POTENTIAL RESOURCE ISSUE:

- Modification of aquatic and riparian habitat.

PROJECT NEXUS:

- Project operations modify the flow regime in the bypass reaches. The modified flow regime may affect the amount and distribution (temporal and spatial) of aquatic and riparian habitat.

POTENTIAL LICENSE CONDITION:

- Instream flow releases.

STUDY OBJECTIVES:

- The overall study objective is to characterize aquatic and riparian habitat as a function of flow using ecological principles and site-specific hydraulic and habitat modeling (e.g., Bovee et al. 1998). The information developed from this study, in combination with other resource studies (e.g., water temperature, fish passage, fish population, and special-status amphibian and reptile studies), will provide a basis for streamflow-related resource management decisions.
- The specific objectives of the study include:
  - Delineate the bypass rivers into segments with similar hydrology and channel characteristics (e.g., slope, channel dimensions, channel pattern);
  - Map the mesohabitat types (e.g., pool, run, riffle) in the bypass river segments;
  - Quantify the habitat versus flow relationships for fish, special-status amphibian, benthic macroinvertebrate, and riparian resources in the bypass river segments;
  - Use the habitat versus flow relationships to develop a time series analysis of aquatic habitat under existing and unimpaired flow scenarios for the bypass river segments;
  - Identify the time periods, flow conditions, and life stages when habitat may be a limiting factor for fish, benthic macroinvertebrate, special-status amphibian, and riparian populations for the existing and unimpaired scenarios; and
  - Provide information necessary to quantify the potential effects of other alternative flow scenarios on aquatic and riparian habitat.

EXTENT OF STUDY AREA:

- The study area includes the active channel and floodplain in the bypass river segments and selected riparian vegetation reference reaches outside the influence of the Project. The study area is identified in Table AQ 1-1 and Map AQ 1-1. Some portions of the study area in the East Fork Kaweah River may be difficult to access due to the rugged terrain (see Map AQ 1-1) and, therefore, field data will only be collected in portions of the study area that are reasonably safe to access. The riparian vegetation reference reaches outside of the bypass river segments will be used to interpret riparian vegetation versus flow relationships; therefore, instream flow and riparian vegetation data collection in these reaches will be limited to that purpose.
- It should be noted that the majority of lands along the bypass river segments are privately owned and outside the FERC Project boundary. For the purposes of this instream flow

study described herein, SCE will take the following steps to obtain approval to conduct field studies on private property:

- Provide notification to landowner of Project relicensing and request authorization to enter property to conduct field studies.
- If authorization is obtained, SCE will complete field studies as described in this technical study plan.
- If authorization is not obtained, SCE will limit field studies to only those lands where landowners have provided access.

STUDY APPROACH:

The following describes the general instream flow modeling approach which includes: (1) target species and/or guilds; (2) habitat suitability criteria (HSC); (3) study area stratification and study site selection; (4) coordination of study site selection; (5) study site modeling; (6) hydrodynamics modeling; and (7) habitat modeling. Modeling associated with the AQ-1 TSP will be completed by a contractor with extensive experience in aquatic habitat modeling. The contractor will be selected by Southern California Edison after submittal of the Pre-Application Document.

Target Species and/or Guilds

- A species distribution map for fish, special-status amphibians and reptiles, and riparian resources within the bypass river segments will be generated from the results of the AQ 2 – Fish Population Technical Study Plan (TSP), AQ 7 – Special-Status Amphibian and Aquatic Reptile TSP, and TERR 1 – Botanical Resources TSP. Existing information (e.g., literature and agency consultation) and pertinent study results will be used to develop a life stage periodicity chart (i.e., season of occurrence) for the aquatic species and riparian vegetation present in each study reach.
- The species and life stages (and/or guilds) used for instream flow habitat modeling will be selected in collaboration with the interested resource agencies based on management importance and/or sensitivity to Project operations. Southern California Edison (SCE) proposes that rainbow trout and brown trout[1] life stages would be modeled in the bypass reaches where water temperature is potentially suitable (juvenile rearing, adult rearing, spawning/incubation). Hardhead (juvenile and adult life stages) and foothill yellow-legged frogs (FYLF) (breeding and larval development) would also be modeled, if these species are present or potentially present in the study area. All other aquatic species/life stages are proposed to be modeled using a guild approach.

Habitat Suitability Criteria

- Extensive development of HSC for west-slope Sierra Nevada species/life stages (trout, FYLF, hardhead, native species guilds) was recently conducted in collaboration with resource agencies for the Placer County Water Agency (PCWA) Middle Fork Project relicensing (PCWA 2011). It is proposed that these HSC be used for habitat modeling.

Stratification and Study Site Selection

- Channel characteristics (slope, channel dimensions, channel pattern), hydrology, and mesohabitat (e.g., run, pool, and riffle) data will be used to stratify the bypass reaches. Instream flow data will be collected and analyzed within these strata. The largest strata,

[1] Where brown trout have been targeted as a management objective.

river segments, will be based on channel characteristics and hydrology. Within these river segments, the river will be further stratified based on mesohabitat types. All accessible bypass river segments will be mesohabitat mapped (typed) (either by helicopter or foot travel) using the detailed level of mesohabitat typing outlined in McCain et al. (1990) (i.e., a potential of 22 mesohabitat types). These habitat types will be collapsed into a lower level of detail to facilitate river stratification for instream flow modeling. SCE proposes to aggregate the McCain et al. (1990) mesohabitat types into approximately five types (pool, run, low-gradient riffle, high-gradient riffle, and cascade) for stratification of the study sites and river segments.

- Study sites selected to represent the different river segments will be representative reaches stratified by mesohabitat type. The stratified representative reaches will be at least 20 to 40 channel widths in length (or longer) and will contain a full complement of mesohabitat types that are representative of the larger river segment. Where possible, the sites will overlap the other aquatic study sites (e.g., fish population, macroinvertebrates, special-status amphibians and reptiles, etc.).
- The preliminary river segments and locations of the study sites within the river segments are shown in Table AQ 1-1 and Map AQ 1-1. The specific locations and lengths of the representative reach study sites will be selected in the field in consultation with interested resource agencies. Prior to study site selection in the field, SCE will summarize the mesohabitat characterization data and make a preliminary selection of study site locations. A field trip will be scheduled with interested resource agencies to select study sites and specific habitat units and transects to model (also see Study Site Modeling below).

<u>Coordination of Study Site Selection</u>

- Study site selection will be coordinated with the AQ 7 – Special-Status Amphibian and Aquatic Reptile TSP to include FYLF habitat, where appropriate, within the study sites. In addition, if unique locations (e.g., breeding sites) are identified by the AQ 7 – Special-Status Amphibian and Aquatic Reptile TSP then these sites will be modeled as part of the AQ 1 – Instream Flow TSP. Study sites will also be selected to include riparian vegetation representative of the river segments.

<u>Study Site Modeling</u>

- Aquatic habitat modeling will be accomplished by sampling and modeling representative mesohabitat types in each study site with one-dimensional hydrodynamics and habitat models. The results for each mesohabitat type will be weighted and combined to develop a representation of hydrodynamics and habitat for the larger river segment. The weighting will be based on the percentage of each mesohabitat within the river segment.
- Within a study site, mesohabitat types will be sampled approximately in proportion to their abundance. Adjustments to the proportional sampling may be made based on the importance or variability of particular mesohabitat types. Typically, 10 mesohabitat units within a geomorphic river segment will be sampled (modeled). This provides enough sampling to replicate each major mesohabitat type (e.g., two mesohabitat samples of each type) and provides for additional sampling in abundant and/or important mesohabitat types (e.g., 3 or more mesohabitat samples of abundant and/or important types). Each major mesohabitat type (greater than approximately 5-10% of the geomorphic/hydrologic reach) will be modeled. Rare mesohabitat types (<5%) that provide unique or important habitat (e.g., spawning, passage) will be modeled if present in the study site. In particular, patches of spawning gravel may be important habitat features to sample in the study sites.

Mesohabitat types (e.g., cascades) that do not contain significant habitat for the primary target species or rare mesohabitat types (<5%) that do not have unique habitat importance will not be modeled.

- The stratified representative reach study sites may contain more mesohabitat units than will be modeled. The specific mesohabitat units selected for modeling will be those that are most representative of the mesohabitats in the geomorphic/hydrologic river segment. Results from mesohabitat mapping will be used to compare (e.g., average length, width, depth, and substrate) mesohabitat types in the geomorphic river segment with the mesohabitats in the study site. These data, along with a visual assessment of the representativeness of the mesohabitat units within the study site, will be used to select units to model. Final selection of the habitat units will be completed in the field in collaboration with interested resource agencies. SCE does not recommend random sampling of mesohabitat units because unrepresentative results could occur.
- For one-dimensional modeling, typically three cross-sections will be visually placed in the mesohabitat units to best represent the habitat over a range of flows. Fewer cross-sections may be placed in simple mesohabitat units with little variability or where the cross-sections are being placed to sample a variety of mesohabitat units of a particular type and not necessarily to fully characterize particular mesohabitat units. In some cases, additional cross-sections may be placed in highly variable mesohabitat units, if appropriate. Concurrence regarding cross-section placement within mesohabitat units will be obtained from interested resource agencies.
- Overall, for the one-dimensional modeling sites (not including the riparian comparison sites) the target total number of modeling cross-sections will be 18-24 cross-sections for each of the geomorphic river segments.

<u>Hydrodynamics Modeling</u>

- PHABSIM (e.g., Milhouse et al. 1989) or equivalent one-dimensional hydraulics modeling procedures, as appropriate for the study site and specific objectives for the site, will be used for modeling water surface elevations and velocities across each cross-section. These procedures include stage-discharge regressions, Manning's equations, backwater step models (e.g., WSP, HecRas), and IFG4.
- Hydrodynamics (depth, velocity, water surface elevations) will be modeled over a wide range of discharges, appropriate to the Project hydrology of each reach. Specific data to be collected using standard techniques include:
  - Channel topography will typically be in the form of cross-sections (1-D). Cross-sections will be marked with semi-permanent headpins and approximate GPS locations will be recorded.
  - For one-dimensional modeling, empirical water surface elevations will be measured (surveyed) for at least three calibration discharges at each cross-section. The discharges will span the range of flows of interest (Table AQ 1-1). The calibration flows will be determined in consultation with interested resource agencies once the hydrology has been compiled.
  - Empirical velocity data will be collected across each cross-section (15-20 locations) at the high calibration discharge (or middle calibration discharge if determined by the interested resource agencies to be the most appropriate discharge). Table AQ 1-1 shows the target calibration discharges. All velocities will be collected with calibrated

velocity meters. Discharges will be measured using standard gaging techniques (Rantz 1982) and/or an acoustic doppler current profiler (ADCP).

Habitat Modeling

- Habitat modeling will be conducted using an approach consistent with the Instream Flow Incremental Methodology (IFIM) approach (Bovee et al. 1998). The specific details of the habitat modeling will be developed in consultation with the interested resource agencies. The general approach will be as follows:
  - Collect substrate and cover information for habitat modeling across each cross-section (1-D) that is compatible with the HSC criteria developed in consultation with the interested resource agencies.
  - Collect appropriate riparian vegetation information (e.g., polygons of vegetation type, age) at the study sites.
  - Develop habitat modeling algorithms or approaches appropriate for each selected species and life stage or guild in consultation with the interested resource agencies.
  - Develop habitat versus flow relationships for each species life stage or guild over a wide range of flows (15 to 30 flows).
  - Complete a habitat time series analysis comparing the seasonal and daily distribution of habitat for the existing and unimpaired Project hydrology over the period of record (e.g., 1975 to present). Compare and contrast the amount of habitat during different biologically significant time periods (e.g., reproduction, rearing) and identify potential habitat limiting factors and time periods.
  - Coordinate with the AQ 7 – Special-Status Amphibian and Aquatic Reptile TSP to identify outputs from the instream flow modeling that will assist in analyzing the relationship between instream flow and FYLF habitat.

SCHEDULE:

Date	Activity
October/November 2017	Select instream flow modeling sites
November 2017–February 2018	Consult with the interested resource agencies regarding: habitat suitability criteria, periodicity charts, and habitat modeling methods
March–October 2018	Conduct field surveys (topography, water surface elevations, velocities, substrate/cover data collection)
November 2018–June 2019	Analyze data and prepare draft report
June 2019	Distribute draft report to the stakeholders
July–September 2019	Stakeholders review and provide comments on draft report (90 days)
October–December 2019	Resolve comments and prepare final report
December 2019	Distribute final report in Final License Application

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Bovee, K.D., B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004. 131 p.

McCain, M., D. Fuller, L. Decker, and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHR Currents: R-5's fish habitat relationships technical bulletin. No. 1. U.S. Dept. of Agriculture, Forest Service, Pacific Southwest Region, Arcata, California.

Milhous, R.T., M.A. Updike, and D.M. Schneider. 1989. Physical habitat simulation system reference manual -- version II. Washington, DC: U.S. Fish and Wildlife Service. Biological Report 89(16).1-403p.

Placer County Water Agency (PCWA). 2011. Application for New License. Middle Fork American River Project (FERC Project No. 2079). AQ 1 – Instream Flow Technical Study Report (2010). Exhibit E, Volume 3, Supporting Document B. Filed with FERC February 23, 2011.

Rantz, S.E. 1982. Measurement and computation of streamflow: Volume 1. Measurements of stage and discharge. United States Geological Survey Water Supply Paper 2175. 284p.

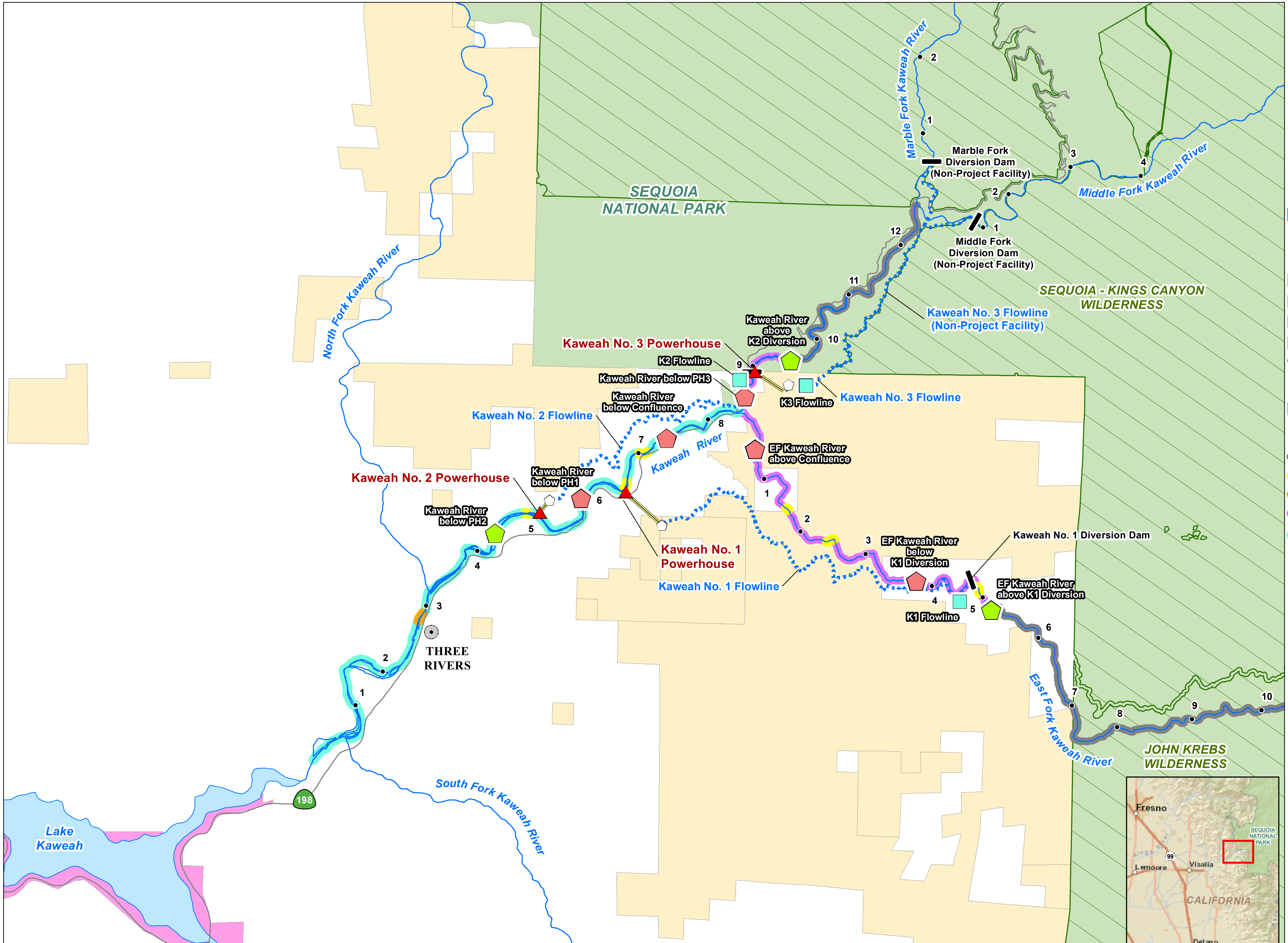
TABLE

Table AQ 1-1. Instream Flow Study Reaches and Modeling Methods.

<table>
<tr><th rowspan="3">Study River Segments/Sites</th><th rowspan="3">Bypass River Segment</th><th rowspan="3">Reaches Upstream of Project Facilities</th><th rowspan="3">Site Name</th><th rowspan="3">Approximate Number of Mesohabitat Units to Sample [1]</th><th colspan="4">Approximate Discharges for Model Calibration (cfs)[2]</th><th rowspan="3">Modeling Methods</th></tr>
<tr><th colspan="3">Aquatic Habitat Modeling</th><th rowspan="2">Extra High for Riparian /Geomorphic Modeling</th></tr>
<tr><th>Base</th><th>Med</th><th>High</th></tr>
<tr><td colspan="10">Kaweah River</td></tr>
<tr><td>Kaweah River Upstream of Kaweah No. 3 Powerhouse</td><td></td><td>●</td><td>IF K9.5</td><td>1-3</td><td>5-10</td><td>30-40</td><td>90-110</td><td>Based on availability of spring high flows (HF[3])</td><td>Develop stage-discharge relationship for riparian vegetation comparisons</td></tr>
<tr><td>Kaweah River Downstream of Kaweah No. 3 Powerhouse and Upstream of the East Fork Kaweah River Confluence</td><td>●</td><td></td><td>IF K8.7</td><td>10</td><td>5-10</td><td>30-40</td><td>90-110</td><td>HF[3]</td><td>1D</td></tr>
<tr><td>Kaweah River Downstream of East Fork Kaweah Confluence and Upstream of Kaweah No. 1 Powerhouse</td><td>●</td><td></td><td>IF K7.3</td><td>5</td><td>5-10</td><td>30-40</td><td>90-110</td><td>HF[3]</td><td rowspan="2">1D (results from K7.3 and K6.9 will be combined)</td></tr>
<tr><td>Kaweah River Downstream of Kaweah No. 1 Powerhouse and Upstream of Kaweah No. 2 Powerhouse</td><td>●</td><td></td><td>IF K6.9</td><td>5</td><td>5-10</td><td>30-40</td><td>90-110</td><td>HF[3]</td></tr>
<tr><td>Kaweah River Downstream of Kaweah No. 2 Powerhouse</td><td>●</td><td></td><td>IF K4.3</td><td>1-3</td><td>5-10</td><td>30-40</td><td>90-110</td><td>HF[3]</td><td>1D</td></tr>
<tr><td colspan="10">East Fork Kaweah River</td></tr>
<tr><td>East Fork Kaweah River Upstream of the Kaweah No. 1 Diversion</td><td></td><td>●</td><td>IF EFK5.2</td><td>1-3</td><td>5-7</td><td>10-20</td><td>30-50</td><td>HF[3]</td><td>Develop stage-discharge relationship for riparian vegetation comparisons</td></tr>
<tr><td rowspan="2">East Fork Kaweah River Downstream of the Kaweah No. 1 Diversion</td><td rowspan="2">●</td><td rowspan="2"></td><td>IF EFK3.8</td><td>5</td><td>5-7</td><td>10-20</td><td>30-50</td><td>HF[3]</td><td rowspan="2">1D (results from EFK3.8 and EFK0.7 will be combined)</td></tr>
<tr><td>IF EFK0.7</td><td>5</td><td>5-7</td><td>10-20</td><td>30-50</td><td>HF[3]</td></tr>
</table>

[1]Number of habitat units to model in some reaches may be modified due to circumstances in the particular reach. See text for details.
[2]The discharges are approximate (or target discharges) and the exact discharge may vary depending on circumstances during the study period (e.g., ability to accurately release flows, weather, etc.). The intent of the target discharges is to provide water surface elevations and a velocity data set to calibrate the hydraulic models. Velocity will not be collected at the extra high data set.
[3]Based on availability of spring high flows.

MAP



Facilities

- Powerhouse
- Diversion
- Forebay
- Flowline
- Penstock

Other Features

- City/Town
- Highway/Road
- Watercourse
- Water Body
- River Mile

Land Jurisdiction*

- Bureau of Land Management
- U.S. Army Corps of Engineers
- National Park Service
- Private

*SOURCE: BLM 2012

Land Management

- National Wilderness Area

Channel Characterization

- NA
- bedrock
- bedrock/cascade
- bedrock/step-pool/cascade
- pool-riffle/plane-bed

Sampling Locations

- Entrainment Monitoring (flowlines)
- Fish, BMI, FYLF, Riparian
- Fish, BMI, FYLF, Riparian, Instream Flow

SOUTHERN CALIFORNIA EDISON®
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Eastern Hydro Generation

Map AQ 1-1

Kaweah Project
Aquatic and Riparian Sampling Locations

0 0.25 0.5 1 Miles

Date: 12/8/2015

Projection: UTM Zone 11
Datum: NAD 83

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