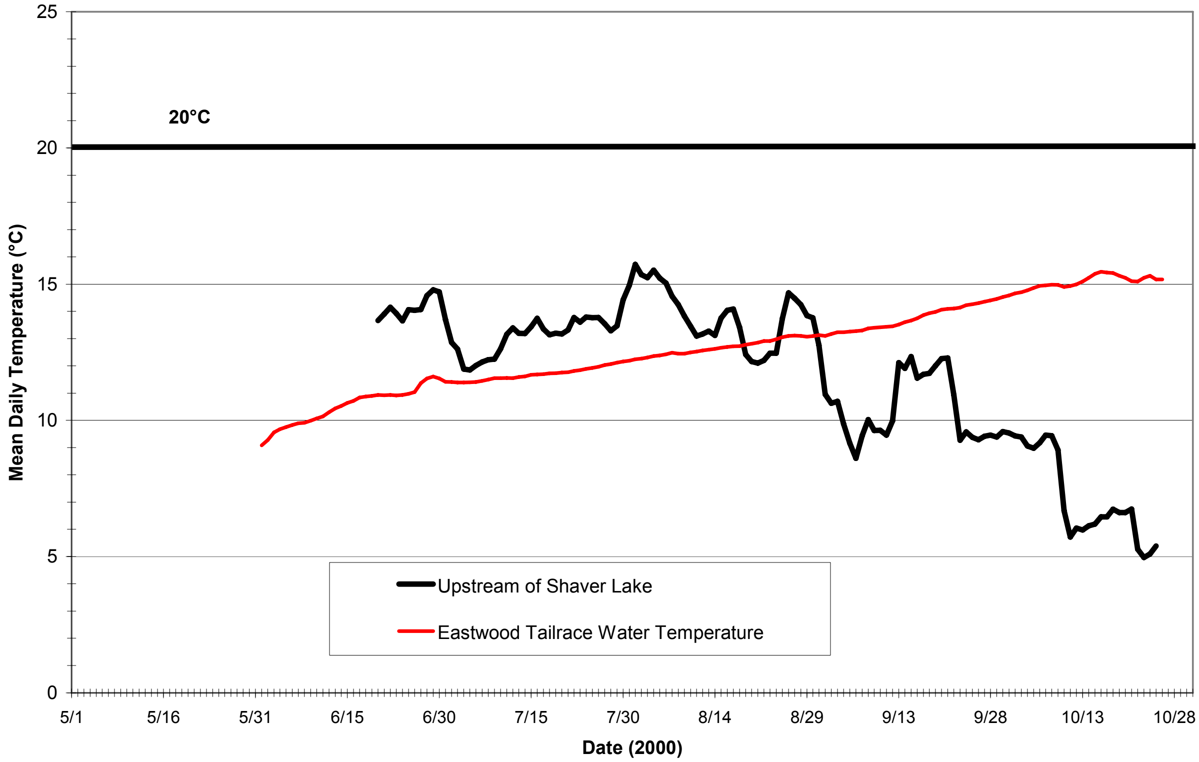


Figure 5.2.4.2-26. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. North Fork Stevenson Creek.



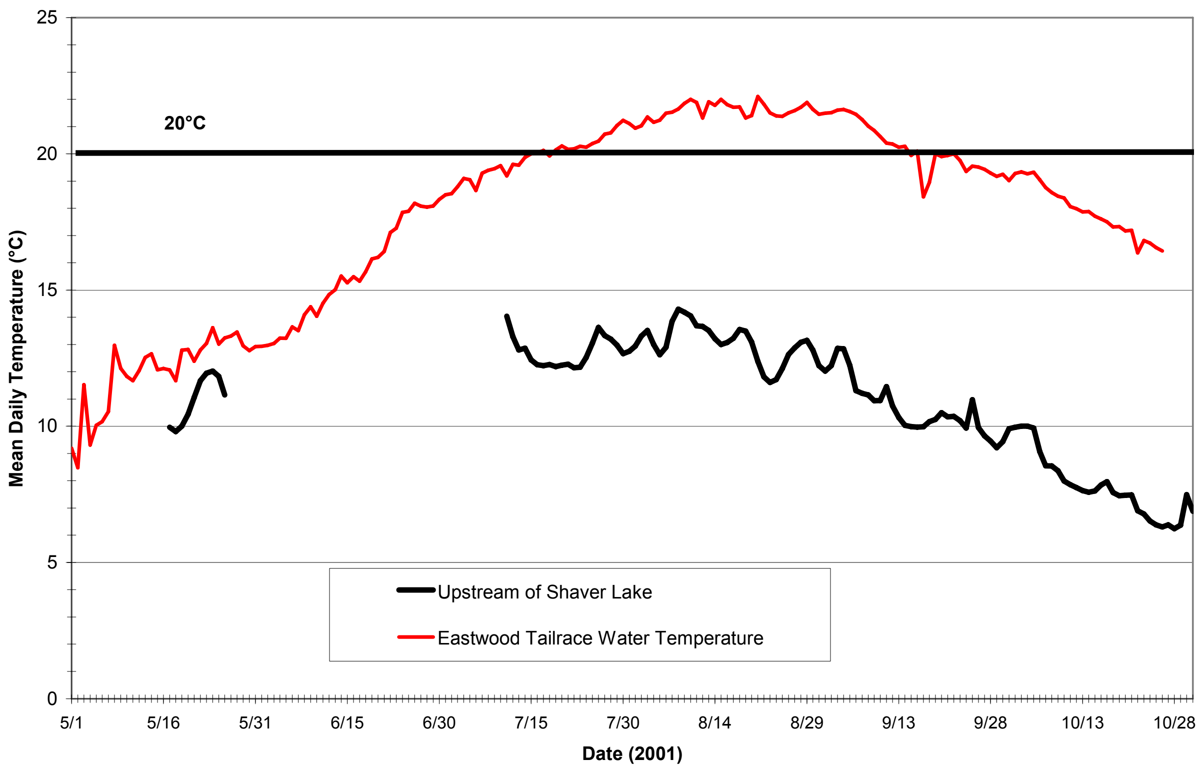
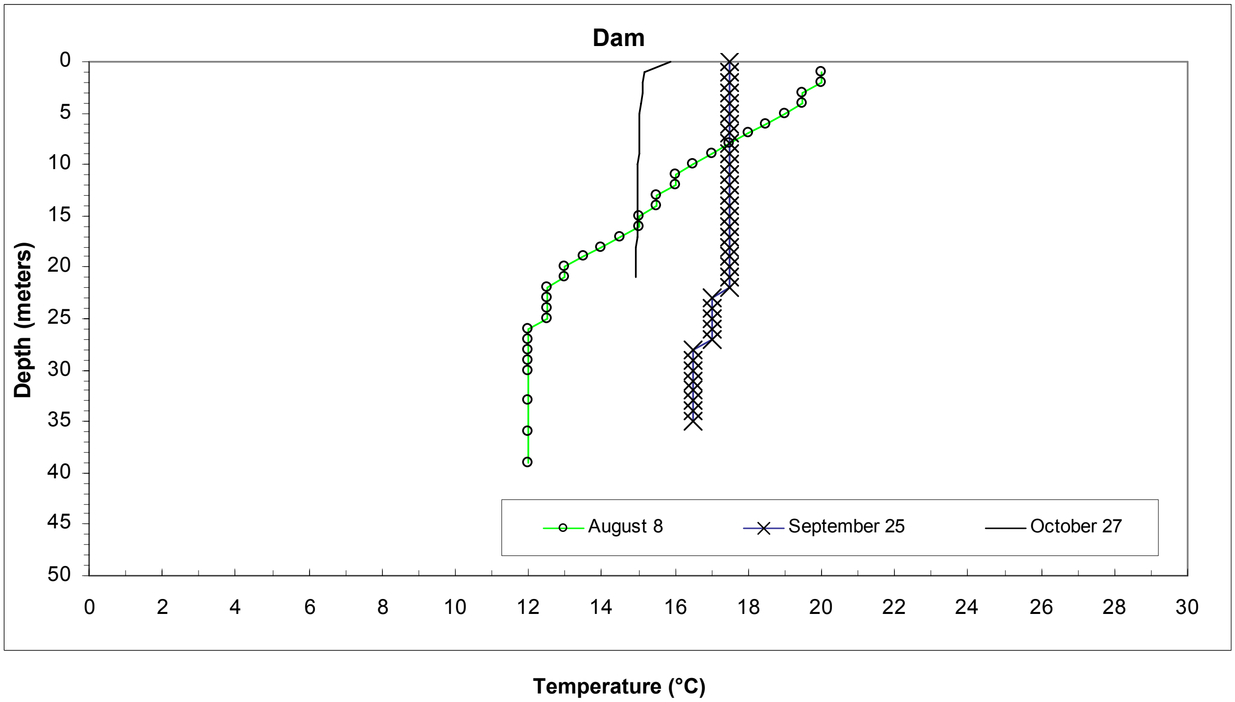


Figure 5.2.4.2-27. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Eastwood Tailrace.

2000



2001

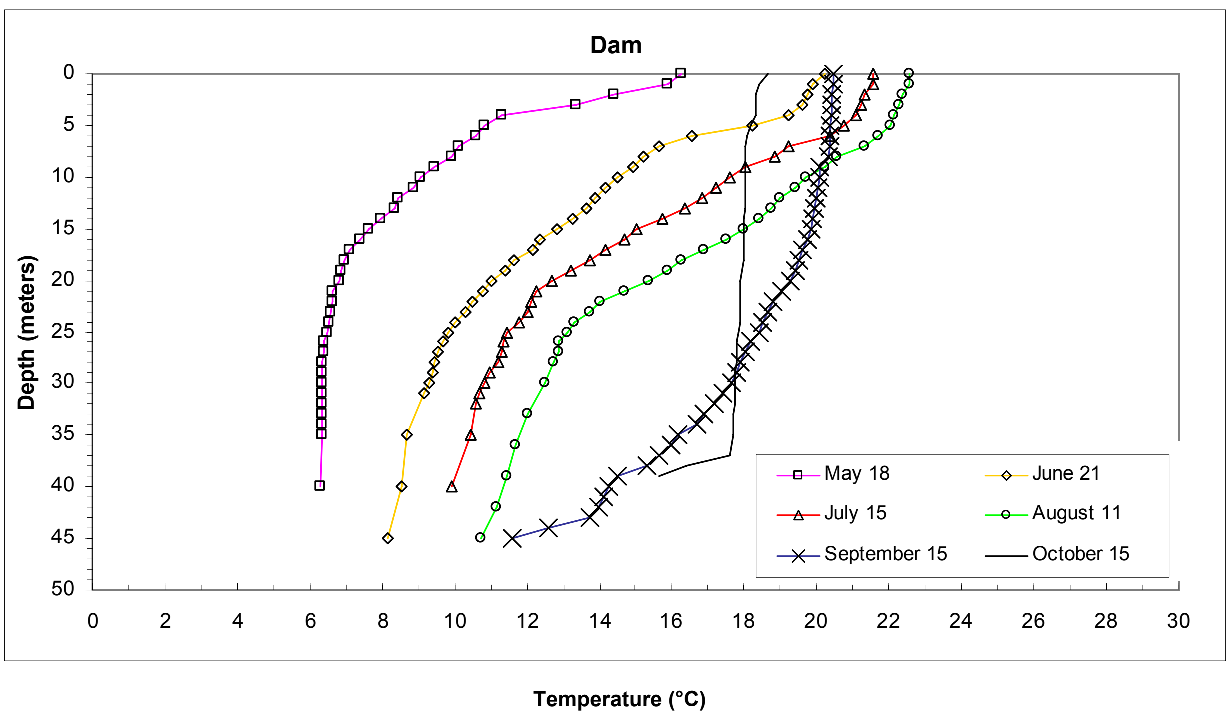


Figure 5.2.4.2-28. Shaver Lake Water Temperature Profiles, 2000 and 2001.

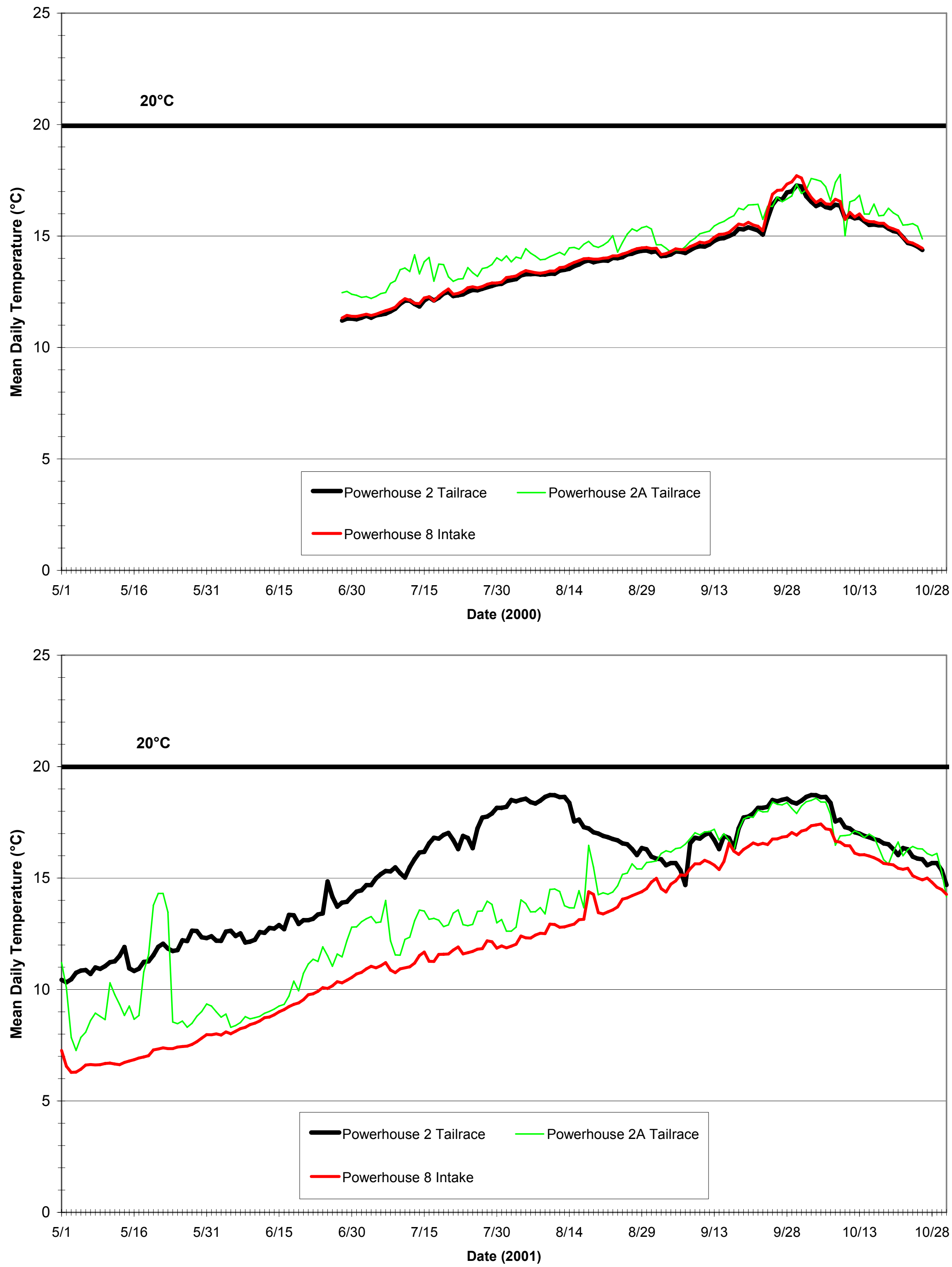
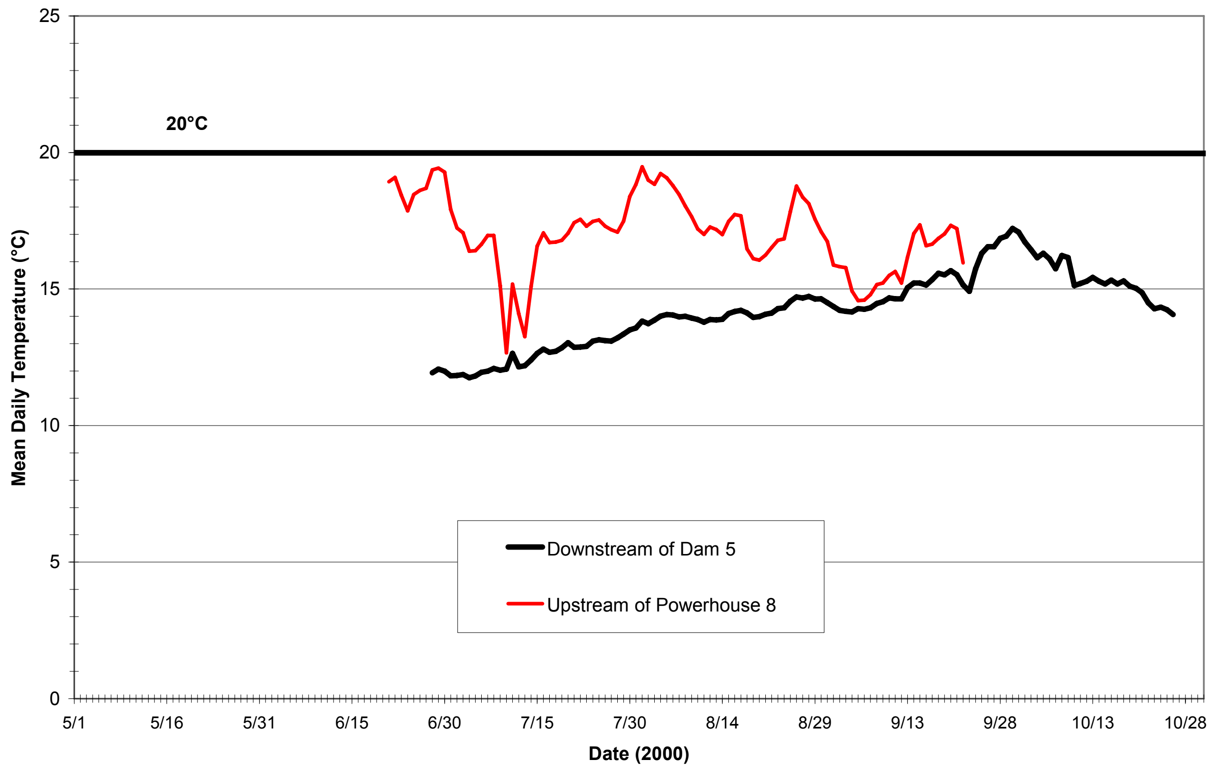


Figure 5.2.4.2-29. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Big Creek Powerhouse 8 Forebay (Dam 5).



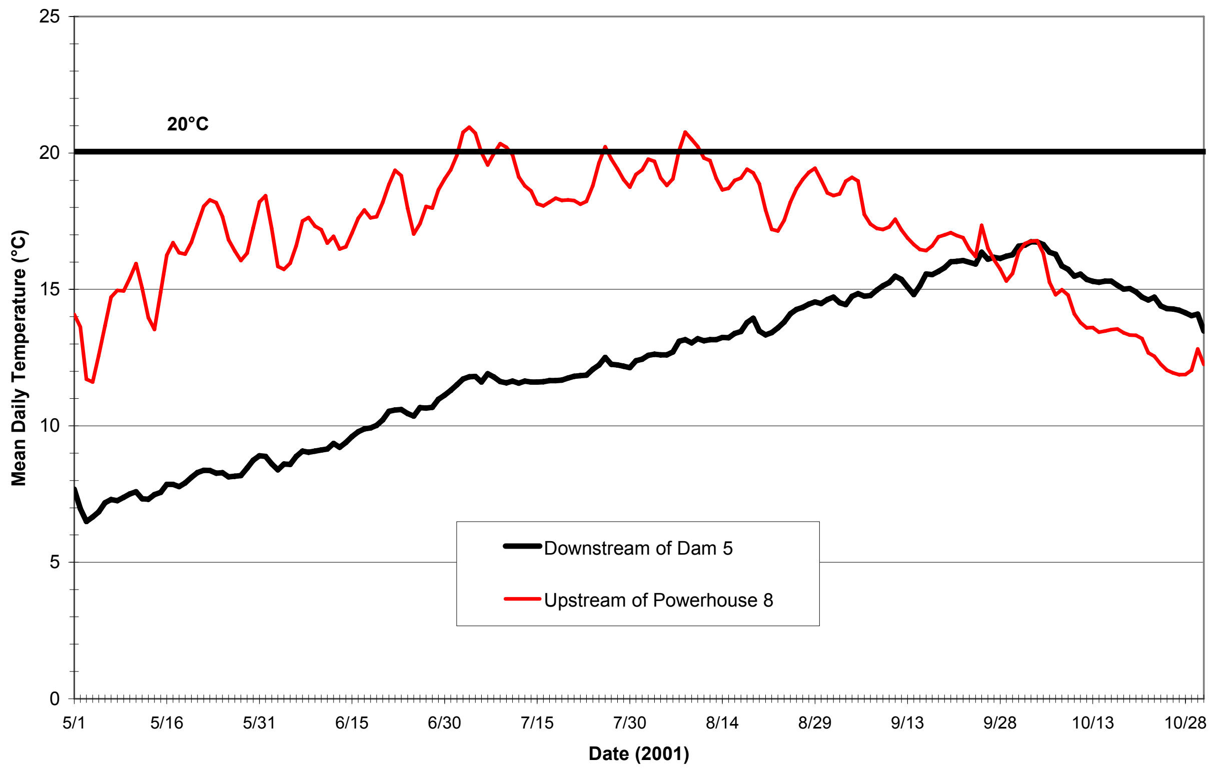
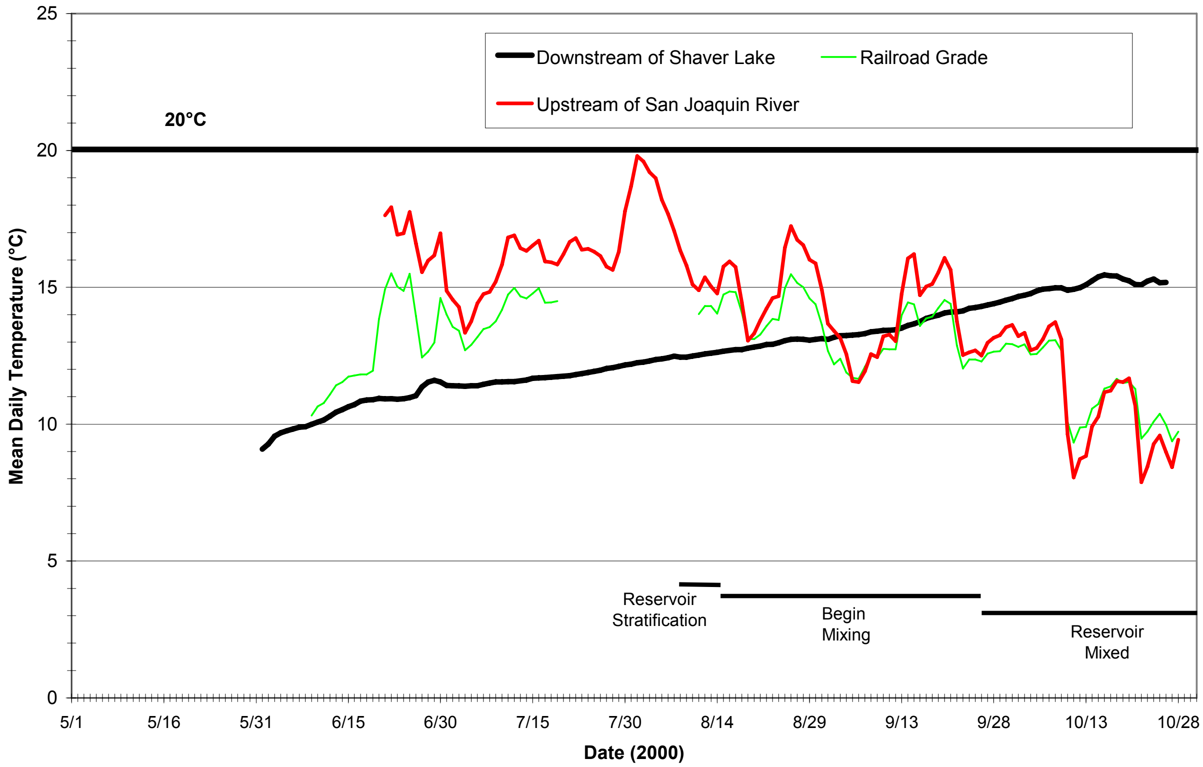


Figure 5.2.4.2-30. Big Creek, Dam 5 to Powerhouse 8/SJR Mean Daily Water Temperatures, 2000 and 2001.



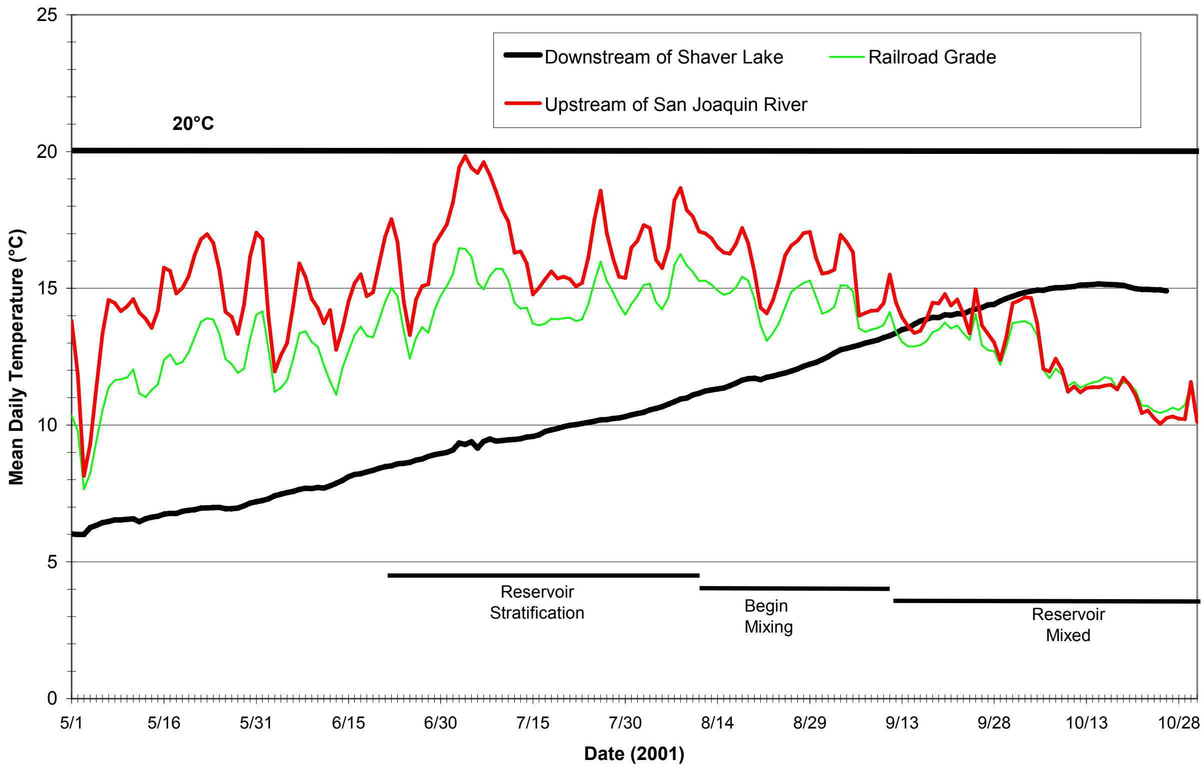


Figure 5.2.4.2-31. Big Creek 2A, 8 and Eastwood 2 Project Areas Mean Daily Water Temperatures, 2000 and 2001. Stevenson Creek - Downstream of Shaver Lake to San Joaquin River Confluence.

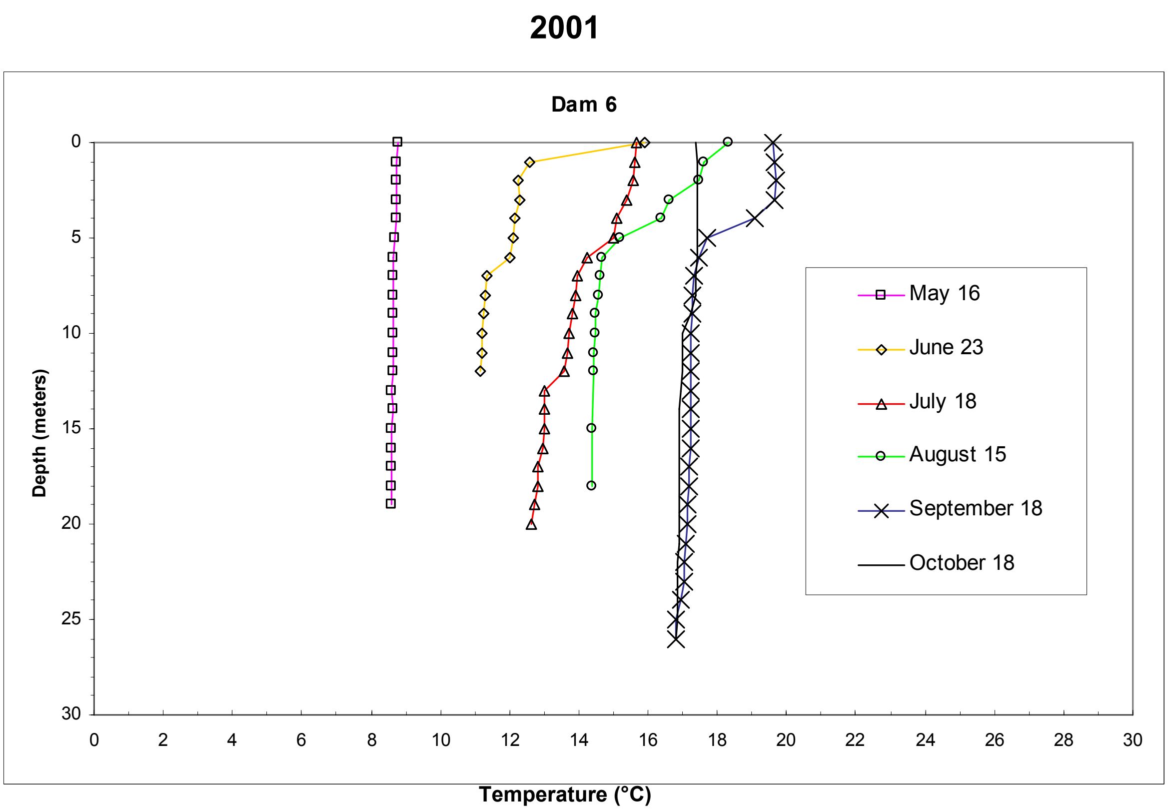


Figure 5.2.4.2-32. Powerhouse 3 Forebay Water Temperature Profile, 2001.

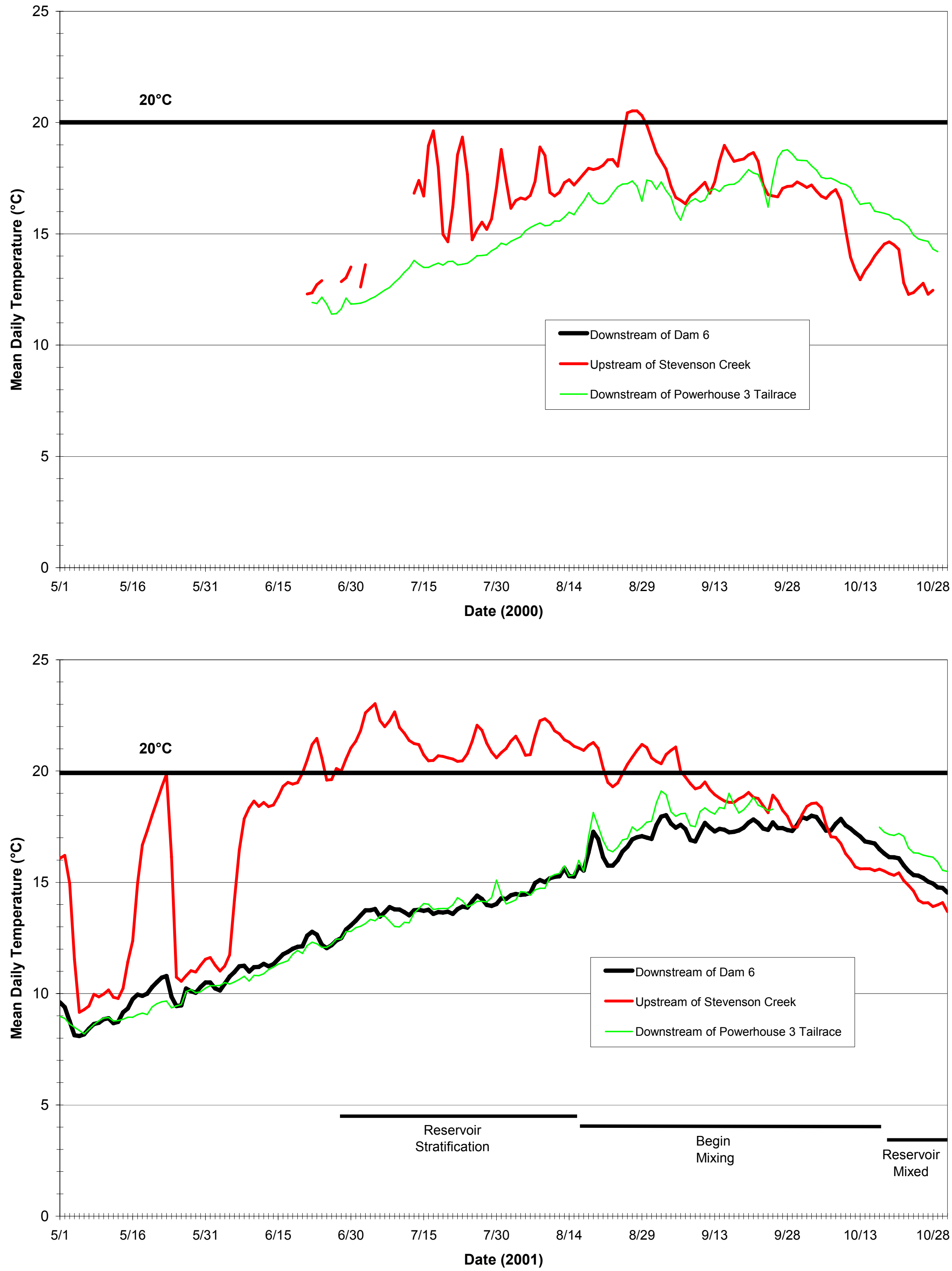


Figure 5.2.4.2-33. San Joaquin River, Dam 6 to Powerhouse 3/Redinger Lake Project Area Mean Daily Water Temperatures, 2000 and 2001.

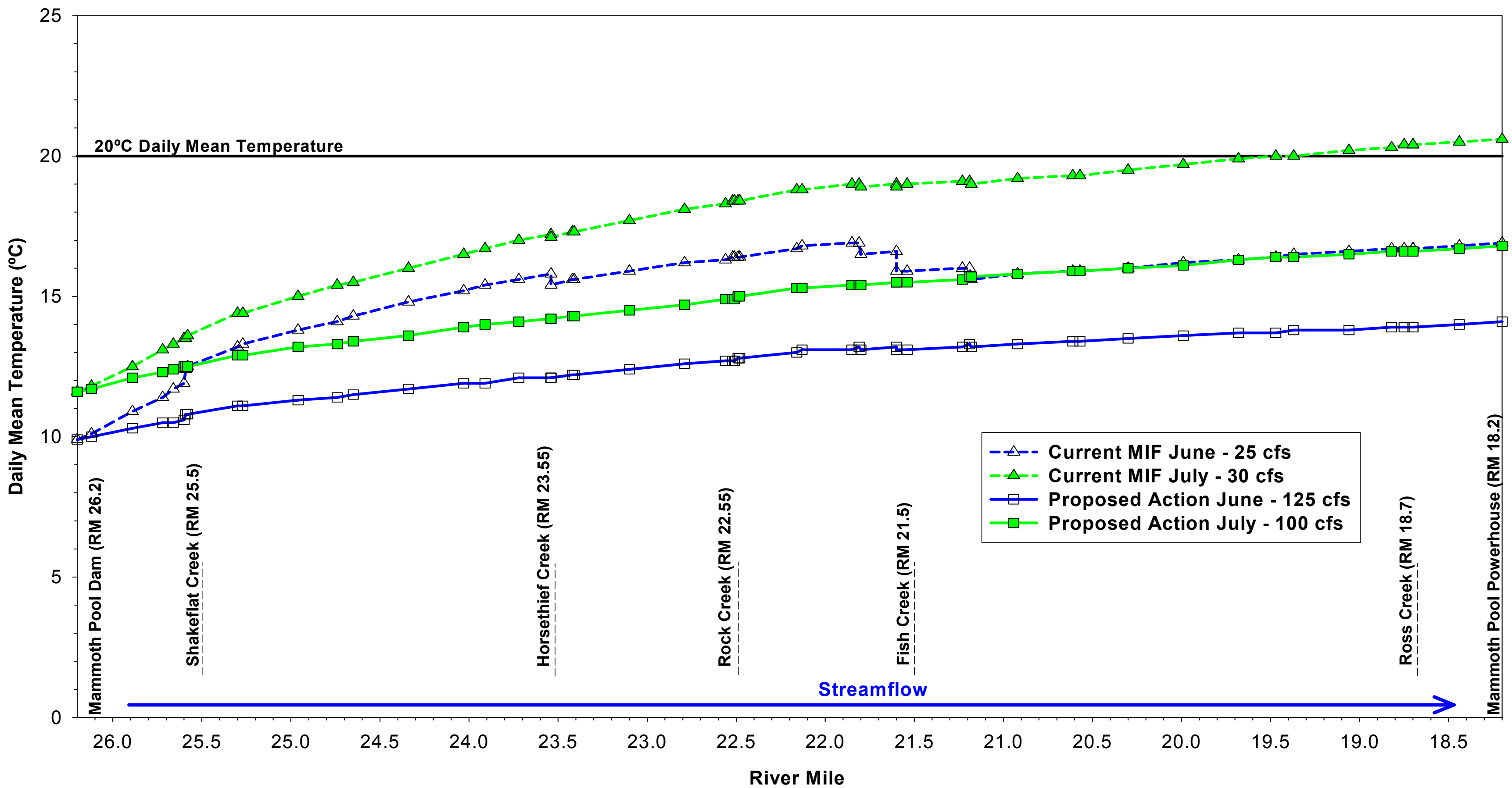


Figure 5.2.4.3.1-1. San Joaquin River Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse/Dam 6) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of June and July in Above Normal Water Years with Normal Meteorology.

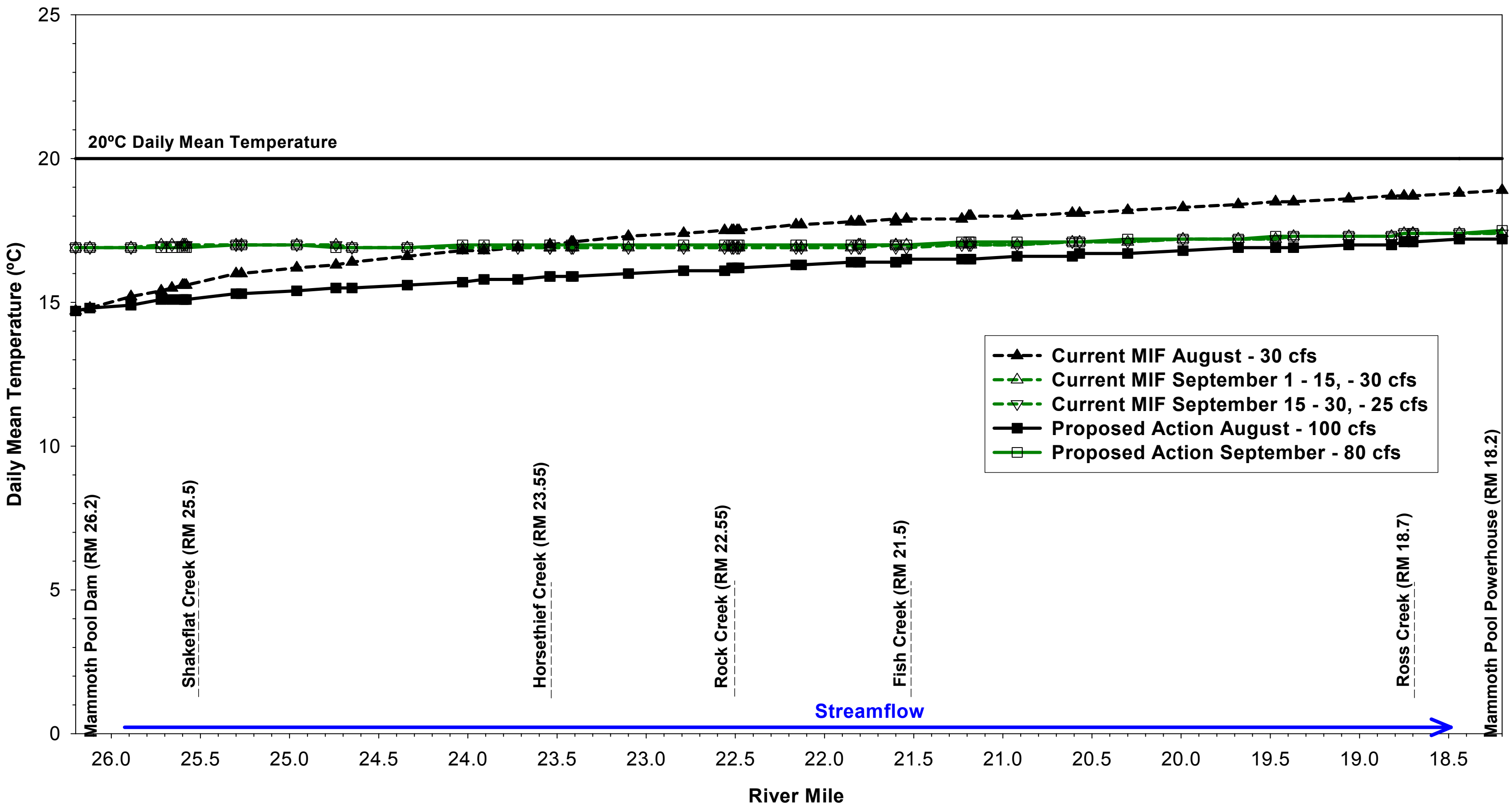


Figure 5.2.4.3.1-2. San Joaquin River Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse/Dam 6) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of August and September in Above Normal Water Years with Normal Meteorology.

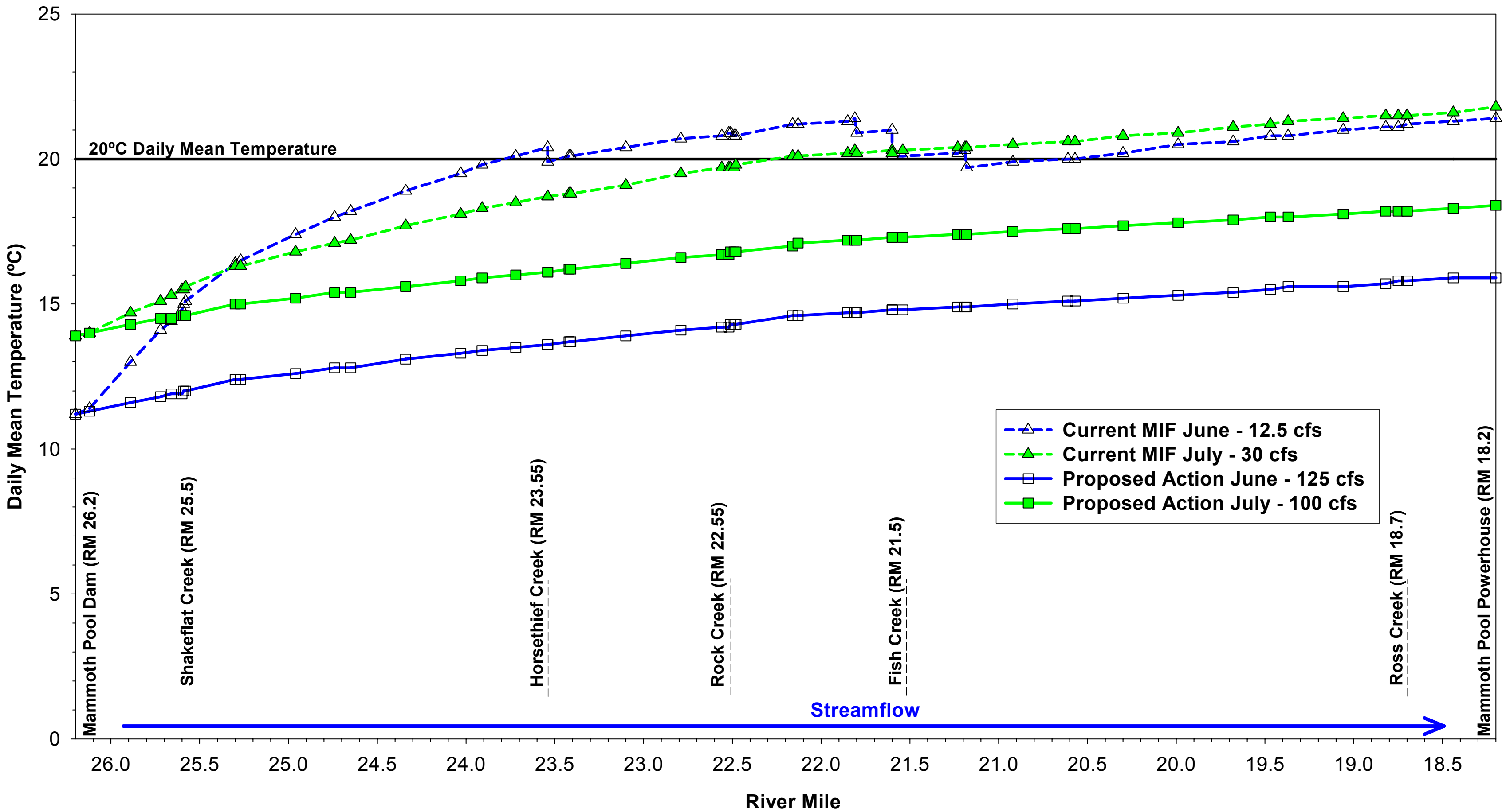


Figure 5.2.4.3.1-3. San Joaquin River Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse/Dam 6) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of June and July in Dry Water Years with Warm Meteorology.

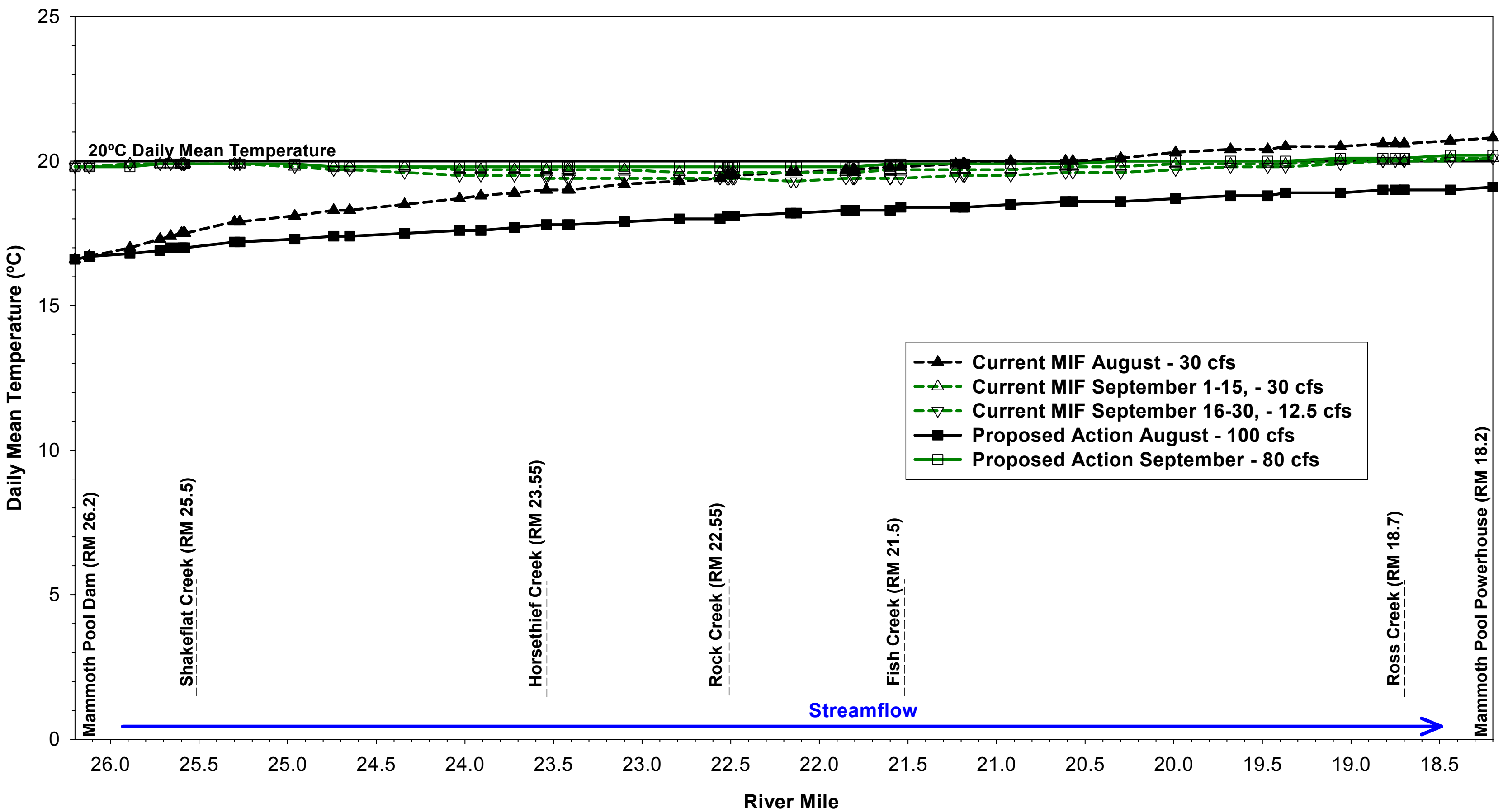
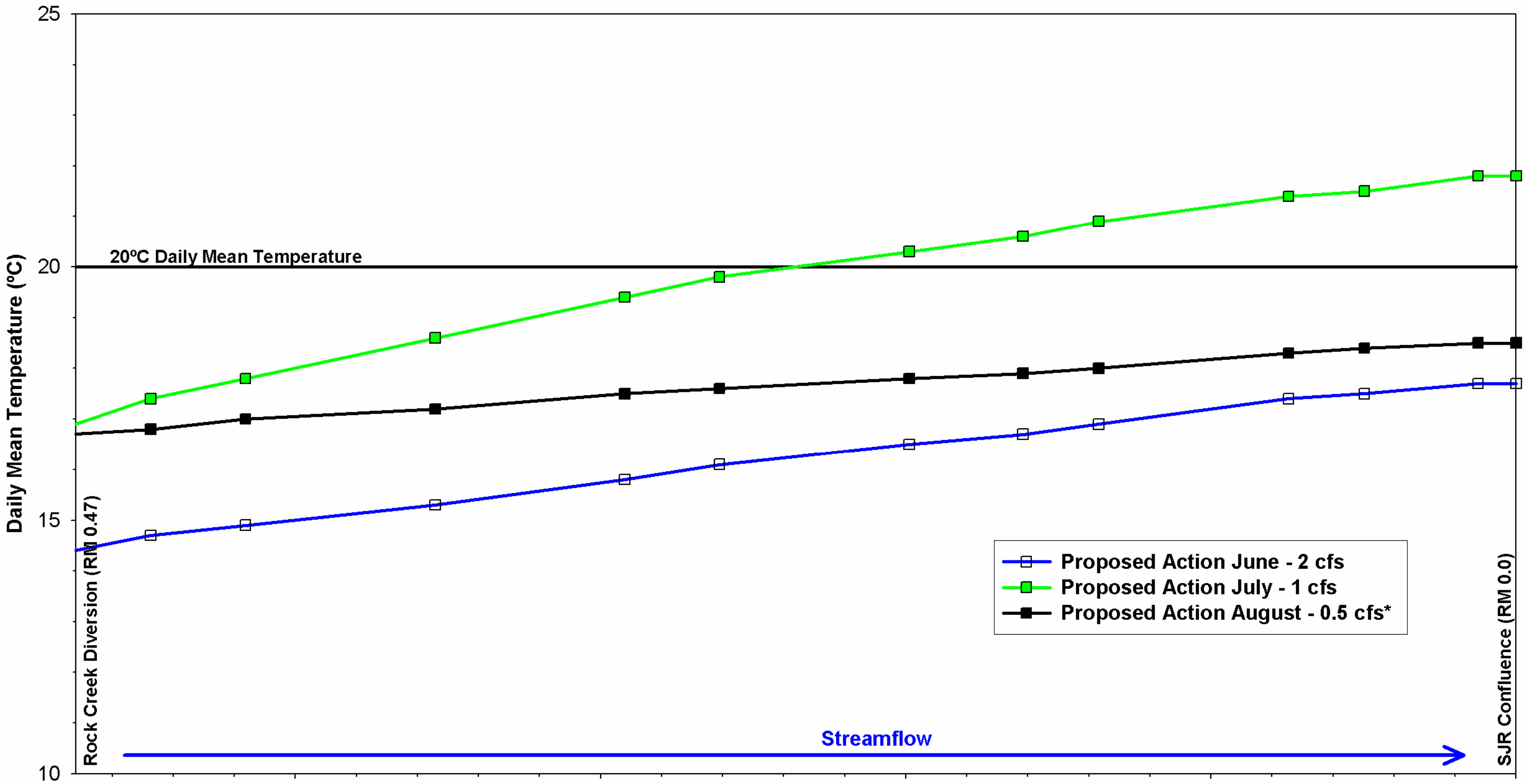


Figure 5.2.4.3.1-4. San Joaquin River Mammoth Reach (Mammoth Pool Dam to Mammoth Pool Powerhouse/Dam 6) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of August and September in Dry Water Years with Warm Meteorology.



*Proposed Action flow of 0.5 cfs was not modeled; Proposed Action flow is represented by the closest modeled flow of 1 cfs.
**Distances relative to the San Joaquin River (upstream)

Figure 5.2.4.3.1-5. Rock Creek Simulated Daily Mean Water Temperatures for Proposed Action for the Months of June, July and August in Above Normal Water Years with Normal Meteorology.

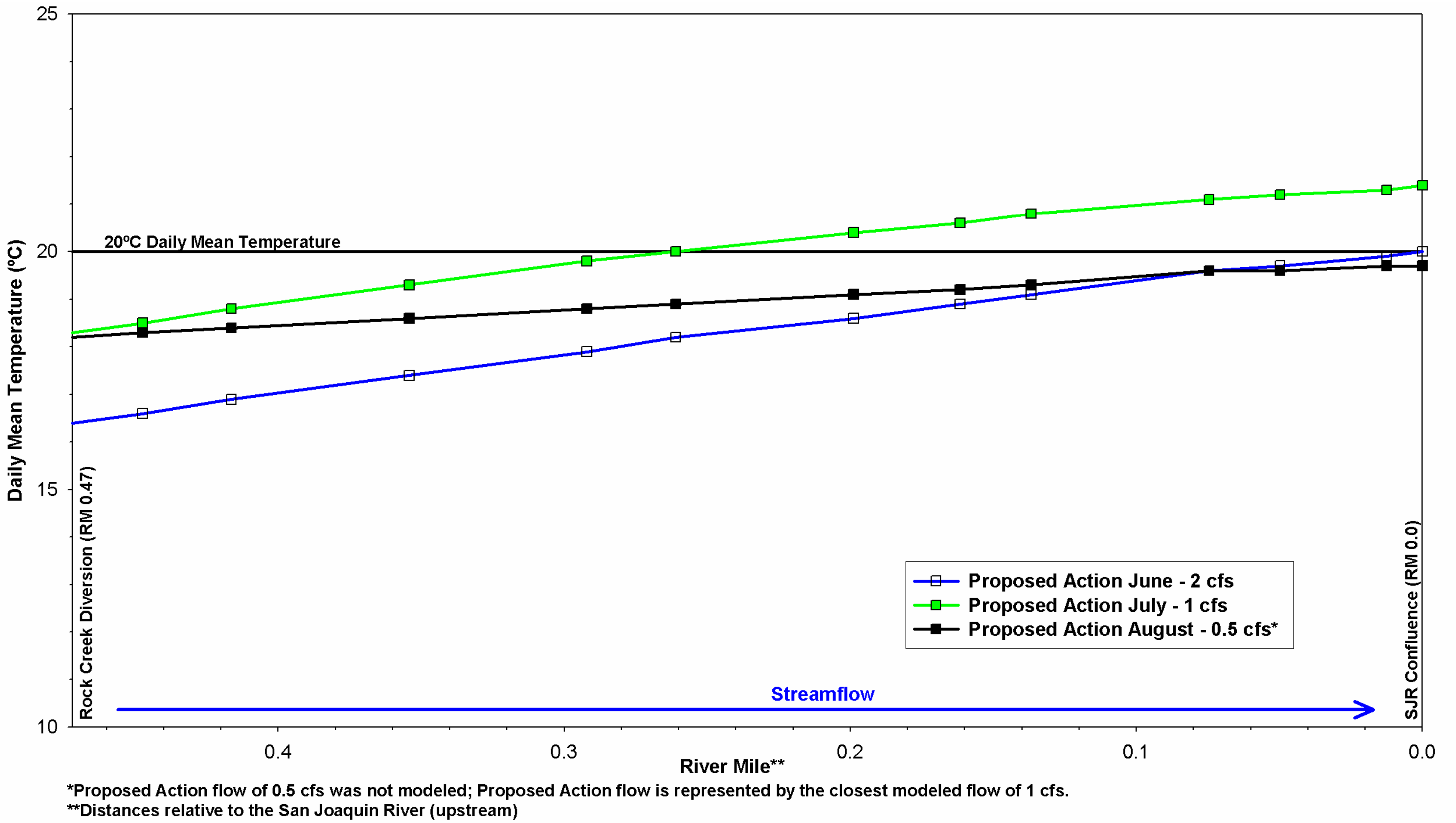
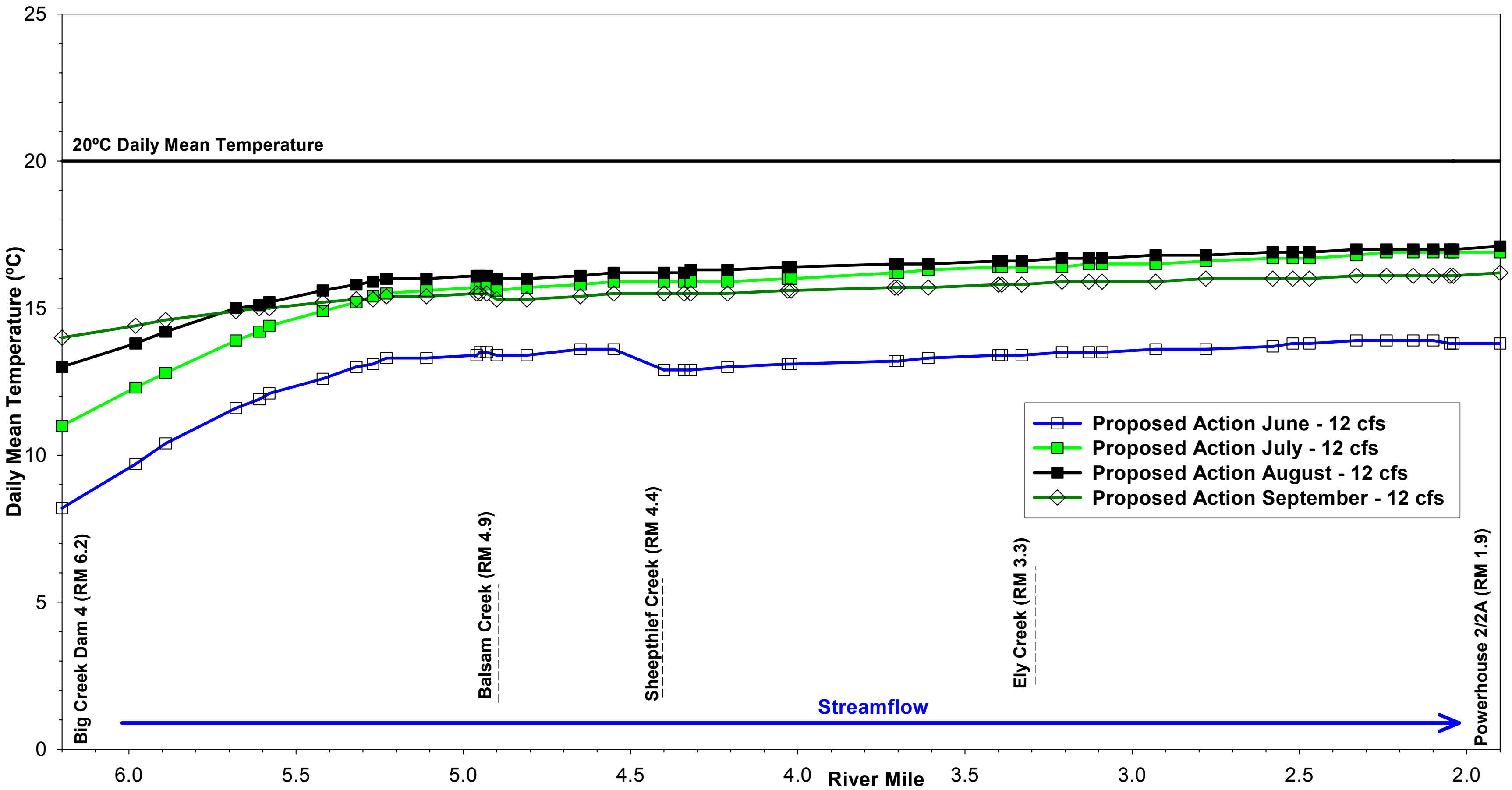
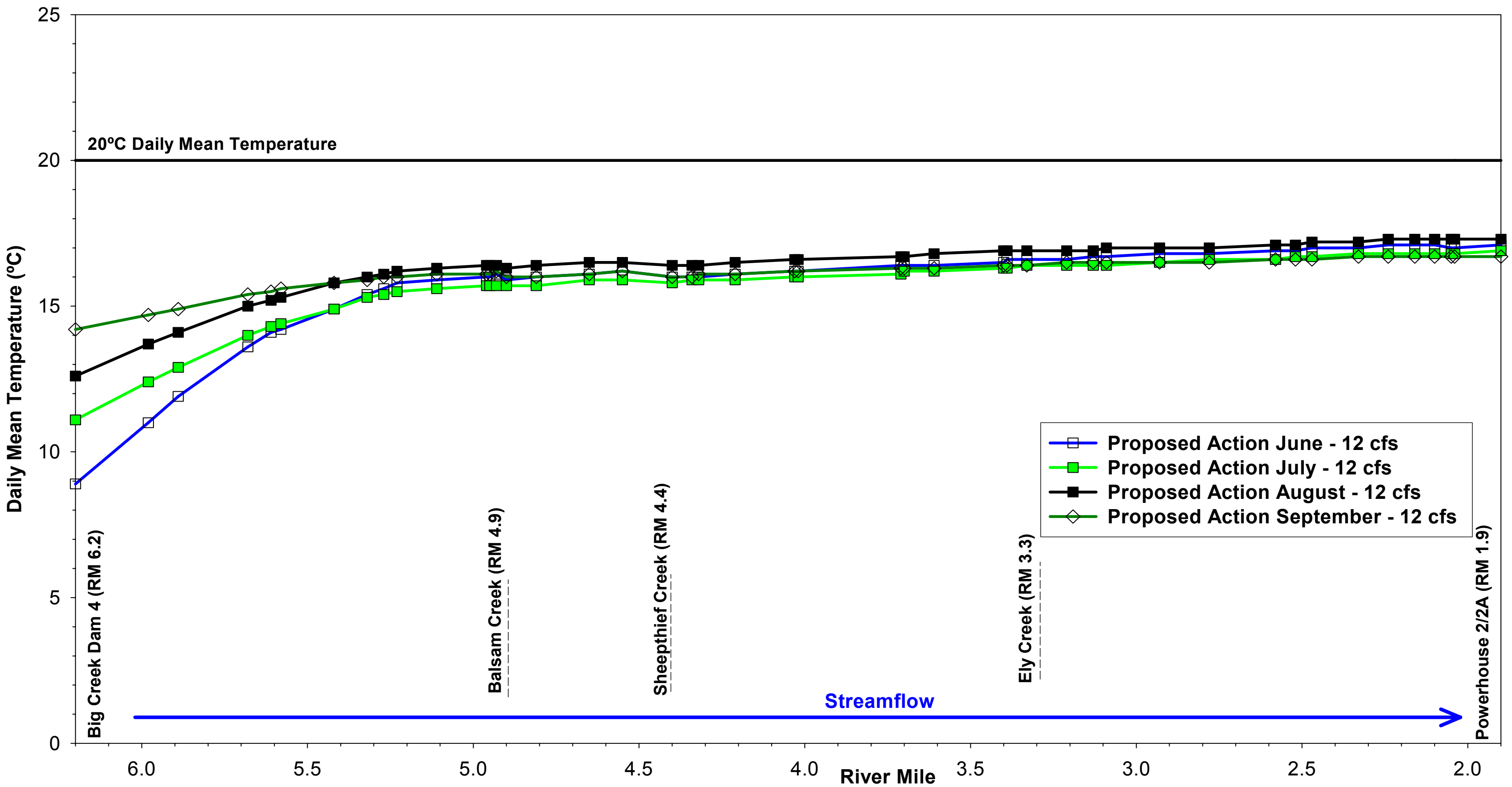


Figure 5.2.4.3.1-6. Rock Creek Simulated Daily Mean Water Temperatures for Proposed Action for the Months of June, July and August in Dry Water Years with Warm Meteorology.



*There are currently no Minimum Instream Flow (MIF) requirements downstream of Dam 4.

Figure 5.2.4.3.2-1. Big Creek (Dam 4 to Powerhouse 2/2A/Dam 5) Simulated Daily Mean Water Temperatures for Proposed Action for the Months of June, July, August and September in Above Normal Water Years with Normal Meteorology.



***There are currently no Minimum Instream Flow (MIF) requirements downstream of Dam 4.**

Figure 5.2.4.3.2-2. Big Creek (Dam 4 to Powerhouse 2/2A/Dam 5) Simulated Daily Mean Water Temperatures for Proposed Action for the Months of June, July August and September in Dry Water Years with Warm Meteorology.

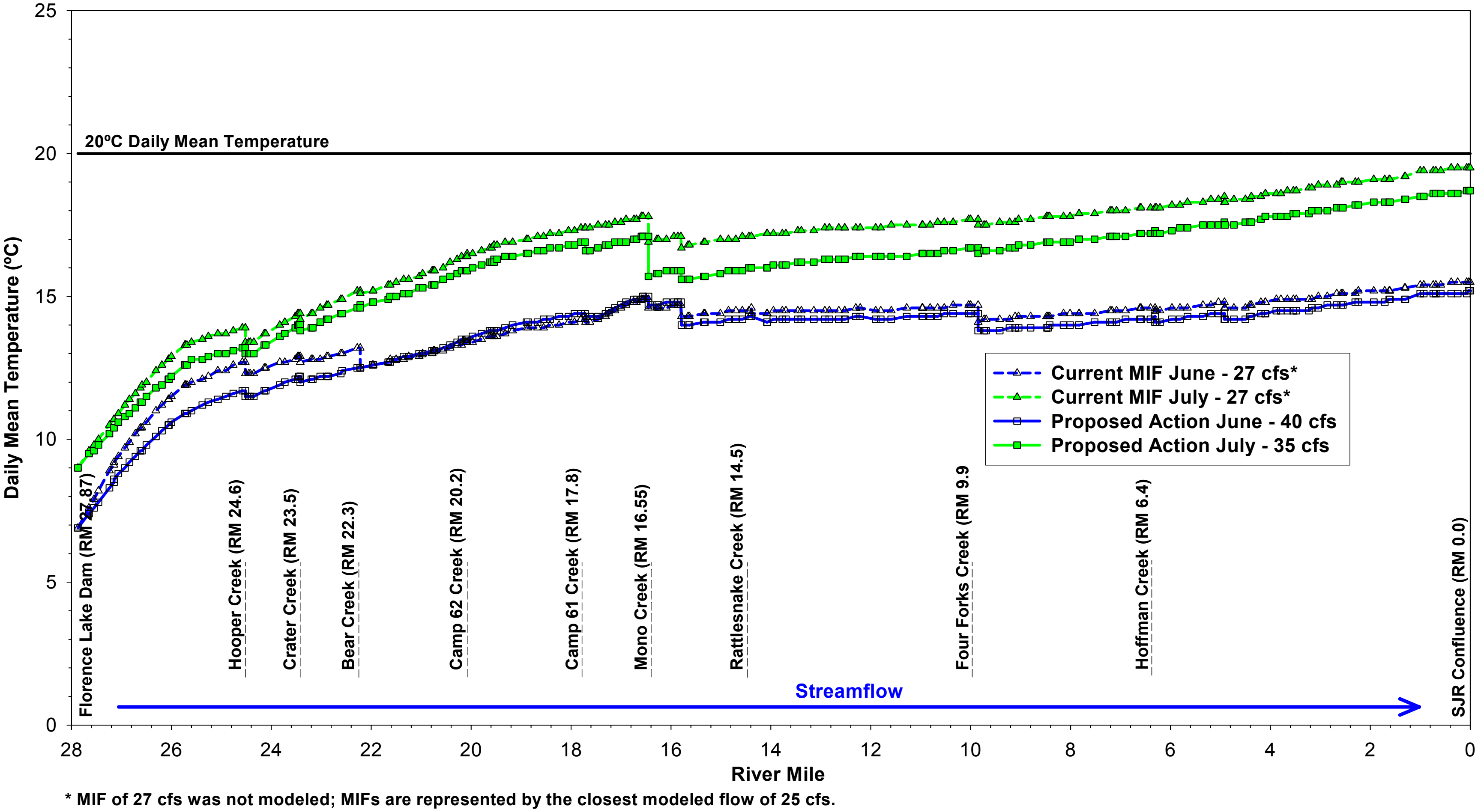
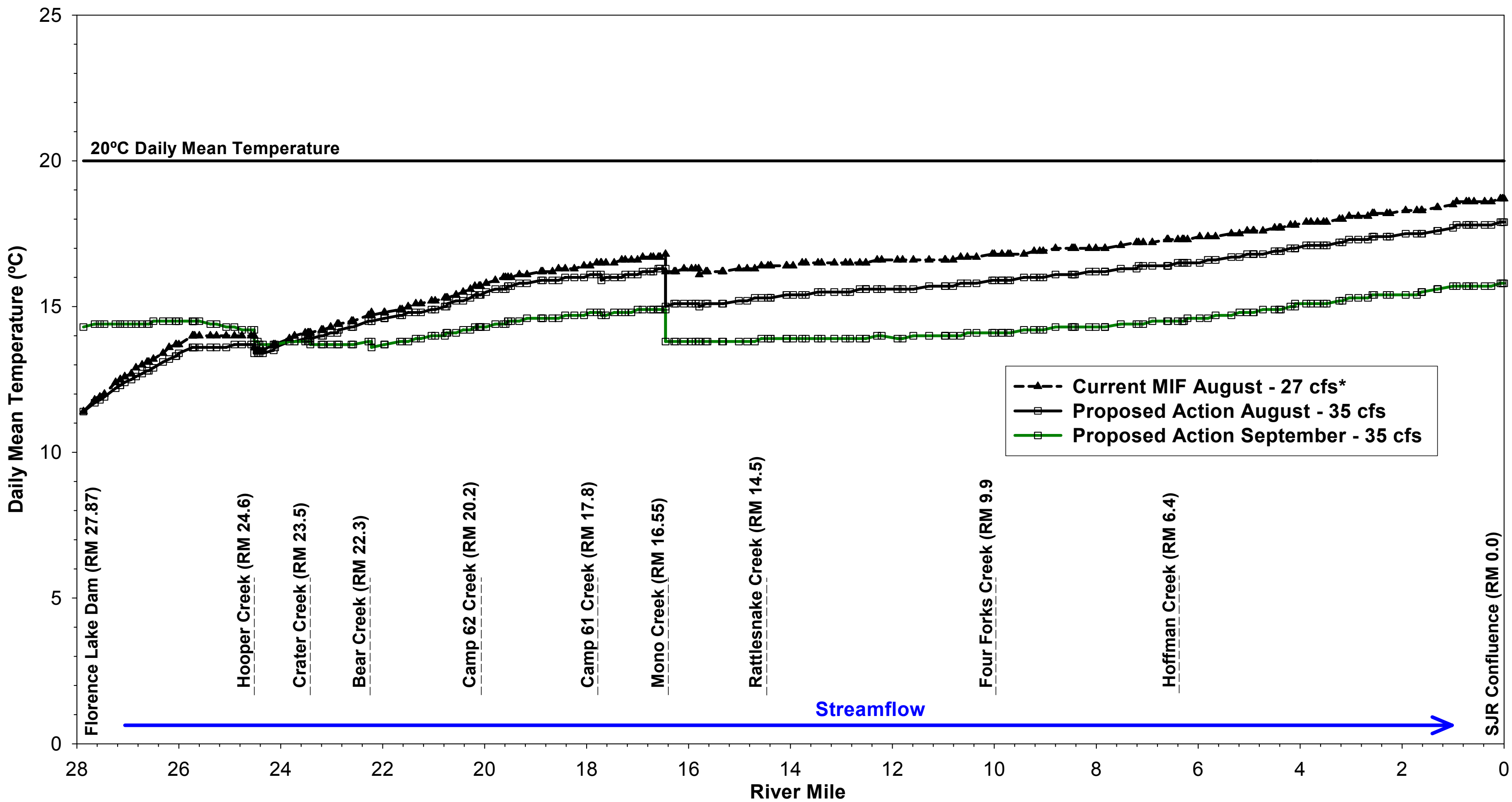


Figure 5.2.4.3.3-1. South Fork San Joaquin River Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Above Normal Water Years with Normal Meteorology.



* MIF of 27 cfs was not modeled; MIFs are represented by the closest modeled flow of 25 cfs.

Figure 5.2.4.3.3-2. South Fork San Joaquin River Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of August and September in Above Normal Water Years with Normal Meteorology.

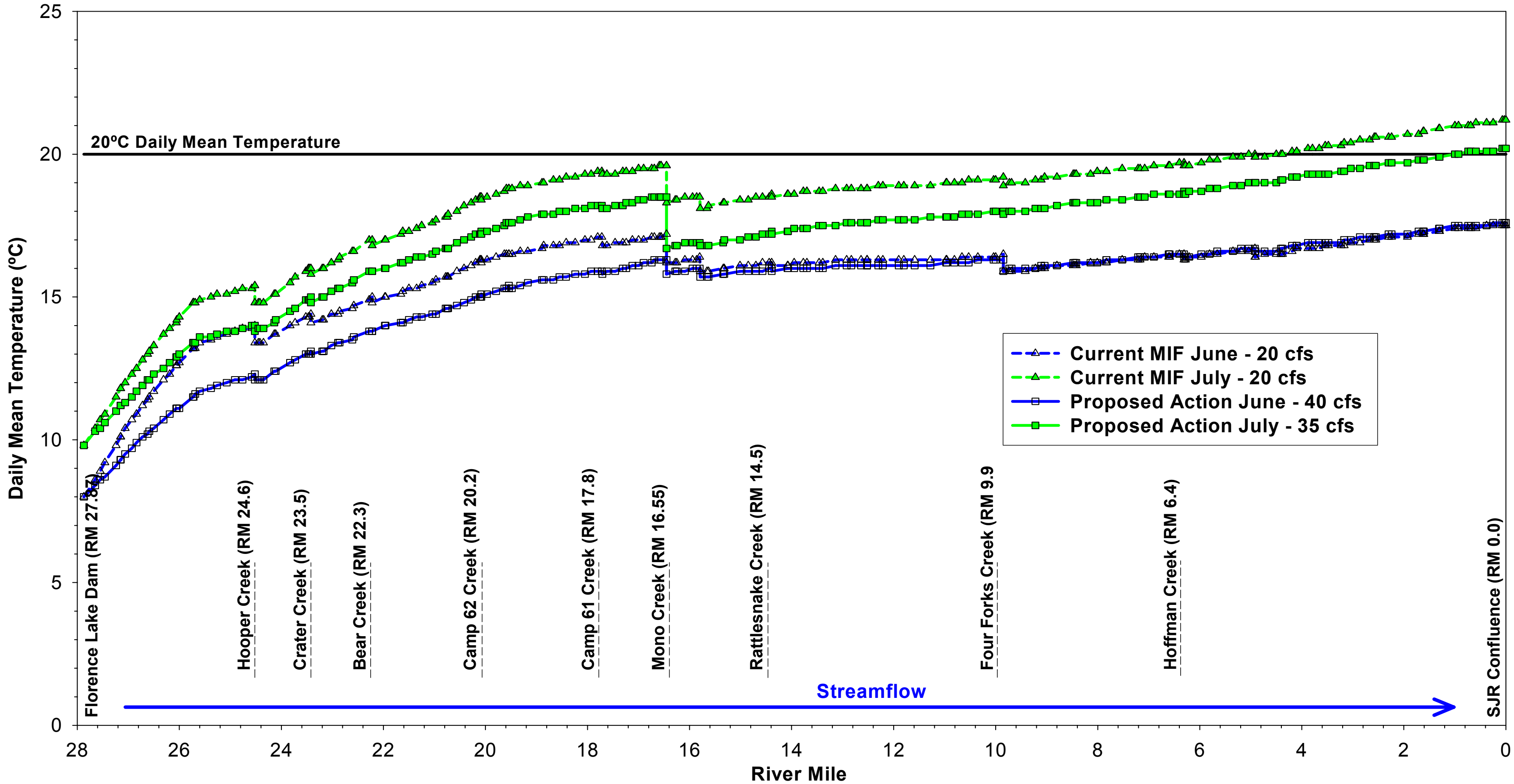


Figure 5.2.4.3.3-3. South Fork San Joaquin River Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Dry Water Years with Warm Meteorology.

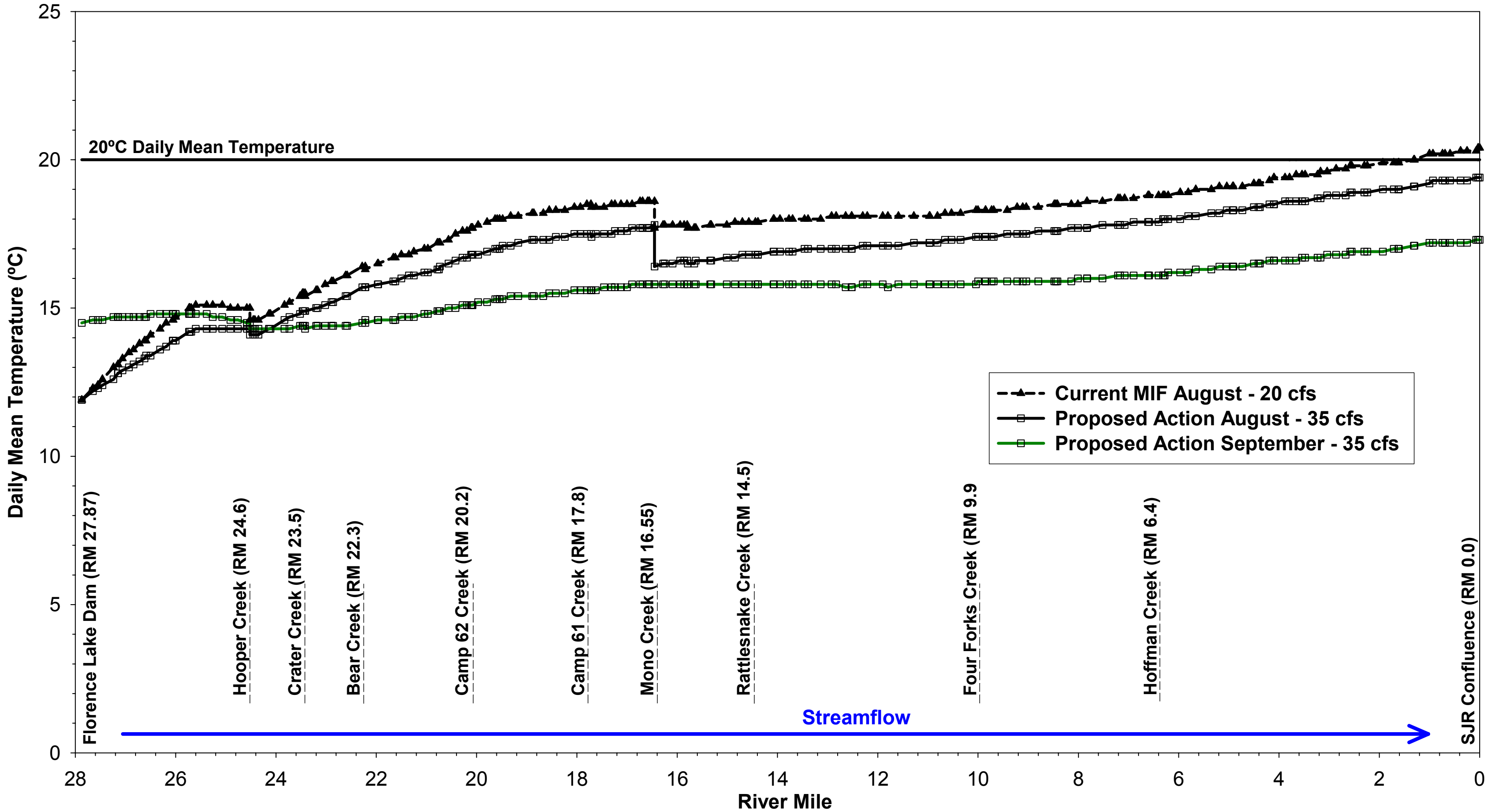


Figure 5.2.4.3.3-4. South Fork San Joaquin River Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of August and September in Dry Water Years with Warm Meteorology.

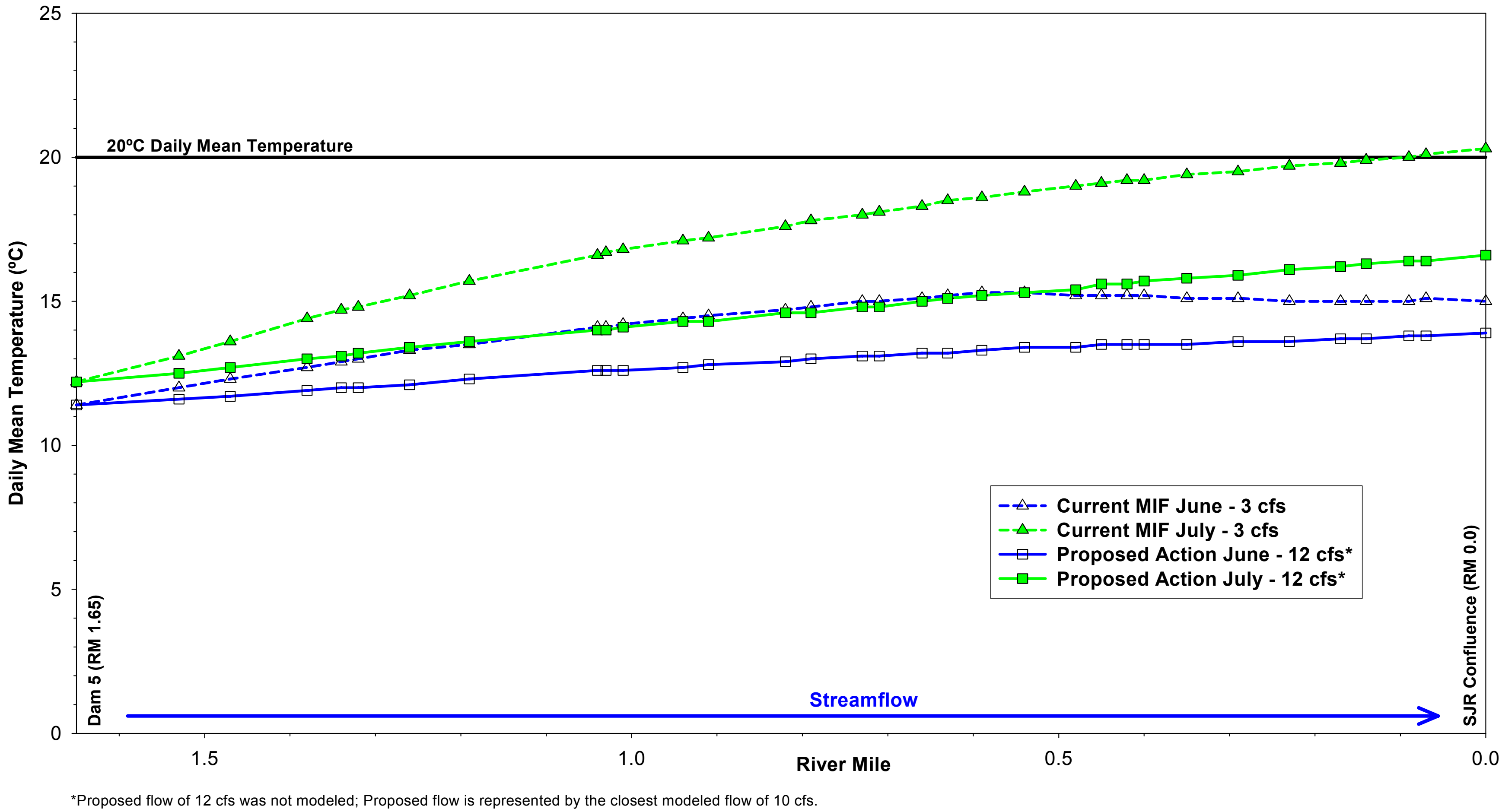


Figure 5.2.4.3.3-5. Big Creek (Dam 5 to Powerhouse 8/SJR) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Above Normal Water Years with Normal Meteorology.

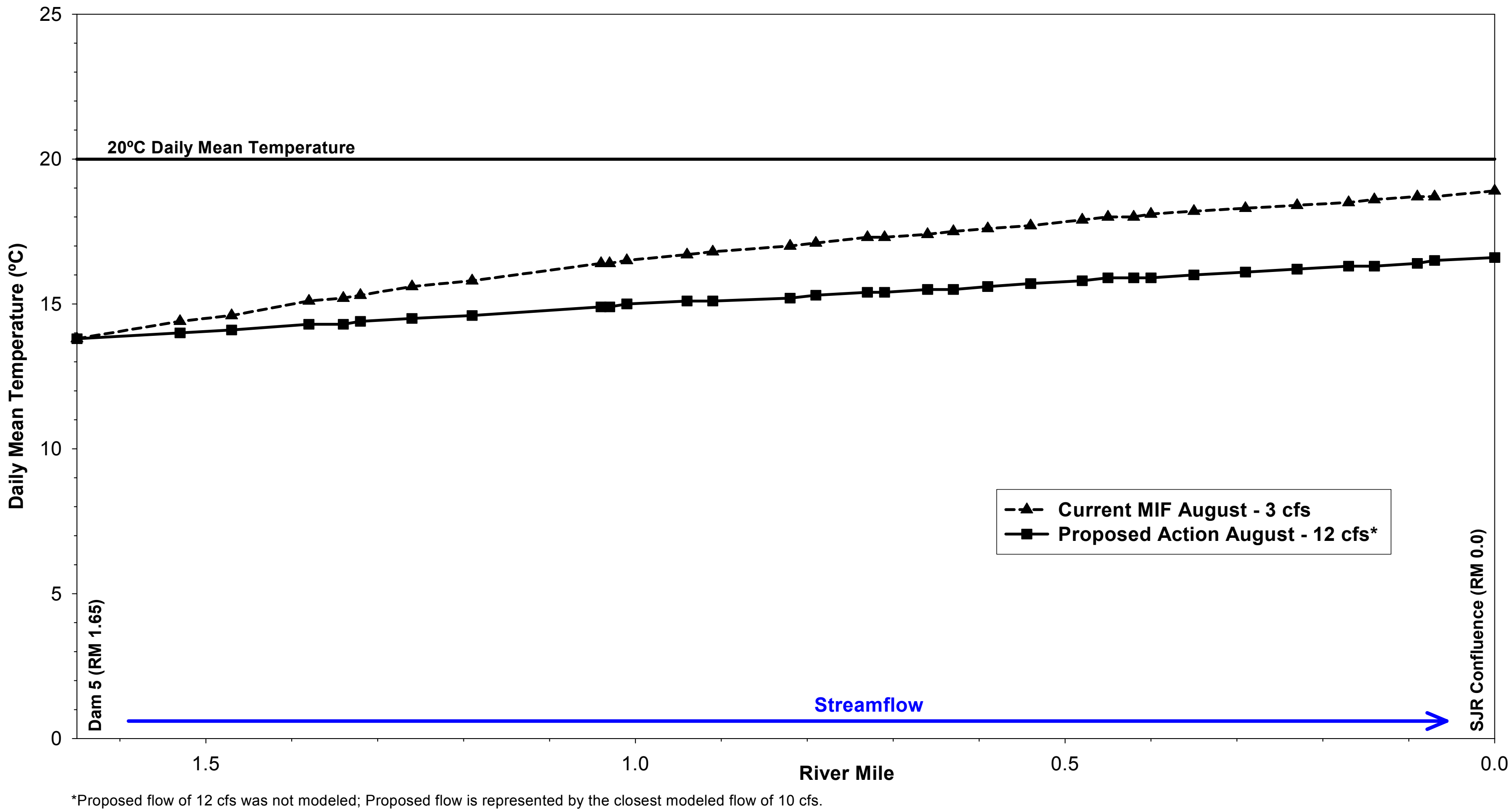


Figure 5.2.4.3.3-6. Big Creek (Dam 5 to Powerhouse 8/SJR) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Month of August in Above Normal Water Years with Normal Meteorology.

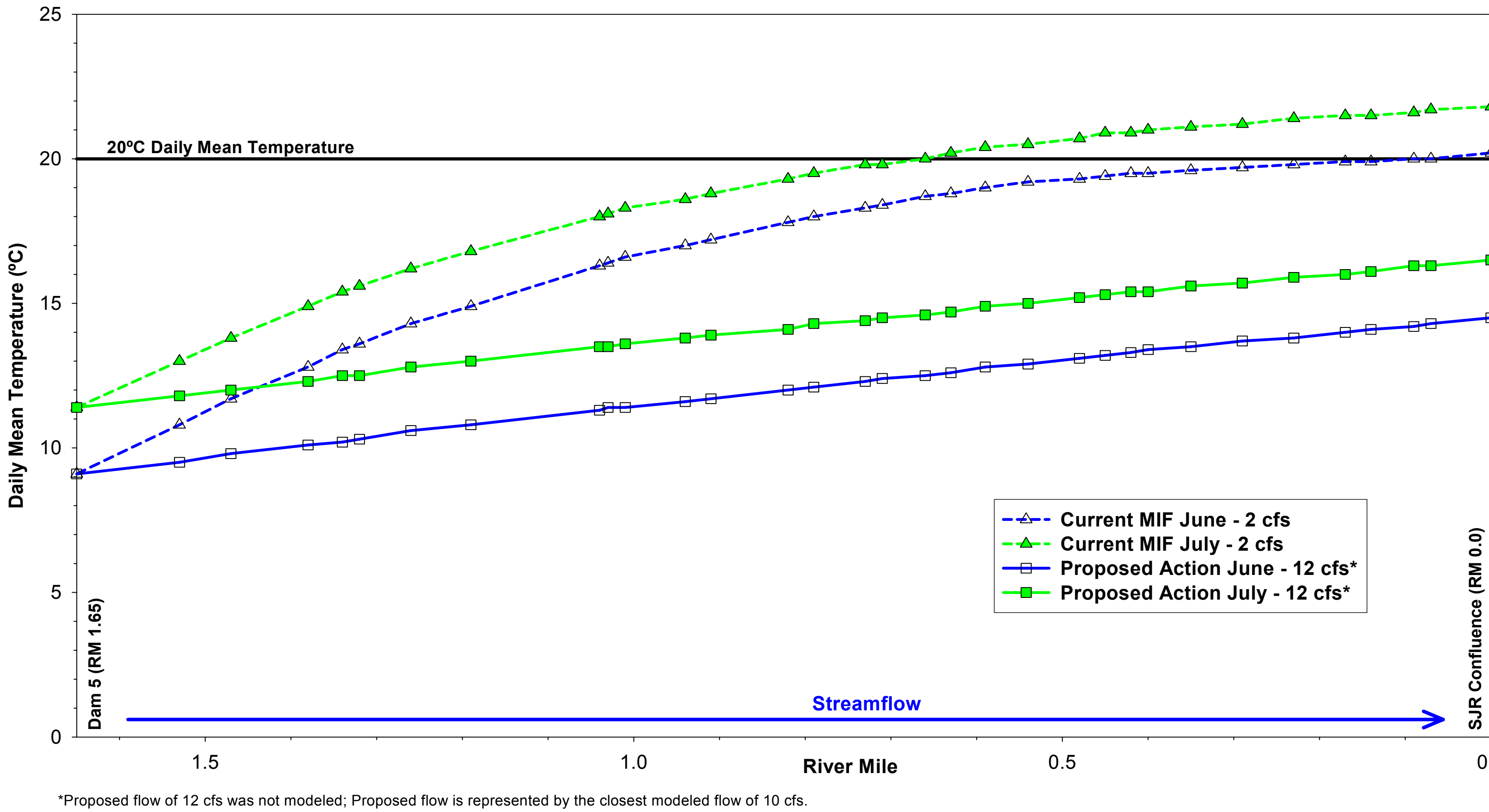


Figure 5.2.4.3.3-7. Big Creek (Dam 5 to Powerhouse 8/SJR) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Dry Water Years with Warm Meteorology.

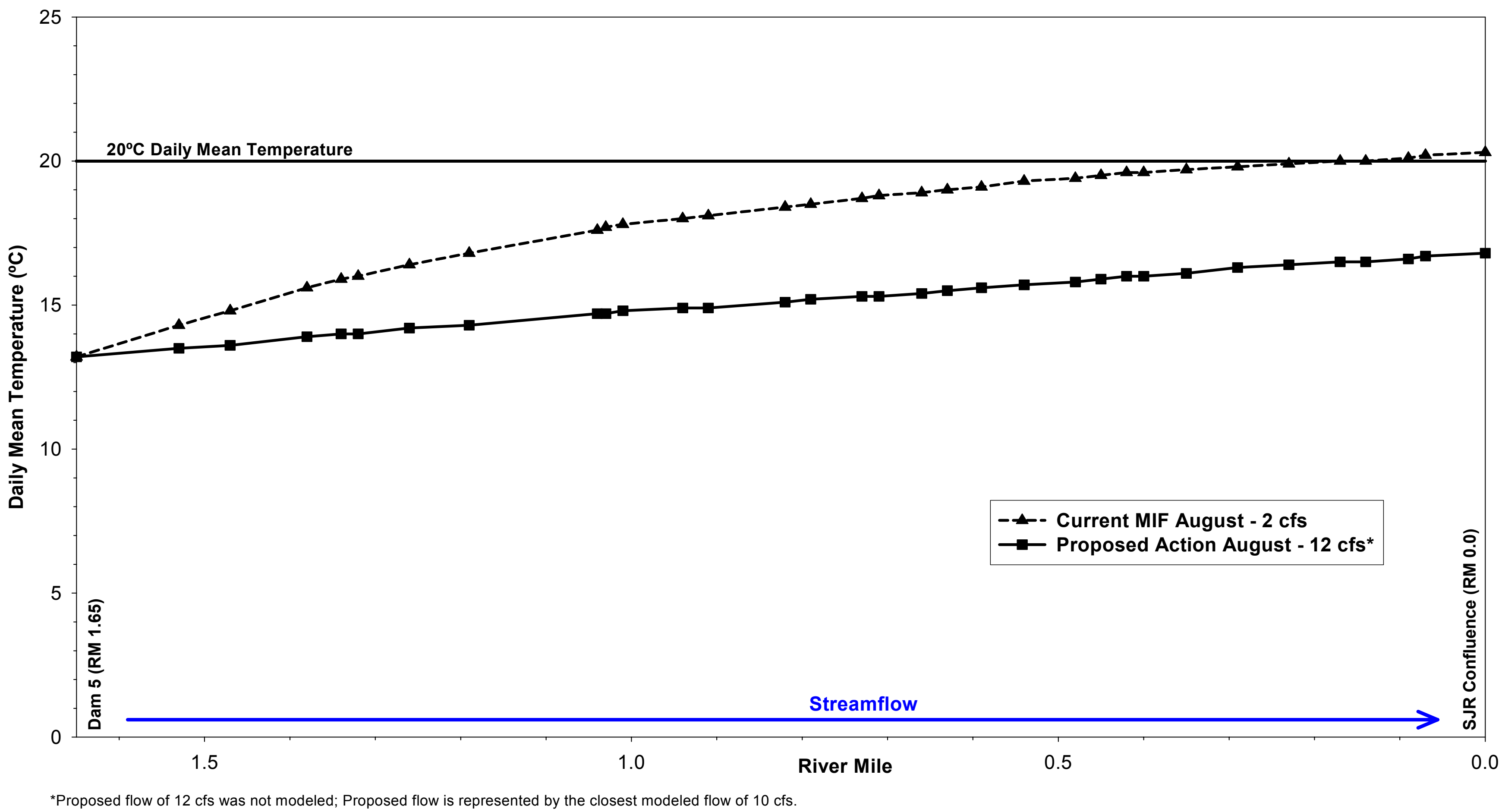
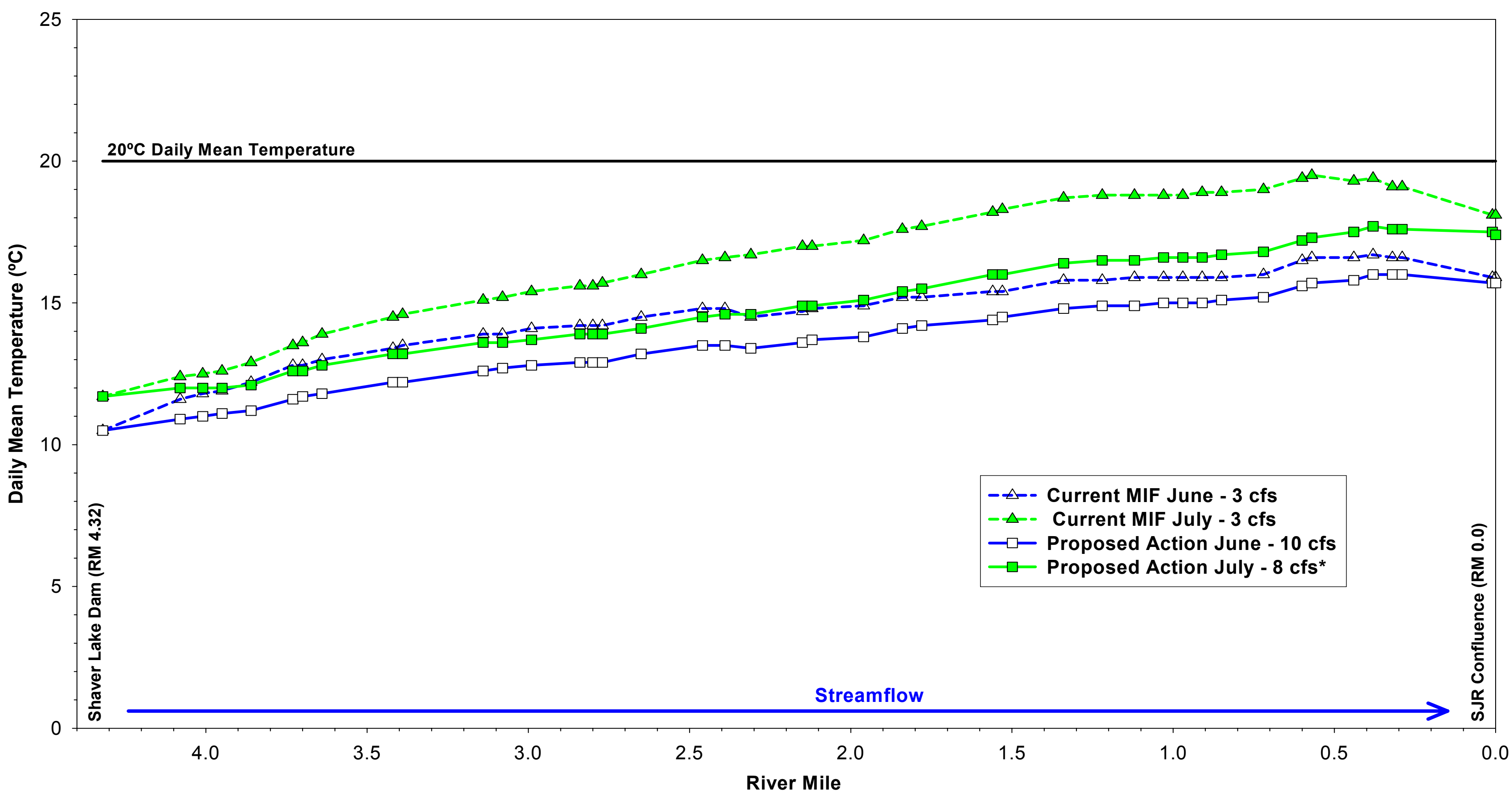
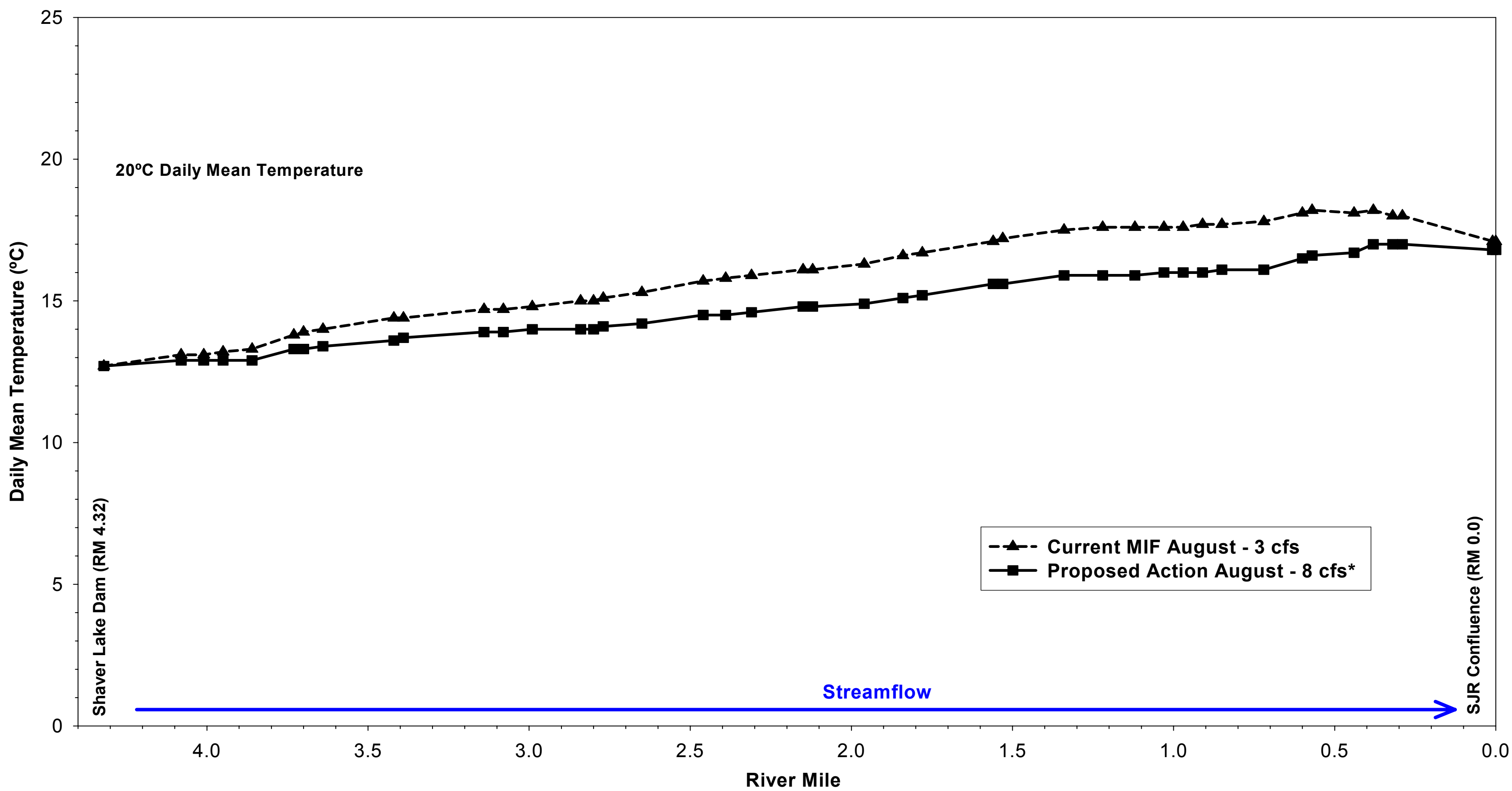


Figure 5.2.4.3.3-8. Big Creek (Dam 5 to Powerhouse 8/SJR) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Month of August in Dry Water Years with Warm Meteorology.



* Proposed Action flow of 8 cfs was not modeled; Proposed flow is represented by the closest modeled flow of 10 cfs.

Figure 5.2.4.3.3-9. Stevenson Creek (Shaver Lake Dam to San Joaquin River) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Above Normal Water Years with Normal Meteorology.



*** Proposed Action flow of 8 cfs was not modeled; Proposed flow is represented by the closest modeled flow of 10 cfs.**

Figure 5.2.4.3.3-10. Stevenson Creek (Shaver Lake Dam to San Joaquin River) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Month of August in Above Normal Water Years with Normal Meteorology.

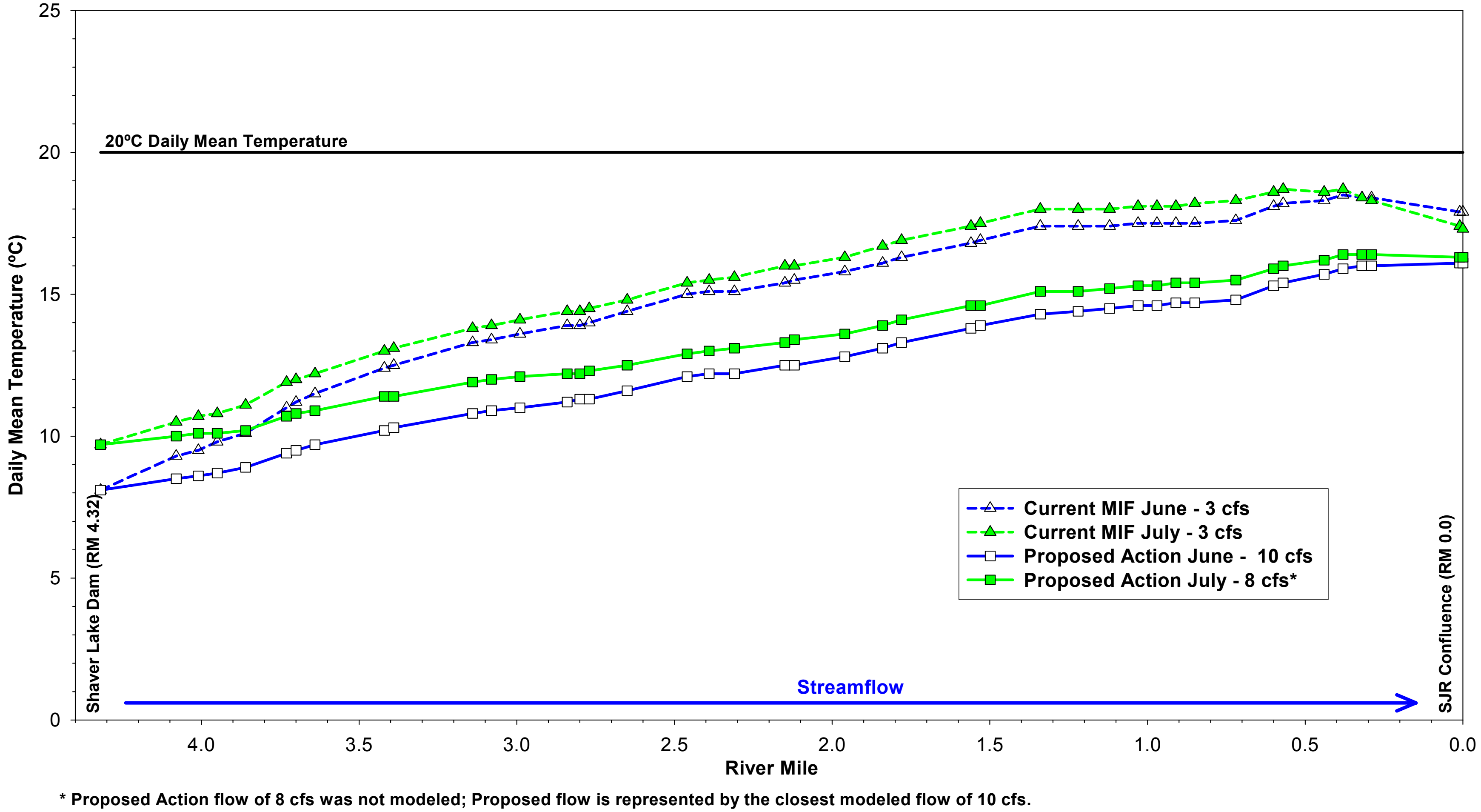
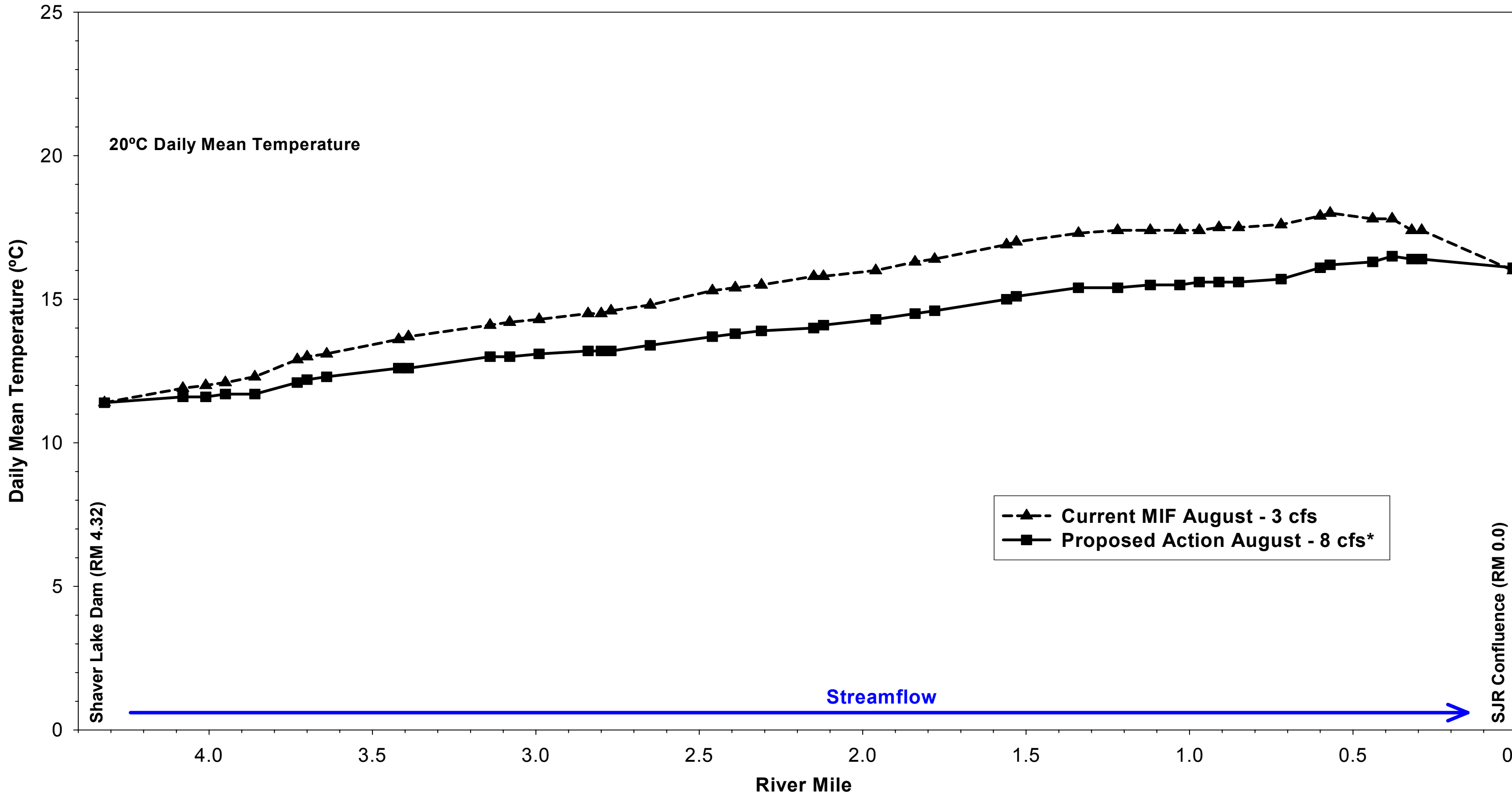
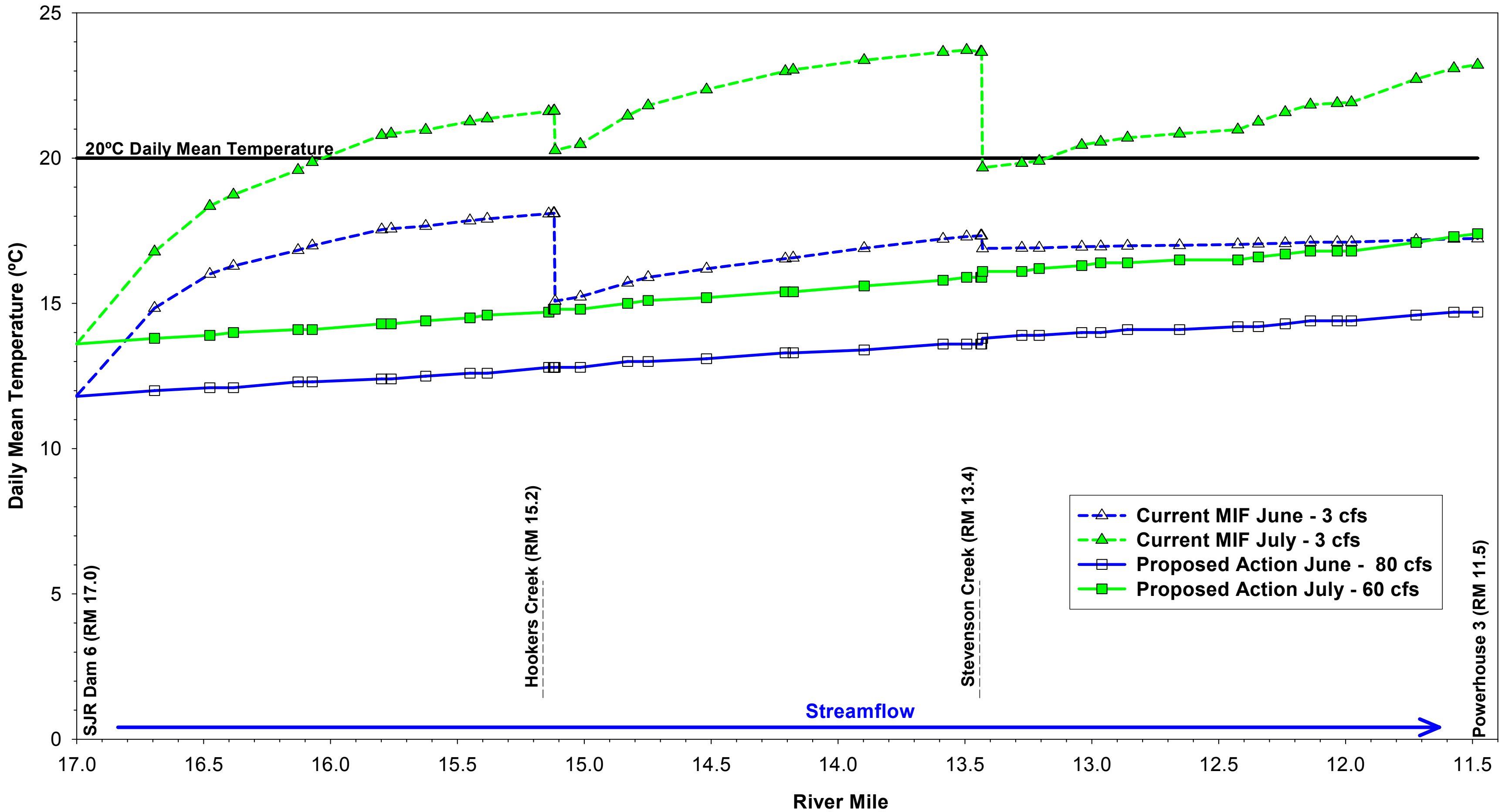


Figure 5.2.4.3.3-11. Stevenson Creek (Shaver Lake Dam to San Joaquin River) Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Months of June and July in Dry Water Years with Warm Meteorology.



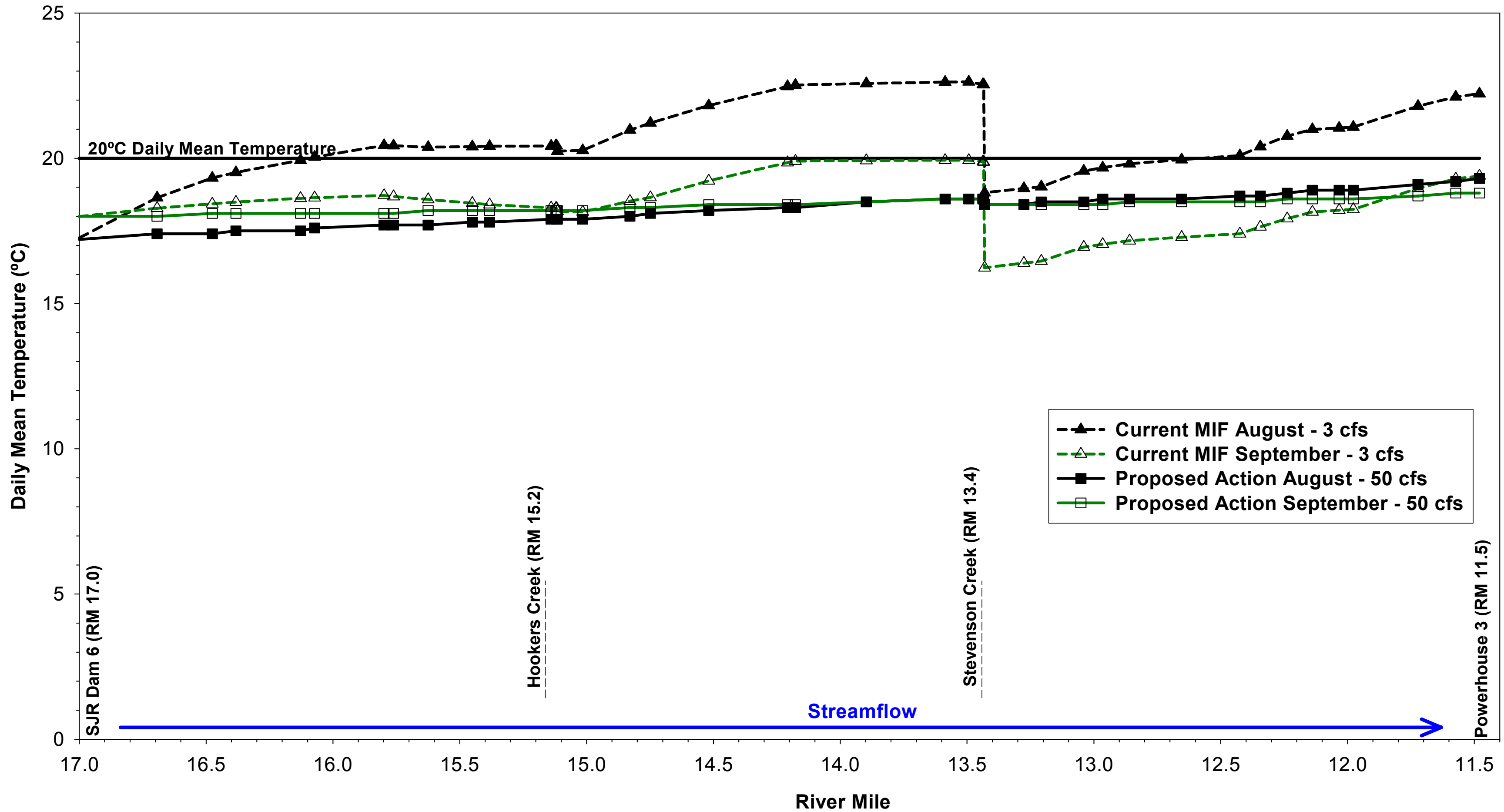
* Proposed Action flow of 8 cfs was not modeled; Proposed flow is represented by the closest modeled flow of 10 cfs.

Figure 5.2.4.3.3-12. Stevenson Creek (Shaver Lake Dam to San Joaquin River Simulated Daily Mean Water Temperatures for Proposed Action and Minimum Instream Flows (MIF) for the Month of August in Dry Water Years with Warm Meteorology.



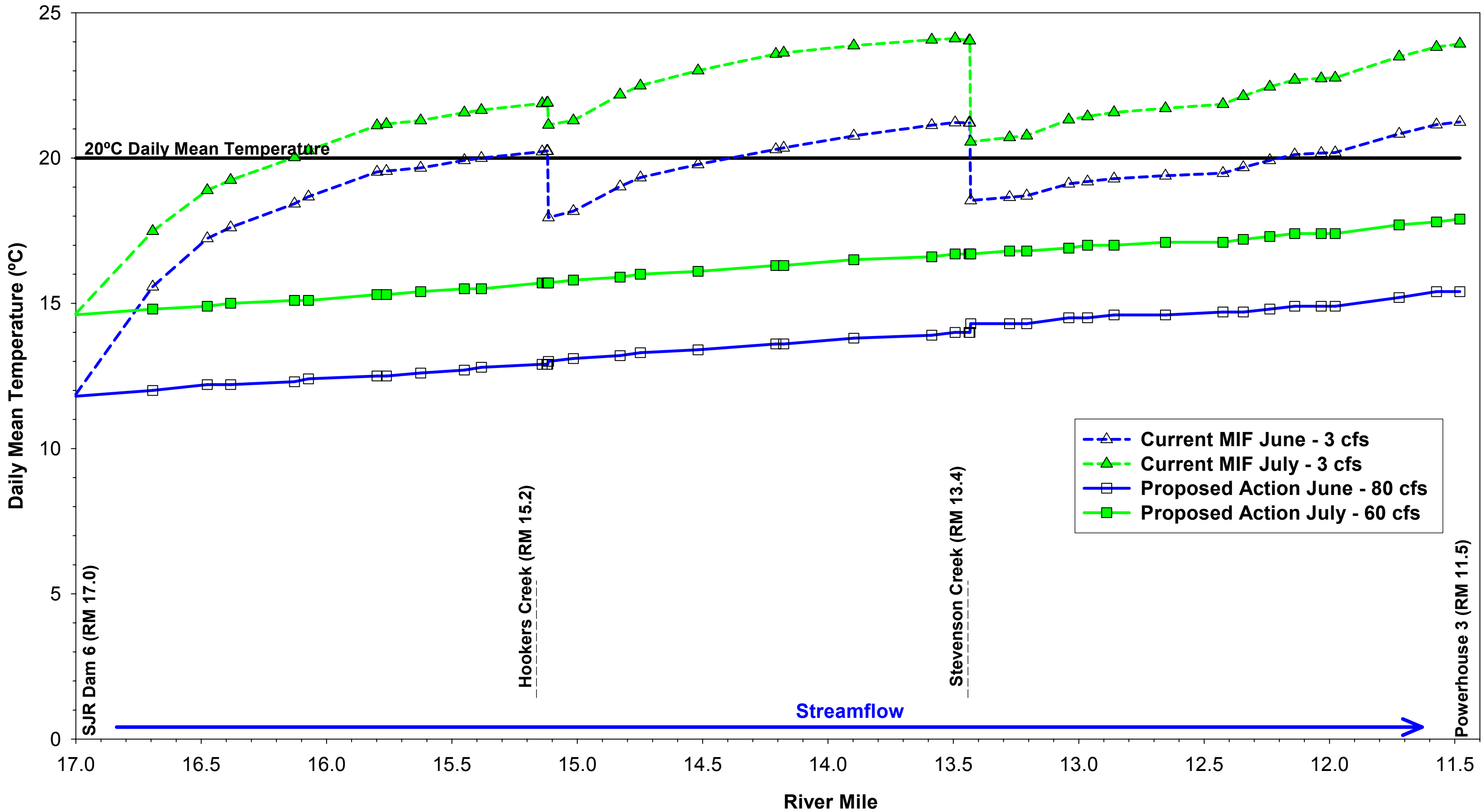
* Proposed flow released from Dam 6. Model includes proposed flow from Dam 6 and Stevenson Creek.

Figure 5.2.4.3.4-1. San Joaquin River Stevenson Reach (Dam 6 to Powerhouse 3/Redinger Lake) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of June and July in Above Normal Water Years with Normal Meteorology.



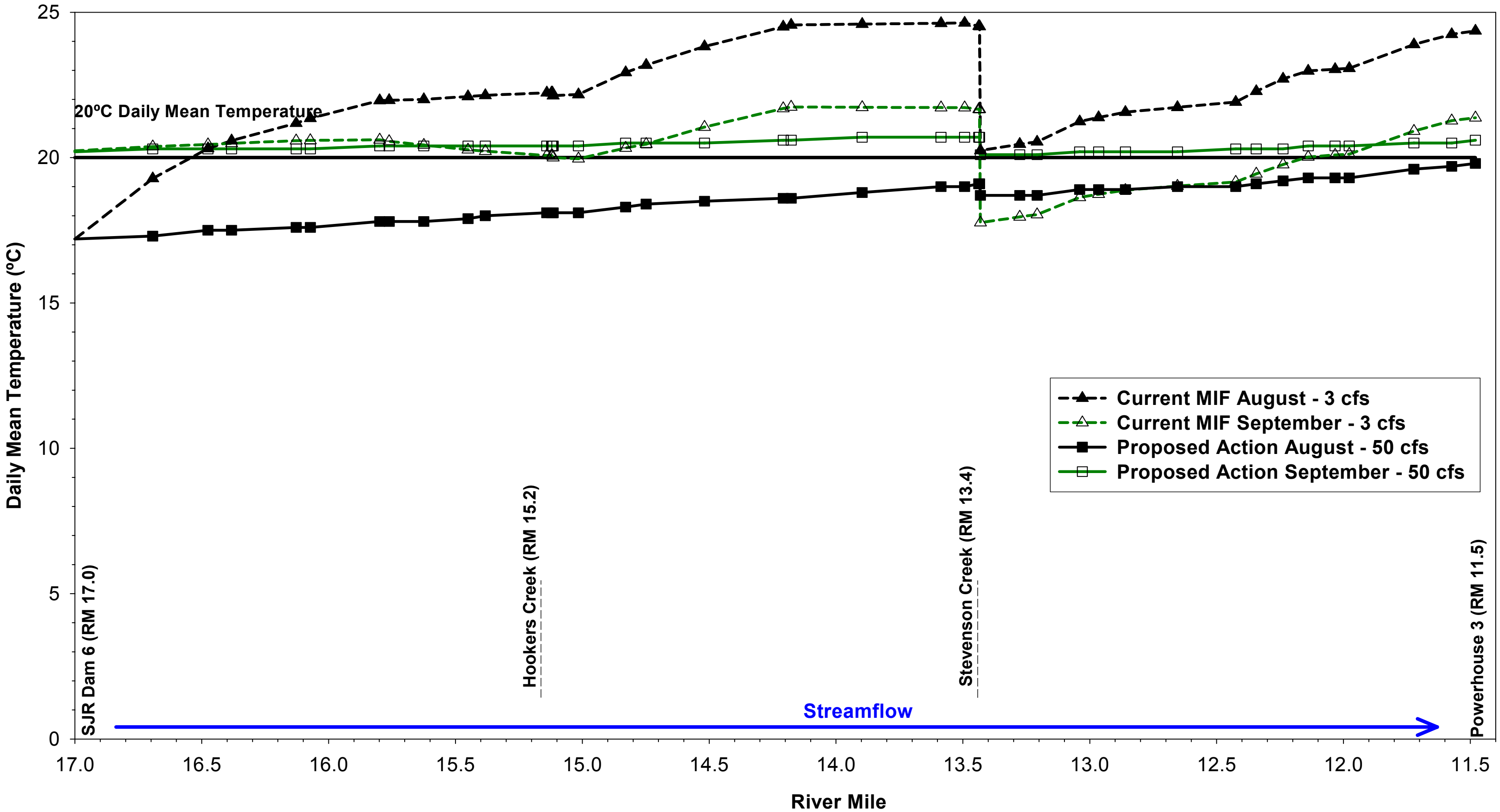
* Proposed flow released from Dam 6. Model includes proposed flow from Dam 6 and Stevenson Creek.

Figure 5.2.4.3.4-2. San Joaquin River Stevenson Reach (Dam 6 to Powerhouse 3/Redinger Lake) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of August and September in Above Normal Water Years with Normal Meteorology.



* Proposed flow released from Dam 6. Model includes proposed flow from Dam 6 and Stevenson Creek.

Figure 5.2.4.3.4-3. San Joaquin River Stevenson Reach (Dam 6 to Powerhouse 3/Redinger Lake) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of June and July in Dry Water Years with Warm Meteorology.



* Proposed flow released from Dam 6. Model includes proposed flow from Dam 6 and Stevenson Creek.

Figure 5.2.4.3.4-4. San Joaquin River Stevenson Reach (Dam 6 to Powerhouse 3/Redinger Lake) Simulated Daily Mean Water Temperatures for Proposed Action and Current Minimum Instream Flows (MIF) for the Months of August and September in Dry Water Years with Warm Meteorology.