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5.2.6 Riparian Resources

5.2.6.1 Environmental Setting and Expected Environmental Impacts

This section describes the riparian resources in the vicinity of the four BC ALP Projects, potential riparian resources issues under existing Project operations (No Action Alternative), and environmental effects of implementation of new environmental measures recommended in the Proposed Action.

Methods

This assessment of riparian resources is based on a review of relevant information, qualitative and quantitative studies, and extensive agency and other stakeholder consultation. The riparian and meadow habitats along bypass and flow-augmented streams in the vicinity of the four BC ALP Projects and selected comparison streams were evaluated between 2002 and 2006. The objectives of the studies were to evaluate existing conditions and determine the effects of modified flow regimes on riparian resources.

Riparian studies included:

- Mapping of riparian and meadow locations and coverage extents in 2002 as described in CAWG 11, Riparian, Section 4.0, Study Methodology, 2002 Technical Study Report (TSR) (SCE 2003; Volume 4, SD-C (Books 9 and 21)), and TERR 1, Vegetation Communities, Section 5.0, Study Results and Analysis, 2002 TSR (SCE 2003; Volume 4, SD-C (Books 10 and 22)).

- Data evaluation of identified adjustable reaches (2002 surveys) containing potential floodplains and/or segments along which riparian resources may have been altered by Project operations. These segments are listed in Table 5.2.6-1, and described in CAWG 11, Riparian, 2002 and 2003 TSRs (SCE 2003; SCE 2004; Volume 4, SD-C (Books 9 and 21) and SD-D (Books 14 and 23)) and CAWG 2, Geomorphology, 2002 and 2003 TSRs (SCE 2003; SCE 2004; Volume 4, SD-C (Books 7 and 21) and SD-D (Books 11 and 23)).

- Quantitative studies along adjustable and comparison segments on unregulated streams in 2003 as listed in Table 5.2.6-1. Limited hydrology data for most of the comparison streams constrained the development of deterministic relationships between hydrologic regime and riparian vegetation attributes. Detailed reporting of the quantitative studies can be found in CAWG 11, Riparian, 2003 TSR, Section 4.0, Study Methodology and Appendix A (SCE 2004; Volume 4, SD-D (Books 14 and 23)).

- Utilization of information from other Big Creek ALP relicensing studies to further evaluate potential effects of flow-related changes caused by Project operations on riparian resources, including CAWG 2, Geomorphology; CAWG 3, Instream Flow

Studies-PHABSIM; and CAWG 6, Hydrology, 2003 TSRs (SCE 2004; Volume 4, SD-D (Books 11, 13 and 23)).

- HEC-RAS and PHABSIM modeling to evaluate the relationship between flows under current operations and existing riparian vegetation on certain streams. The HEC-RAS hydraulic modeling and results are described in CAWG 2, Geomorphology, 2003 TSR, Appendices 7.2.1 and 7.2.2, and CAWG 3, Instream Flow Studies-PHABSIM, 2003 TSRs (SCE 2004; Volume 4, SD-D (Books 11 and 23)). The availability of existing hydrologic data and synthetic data for the stream reaches is discussed in CAWG 6, Hydrology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 13 and 23)).

- Additional studies on two streams, South Fork San Joaquin River – Jackass Meadow area (Jackass Meadow Inundation Study (SCE 2005a; SCE 2007a; Volume 4, SD-E (Books 19 and 24)) and Mono Creek downstream of the Mono Creek Diversion Dam (Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)) in 2005 and 2006, to refine the relationship between riparian and geomorphic resources and flow magnitudes.

An important consideration during the interpretation of the qualitative and quantitative data is that the existing conditions of the riparian community reflect historical and recent climatic conditions, land uses, watershed activities, hydrology, and sediment transport. A general description of the existing riparian resources along each bypass and flow-augmented stream for each of the four BC ALP Projects is provided in the following section.

5.2.6.2 Affected Environment

Significant riparian habitat occurs along approximately 47 river miles or 54% of the total river miles along streams associated with the four BC ALP Projects (Table 5.2.6-2). Wet Montane Meadows comprise approximately 1.6 river miles or 3.4% of the mapped area along these streams. Wide corridors of riparian vegetation, however, were found to be relatively uncommon in the vicinity of the four Projects due to the geology, steep hillslopes, narrow valley bottoms, coarse substrate, and/or entrenched stream channels with limited soil development and sediment deposition sites. These factors result in only limited areas for riparian habitat to become established. In addition, many of the larger streams are deeply entrenched in bedrock-boulder channels with few locations for riparian vegetation establishment.

Five riparian community types were identified in streams associated with the four BC ALP Projects, varying with elevation (Table 5.2.6-2). The understory is composed of grasses and forbs, with few non-native species. Riparian attributes, including dominant species, community type, herbaceous species richness, presence of non-native species, age class structure and distribution, coverage extent, evidence of unusual mortality or stress, floodplain connectivity and bar inundation, and the timing of high flows for each stream are described in Tables 5.2.6-3 and 5.2.6-4. Refer to CAWG 11, Riparian, 2002 TSR, Section 5.0, Study Results and Analysis (SCE 2003; Volume 4, SD-C (Books 9 and 21)) and CAWG 11, Riparian, 2003 TSR, Appendix C (SCE 2004; Volume 4, SD-D (Books 14 and 23)) for detailed riparian resource information.

Mammoth Pool Project (FERC Project No. 2085)

The riparian communities along three stream segments associated with the Mammoth Pool Project are described below.

San Joaquin River, Mammoth Pool Dam to Dam 6 (8 mi.): The white alder riparian scrub community is generally sparse except near tributary confluences. The dominant species include alder and willow. Most of the stream banks consist of boulders.

Numerous coarse bars occur between Mammoth Pool Dam and Dam 6. The majority of these boulder or cobble-dominant bars is sparsely vegetated or is lined with younger vegetation near the water, with the exception of the bar near the Shakeflat Creek confluence, which has more vegetation. Encroachment of mature riparian vegetation within the channel or upland species on the bars has not occurred because Mammoth Pool spills during all above normal and wet water years, inundating at least portions, and usually the majority, of the area of the bars.

On average, approximately 40% of the area of bars were inundated at 860 cfs (whitewater single flow study release), which is also illustrated on cross-sections with observed water surface elevations (Figure 5.2.6-1). Calculated unimpaired daily discharges indicate that, at least during wet and above normal water years, flows remained high through late July and sometimes into August, inundating bar areas (see IHA results in CAWG 6, Hydrology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 13 and 23)). Under existing operations, Mammoth Pool spills during all above normal and wet water years, with daily mean peak magnitudes ranging from a few hundred cfs to more than 20,000 cfs. During the past 20 years, the median daily peak discharge was approximately 4,700 cfs. The existing and unimpaired 10-year recurrence interval flows are similar (24,230 cfs and 24,116 cfs, respectively). As a result of the relatively frequent spills over Mammoth Pool Dam, bars are inundated under existing project operations during wet and above normal water years and high flows generally coincide with the natural timing of peak flows, between March and early June.

Rock Creek, Diversion to San Joaquin River (0.39 mi.) and Ross Creek, Diversion to San Joaquin River (0.85 mi.): The existing riparian communities, dominated by white alder along both streams, have a diverse age structure and species composition, which indicates that the flows associated with existing Project operations are sufficient to support the riparian communities. The riparian coverages are sparse, except near the San Joaquin River confluence, where coverage increases. Riparian coverages and composition are similar to comparison streams at similar elevations with similar geomorphology and geology.

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

The riparian communities along five stream segments associated with the Big Creek Nos. 1 and 2 Project are described below.

Big Creek, Huntington Lake to Dam 4 (3.5 mi.): Coverage by the existing riparian vegetation includes sparse, and non-continuous and wide corridors of white alder riparian scrub or white alder/montane riparian scrub. The channel is primarily a non-adjustable, bedrock and boulder channel, with the exception of a 2-mile adjustable segment downstream of Huntington Lake. Dominant species include alder and willow, with black cottonwood present. Riparian vegetation is encroached for approximately 1.6 miles downstream of Huntington Lake within the 2-mile adjustable segment, where total stem densities and densities of large/mature stems within historic bankfull indicators are high, compared with other streams. Regeneration of riparian species is also limited. Upland species and non-native species are present within the riparian corridor in the 1.6-mile segment.

Historically, the areas along the channel in this 1.6-mile segment, immediately downstream of Huntington Lake, would have been completely inundated for prolonged periods of time during spring runoff. This would have prevented mature vegetation from establishing within the channel, and created a dynamic floodplain environment for establishment of vegetation. Under existing operations, the unimpaired 1.5-year flow has been exceeded twice in the past 56 years.

The remaining 1.9 miles downstream of this reach is a steep bedrock and boulder channel. Changes in vegetation cover between 1944 and 2001 were not observed when comparing aerial photographs, although the bedrock canyon walls, forested canopy, and topographic shading obscured visibility in some sections. Flows and water surface elevations up to 20 cfs were modeled within the non-adjustable reaches (Figure 5.2.6-2). These cross-sections clearly show the small channel that is currently inundated under existing operations, and that the majority of the valley bottom would have been inundated at the higher flows that would have regularly occurred under unimpaired conditions ($Q_{1.5\ peak}$ = 1,157 cfs).

Big Creek, Dam 4 to Dam 5 (4.3 mi.): The existing riparian corridor, dominated by willows and alders, is non-continuous or sparse in the steep, bedrock-controlled reaches and continuous along the lower gradient boulder-dominated reaches and near tributary confluences (including Sheep Thief Creek and Balsam Creek), where suitable substrate is available. Changes in vegetation coverage between 1944 and 2001 were not observed when comparing aerial photographs, although the bedrock canyon walls, forested canopy, and topographic shading obscured visibility in some sections.

Although insufficient hydrology data exists to characterize the hydrologic regime within this reach, data from Big Creek near the confluence with the San Joaquin River indicate that high flows periodically occur during wetter years downstream of Dam 5. In addition, flows from Balsam and Ely creeks and other tributaries deliver water into this reach.

Balsam Creek, Diversion to Big Creek (0.74 mi.): The existing riparian community along Balsam Creek downstream of the diversion has a diverse age structure and species composition, indicating that the current operations supply sufficient water to support the riparian community. The riparian vegetation along the steep bedrock and boulder channel is predominantly a non-continuous, narrow corridor, interspersed with reaches having continuous corridors (particularly near the confluence with Big Creek), and is composed of white alder riparian scrub. Dominant species include alder and willow.

Ely Creek, Diversion to Big Creek (1.0 mi.): The existing non-continuous riparian corridor along the steep, high gradient bedrock and boulder channel has a diverse age structure and species composition. Dominant species include alder and willow. Riparian coverage and composition are similar to comparison streams at similar elevations with similar geomorphology and geology. High flows periodically occur along Ely Creek, particularly during wet water years, as the diversion rarely operates during these years.

Rancheria Creek below Portal Powerhouse (1.9 mi.): The riparian vegetation, composed of montane riparian scrub, is a continuous narrow corridor for approximately half of the reach and a continuous wide corridor downstream of the Portal Powerhouse to Huntington Lake.

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

Big Creek Nos. 2A, 8 and Eastwood Project includes riparian resources along 16 stream segments as described in the following sections.

South Fork San Joaquin River, Florence to San Joaquin River (27.7 mi.): The South Fork San Joaquin River consists of two main segments. The first extends from Florence Dam to the Jackass Meadow Complex (1.65 mi.). The second reach extends from the Jackass Meadow Complex to the confluence with the San Joaquin River (26.1 mi.)

Florence Lake Dam to Jackass Meadow Reach (1.65 mi.), including Jackass Meadow: The riparian corridor consists of mountain alder, with willows and quaking aspen present from Florence Lake Dam to Jackass Meadow. Jackass Meadow is a complex composed of a few large meadow areas along Tombstone Creek and the South Fork San Joaquin River. The majority of vegetation present is montane riparian scrub, dominated by mountain alder and willows, with lodgepole pine present. The community has a diverse age class structure and species composition. Five meadows, and the riparian corridor within the meadow complex, were quantitatively studied. The riparian corridor ranges from 7 to 39 meters in width. The characteristics of the riparian composition and structure vary among the meadow reaches sampled. Upland species tree seedlings were found near the 2003 summer low flow channel along four of the five meadow reaches. Densities of riparian seedlings on the alluvial surfaces were low along three of the four meadow reaches, and stem densities were comparatively high along two of the five reaches. Herbs and shrubs were grazed by pack animals.

Coverage by trees along the stream banks and bars has increased since 1944, as observed in comparisons of 1944 and 2001 aerial photography. Florence Dam, however, was operational for approximately 15 years prior to the earliest available photography in 1944. Changes in channel form that could have influenced the distribution of riparian vegetation may have occurred prior to 1944.

The studied meadows within the Jackass Meadow complex range in width from 67 to 182 meters. Ground cover is typically high; however, the herbs and young willows were heavily grazed at the time of sampling. Additional vegetation surveys completed in support of the Jackass Meadow Inundation Study Summary (SCE 2007a; Volume 4, SD-E (Books 19 and 24)) indicated that considerable portions of the meadows are dominated by wetland species (obligate or facultative-wetland species). Kentucky bluegrass and common dandelion, non-native species, were identified and are dominant, within some of the meadows. Species more commonly found in drier conditions tend to be found on the higher surfaces, including the stream banks, compared to the lower elevations within the meadows. Bands of willows occur within three of the five meadows, often occurring along areas of comparatively lower elevations and/or high flow channels that distribute flow through the meadow. These willows tend to have high stem densities and age class diversity; however, stem decadence is relatively high. Based on hydraulic modeling and the Jackass Meadow Inundation Study, Jackass Meadow was likely historically inundated by overbanking flows to some extent almost every year (CAWG 2, Geomorphology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)); Jackass Meadow Inundation Study (SCE 2005a; SCE 2007a; Volume 4, SD-E (Books 19 and 24)). Graphical representations illustrating changes in wetted width and depth within the stream channel with increases in flow are provided in CAWG 2, Geomorphology, 2003 TSR, Appendix 7.2.3 (SCE 2004; Volume 4, SD-D (Books 11 and 23)). The channel bars were historically inundated multiple times per year during all water year types, for extended durations. Large portions of the meadow complex are also annually inundated by snow melt and local runoff. The timing of the snow melt varies from year to year, depending on the temperatures during a given year. Certain meadows, including the meadow located near Tombstone Creek, were observed to be draining both prior to and after spill, at least through early August (Jackass Meadow Inundation Study (SCE 2005a; SCE 2007a; Volume 4, SD-E (Book 19)). Under current operations, the bars and floodplains are only inundated by overbanking flows during wetter water years, less frequently, and for shorter durations compared to unimpaired conditions.

In addition to Project operations, riparian resources in the vicinity of the Project are also affected by grazing by pack animals and damage from recreational activities. Meadow herb vegetation was grazed to a few inches above the ground surface and browsing of many young willows was observed during the studies. Pack animals were also observed on the stream banks, bars, and within the channel. Recreation trails were observed along the channel banks and bars where trampled vegetation and disrupted soil was observed. These activities affect seedling survival and herbaceous coverage and composition (CAWG 11, Riparian, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 14 and 23)); Jackass Meadow Inundation Study (SCE 2005a; SCE 2007a; Volume 4, SD-E (Books 19 and 24)).

Prior to and during the early 1900's, most of the allotment meadows that were studied were heavily grazed by sheep. Since then, the majority of the allotments of Forest Service Special Use Permits has been, and is presently used for commercial grazing and/or pack animal grazing. Poison Meadow (discussed below), and the Jackass Meadow Complex have been used as pastures for pack animals since the mid-1940's. Assessments conducted in these meadows in the mid-1960's indicated that the meadow conditions were fair in Jackass Meadows and Poison Meadow (Philpot 1995). Recent meadow assessments by the Sierra National Forest (SNF) identified resource issues in the meadows related to both the Project and grazing, including soil compaction and sod fragmentation (USDA-FS 2005). The Forest Service evaluated their grazing management policies in the SNF (USDA-FS 2005). The current annual number of pack stock nights allowed is 400 for the Jackass Meadow Complex. The selected alternative increases the number of annual stock nights allowed to 2,025. A number of potential cumulative and direct impacts were identified that may result from this increase in grazing, including localized increases in trampling near gates, increased stream bank trampling near water and stream crossings, losses of riparian and meadow vegetation, and meadow compaction.

Jackass Meadow to San Joaquin River Reach (26.1 mi.): Downstream of Jackass Meadow to the Bear Creek confluence, the channel is predominantly a moderate gradient channel with moderate to high entrenchment. The segment is an adjustable channel type with dominant bed particle size of small boulder to cobble. From the Bear Creek confluence to Mono Crossing, the non-continuous white alder/montane riparian scrub corridor is interspersed with wider corridors of alders and willows. The majority of this segment is non-adjustable (75%).

The riparian corridor along Poison Meadow is 50 meters wide, on average, with high ground cover. The studies indicate a diversity of stem size classes and species composition. The riparian community is dominated by mountain alder, with willows and cottonwood present. Poison Meadow is approximately 350 meters wide and is bordered by aspen riparian forest. Bands of willows occur within the meadow, from 60 to 150 meters from the channel banks. Ground cover is typically high within the meadow. Kentucky bluegrass, a non-native, was identified within the meadow. The shape and size of Poison Meadow appears to be the same in 1944 and at present. A few areas at the margins of the meadow have filled with trees. Historically and under current operations, Poison Meadow was not regularly inundated (less frequently than once every 2 to 3 years).

An adjustable segment of this stream reach is located near Mono Hot Springs. The bars here are sparsely vegetated, compared to other reaches sampled, with a few mountain alders, willows, rose, and western juniper. The width of the riparian corridor is approximately 5 meters. Ground cover is variable, depending on the transect. The bar areas are heavily recreated, which likely affects seedling survival and herbaceous cover and composition. The bars within this reach were historically inundated annually for extended durations. Under existing conditions, the bars are inundated primarily during wet water years, for shorter durations than under unimpaired conditions.

Two meadows were identified in the vicinity of Mono Hot Springs along the river. These meadows historically functioned as terraces and continue to function as terraces under existing conditions (CAWG 11, Riparian, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 14 and 23)). The meadows were observed to be draining down to the channel. Kentucky bluegrass, a non-native species, was identified within the meadow. Ground cover within the meadow is high. These meadows (the Mono Hot Springs allotment) were historically grazed primarily by sheep until the 1940's, when the range use was converted to cattle. In the 1960's, the meadows were severely over-grazed, with cropped grass; erosion channels within the meadow, and vegetation encroachment (USDA-FS 1960). Since the 1960's, the meadow conditions have improved.

From Mono Crossing to Rattlesnake Crossing, the riparian vegetation consists of a non-continuous, narrow corridor interspersed with areas of sparse vegetation. Alders and willows are the dominant species. A large portion of the reach (62%) consists of adjustable channel. Mountain alder, willow, rose, and black cottonwood occurs along the channel. The riparian corridor width ranges from 4 to 28 meters. Ground cover is typically minimal, and cover by riparian species, such as willows, is low compared to other adjustable reaches. A diversity of stem size classes is present. The Mono Crossing reach historically and currently functions as a terrace.

From Rattlesnake Crossing downstream for approximately 8.5 miles, the riparian vegetation consists of non-continuous, narrow bands of white alder riparian scrub/montane riparian scrub interspersed with segments supporting minimal vegetation. In the remaining 6 miles of the reach downstream to the confluence with the San Joaquin River, riparian vegetation is sparse, as the channel is a deeply entrenched gorge, dominated by boulders. Short, non-continuous narrow bands of white alder riparian scrub occur in association with bars, tributary confluences, or areas where the valley widens. Dominant species include alder, with willow present.

Bear Creek, Diversion to South Fork San Joaquin River (1.6 mi.): The existing riparian community, composed of alder and willows, has a diverse age structure and species composition, indicating that establishment has been successful when conditions have been suitable and that current operations supply sufficient water to support riparian resources. Young riparian vegetation has established within the channel for approximately 0.5 mile downstream of the diversion. The riparian vegetation along the steep bedrock and boulder stream is a continuous narrow corridor, interspersed with non-continuous bands, with greater coverage along portions of the lower gradient reaches where suitable substrate occurs. Riparian coverage and composition are similar to streams without flow regulation at similar elevations and with similar geomorphology and geology. Seven spill events exceeding 450 cfs (which equals the unimpaired 1.5-year flow) have occurred over a 19-year period (1984-2002 (no data is available for 1983)), so high flows under existing operations occur in similar frequency to unimpaired conditions (i.e., 1.5-year unimpaired event occurs every 2 to 3 years on average under existing operations).

Mono Creek, Diversion to South Fork San Joaquin River (5.8 mi.): The existing vegetation along the non-adjustable reaches (88% of stream length) is comprised of alders, with willows present. Coverage within and along the channel is high compared to other non-adjustable stream reaches evaluated. The riparian corridor ranges in width from 2.5 to 4.5 meters.

Within the adjustable reaches (0.7 mi.), the wide white alder/montane riparian scrub community is dominated by alders, with willows present. The width of the riparian corridor ranges from 3 to 18 meters within the quantitatively studied reaches. However, riparian species coverage was relatively low on the bar surfaces and typically occurred adjacent to the low flow channel. In addition, upland tree species seedlings, rose, and two non-native species were observed near the summer low flow channel and on the bars. The riparian growth present on the stream banks tends to be dominated by mature stem sizes. Historically, portions of the bars would have been inundated for extended durations during all water year types. Under existing conditions, portions of the bars are inundated only during wetter years, and for shorter durations than under unimpaired conditions. Modeling results illustrating changes in wetted width and depth with increases in flow at bars in the adjustable reaches are provided in Figure 5.2.6-3, CAWG 2, Geomorphology, 2003 TSR; Appendix 7.2.3 (SCE 2004; Volume 4, SD-D (Books 11 and 23)), and the Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)).

Numerous meadows occur along Mono Creek between RM 2.8 and 4.3 (CAWG 11, Riparian, 2002 TSR (SCE 2003; Volume 4, SD-C (Books 9 and 21)). These meadows were historically terraces and continue to function as terraces under existing operations (CAWG 11, Riparian, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 14 and 23)). The meadows located along Mono Creek were used primarily by pack stock until the 1960's, and were subsequently used for commercial livestock. Encroachment of lodgepole pines and willows was noted in the early 1940's, with meadow conditions ranging from poor to good in the Mono allotment areas (USDA-FS 1944).

Upper Basin Tributaries

The Big Creek Nos. 2A, 8 and Eastwood Project includes riparian resources along seven Upper Basin tributaries.

Bolsillo Creek, Diversion to South Fork San Joaquin River (1.6 mi.): The existing riparian community along Bolsillo Creek has a diverse age structure and species composition. The vegetation along the primarily steep bedrock and boulder channel, with one short lower gradient segment (0.4 mi.), is a continuous narrow corridor of montane riparian scrub and white alder/montane scrub, comprised of alders and willows, and aspen riparian forest. The extent of the riparian corridor is less within the steep, bedrock reaches. Riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology. The maximum diversion capacity is 12 cfs (unimpaired $Q_{1.5}$ is 14 cfs), such that high flows do periodically occur downstream of the diversion. Under existing operations, high flows occur during some, but not all, wet years.

Camp 62 Creek, Diversion to South Fork San Joaquin River (1.37 mi.): The existing riparian community along Camp 62 Creek has a diverse age structure and species diversity, which indicates that the existing Project operations are sufficient to support a healthy riparian community. The existing riparian community is comprised of willows and alder. Coverage patterns tend to be controlled by valley width along the stream. Riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology. In Camp 62 Creek, flows have exceeded 20 cfs in 3 out of 19 years during high water years over the period of record. Peak flows have been diverted during some but not all wet years.

Chinquapin Creek, Diversion to South Fork San Joaquin River (0.81 mi.): The existing riparian community along Chinquapin Creek has a diverse age structure and species composition, which indicates that the existing operations are sufficient to support a healthy riparian community. The alders and willows are distributed as narrow corridors, interspersed with wide corridors in the comparatively wider valley reaches with lower gradients. Riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology. The unimpaired 1.5-year flow (average daily basis) from the flood frequency curve is 24 cfs. Based on the limited data records downstream of the diversion and data from the diversion, peak flows are diverted during some wet years, but not all.

Crater Creek, Diversion to South Fork San Joaquin River (3.0 mi.): The existing riparian community along the non-adjustable steep bedrock and boulder reaches of Crater Creek (2.44 mi.) has a diverse age structure and species composition, which indicates that the existing Project operations are sufficient to support a healthy riparian community. The riparian community is comprised of alder, willows, and aspen. It occurs as a narrow non-continuous or continuous corridor along the channel.

Within the lower gradient, adjustable reach (0.5 mi.), which includes Hellhole Meadow, the continuous riparian corridor is dominated by alder and willow, with lodgepole pine present. A diversity of riparian shrub species and age class structure was observed. Aspen occur along the stream at the upper meadow and along the meadow margins. The width of the riparian corridor is 20 meters, on average. Greater coverage by lodgepole pine along the stream margins and meadow perimeter, particularly in the lower sections of the meadow, is evident in the 1944 historical aerial photographs compared to current conditions. Lodgepole pine seedlings were observed near the stream channel.

Hellhole Meadow extends approximately 145 meters from the channel margins, and is bordered by aspen at the bedrock walls where an intermittent stream was observed. This stream is most likely fed both from hillslope runoff and Crater Creek during high flows. Various wetland species and two non-native species were identified within the meadow. Ground cover is typically high. Dense bands of willow occur between 49 and 90 meters from the channel margins, with relatively high decadence of lower stems.

Grazing activities have historically affected meadow and riparian resources within the adjustable reach. Prior to and during the early 1900’s, the allotment meadow was heavily grazed by sheep. Hellhole Meadow has been used as pastures for pack animals since the mid-1940's. Assessments conducted in the mid-1960's indicated that the meadow conditions were poor (Philpot 1995). Conditions within the meadow, including plant cover, bank conditions, and species habitat (i.e., willow flycatcher) have improved since this time (Philpot 1995; CAWG 11, Riparian, 2002 and 2003 TSRs (SCE 2003; SCE 2004; Volume 4, SD-C (Books 9 and 21) and SD-D (Books 14 and 23)).

Although limited hydrology data exists, the diversion is believed to capture almost all of the flow from Crater Creek (high flows infrequently occur during extremely wet years), which reduces water availability throughout the year, particularly in the meadow segment. Flows that support and inundate the meadow occur less frequently under current operations than under umimpaired conditions.

North Slide Creek, Diversion to South Fork San Joaquin River (0.24 mi.) and South Slide Creek, Diversion to Confluence with North Slide Creek (0.30 mi.): The existing riparian communities, dominated by aspen, along North Slide Creek and South Slide Creek have a diverse age class structure and species composition, indicating that the current flow regimes are sufficient to support the riparian vegetation. Currently, and for the last two decades, the diversions have been out-of-service.

Tombstone Creek, Diversion to South Fork San Joaquin River (1.1 mi.): The riparian corridor along Tombstone Creek is dominated by aspen upstream of Jackass Meadows, with mountain alder present. The vegetation has a diverse species composition and age class structure, although the shrubs tend to have more old than young stems. Upland tree seedlings were observed on alluvial surfaces along the channel. Currently, and for the last two decades, the diversion is out-of-service.

Along the segment of Tombstone Creek that crosses Jackass Meadow, the riparian corridor is a non-continuous aspen riparian forest, with willows along the stream channel as it flows adjacent to Jackass Campground. The riparian width at the adjustable, meadow reach is approximately 5 meters. Ground cover is high. Kentucky bluegrass and common dandelion, non-native species, were identified within the meadow.

The segment within the vicinity of the meadow is extensively grazed by pack animals and heavily recreated by campers from Jackass Campground that borders the creek on the western side and a boardwalk that originates in the campground and goes around the meadow perimeter. Campers regularly traverse the creek banks and bars and the meadow (see grazing discussion above for the Jackass Meadow Complex).

Hooper Creek, Diversion to South Fork San Joaquin River (0.73 mi.): The existing riparian community along Hooper Creek has a diverse age class structure and species composition, indicating that the existing Project operations provide sufficient flows to support a healthy riparian community. The stream channel is more stable today than it was under historical flow conditions, as the multiple overflow channels are not wetted as frequently and avulsions occur rarely. The riparian community is a non-continuous narrow montane riparian scrub corridor dominated by mountain alder, willow, and bitter cherry. The riparian corridor ranges from 2 to 5 meters in width. A fire occurred in the watershed in the early 2000's. The 1.5-year flow has been exceeded four times in the last 16 years, during most wet years.

Lower Basin Tributaries

The Big Creek Nos. 2A, 8 and Eastwood Project includes riparian resources along five Lower Basin tributaries.

Balsam Creek, Forebay to Balsam Creek Diversion (2.05 mi.): The existing riparian community along Balsam Creek between the Balsam Meadow Forebay and the Balsam Creek Diversion has a diverse age structure and species composition, which indicates that current operations supply sufficient water to support a healthy riparian community. The riparian vegetation is predominantly a non-continuous narrow white alder/montane riparian scrub corridor interspersed with a narrow continuous white alder montane/riparian scrub corridor along the steep bedrock channel. Downstream of the Forebay, Balsam Creek is a flow-augmented stream due to current minimum instream flow (MIF) requirement from the Forebay, which is greater than would occur under unimpaired conditions.

Big Creek, Dam 5 to San Joaquin River (1.7 mi.): The riparian corridor, comprised of white alder riparian scrub, is sparse or a non-continuous narrow corridor in the steep, bedrock-controlled reaches, with black cottonwood riparian forest occurring near the confluence with the San Joaquin River. The extent of the riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology. Changes in vegetation coverage between 1944 and 2001 along the river were not observed in aerial photography, although the bedrock canyon walls, forested canopy, and topographic shading obscured visibility in some sections. High flow events of variable magnitude and duration occurred during most, but not all, wet years, during the period of natural spring runoff.

North Fork Stevenson Creek, Tunnel Outlet to Shaver Lake (2.6 mi.): The existing riparian community along the mostly non-adjustable, steep bedrock and boulder segments of North Fork Stevenson Creek has a diverse age structure and species composition. The sparsely distributed montane riparian scrub community along these reaches is dominated by mountain alder and willows. Riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology.

Within the studied adjustable reaches (0.5 mi.), the wide montane riparian scrub corridor is dominated by mountain alder and willow. The riparian corridor ranges from 5 to 50 meters, depending on the width of the valley bottom. Riparian seedlings and new stem growth were observed. The riparian community reflects current operations, which include comparatively high discharges (flows greater than 1,000 cfs have occurred three times in the last 10 years, the historic 100-year flow is estimated at 452 cfs) that have caused substantial erosion downstream of the diversion, channel form changes, and gravel deposition within the adjustable reaches. The stream was historically used to convey water from Huntington Lake into Shaver Lake prior to the construction of the Eastwood Power Project. These historic operations transformed sections of the stream from a small headwater stream into a stream with adjustable segments (approximately 0.9 miles in total), with considerably different stream morphology (aggradation, wider stream, and smaller particle sizes).

Coverage by riparian species along the existing summer low flow channel margins, total stem densities, and densities of mature stems are high compared to other similar reaches evaluated. Upland species seedlings were also observed along the stream, as the channel and vegetation are responding to the lower flows following the last high flow release. The results, illustrating changes in wetted width and depth with increases in flow, are provided in CAWG 2, Geomorphology, 2003 TSR, Appendix 7.2.3 (SCE 2004; Volume 4, SD-D (Books 11 and 23)).

Pitman Creek, Diversion to Big Creek (1.5 mi.): The existing riparian community along Pitman Creek has a diverse age structure and species composition, indicating that establishment has been successful when conditions have been suitable and that current operations supply sufficient water to support a healthy riparian community. The riparian vegetation is a sparse or non-continuous corridor of white alder/montane riparian scrub along the steep, high gradient, bedrock channel. These non-continuous corridors occur within the slightly lower-gradient reaches. The dominant species is primarily alder, with willow present. Riparian coverage and composition are similar to comparison streams at similar elevations and with similar geomorphology and geology.

Stevenson Creek, Shaver Lake Dam to San Joaquin River (4.3 mi.): Two adjustable reaches occur along Stevenson Creek, between Shaver Lake and Highway 168 (0.1 mi.) and between RM 3.3 and 2.75 downstream of Railroad Grade Road (totaling 15% of the total reach length). Riparian widths in the adjustable reaches range from 1.8 to 27 meters. Downstream of Shaver Lake and upstream of Highway 168, the riparian vegetation is comprised of mountain alder, willow, and creek dogwood. The community has high shrub and stem densities with a diverse stem age class structure. Highway 168, culvert flow restrictions, and bank rip-rap within this reach also affect the existing riparian resources. Lastly, a mill pond was historically located within this reach, potentially affecting the existing riparian resources. Upland species tree seedlings occur within the adjustable reach downstream of Railroad Grade Road (RM 3.3 to 2.75). In addition, regeneration was observed to be low within this reach. Himalayan blackberry, common sheep sorrel, spearmint, and common dandelion, all non-natives, occur within both adjustable reaches. In the non-adjustable reaches, the stream is a steep, confined channel interspersed with moderately entrenched, moderate gradient reaches. The vegetation cover is sparse or distributed in continuous corridors of white alder riparian scrub where the stream valley widens.

The frequency and duration of floodplain connectivity in the adjustable reaches is less under current operations than unimpaired conditions. The 1.5-year flow, 300 cfs, has been exceeded six times in the past 12 years, during most wet years. Hydraulic analyses indicated that historic flows overtopped the banks in the Shaver Lake reach about every 2.3 years. Within the adjustable reach downstream of Railroad Grade

Road, flows overtopped the banks about every 2.3 to more than 10 years. Under the existing operations, the floodplain is inundated every 2 to 25 years, depending on local topography. The results of the hydraulic analyses, illustrating changes in wetted width and depth with increases in flow, are provided in CAWG 2, Geomorphology, 2003 TSR, Appendix 7.2.3 (SCE 2004; Volume 4, SD-D (Books 11 and 23)). High flows are released from Shaver Lake when SCE is intentionally moving water during periods of high runoff, consistent in timing with the period of natural runoff.

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

The Big Creek No. 3 Project includes riparian resources along one stream segment.

San Joaquin River, Dam 6 to Redinger Lake (5.7 mi.): The riparian community is primarily sparse white alder scrub with approximately 1 mile of non-continuous white alder scrub upstream of Redinger Lake. Some coarse bars occur along the San Joaquin River between Dam 6 and Redinger Lake. The characteristics of the bar features and associated riparian vegetation were visually compared in aerial photography from 1944 and 2001. Differences were not identified in bar size, position, and frequency or extent of riparian vegetation on the bars between the recent and historic photographs. At 860 cfs, at least some of the bars are inundated (Larry Wise, pers. comm.). One bar studied at RM 15.5 was inundated at 500 cfs (Larry Wise, pers. comm.). Flows and water surface elevations were modeled to examine the inundated area along the San Joaquin River (downstream of Mammoth Pool) with changes in discharge under existing Project operations (Figure 5.2.6-1).

The calculated historic daily discharges indicate that, at least during wet and above normal water years, flow remained high (the 90-day synthetic maximum flows is 5,537 cfs) through late July and sometimes into August. Therefore, historically, it is likely that these bars were inundated for prolonged periods of time with substantially high stream powers capable of preventing the establishment of vegetation and eroding established riparian vegetation. Under existing operations, Dam 6 spills during all above normal and wet water years (as when Mammoth Pool spills, Dam 6 also spills). The spills at Dam 6 coincide with the natural timing of peak flows between March and early June.

5.2.6.3 Impacts of Proposed Action

This section discusses potential impacts on riparian resources of continued operations and maintenance of the four Big Creek ALP Projects under the Proposed Action. First, potential riparian resource issues are generally described. These potential resource issues reflect conditions under the current Project operations (No Action Alternative). A discussion of environmental impacts resulting from implementation of new environmental measures recommended in the Proposed Action for each of the four Big Creek ALP Projects follows.

Potential Resource Issues

Existing Project operations and maintenance have the potential to partially affect riparian resources primarily through changes in flow regime, including timing, in Project bypass and augmentation stream reaches. Flows can affect the dynamism of the landforms, the substrate available for supporting riparian vegetation, transport of seeds and stems, and viability of vegetation once established. Flow attributes that are important for maintaining the distribution of and structural and compositional complexity of riparian habitat, including discouragement of riparian encroachment, regeneration, and water availability, were evaluated for the reaches with sufficient hydrologic data. Other activities and natural events (past and present) within the watersheds that could potentially affect riparian resources, including grazing, recreation, timber management, and fire, were also considered. These activities could affect vegetation vigor and vitality; hydroperiod, hillslope and channel form processes; sediment availability; sediment transport and deposition; and particle size distributions. However, a significant proportion of streams in this watershed are constrained in bedrock-controlled channels, which are not responsive (non-adjustable) to flow changes, with minimal riparian vegetation. Consequently, some of these potential riparian resource issues are not likely to occur along these types of stream channels.

Evaluation of the effects of operations and maintenance activities on riparian resources included consideration of changes to:

- Age class structure.
- Community composition.
- Coverage, including channel encroachment, upland encroachment, and coverage extent.
- Unusual mortality or stress.
- Floodplain connectivity and bar inundation.
- Timing of high flows.

Project Impacts

The Proposed Action recommends modifying the existing flow regime to enhance riparian, geomorphic, and aquatic resources in selected bypass streams where Project-related resource issues have been identified (Table 5.2.6-5). These proposed recommendations include increasing the frequency and magnitude of high flows in selected reaches by establishing channel riparian maintenance flows (CRMF) through scheduled releases and establishing time periods when diversions may not be operated. The proposed recommendations also include trend monitoring, as proposed in the Riparian Monitoring Plan (SCE 2007b; Volume 4, SD-G (Books 19 and 24)). Lastly, increased MIF are also proposed to enhance aquatic resources. Although substantial changes in riparian vegetation are unlikely to occur, the increases in MIFs will protect, and may be beneficial to, riparian resources by increasing the amount of water available to the rooting zone, particularly during the drier months.

Implementation of the Proposed Action would restore some of the natural flow to the streams in the vicinity of the four Big Creek ALP Projects, particularly during spring runoff of wetter years, and would improve riparian resource conditions in the Upper San Joaquin River Basin. The proposed trend monitoring will identify if the environmental measures are meeting riparian resource objectives. Lastly, implementation of the proposed increases in MIFs will protect and possibly enhance riparian resources. As a result, the environmental measures of the Proposed Action will enhance and benefit riparian resources, in the Upper San Joaquin River Basin.

Mammoth Pool Project (FERC Project No. 2085)

San Joaquin River, Mammoth Pool Dam to Dam 6: Under existing Project operations, flows are sufficient to support and protect riparian resources within this stream segment, as no riparian resource issues were identified. Spills occur during all wet years and mean spill magnitudes ranged from 1,046 cfs to 1,601 cfs during above normal water years. Spill durations ranged from 9 to 48 days.

Under the Proposed Action, high flows are not proposed to change. No adverse impacts are expected, as riparian resource issues were not identified within the reach under existing operations. Excessive mature vegetation is not likely to become established adjacent to the low flow channel since spills occur, and will continue, during wet and above normal water years. In addition, since the high flows are associated with high spring runoff, the timing of the flows is consistent with riparian species recruitment adaptations. During below normal, dry, and critically dry water years, the riparian vegetation is supported by MIFs and local runoff. The differences in water surface elevations between the high flows in wetter years and lower flows during the non-spill periods of these and other water year types, based on surveyed cross-sections (CAWG 2, Geomorphology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)) appear to be within the range accessible for established, mature individual plants (Shafroth et al. 2000; Borman and Larson 2002; USDA-FS 2004).

Rock Creek, Diversion to San Joaquin River and Ross Creek, Diversion to San Joaquin River: Under existing Project operations, flows are sufficient to support and protect riparian resources within this stream segment, as no riparian resource issues were identified.

Under the Proposed Action, high flows are not proposed to change. Therefore, the existing riparian habitat is not expected to be adversely impacted.

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

Big Creek, Huntington Lake to Dam 4: Riparian resource issues occur in the 1.6-mile reach within the adjustable segment along Big Creek immediately downstream of Huntington Lake. Riparian resources issues include low diversity in age class structure and extensive (encroached) riparian coverage within the stream channel, and to a lesser extent, community species composition (upland species within the riparian corridor). The lack of high flows and inundation of the areas adjacent to the channel have led to the extensive establishment of mature woody riparian vegetation within the channel. In addition, the cross-sectional area is smaller; bed particle sizes have decreased; and sediment deposition has increased within this segment. Functionally, this reach is a first order stream with a prolonged baseflow similar to a spring fed hydrograph, rather than a stream with a snowmelt hydrograph. Dams 1, 2, and 3 were constructed almost 100 years ago to impound Huntington Lake. For more than 60 years, operational and safety constraints have required that Huntington Lake does not spill and threaten downstream infrastructure, including the domestic water supply diversion and bridge serving the community of Big Creek and the Big Creek Powerhouse No. 8.

Under the Proposed Action, high flows are not proposed. The magnitude and frequency of flows necessary to discourage the extensive riparian vegetation in this reach are not practical or safe, for the reasons mentioned in this section.

Big Creek, Dam 4 to Dam 5: Under existing Project operations, flows are sufficient to support and maintain riparian resources within this stream, as no riparian resources were identified.

Under existing conditions, high flows of variable magnitude and duration occur during most, but not all wet water years, during the period of natural spring runoff. As the high flow regime is not proposed to change under the Proposed Action, adverse impacts to the existing riparian habitat are not expected.

Balsam Creek, Diversion to Big Creek: Under existing Project operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect the high flow regime, and is not expected to adversely impact riparian resources.

Ely Creek, Diversion to Big Creek: Under existing Project operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect the high flow regime, and is not expected to adversely impact the riparian resources.

Rancheria Creek below Portal Powerhouse: Under existing operations at Rancheria Creek below Portal Powerhouse, flows are sufficient to support and protect the riparian resources, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect instream flows, and is not expected to adversely impact the riparian resources.

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

South Fork San Joaquin River, Florence to San Joaquin River: Riparian resource issues along the South Fork San Joaquin River primarily occur in the Jackass Meadow Complex and adjustable reaches. The riparian vegetation in the non-adjustable reaches does not appear to have been adversely affected by Project operations. Within the riparian corridor and Jackass Meadow Complex, riparian resource issues include age class structure (regeneration), community composition, encroachment of upland species, stress (high willow decadence; grazing and recreation pressures), and changes in the frequency of high flows that inundated the bars and meadow. Under existing conditions, the bars and meadow were inundated during most, but not all, wet water years and rarely during drier water year types. The high flows were associated with spill events, and the flows often receded very quickly.

Under the Proposed Action, SCE proposes high CRMF over 14 days, with three days of flow increases from the MIF to peak flow, three days at 1,600[1] cfs, and eight days of down ramping flows in wet water years, with a total volume of at least 22,000 ac-ft. During some wet water years, these flows will be achieved through uncontrolled spills. During these years, SCE will make a good faith effort to provide downramping releases over six days. These high flows will inundate the meadows, bars, and floodplains more frequently than under existing conditions. The slower recession rate compared to existing operations may also maintain higher moisture conditions on the meadows for a longer period of time. These flows will occur during all wet water years during the period of spring runoff, in comparison to times when Florence Lake spills (some, but not all wet years) under existing conditions. In addition, under the Proposed Action, high flows (CRMF) are recommended in above normal water year types over eight days, with flows increasing from MIF to peak flow over one day, two days of peak flow[2] and downramping over five days. The release volume will be at least 6,000 ac-ft and two days of peak flows, with a total release volume not exceeding 13,000 ac-ft.

[1]During the first two wet water years after issuance of the new license, SCE, in consultation with the Forest Service and other interested governmental agencies, will conduct a study to determine if a lesser peak flow in wet water years would provide inundation comparable to the inundation provided by the 1,600 cfs peak flow. The total volume released will be at least 22,000 ac-ft.

[2]The peak flow during above normal water years will inundate approximately 75% of the meadow area inundated at 1,600 cfs. This will be determined during studies that will be implemented during the first two wet water years after implementation of the new license.

Historically, portions of Jackass Meadow were likely inundated almost every year. Under existing operations, it is inundated less frequently (4 of 6 wet water years, and almost never during above normal water year types, based on data from 1983-2002 (excluding 1998 water year)) and for shorter durations. Channel and floodplain connectivity was observed during flow releases of 1,250 cfs (Jackass Meadow Inundation Study (SCE 2005a; SCE 2007a; Volume 4, SD-E (Books 19 and 24)). However, during uncontrolled spills in wet water years, flows often exceeded 1,600 cfs. For example, 1,600 cfs was exceeded for 39 days in 1983, seven days in 1986, and 16 days in 1995. During the above normal water year types between 1983 and 2002, spill rarely occurred and the maximum recorded mean daily flow during these above normal water years was 371 cfs on June 17, 2000. Erosion of the bar surfaces and banks may occur, which will discourage the establishment and survival of upland trees and herbs in low-lying areas. Bank erosion in adjustable reaches is expected to occur periodically, and will also create new establishment sites for riparian vegetation.

The Proposed Action will likely enhance the riparian habitat along the San Joaquin River, particularly in the Jackass Meadow area by: (1) depositing fresh alluvium on the bar and meadow surfaces, which is important for successful establishment of riparian species; (2) providing higher moisture conditions to support wetland species within the meadow; and (3) potentially discouraging continued encroachment of upland species on the bars. However, the success of enhancement flow objectives will be reduced if pack animal grazing and recreation are allowed to continue in these sensitive areas. Regeneration (age class structure) may be limited, as the shrubs are often browsed and/or trampled by animals and people, and stress to meadow vegetation is likely to continue. The Proposed Action also includes the Riparian Monitoring Plan (SCE 2007b; Volume 4, SD-G (Books 19 and 24)) to monitor trends in the condition of the riparian community along South Fork San Joaquin River (Jackass Meadow area) to ensure that the recommended flows meet defined objectives for the riparian resources.

Bear Creek, Diversion to South Fork San Joaquin River: Under existing operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified. Under existing conditions, diversion operations changed the timing of spring runoff flows and decreased the frequency of high flow events which occur every two to three years during the period of spring runoff.

The Proposed Action will likely increase the flow magnitude and duration during the time period of natural spring runoff, which coincides with riparian regeneration, compared to existing operations. These proposed changes in flows will protect, and may be beneficial to, the riparian resources.

Mono Creek, Diversion to South Fork San Joaquin River: Riparian resource issues were identified along Mono Creek in the adjustable reaches, including coverage of non-riparian species on bars, riparian encroachment, age class structure (regeneration), and changes in the frequency and timing of high flows. Within the adjustable stream reaches, the frequency of inundation of the bars and floodplain has decreased. Within the non-adjustable reaches, potential riparian resource issues include higher riparian coverage within the stream channel than observed in other non-adjustable stream reaches evaluated.

Under the Proposed Action, the magnitude and frequency of high flows will be increased by providing CRMF in all wet and above normal water years and increasing the extent of floodplain inundation and the frequency of floodplain connectivity. During wet water years, peak flows will either be 800 or 450 cfs. During above normal water years, seven days of flows, with two days of ramp up from MIF to the peak flow, three days of downramping, and two days with 450 cfs peak flows, as described in the Mono Creek Channel Riparian Maintenance Flow Plan (SCE 2007c; Volume 4, SD-G (Book 19)).

Under the Proposed Action, flows will inundate areas adjacent to the channel in all wet and above normal water years during the natural spring runoff period. Under existing operations in wet water year types between 1983 and 2002, 800 cfs occurred for 17 days during one year (1995), and 450 cfs occurred in three of seven years. During the above normal water years between 1983 and 2002, 450 cfs never occurred. The maximum daily mean above normal water year flow was 443 cfs, which occurred for one day in 1984. Flows greater than 50 cfs only occurred 3 times (all in 1984). The proposed flows in wet water years will increase the wetted width by approximately 130 feet, on average, within the adjustable reaches (based on results from the Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)). The flows proposed for above normal water years will increase the wetted width by approximately 43 feet on average, within the adjustable reaches.

The riparian resource issues will be enhanced by the Proposed Action. The higher flows will: (1) scour young vegetation that has recently established and may establish within the channel during the drier water years; (2) cause localized bank erosion, scouring mature vegetation established within the channel margins; (3) deposit fresh alluvium on the bar surfaces, which is important for successful establishment of riparian species; (4) provide higher moisture conditions to support wetland species on bars and floodplains; and (5) may discourage continued encroachment of upland species on the bars.

The inundated area and flow depths will be increased under the Proposed Action. Inundation of the low lying areas adjacent to the channel during wet and above normal water years will discourage the establishment of vegetation within the stream channel. Survival of individuals on surfaces near the summer low flow channel will be less than under existing conditions as the greater frequency and magnitude of the CRMF will inundate these areas where vegetation is currently established, as well as mobilized channel and bar sediments, and possibly cause localized bank erosion. Encroached vegetation, inundated during test flows of 425 cfs was evaluated during the Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)). Flows of at least 450 cfs provide partial mobilizations of particles on the bed and bars (Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)). In addition, the existing encroached vegetation may be damaged or removed during the proposed CRM flow release by abrasion from large woody debris or areas of localized bank failure or scour (which can be caused by large woody debris deposits), as was observed during the test flow releases (Mono Creek Sediment Transport and Floodplain Connectivity Study (SCE 2005b; Volume 4, SD-E (Books 19 and 24)).

The proposed high flows will likely deposit fresh alluvium up on bar surfaces, which is important for successful riparian regeneration on these surfaces. If vegetation establishes at these higher elevations on the bars, the difference in water surface elevations between the recommended high flows and flows during other water year types would likely be within the range accessible for young to old individuals (Shafroth et al. 2000; Borman and Larson 2002; USDA-FS 2004).

The Proposed Action also includes a Riparian Monitoring Plan (SCE 2007b; Volume 4, SD-G (Books 19 and 24)) to monitor the trends in condition of the riparian community along Mono Creek to ensure that the recommended flows, including MIFs, meet defined objectives for riparian resources.

Upper Basin Tributaries

Bolsillo, Camp 62, and Chinquapin Creeks: Under existing conditions, flows are sufficient to support and protect riparian resources within these streams, as no riparian resource issues were identified. High flows currently occur during some, but not all wet years.

Under the Proposed Action, the magnitude and duration of high flows will increase compared to existing operations. The Proposed Action recommends that the diversions will be left open between April 1 and June 30 during wet water years, which will maintain the natural variability in the timing, magnitude, and duration of high spring runoff flows during wet water years. This will also ensure that peak flows during most wet years would flow through the channel(s). The SCE proposed changes in duration, frequency, and/or magnitude of high flows will protect, and may be beneficial to, the riparian resources.

Crater Creek: Riparian resource issues along Crater Creek downstream of the diversion primarily occur in the adjustable reach, which includes Hellhole Meadow (RM 0.0 to 0.5). These issues include upland species present in the meadow and riparian corridor, high willow decadence, decreased floodplain connectivity, and changes in the natural hydrologic regime. The riparian vegetation upstream of RM 0.5 does not appear to have been adversely affected by Project operations, as no riparian resource issues were identified within this stream segment (non-adjustable).

Under the Proposed Action, the diversion will be decommissioned, thereby providing natural flows in the channel and on the floodplain, including Hellhole Meadow. Although hydrology information downstream from the diversion is unknown, the diversion is believed to take most of the flow for considerable portions of the year. By decommissioning the diversion, 3.0 miles of bypass reach are returned to a free-flowing stream. Natural flow will remain in the channel in all water year types, and more water will be provided to downstream resources which will likely enhance the riparian resources, as well as other resources dependent on the riparian habitat, along Crater Creek and in Hellhole Meadow, unless grazing use was to increase within the meadow. The natural flows will: (1) increase the frequency and duration of meadow inundation; (2) provide higher moisture conditions to support wetland species within the meadow; (3) deposit fresh alluvium on the bar and meadow surfaces, which is important for successful establishment of riparian species; and (4) may discourage continued encroachment of upland species on the bars.

North Slide, South Slide, and Tombstone Creeks: Under the Proposed Action, the diversions will be decommissioned. As the diversions have been out-of-service for over 20 years, the conditions of the resources are expected to remain the same. By decommissioning these diversions, 1.64 miles of bypass reaches are returned to free-flowing streams (including Tombstone Creek, discussed below).

Tombstone Creek: Resource issues, including coverage of upland and non-wetland species within the riparian zone and the meadow, and stress (high willow decadence; grazing and recreation pressures) to riparian and meadow vegetation, were identified on Tombstone Creek in the meadow near Jackass Meadows and in the riparian corridor within the vicinity of the Jackass Campground. These riparian resource issues could potentially reflect natural flow conditions, as the diversion has been out of operation for over 20 years. Under the Proposed Action, the diversion on Tombstone Creek will be decommissioned, which is expected to result in little change to riparian resources. This area, however, is currently extensively grazed by pack animals and heavily used by campers. If grazing by pack animals and heavy recreation continues in the meadows and within the stream channel, regeneration (age class structure) may continue to be limited as the younger stems of shrubs are often eaten and/or trampled by animals and people.

Hooper Creek: Under existing operations flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect the high flow regime from current operations, and are not expected to adversely impact the riparian resources.

Lower Basin Tributaries

Pitman Creek, Diversion to Big Creek: Under existing operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect the high flow regime from current operations, and are not expected to adversely impact riparian resources.

Balsam Creek, Forebay to Balsam Creek Diversion: Under existing operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

The Proposed Action does not change operations that would affect the high flow regime from current operations, and are not expected to adversely impact riparian resources.

North Fork Stevenson Creek, Tunnel Outlet to Shaver Lake: Along North Fork Stevenson Creek, riparian resource issues include riparian community structure and coverage (high stem densities), coverage of upland species within the riparian zone, and changes in the hydrologic regime. Historically, this stream segment was used to convey water from Huntington Lake into Shaver Lake prior to the construction of the Eastwood Power Project that changed the shape and size of the channel, and most likely, the dominant grain size within the adjustable reach. The observed vegetation reflects the changes that resulted from these flows, as well as the subsequent lower flow condition that now reflects existing operations.

The Proposed Action does not change operations that would affect the high flow regime from current operations. As high flows are not proposed to change, the riparian resources will continue to adjust to the lower flow regime since the last large release from Tunnel 7.

Big Creek, Dam 5 to San Joaquin River: Under existing operations, flows are sufficient to support and protect riparian resources within this stream, as no riparian resource issues were identified.

Under existing conditions, high flows of variable magnitude and duration occur during most, but not all wet water years, during the period of natural spring runoff. As the high flow regime is not proposed to change, adverse impacts to the existing riparian habitat are not expected.

Stevenson Creek, Shaver Lake Dam to San Joaquin River: Along Stevenson Creek, potential riparian resource issues were identified within the adjustable reaches, including stress associated with erosion control measures and flow capacity constrictions of the culvert at Highway 168, and to a lesser degree, age class structure, and upland species encroachment.

The Proposed Action does not change the high flow regime occurring under current operations. Under existing operations, flows that equal and exceed the 1.5-year flow magnitude and duration occur. The riparian vegetation within the adjustable reach downstream of Shaver Lake (0.1 mi) is also affected by the erosion control measures that have been implemented (rip-rapped banks) and flow capacity constraints through the culvert underneath Highway 168, which would continue to impact the riparian resources under any potential flow regime.

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

San Joaquin River, Dam 6 to Redinger: Under existing operations, flows are sufficient to support and protect riparian resources within this stream segment.

As no riparian resource issues were identified within the reach under existing operations, no adverse impacts are expected from the Proposed Action. High flows associated with spills occur during wet and above normal water years, and periodic spills occur during dry water years under existing operations. Excessive mature vegetation is not likely to become established adjacent to the low flow channel, as spills occur during wet and above normal water years. In addition, since the high flows are associated with high spring runoff, the timing of the flows is consistent with riparian species recruitment adaptations. During below normal, dry, and critically dry water years, the riparian vegetation is supported by MIFs, periodic spill discharge flows, and local runoff.

5.2.6.4 Unavoidable Adverse Impacts

No unavoidable adverse impacts to riparian resources have been identified under the Proposed Action.

TABLES

Table 5.2.6-1. Project and Comparison Stream Reaches.

Quantitative Study Reaches
Project Reaches
Potential Floodplain Reaches[1]
Mono Creek Floodplain RM 2.3 - 2.8
Mono Creek Floodplain RM 3.5 - 3.7
South Fork San Joaquin River Floodplain RM 17.8 - 18.0 (historically functioned as terrace)
Stevenson Creek Floodplain RM 3.9 - 4.3
Big Creek Floodplain RM 8.3 - 8.6
North Fork Stevenson Creek Floodplain RM 1.7 - 2.4
Stevenson Creek Floodplain RM 2.7 - 3.2
Meadow 31/Tombstone Creek Floodplain RM 0.00 - 0.56 (Right Bank)
Meadow 20/Crater Creek Floodplain RM 0.0 - 0.54
Meadow 26/South Fork San Joaquin River Floodplain RM 26.1 - 27.7 (Left Bank)
Meadow 30/South Fork San Joaquin River Floodplain RM 26.1 - 27.7 (Right Bank)
Meadow 19/ South Fork San Joaquin River Floodplain RM 22.0 - 24.1 (Right Bank) (historically functioned as terrace)
Meadow 16/South Fork San Joaquin River Floodplain RM 19.9 - 21.0 (Left Bank) (historically functioned as terrace)
Meadow 18/South Fork San Joaquin River Floodplain RM 19.9 - 21.0 (Left Bank) (historically functioned as terrace)
Meadow 34/South Fork San Joaquin River Floodplain RM 26.1 - 27.7 (Left Bank)
Meadow 36/South Fork San Joaquin River Floodplain RM 26.1 - 27.7 (Left Bank)
Meadow 28/South Fork San Joaquin River Floodplain RM 26.1 - 27.7 (Right Bank)
Group 1 Stream Reaches
North Slide Creek (RM 0 – 0.3)
South Slide Creek (RM 0 – 0.3)
Hooper Creek (RM 0 – 0.63)
Mono Creek (RM 4.4 – 4.7)
Big Creek (RM 7.0 – 9.9)
Comparison Reaches
Stevenson Creek Floodplain RM 8.9 - 9.2
Coon Creek Floodplain RM 1.0 - 1.3
Coon Creek Floodplain RM 1.4 - 1.7
Chiquito Creek Floodplain RM 1.5 - 2.4
Saginaw Creek Floodplain RM 2.4 - 2.6
Tamarack Creek Floodplain RM 1.1 - 1.9
Boulder Creek Floodplain RM 0.2 - 0.4
Bear Creek Meadow
Stevenson Creek Meadow
Coon Creek Meadow
South Fork San Joaquin River Meadow (Blayney)
Coon Creek RM 1.7 - 1.8 Group 1
Mono Creek above Lake Edison Floodplain

Table 5.2.6-1. Project and Comparison Stream Reaches.

Qualitative Study Reaches
Group 2 Stream Reaches
Project Reaches
Balsam RM 0.0-0.7
Bear RM 1.6-0.0
Big Creek below Kerckhoff Dome RM 7.0-0.0
Bolsillo RM 1.6-0
Camp 62 RM 1.4—0.0
Chinquipin RM 0.9-0.0
Crater Diversion RM 2.9-0.0
Crater RM 2.9-0.5
Ely RM 1.0-0.0
North Fork Stevenson Creek RM 3.6-2.8, 1.5-1.0
Pitman RM 1.5-0.0
Rock RM 0.5-0.0
Ross RM 0.9-0.0
South Fork San Joaquin River 1 RM 26.1-24.5
South Fork San Joaquin River 2 RM 14.0-6.4
South Fork San Joaquin River 3 RM 6.4-0.0
San Joaquin River RM 38.4-6.1
Stevenson Creek RM 2.6-0.0
Stevenson Creek RM 3.9-3.5
Tombstone RM 1.0-0.6
Comparison Reaches
Bear Creek RM 1.6-3.6
Boulder Creek RM 0.0-1.3
Coon Creek RM 0.3-2.3
Jose Creek RM 1.4-2.9
Middle Fork San Joaquin River RM 0.0-3.5
Saginaw Creek RM 0.9-1.3
Sallie Keyes RM 0.0-2.0
South Fork San Joaquin River RM 0.0-14.0, 24.5-26.1
Shakeflat Creek RM 1.3-3.4
San Joaquin River RM 38.5-48.8
Stevenson Creek above Shaver Lake RM 8.0-9.8
Tamarack Creek RM 1.0-3.0

[1]Following hydraulic analyses, a few reaches initially identified as potential floodplains and connected to the channel two out of every three years were determined to be inundated less frequently historically, and therefore functioned historically as terraces. These reaches are indicated.

Table 5.2.6-2. Linear Miles of Riparian Vegetation by Project within the Project Area.

Project	Riparian Community Type	Dominant Species	Total Linear Miles	Patchy Riparian	Discontinuous Corridor	Continuous Corridor	Polygon
Mammoth Pool Project (FERC Project No. 2085)			**1.55**				
	White Alder Riparian Scrub	*Alnus rhombifolia* and *Salix* spp.	1.55	0.07	1.48	0.00	0.00
Big Creek Nos. 1 and 2 Project (FERC Project No. 2175)			**8.91**	**0.0**	**4.7**	**1.6**	
	Montane Riparian Scrub	*Alnus incana* ssp. *tenuifolia,* and *Salix* spp.	1.37	0.00	0.00	1.37	0.00
	White Alder Riparian Scrub	*Alnus rhombifolia* and *Salix* spp.	4.89	0.00	4.63	0.26	0.00
	White Alder Riparian Scrub/Montane Riparian Scrub	*Alnus incana* ssp. *tenuifolia, Alnus rhombifolia,* and *Salix* spp.	2.35	0.01	0.10	0.00	2.24
	Wet Meadow		0.31	0.00	0.00	0.00	0.31
Big Creek Nos. 2, 8 and Eastwood Project (FERC Project No. 67)			**34.92**	**0.2**	**16.1**	**17.2**	
	Aspen Riparian Forest	*Populus tremuloides*	3.73	0.00	1.11	2.61	0.00
	Montane Riparian Scrub	*Alnus incana* ssp. *tenuifolia,* and *Salix* spp.	6.38	0.00	1.01	5.37	0.00
	White Alder Riparian Scrub	*Alnus rhombifolia* and *Salix* spp.	4.49	0.12	1.92	2.34	0.11
	White Alder Riparian Scrub/Montane Riparian Scrub	*Alnus incana* ssp. *tenuifolia, Alnus rhombifolia,* and *Salix* spp.	18.96	0.04	12.08	6.85	0.00
	Montane Black Cottonwood Riparian Forest	*Populus balsamifera* spp. *trichocarpa*	0.08	0.00	0.00	0.00	0.08
	Wet Meadow		1.27	0.00	0.00	0.00	1.27
Big Creek No. 3 Project (FERC Project No. 120)			**1.08**				
	White Alder Riparian Scrub	*Alnus rhombifolia* and *Salix* spp.	1.08	0.01	1.07	0.00	0.00

Table 5.2.6-3. Riparian Resource Issues Identified during Relicensing Studies.

Riparian Characteristic	Description
Age Class Structure	Refers to the distribution of stem size classes, as a surrogate for age. The resource includes seedling and vegetative establishment success and densities of mature stems.
Community Composition	Refers to the variety and distribution of species within the riparian zone. The attribute includes the frequency of common riparian species and the presence of non-riparian and non-native species within the riparian zone.
Riparian Coverage	Refers to the relative amount of riparian vegetation along the channel. The attribute includes coverage along adjustable and non-adjustable channel reaches, channel encroachment, and upland encroachment.
Evidence of Unusual Mortality or Stress	Refers to observable stress or mortality of riparian vegetation, which includes evidence of disease, decadence, grazed, or trampled vegetation.
Floodplain Connectivity and Bar Inundation	Refers to the frequency of overbanking or bar inundation under current operations.
Timing of Peak Flows	Refers to the timing of the peak flows under current operations that under a natural hydrologic regime would be associated with spring runoff.

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Bypass Stream Reaches (Small Tributaries)					
Tombstone Creek Diversion to Meadow (RM 0.6 - 1.1) (FERC Project No. 67)	• ARF • POTR, ALINTE present	• Continuous narrow ARF corridor (0.42 mi)	• Seedlings and young individuals present on banks • Diverse age class structure (seedling, young, and mature individuals present)		
Tombstone Creek, Jackass Campground Meadow reach to SFSJR (RM 0.0-0.6) (FERC Project No. 67)	• ARF • *Salix* spp., PICOMU, ABCO, PIJE present • Upland tree species seedlings present on alluvial surfaces	• Non-continuous ARF (0.56 mi) • <u>Average Riparian Width</u>: 5 m • <u>Ground cover</u> within plots is typically 100% (mode) and ranges from 2 to 100% • Increased tree coverage at Jackass Meadow Campground and near South Fork San Joaquin River (SFSJR) since 1944 (aerial photograph comparison) • Comparatively low stem densities on alluvial surfaces	• Low seedling establishment success and minimal new stem growth • Dominated by stems 1/2" to 3" in diameter with few stems <1/2" or greater than 3" in diameter	• Heavily grazed herbs and shrubs (pack animals) • Recreation (Jackass Meadow Campground)	• Organic, sand, silt/clay
North Slide Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• ARF • *Salix* spp., ALINTE, PREM, *Lonicera* spp., RINE, RULE, JUOC, POTR present • <u>Herbaceous species richness</u>: 0.6 species/m^2	• Wide POTR corridor with non-continuous *Salix* spp. and PREM along channel • <u>Riparian Corridor Width</u>: 2 to 6.5 m • <u>Ground cover</u> within plots is typically between 10 and 39% (mode) and ranges from 0 to 99%	• Seedlings and young individuals present on banks • Few large stem sizes classes present		• Boulder, cobble, sand, silt/clay
South Slide Creek, Diversion to Confluence with North Slide Creek (FERC Project No. 67)	• ARF • *Salix* spp., ALINTE, PREM, RINE, RULE, JUOC, POTR present • <u>Herbaceous species richness</u>: 1.4 species/m^2	• Wide POTR corridor with non-continuous *Salix* spp. and PREM along channel • <u>Riparian Corridor Width</u>: 4.6 to 6.5 m • <u>Ground cover</u> within plots is typically between 60 and 99% (mode) and ranges from 2 to 99%	• Seedling, young, and mature individuals present on banks • Diverse stem age class structure		• Boulder, cobble, sand, silt/clay, organic
Crater Creek, Diversion (RM 3.0) to RM 0.5 (upstr. from adjustable reach) (FERC Project No. 67)	• ARF • MRS • WAMRS • ALINTE, *Salix* spp., PICOMU, POTR present	• Non-continuous ARF and MRS (1.04 mi) • Continuous corridor of MRS, WAMRS, or ARF (1.81 mi)	• Seedling, young, and mature individuals present on banks		
Crater Creek, adjustable meadow reach (RM 0.0-0.5) (FERC Project No. 67)	• WAMRS • ALINTE, *Salix* spp., PICOMU present • <u>Upland tree species seedlings</u> present on alluvial surfaces	• Continuous WAMRS (0.23 mi) • <u>Average Riparian Width</u>: 20 m • <u>Ground cover</u> within plots is typically between 60 and 99% • Increase in tree coverage along channel in comparison to 1944 aerial photography	• Seedlings and new growth present • Moderate stem densities and stem age class diversity (along channel, dominated by stems < 1" in diameter)	• Greater than 30% *Salix* spp. decadence in more than 20% of plots • Light grazing	• Boulder, sand, silt/clay, duff
Chinquapin Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• MRS • ALINTE, *Salix* spp., POBA present	• Narrow and wide corridors of MRS (0.50 mi)	• Young individuals present on bars • Seedlings and young individuals present on banks		
Camp 62 Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• MRS • MBCRF • ALINTE, *Salix* spp. present	• Wide corridors of MRS downstream of diversion and in upper lower gradient reach (0.24 mi) • Continuous narrow band of MRS with a small reach with MBCRF (1.1 mi) • Sparse riparian vegetation (0.12 mi)	• Young individuals present on bars • Seedlings and young individuals present on banks		

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Bypass Stream Reaches (Small Tributaries) (continued)					
Bolsillo Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• MRS • ARF • WAMRS • ALINTE, *Salix* spp., POTR, PICOMU, PIJE, ABCO present	• Wide corridor montane MRS along steep bedrock channel downstream of diversion (potentially encroached) (0.1 mi) • Narrow continuous MRS corridor (0.74 mi), ARF (0.08 mi), and WARMS (0.50 mi) along majority of stream reach • Non-continuous MRS corridor within narrow boulder reach (0.28 mi)	• Seedlings and young individuals present on banks		
Rock Creek, Diversion to San Joaquin River (FERC Project No. 2085)	• WARS • ALINTE present	• Sparse WARS community (0.24 mi) • Non-continuous WARS community near confluence with the SJR (0.15 mi)	• Seedlings and young individuals present on banks		
Ross Creek, Diversion to San Joaquin River (FERC Project No. 2085)	• WARS • ALINTE present	• Sparse WARS community (0.75 mi) • Non-continuous narrow WARS corridor near confluence with the SJR (0.1 mi)	• Seedlings and young individuals present on banks		
Ely Creek, Diversion to Big Creek (FERC Project No. 2175)	• WARS • ALINTE, *Salix* spp. present	• Sparse WARS community near confluence with Big Creek (0.2 mi) • Non-continuous WARS corridor (0.78 mi)	• Young individuals present on bars • Seedlings, young, and mature individuals present on bank		
Balsam Creek, Diversion to Big Creek (FERC Project No. 2175)	• WARS • ALINTE, *Salix* spp. present	• Non-continuous WARS (0.5 mi) • Continuous WARS near confluence (0.2 mi)	• Young individuals present on bars • Seedlings, young, and mature individuals present on banks		
Bypass Stream Reaches (Moderate Tributaries)					
Bear Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• MRS • WAMRS • ALINTE, *Salix* spp., POTR present	• Continuous narrow corridor of MRS (0.85 mi) or WAMRS (0.39) • Non-continuous and wide corridors of WAMRS along steep bedrock section to confluence with SFSJR (0.32 mi)	• Young individuals present on bars • Seedlings and young individuals present on banks		
Mono Creek, Diversion to South Fork San Joaquin River (excluding two adjustable reaches) (FERC Project No. 67)	• MRS • WAMRS • ALINTE, *Salix* spp., JUOC, PIJE present • <u>Herbaceous species richness</u>: 0.4 species/m^2	• Continuous narrow corridor of MRS 0.76 mi downstream of diversion • <u>Riparian Corridor Width</u>: 2.5 to 4.5 m • <u>Ground cover</u> within plots is typically 0% (mode) and ranges from 0 to 99% • High stem densities within bankfull indicators from diversion to 1.3 mi upstream of SFSJR confluence (potentially encroached, 4.3 mi)	• Diverse age class structure (seedlings to stems 5" in diameter) • Seedlings and young individuals present on banks and bars		• Organic, bedrock, boulder, cobble, gravel, sand, silt/clay, duff

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Bypass Stream Reaches (Moderate Tributaries) (continued)					
Mono Creek, adjustable reaches (RM 2.3-2.8 and 3.5-3.7) (FERC Project No. 67)	• WAMRS • ALINTE, *Salix* spp., PICOMU, POBA, POTR present • Upland tree species seedlings present on alluvial surfaces (both reaches) • Non-native species present: POPR, TAOF • Herbaceous species richness: 1.0 and 1.2 species/m^2	• Wide riparian corridors of ALINTE and *Salix* spp. with short sections of non-continuous narrow corridors to the confluence with SFSJR (5.04 mi) • **RM 2.3-2.8**: Riparian Corridor Width: 3 to 18 m • Comparatively low frequencies of *Salix* spp. on alluvial surfaces • Comparatively low stem densities on alluvial surfaces • Ground cover within plots is typically between 60 and 99% (mode) and ranges from 2 to 99% • **RM 3.5-3.7**: Riparian Corridor Width: 6 to 37 m • Ground cover within plots is typically between 40 and 59% (mode) and ranges from 2 to 99%	• Seedlings present, but fairly low seedling regeneration success on alluvial bars • **RM 3.5 - 3.7**: Dominance of stems >1" in diameter with few seedlings present	• **RM 2.3-2.8:** Greater than 10% ALIN decadence in more than 20% of plots • RM 2.3-2.8 and RM 3.5-3.7: Greater than 30% *Salix* spp. decadence in more than 20% of plots • Yellow-orange fungus on willows, leaf loss • Light to moderate grazing • Recreation	• **RM 2.3-2.8**: Boulder, gravel, sand, silt/clay, duff • **RM 3.5-3.7**: Cobble, gravel, sand, silt/clay, organic, duff
Hooper Creek, Diversion to South Fork San Joaquin River (FERC Project No. 67)	• MRS • ALINTE, *Lonicera* spp., CADE, PIJE present • Herbaceous species richness: 0.6 species/m^2	• Quantitative studies indicate non-continuous corridor with ALINTE, *Salix* spp., PREM • Riparian Corridor Width: 2 to 5.1 m • Ground cover within plots is typically 0% (mode) and ranges from 0 to 59%	• Seedling, young, and mature individuals present		• Bedrock, boulder, cobble, gravel, sand, silt/clay, duff
Pitman Creek, Diversion to Big Creek (FERC Project No. 67)	• WAMRS	• Sparse (0.92 mi) and non-continuous corridor (0.61), including lower gradient reach) of WAMRS • Non-continuous WAMRS corridor within steep, bedrock reach (0.5 mi)	• Seedlings present on banks		
Big Creek, Huntington Lake (RM 9.9 to RM 7.9) (FERC Project No. 2175)	• WARS • WAMRS • ALINTE, *Salix* spp., RINE, SPDE, JUOC, PICOMU, ABCO present • Non-native species present: POPR • Herbaceous species richness: 1.0 species/m^2	• Non-continuous corridor (0.7 mi) to sparse (0.9 mi) WARS or WAMRS • Riparian Corridor Width: 5.5 to 40.5 m • Ground cover within plots is typically between 2 and 9% (mode) and ranges from 0 to 99% • Wide corridor of ALINTE and *Salix* spp. between RM 7.9 to 9.9	• Extensive vegetative new growth • Diverse stem age class diversity (seedlings to 5" in diameter) • Relatively high densities of mature stems (> 1" in diameter) • Minimal successful seedling establishment observed		• Organic, bedrock, gravel
Adjustable channel reach (RM 8.3 - 8.6) (FERC Project No. 2175)	• MRS • ALINTE, *Salix* spp., SPDE, JUOC, PICOMU, ABCO, POBA, LOCO, CHSE present • Non-native species present: RUDI • Herbaceous species richness: 1.2 species/m^2	• Wide corridors of WAMRS • Riparian Corridor Width: 7.6 to 17.7 m • Ground cover within plots is typically between 60 and 99% (mode) and ranges from 0 to 99% • Comparatively low frequencies of willows along channel	• Limited new successful establishment • High densities of mature stems (>1 " in diameter) • Diversity of age classes present (stems < 1/2" to 5" in diameter), few new seedlings • High total stem densities		• Cobble, sand, silt/clay, organic, duff
Big Creek, RM 7.9 to Dam 4 (RM 6.4) (FERC Project No. 2175)	• WARS • WAMRS • ALINTE, *Salix* spp. present	• Wide (0.1 mi), non-continuous corridor (0.3 mi) to sparse (1.1 mi) WARS or WAMRS			
Big Creek, Dam 4 to Dam 5 (FERC Project No. 2175)	• WARS • ALINTE, *Salix* spp. present	• Sparse (0.7 mi), non-continuous (3.3 mi), and continuous (0.3) WARS			

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Bypass Stream Reaches (Moderate Tributaries) (continued)					
Big Creek, Dam 5 to San Joaquin River (FERC Project No. 67)	• WARS • MBCRF • ALINTE, *Salix* spp. present	• Sparse (1.7 mi) to non-continuous WARS (0.15 mi) with narrow corridor of MBCRF (0.09 mi)			
Stevenson Creek, Shaver Lake Dam (RM 4.2 to RM 4.1) (FERC Project No. 67)	• WAMRS • ALINTE, *Salix* spp., COSE, PSMEME, PIPO present • Non-native species present: RUAC, MESPSP, TAOF • Herbaceous species richness: 1.2 species/m^2	• Continuous WAMRS (0.38 mi) • Continuous WAMRS corridors (1.35 mi) • Sparse to non-continuous corridors of white alder riparian scrub (2.54 mi) • Riparian Corridor Width: 1.8 to 42 m • Ground cover within plots is typically between 60 and 99% (mode) and ranges from 0 to 99%	• High shrub densities and age class diversity • Seed and vegetative regeneration present • High densities of mature stems (> 1" in diameter)	• Rip-rap • Road/culvert	• Boulder, sand, silt/clay, organic, duff
Stevenson Creek, RM 4.1 to RM 3.3 (FERC Project No. 67)	• WARS • ALINTE, *Salix* spp. present	• Sparse to non-continuous band of WARS			
Bypass Stream Reaches (Moderate Tributaries) (continued)					
Stevenson Creek, RM 3.3 to RM 2.75 (FERC Project No. 67)	• WARS • CONU, *Ribes* spp., RUDI, RULE, ALRH, CADE, ROWO present • Upland tree seedlings establishment along channel • Non-native species present: RUDI • Herbaceous species richness: 1.3 species/m^2	• Continuous corridor of WARS • Riparian Corridor Width: 9 to 27 m (RM 2.7 - 3.2) • Ground cover within plots is typically between 40 and 59% (mode) and ranges from 0 to 99%	• Low shrub seedling densities • Low successful seedling establishment		• Boulder, cobble, gravel, sand, silt/clay, duff
Stevenson Creek, RM 2.75 to San Joaquin River (FERC Project No. 67)	• WARS • ALINTE, *Salix* spp. present	• Narrow, continuous band of WARS			
Bypass Stream Reaches (San Joaquin River)					
South Fork San Joaquin River Jackass Meadow to SJR, (RM 26.1 to RM 0.0) (excluding adjustable channel reaches) (FERC Project No. 67)	• MRS • WAMRS • ARF	• Narrow continuous corridor of MRS (2.13 mi) and WAMRS (2.2 mi) with narrow continuous corridor of ARF near confluences with North and South Slide Creeks (1.1 mi) • Continuous, narrow WAMRS to Bear Creek confluence (2.2 mi) • Non-continuous narrow corridor, interspersed with wide WAMRS to Mono Creek confluence (5.76 mi) • Non-continuous narrow corridor, interspersed with sparse WARS to RM 6.4 (10.14 mi) • Sparse to no WARS (6.09) with two wide corridor reaches (0.31 mi)			

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	Coverage Extent	Age Class Distribution	Stress/Mortality	Floodplain Substrate
Bypass Stream Reaches (San Joaquin River) (continued)					
South Fork San Joaquin River, Jackass Meadow (RM 27.7 to 26.1) (FERC Project No. 67)	• MRS • ALINTE, *Salix* spp., PICOMU present • **Meadows 36, 30, 34, 26:** Upland tree species seedlings present on alluvial surfaces	• Continuous ALINTE, *Salix* spp. at Jackass Meadow riparian corridors • **Meadow 26**: Average Riparian Width: 20 m • Ground cover within plots is typically 100% (mode) and ranges between 60% and 100% • **Meadow 30**: Average Riparian Width: 29 m • Ground cover within plots is typically between 60% and 99% (mode) and ranges between 60% and 100% • **Meadow 34**: Average Riparian Width: 7 m • Ground cover within plots is typically between 60% and 99% (mode) and ranges from 2% and 99% • **Meadow 36**: Average Riparian Width: 39 m • Ground cover within plots is between 60% and 99% • **Meadow 28**: Average Riparian Width: 21 m • Ground cover within plots is between 60% and 99% • **Meadows 26, 34, and 36:** Low densities of seedlings on alluvial surfaces • **Meadows 30 and 36:** Comparatively high densities of stems • Increase in coverage by trees along stream banks	• **Meadow 26**: Stem sizes present: 1/2 to 3" (minimal new establishment) • **Meadow 28**: Diverse age class structure (seedlings to stems 3" in diameter) • **Meadow 30**: Diverse age class structure (seedlings to stems 3" in diameter) • **Meadow 34**: Diverse age class structure, except few seedlings present (< 1/2" to 1") • **Meadow 36**: Diverse age class structure, except few seedlings present (< 1/2" to 3")	• **Meadow 26:** Greater than 30% *Salix* spp. decadence in more than 20% of plots • **All Meadows:** Heavily grazed herbs and shrubs (pack animals) • **All Meadows**: Recreation	• **Meadow 30/34**: sand, silt/clay, gravel • **Meadow 36**: silt/clay, sand, gravel • **Meadow 26/28**: silt/clay, organic, sand
Adjustable channel reaches (RM 17.8 - 18.0 and 19.9 - 21.0, 22.0 - 24.1) (Poison Meadow, Mono Hot Springs, Mono Crossing) (FERC Project No. 67)	• WAMRS • **Mono Crossing**: JUOC, PIJE, POBA, *Rosa* spp., ALINTE, *Salix*spp. Present • Herbaceous species richness: 0.7 species/m2 • **Poison**: ALINTE, *Salix* spp., POBA present • **Mono Hot Springs**: *Rosa* spp., *Salix* spp., JUOC present	• **Poison:** Continuous, narrow band of WARS • Average Riparian Corridor Width: 50 m • Ground cover within plots is typically between 60% and 99% (mode) and ranges from 2% to 99% • **MXing:** Riparian Corridor Width: 4 m to 28 m • Ground cover within plots is typically 0% (mode) and ranges between 0% and 99% • Comparatively low frequencies of willows on alluvial surfaces • **Meadow 16 (MHS):** Riparian Corridor Width: 5 m • Ground cover within plots is typically between 60% and 99% (mode), and ranges from 10% to 99% • Comparatively low frequencies of willows on alluvial surfaces • Comparatively low stem densities on alluvial surfaces • **Meadow 18 (MHS):** Riparian Corridor Width: 5 m • Ground cover within plots is typically between 40% and 59% (mode), and ranges from 10% to 99% • Comparatively low frequencies of willows on alluvial surfaces • Comparatively low stem densities on alluvial surfaces	• **MXing:** Low densities of seedlings • Moderate coverage by willow species on alluvial surfaces • Diversity of stem size classes, except seedlings (< 1/2" to 5") • **MHS:** Low densities of seedlings • Only small stem size classes present (no stems >1") • **Poison:** Comparatively high stem densities • Comparatively high densities of mature stems (> 1" in diameter) • Diversity of stem size classes, except seedlings (1/2" to >5")	• **MXing**: Greater than 10% ALIN decadence in more than 20% of plots	• **Meadow 16 and 18**: Boulder, cobble • **Poison**: Boulder, cobble, sand, organic, silt/clay • **MHS**: Boulder, cobble, gravel, sand, silt/clay

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Bypass Stream Reaches (San Joaquin River) (continued)					
San Joaquin River, Mammoth Pool Dam to Dam 6 (FERC Project No. 2085)	• WARS	• Sparse WARS (7 mi) with non-continuous narrow WARS corridors (1.45 mi) near Dam 6, typically associated with tributary confluences (Ross Creek, Rock Creek, Aspen Creek, and Horsethief Creek) • Wide corridor of WARS downstream of Shakeflat Creek confluence (0.29 mi)			
San Joaquin River, Dam 6 to Redinger (FERC Project No. 120)	• WARS	• Sparse WARS (9.9 mi) with 1 mi with non-continuous WARS upstream of Redinger Lake			
Flow Augmented Streams					
Rancheria Creek downstream Portal Powerhouse (FERC Project No. 2175)	• MRS	• Wide corridor of MRS downstream of surge chamber to Huntington Lake • Continuous corridor of MRS (0.9 mi)			
Balsam Creek, Forebay to Balsam Creek Diversion (FERC Project No. 67)	• WAMRS	• Non-continuous WAMRS (1.1 mi) • Continuous WAMRS (0.4 mi) • Non-continuous WAMRS (0.2 mi)	• Seedlings, young and mature individuals present		
North Fork Stevenson Creek, tunnel outlet (RM 3.3) to RM 3.5 (FERC Project No. 67)	• MRS	• Sparse to non-existent MRS	• Seedling and young individuals present		
North Fork Stevenson Creek, RM 3.3 to RM 2.4 (FERC Project No. 67)	• MRS	• Sparse to non-existent MRS	• Seedling and young individuals present		
North Fork Stevenson Creek (Adjustable reaches RM 2.4 to RM 1.8 and RM 1.2-1.3) (FERC Project No. 67)	• MRS • ALINTE, *Salix* spp., RHOC, ABCO, CADE present • Upland tree species seedlings present on alluvial surfaces • Herbaceous species richness: 0.9 species/m^2	• Wide MRS corridor • <u>Riparian Corridor Width</u>: 5 m to 50 m (RM 1.7 to 2.4) • <u>Ground cover</u> within plots is typically 0% (mode) and ranges from 0% to 99% • Large stem sizes and densities within banks (encroached) • Comparatively high frequencies of mountain alder or willows along channel	• Seed and vegetative reproduction • High total stem densities • Size class diversity • High densities of mature stems (>1" in diameter)	• Greater than 30% *Salix* spp. decadence in more than 20% of plots	• Boulder, cobble, gravel, sand, silt/clay, duff

Table 5.2.6-4. Summary of Riparian Resources Along Project Bypass Streams[1].

	Riparian Attributes				
	Community Type/ Dominant Species	**Coverage Extent**	**Age Class Distribution**	**Stress/Mortality**	**Floodplain Substrate**
Flow Augmented Streams (continued)					
North Fork Stevenson Creek, RM 1.8 to Shaver Lake (RM 1.0) (FERC Project No. 67)	• MRS • ALINTE, *Salix* spp. present	• Narrow, non-continuous MRS corridor			

Abbreviations:

MXing: Mono Crossing reach
MHS: Mono Hot Springs reaches
RM: River Mile
Q: Discharge (cfs)

Community Types

ARF: Aspen Riparian Forest
MBCRF: Montane Black Cottonwood Riparian Forest
MRS: Montane Riparian Scrub
WAMRS: White Alder/Montane Riparian Scrub
WARS: White Alder Riparian Scrub

Species

ABCO: *Abies concolor* (white fir)
ABMA *Abies magnifica* (red fir)
ACMA *Acer macrophyllum* (big leaf maple)
ALINTE *Alnus incana* ssp. *tenuifolia* (mountain alder)
ALRH Alnus rhombifolia(white alder)
CADE *Calocedrus decurrens* (incense cedar)
CHSE *Chrysolepis sempervirens* (Sierra chinquapin)
CONU *Cornus nuttallii* (mountain dogwood)
COSE *Cornus sericea* (creek dogwood)
JUOC *Juniperus occidentale* (western juniper)
LOCO *Lonicera conjugialis* (double honeysuckle)
MESPSP *Mentha spicata* ssp. *spicata* (spearmint)
PICOMU *Pinus contorta* ssp. *murrayana*(lodgepole pine)
PIJE *Pinus jeffreyi* (Jeffrey pine)
PIPO *Pinus ponderosa* (ponderosa pine)
POPR *Poa pratensis* (Kentucky bluegrass)
POBATR *Populus balsamerifera* ssp. *trichocarpa* (black cottonwood)
POTR *Populus tremuloides* (quaking aspen)
PREM *Prunus emarginata* (bitter cherry)
PSMEME *Pseudostuga menziesii* ssp. *menziesii* (Douglas-fir)
QUKE *Quercus kelloggii* (black oak(
RHOC *Rhododendron occidentale* (western azalea)
RINE *Ribes nevadense* (Sierra currant)
***Rosa* spp.** (rose)
ROWO *Rosa woodsii* (mountain rose)
RUDI *Rubus discolor* (Himalayan blackberry)
RULE *Rubus leucodermis* (western raspberry)
RUAC *Rumex acetosella* (common sheep sorrel)
***Salix* spp.** (willow)
SPDE *Spiraea densiflora* (dense-flowered spiraea)
TAOF *Taraxacum officinale* (common dandelion)

Table 5.2.6-5. Riparian Resources Issues and Environmental Measures on Streams in the Vicinity of the Four Big Creek ALP Projects.[1]

	Riparian Resource Issues						Enhancement Measures	
	Age Class Structure	Community Composition	Coverage[2]	Unusual Mortality or Stress	Floodplain Connectivity or Bar Inundation	Timing of High Flows	CRMF Release	Return to Natural Flow/ Decommission Diversion
Mammoth Pool Project (FERC Project No. 2085)								
San Joaquin River, Mammoth Pool Dam to Dam 6								
Rock Creek, Diversion to San Joaquin River								
Ross Creek, Diversion to San Joaquin River								
Big Creek Nos. 1 and 2 (FERC Project No. 2175)								
Big Creek, Huntington Lake to Dam 4	X	X	X		X	X		
Big Creek, Dam 4 to Dam 5								
Balsam Creek, Diversion to Big Creek								
Ely Creek, Diversion to Big Creek								
Rancheria Creek below Portal Powerhouse								
Big Creek Nos. 2A, 8 and Eastwood (FERC Project No. 67)								
South Fork San Joaquin River, Florence to Mammoth Pool	X	X	X	X	X		X	
Bear Creek, Diversion to South Fork San Joaquin River							X	
Mono Creek, Diversion to South Fork San Joaquin River	X	X	X	X	X	X	X	
Bolsillo Creek, Diversion to South Fork San Joaquin River							X	
Camp 62 Creek, Diversion to South Fork San Joaquin River							X	
Chinquapin Creek, Diversion to South Fork San Joaquin River							X	
Crater Creek, Diversion to South Fork San Joaquin River								X
North Slide Creek, Diversion to South Fork San Joaquin River								X
South Slide Creek, Diversion to Confluence with North Slide Creek								X

Table 5.2.6-5. Riparian Resources Issues and Environmental Measures on Streams in the Vicinity of the Four Big Creek ALP Projects.[1]

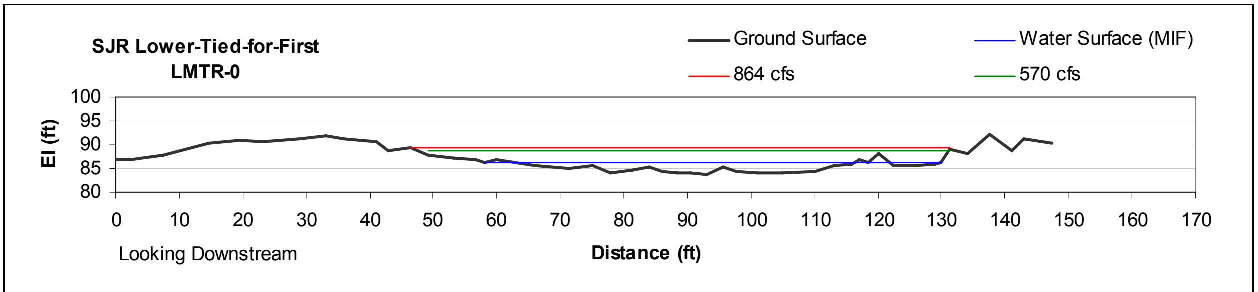
	Riparian Resource Issues						Enhancement Measures	
	Age Class Structure	Community Composition	Coverage[2]	Unusual Mortality or Stress	Floodplain Connectivity or Bar Inundation	Timing of High Flows	CRMF Release	Return to Natural Flow/ Decommission Diversion
Big Creek Nos. 2A, 8 and Eastwood (FERC Project No. 67) (continued)								
Tombstone Creek, Diversion to San Joaquin River		X	X	X				X
Hooper Creek, Diversion to South Fork San Joaquin River								
Balsam Creek, Forebay to Balsam Creek Diversion								
Big Creek, Dam 5 to San Joaquin River								
North Fork Stevenson Creek, Tunnel Outlet to Shaver Lake								
Pitman Creek, Diversion to Big Creek								
Stevenson Creek, Shaver Lake Dam to San Joaquin River								
Big Creek No. 3 (FERC Project No. 120)								
San Joaquin River, Dam 6 to Redinger								

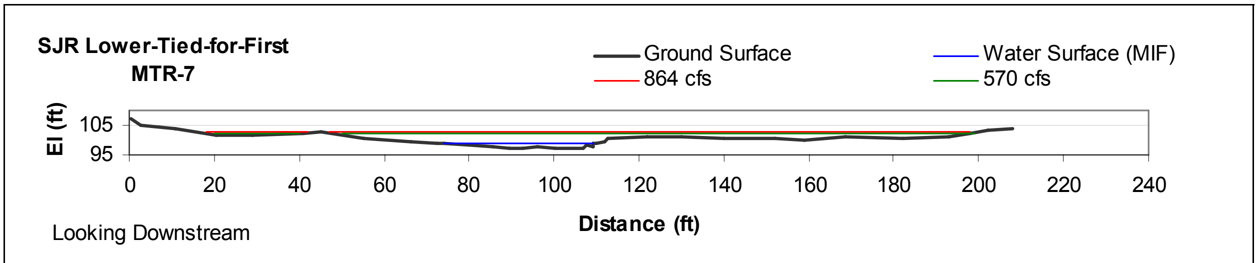
[1]Boxes marked with an X indicate an identified riparian resource issue and the proposed PM&E measure under the Proposed Action to protect and enhance riparian resources.

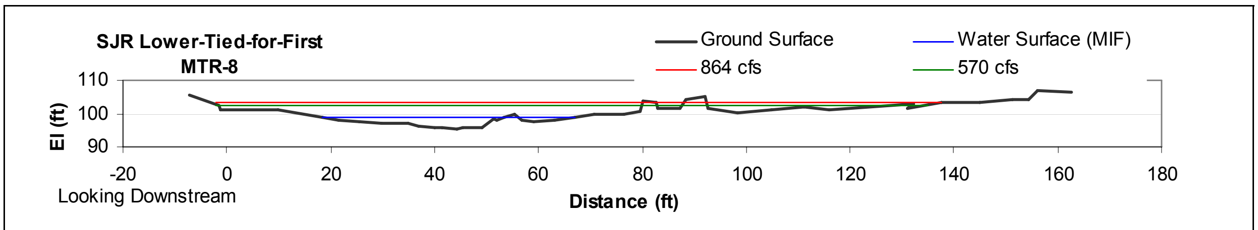
[2]Coverage includes channel encroachment, upland encroachment, and relative extent of riparian coverage within the stream segment.

FIGURES

Figure 5.2.6-1. San Joaquin River, Downstream of Mammoth Pool. Observed Water Surface Elevations and Discharges for Surveyed Transects.

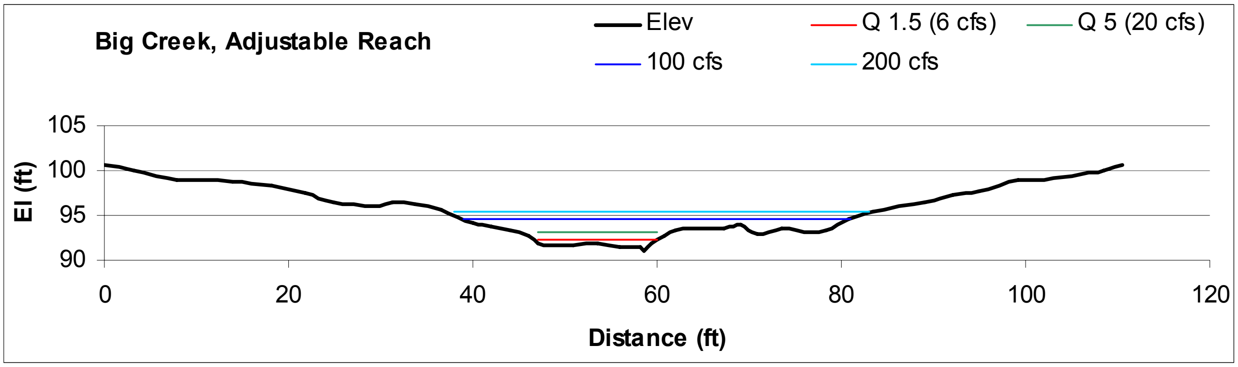


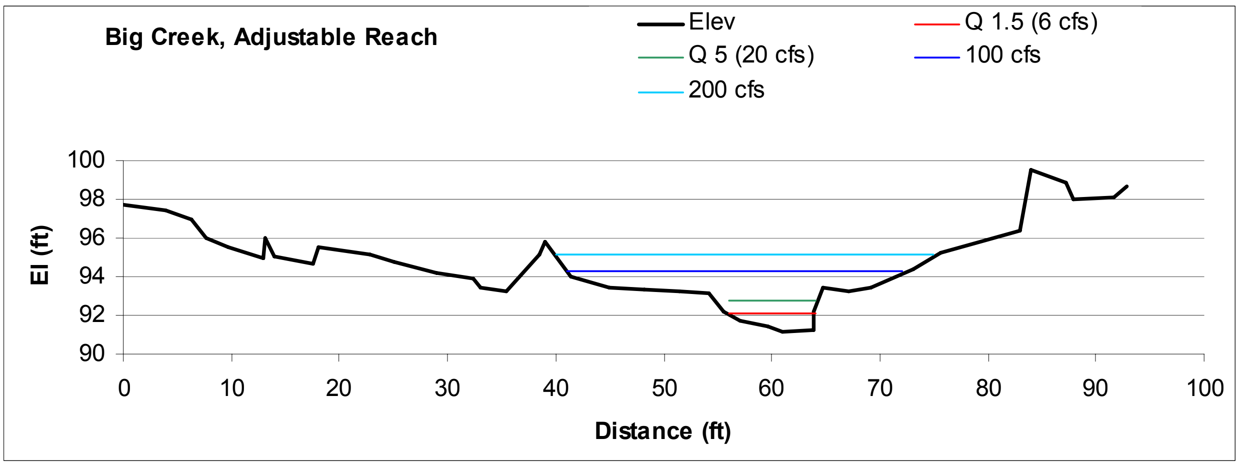


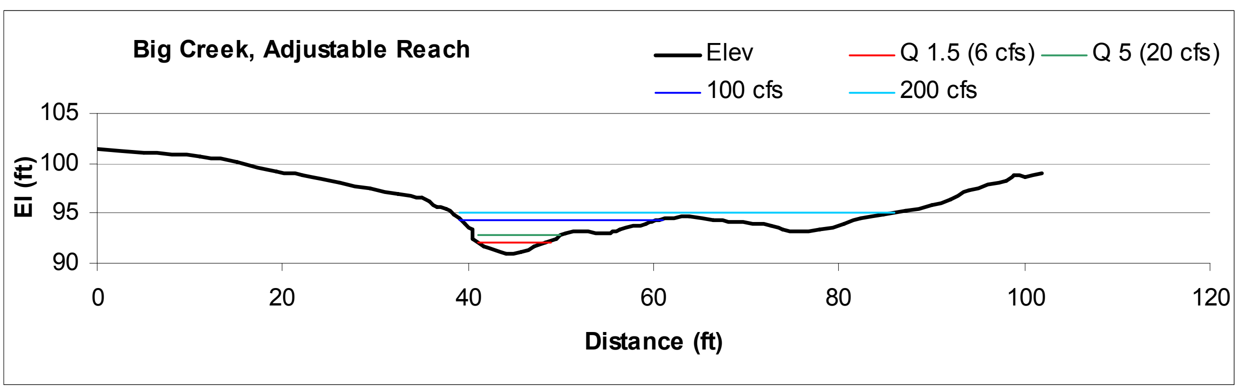


Footnote:
Water surface elevations were modeled by two different methods, using HEC-RAS within the adjustable reaches and meadows (CAWG 2, Geomorphology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)), and PHABSIM within the non-adjustable reaches (CAWG 3, Instream Flow Studies: PHABSIM, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)). The presented water surface elevations in the adjustable reaches were calibrated in the field at higher flows, unless otherwise noted. All elevations are relative elevations. The scales are approximately 1:1. In the non-adjustable reaches, higher flows were not measured for model calibration. In general, the modeled water surface elevations in the non-adjustable reaches are most reasonable at 2.5 times the highest calibrated flow in the non-adjustable reaches. Only reasonable modeled flows are provided. Water surface elevations in the non-adjustable reaches were reasonable when bank geometry did not change for the flow range (i.e. bank slopes were constant). Sensitivity analyses of the modeled flows were conducted by comparing calculated water surface elevations by two different methods, Channel Conveyance and Log-Log Regression.

Figure 5.2.6-2. Big Creek Huntington Lake to Dam 4. Water Surface Elevations and Discharges for Transects within the Adjustable Reaches. Under existing operations, 6 cfs and 20 cfs, are the 1.5-year and 5-year flows, respectively.

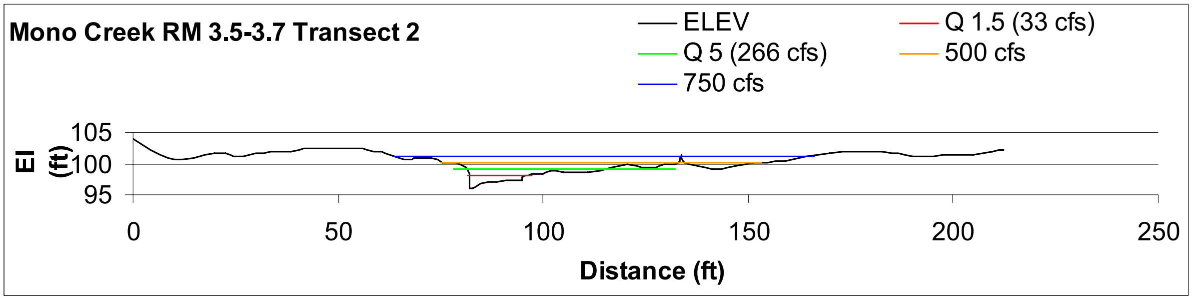


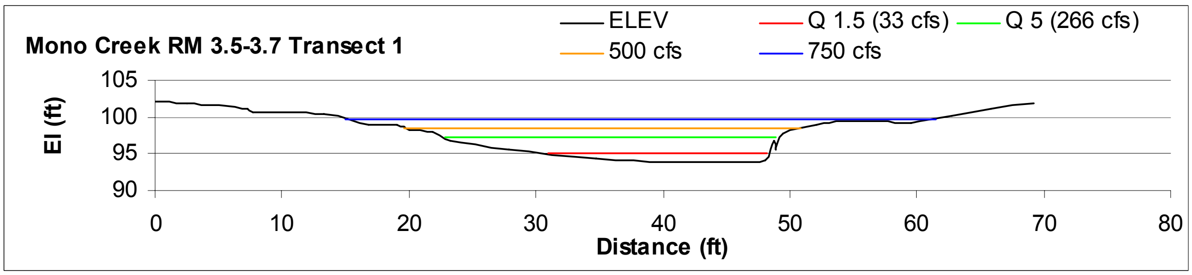




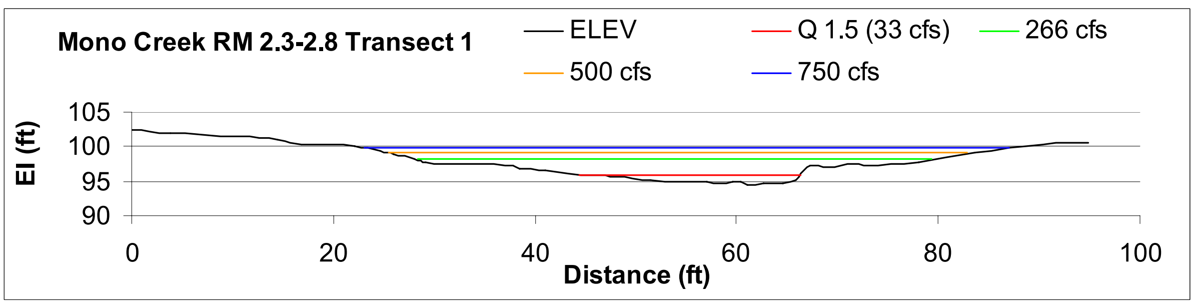
Footnote:
Water surface elevations were modeled by two different methods, using HEC-RAS within the adjustable reaches and meadows (CAWG 2, Geomorphology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)), and PHABSIM within the non-adjustable reaches (CAWG 3, Instream Flow Studies: PHABSIM, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)). The presented water surface elevations in the adjustable reaches were calibrated in the field at higher flows, unless otherwise noted. All elevations are relative elevations. The scales are approximately 1:1. In the non-adjustable reaches, higher flows were not measured for model calibration. In general, the modeled water surface elevations in the non-adjustable reaches are most reasonable at 2.5 times the highest calibrated flow in the non-adjustable reaches. Only reasonable modeled flows are provided. Water surface elevations in the non-adjustable reaches were reasonable when bank geometry did not change for the flow range (i.e. bank slopes were constant). Sensitivity analyses of the modeled flows were conducted by comparing calculated water surface elevations by two different methods, Channel Conveyance and Log-Log Regression.

Figure 5.2.6-3. Mono Creek. Water Surface Elevations and Discharges for Transects within the Adjustable Reaches. Under existing operations, 33 cfs and 266 cfs, are the 1.5-year and 5-year flows, respectively. *Note*: Maximum flow out of Howell Bunger valve is approximately 700 cfs.

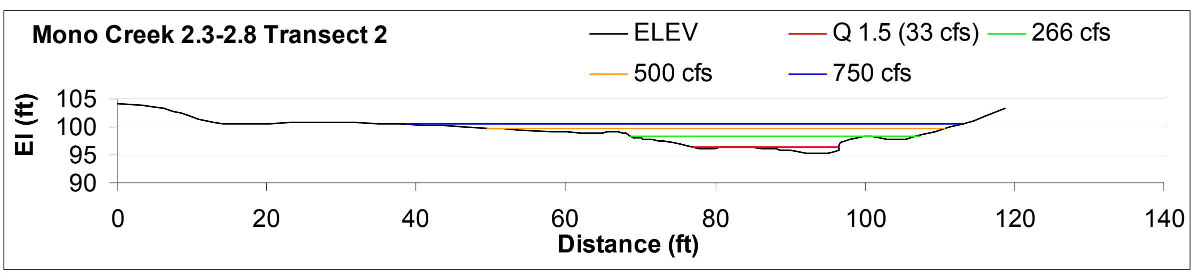




Note: bar extends at least 60 feet to the left.



Note: bar extends at least 30 feet to the right



Footnote:
Water surface elevations were modeled by two different methods, using HEC-RAS within the adjustable reaches and meadows (CAWG 2, Geomorphology, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)), and PHABSIM within the non-adjustable reaches (CAWG 3, Instream Flow Studies: PHABSIM, 2003 TSR (SCE 2004; Volume 4, SD-D (Books 11 and 23)). The presented water surface elevations in the adjustable reaches were calibrated in the field at higher flows, unless otherwise noted. All elevations are relative elevations. The scales are approximately 1:1. In the non-adjustable reaches, higher flows were not measured for model calibration. In general, the modeled water surface elevations in the non-adjustable reaches are most reasonable at 2.5 times the highest calibrated flow in the non-adjustable reaches. Only reasonable modeled flows are provided. Water surface elevations in the non-adjustable reaches were reasonable when bank geometry did not change for the flow range (i.e. bank slopes were constant). Sensitivity analyses of the modeled flows were conducted by comparing calculated water surface elevations by two different methods, Channel Conveyance and Log-Log Regression.

