14.0 *Revised Draft #2* - SFAR Instream Flow and Fluctuation Study Plan

14.1 Pertinent Issue Questions

This South Fork American River (SFAR) Instream Flow and Fluctuation Study Plan addresses the following Aquatic Issue Questions:

2. "What are the appropriate species to be used as indicator species for management of the Project related to flows?"
20. "What effect do flows have on species during critical life stages?"
25. "How do sport fishing releases affect native species and the ability to manage them?"
31. "How does spill water affect aquatic resources?"
35. "How are Project releases into Chili Bar affecting aquatic resources?"
36. "What are the limiting features of a natural (unimpaired/pre-project) hydrograph on aquatic species?"
37. "Are the minimum stream flows defined under the existing license adequate for protecting aquatic resources?

14.2 Background

Instream flows in the South Fork American River downstream of Chili Bar Dam are affected by the joint operation of the Upper American River and Chili Bar projects (collectively "Projects'). In general, flows in the South Fork American River during spring months are reduced due to storage in UARP reservoirs, while late summer/early fall flows are supplemented by releases from the reservoirs. Outflows from Chili Bar Reservoir are dependent on inflows primarily from White Rock Powerhouse, as subsequently modified by operation of the Chili Bar Project. The most characteristic feature in the SFAR associated with the joint operation of both Projects is flow fluctuations. In general, flows range between 200 cfs and 4,000 cfs (sometimes daily) in this section of river, based on the operation of the two Projects. The existing minimum flow requirement below Chili Bar Dam is 100 cfs, although there have been "emergency" exceptions.

The reach downstream of Chili Bar can be divided into three subreaches based on the nature of the SFAR canyon and stream gradient. The upper subreach, which extends approximately 4.5 miles downstream of Chili Bar Dam is contained within a steep-walled canyon and is of moderately high gradient. The middle subreach ("Coloma" subreach) begins upstream of the town of Coloma where the canyon opens and the stream gradient lessens, resulting in more alluvial deposition and long stretches of pool habitat. This subreach extends approximately 8.5 miles to the beginning of "The Gorge." The lower subreach, known as "The Gorge," is contained within a steep-walled canyon and consists of a higher gradient stream, similar to the upper subreach. As with the upper subreach, this section of the SFAR has more complex habitat types consisting of riffle/run habitat and higher velocities than found in the middle subreach. This subreach extends approximately 7 miles to Folsom Reservoir, near Salmon Falls Bridge.

There are several named and unnamed tributaries to the reach downstream of Chili Bar that are not directly affected by operation of the Projects, but may provide important spawning or nursery habitat or other refugia for fish and/or amphibians inhabiting the reach downstream of Chili Bar. The mainstem may also provide refugia at times for conditions in tributaries. The larger tributaries include Dutch Creek, Granite Creek, Greenwood Creek, Jacobs Creek, Hastings Creek, Norton Ravine, and Weber Creek. Some of these creeks may have water quality issues unrelated to the Projects, e.g., Weber Creek, a year-round stream provides substantial flow to the SFAR near Folsom Reservoir during the summertime, and receives discharge from a sewage treatment facility and drainage from subdivisions, all of which may negatively affect water quality in Weber Creek and the SFAR downstream.

This study plan focuses on developing the information necessary to evaluate the effects from Projects facilities and operations, and to make aquatic resource decisions regarding Projects-controllable factors regarding flow and flow fluctuation in the reach downstream of Chili Bar Dam. In general, the approach is to integrate pertinent channel and flow related data from other technical studies (such as geomorphology, CSBP, amphibian, wetted perimeter, fish stranding, etc. as specified in Section 1.1.5) associated with the relicensing, and supplement that data with additional information collected specifically in support of this study. This approach provides both quantitative and qualitative

information on habitat conditions over a full range of normal controlled flows, and will be useful for evaluating potential flow regime effects on aquatic resources.

Two primary groups of issues are being addressed by this study plan: base flow, and flow fluctuation (frequency, rate, magnitude, and duration). Base flow issues are related to the low, or minimum flow that is provided downstream of Chili Bar Dam. The low flow is typically frequent (e.g., daily), but of short duration (e.g., hours or a few days) due to the regular peaking operation of the Projects, but may persist for extended periods of time. Flow fluctuation issues are related to the frequency, rate, magnitude, and duration of change in flow as power generation and reservoir storage vary.

An integrative study approach is being applied to the reach below Chili Bar Dam, because the frequently fluctuating flows in this reach make it unique within the watershed, and result in conditions that require simultaneous consideration of several different resource areas.

14.3 Study Objectives

The study objectives are to integrate and augment existing studies as identified in section 1.1.5; to determine the effect of current instream flows and fluctuations on in-stream resources by:

- Evaluating existing and historic flow conditions (including changes in flow rates) in the reach downstream of Chili Bar relative to the influences of the UARP and the Chili Bar Projects.
- Describing existing habitat conditions for target fish and other aquatic species in the reach downstream of Chili Bar.
- Determining the effects of existing streamflows on target fish and other aquatic species in the reach downstream of Chili Bar.
- Evaluating aquatic habitat suitability in relation to a range of flows associated with operations of the UARP and Chili Bar Projects.
- Identifying constraints to critical life stages of target species associated with current base flows and fluctuating flows.

14.4 Study Area

The study extends along the South Fork American River corridor from Chili Bar Dam to Folsom Reservoir, approximately 20 miles downstream. Varying levels of study effort may apply to different subreaches within this area. The primary area of concern is the streambed that is inundated between 100 and 4,000 cfs. Flows above 4,000 cfs are outside the direct control of, but still may be affected by, the UARP. From the upstream end down, the river sites included in this evaluation are the “old flume” site, Indian Creek, Camp Lotus, Gorilla Rock, Norton Ravine and Weber Creek. Tributary habitats (as identified in section 1.1.1 and 1.1.2) will also be evaluated.

14.5 Information Needed From Other Studies

- Hydrology (hourly, daily and mean monthly flows)
- Channel Morphology (identification of response reaches, channel condition, channel morphology, etc.)
- Habitat Mapping/Typing (extent and distribution of major habitat types at low flows (approximately 100 - 200 cfs).
- Water Temperature/Water Quality (hourly temperatures/seasonal water quality data)
- Fish Surveys (species composition and distribution)
- Amphibians and Aquatic Reptiles (amphibian occurrence and location of important habitat areas)
- Aquatic Bioassessment (macroinvertebrate CSBP metrics)
- Riparian Vegetation (extent and distribution of riparian communities within flow fluctuation zone of mainstem channel and tributary mouths)
- Fish passage study (barriers at tributary confluences)

14.6 Study Methods

Controllable instream flow and flow fluctuations in the reach below Chili Bar Dam occur along a continuum between base flow levels and peak powerhouse discharges. In order to evaluate this complex condition, two general factors are proposed for evaluation. The following study sections detail methods that focus more on the "base flow" end of the continuum or more on the "fluctuating flow" range of the continuum. These data will be combined and analyzed to address development of a recommended flow regime.

A. Base Flows

The evaluation of base flows (flows at the low end of the flow fluctuation range) will begin with an analysis of historic hydrology for the reach below Chili Bar Dam. Analysis of the historic data, as well as unimpaired values generated from the hydrology study, will provide an indication of natural base flow conditions, including minimum flow magnitude, frequency, and duration. An initial estimate of minimum flow needs to protect aquatic resources in the reach below Chili Bar Dam will be based on the hydrologic analysis; however, historic hydrology would not form the sole basis for subsequent base flow recommendations. Understanding the natural hydrology of this system is an important step in evaluating impacts from project operations and facilities. Given the peaking nature of flows below the Chili Bar Dam, minimum flows in this reach will be evaluated in relation to potential flow fluctuation effects on aquatic resources.

The second step of the analysis will be to evaluate fish, amphibian, and macroinvertebrate data for evidence of current aquatic resource impairment. Growth rates, condition factors, species composition, and age class distributions of fish will be evaluated for evidence of population impairment. Spawning gravel availability at low flows may subsequently need to be quantified to determine if spawning gravel is a possible limiting factor. Species composition, life-stage distributions, and habitat conditions for fish and amphibian species will be analyzed with regard to the potential for low base flows to affect the health of the population. Aquatic bioassessment indices will be evaluated for indications of impaired productivity.

Preliminary results from the hydrologic evaluation of base flow needs will be refined, as necessary, based on data from the fish, amphibian, and aquatic bioassessment studies cited above, and from the low-flow range of the flow fluctuation analyses (discussed later).

B. Fluctuating Flows

Fluctuating flows are expected to be one of the most pertinent project-related influences on aquatic resources in the reach downstream of Chili Bar. As a result, several aquatic studies already include data gathering and/or analysis with consideration of flow fluctuation, these studies include geomorphology, CSBP, amphibians, wetted perimeter, fish stranding, etc. Data from these studies will be integrated and supplemented as part of this study plan, over a full range of operational flows up to approximately 4,000 cfs. Data will include:

- Cross section geometry and longitudinal channel profiles from the geomorphology study (four sites) and riparian study
- Substrate distributions from the geomorphology study
- Flow, stage, wetted perimeter and their inter-relationships from the hydrology study, geomorphology study, aquatic bioassessment study, and supplemental field investigations
- Benthic macroinvertebrate data from the flow fluctuation "tidal zone" from expanded CSBP samples (or alternative sampling protocol) in these areas. The tidal zone is defined as that area that is typically inundated and dewatered on a daily basis. Flow fluctuation patterns in the weeks prior to any field sampling will be noted, and an attempt made to sample after a reasonably "normal" flow fluctuation regime.
- Habitat availability/quality for target species from the low flow habitat typing study, fish surveys, amphibian studies, and supplemental field investigations, including selected information (e.g., fish or amphibian refugia, spawning) collected from tributary streams under this study plan.

- Access conditions (fish barriers) at tributary confluences (i.e., Dutch Creek, Granite Creek, Greenwood Creek, Jacobs Creek, Hastings Creek, Norton Ravine, and Weber Creek) from the fish passage study, under a range of flows (e.g., 200-500 cfs).
- Analysis of habitat quantity at selected responsive sites (i.e., quality habitat) as described below will be used to establish a general flow versus habitat relationship.

Transects will be established at study sites in areas believed to be most sensitive to flow fluctuations (e.g., wide, shallow areas; backwater areas; tributary confluences; channel locations with geomorphically terraced features that tend to create isolated pools, etc.), in addition to or in combination with areas used for other studies such as geomorphology, aquatic bioassessment, fish, and possibly amphibians. The transects will be established across the entire channel, and in some cases may have closer spacing of verticals in zones between the water's edge at base flow and the water's edge at the highest peaking flow.

Cross-sectional surveys will be conducted across each transect, typically up to or above the 4,000 cfs flow elevation. Data to be collected at each cross-section (at approximately 2,000 cfs) will include water surface elevations, , channel profile, depth, and discharge, , as well as precise locations of the water's edge and stream width. Water's edge measurements, water surface elevations, and discharge (from gage readings) will be recorded at two other flows (i.e., approximately 200 and 500 cfs) to enable modeling of wetted perimeter versus discharge relationships over flow ranges between 100 and 4,000 cfs.

Study sites for cross-sectional surveys will target five areas (for co-located field studies) expected to be most sensitive to flow fluctuations (based on data from habitat typing, videography, and local knowledge of the river system), but may also include other representative areas that are analyzed as part of other studies. Study sites will also consider important habitat areas including spawning sites, identified by other studies such as the amphibian and aquatic reptile study, channel morphology, fish population and habitat typing studies. The number and location of study sites was determined based on initial results from other technical studies.

Transect data at selected study sites will be supplemented by a habitat map of a maximum of two sites (approximately 200 meters long) per each of three subreaches, based on a series (one set at low flow) of aerial photographs (from a weather balloon) of the sites. Study sites with a variety of habitat types will be sought, with an emphasis on habitat types most sensitive to changes in flow and preferably co-located or overlapping with sites from the cross-sectional surveys. Four habitat categories (i.e., deep/fast, deep/slow, shallow/fast, shallow/slow) will be superimposed (in the field) on the aerial photograph(s) to develop habitat polygons (depth/velocity combinations) at four flows (approximately 200, 500,1000, and 2000 cfs), subject to adjustment based on stream channel geometry and field crew safety. Flows will be provided opportunistically, depending on hydrologic conditions.

Fish stranding analyses will be conducted in areas with the highest stranding potential (wide, flat floodplains with large substrates and terraced channel banks). Field data collection will be adapted from standard instream flow techniques (Bovee and Milhous 1978), and analysis based on Prewitt and Whitmus (1986). Field data collection will also include study site visits under spring or early summer flow conditions in 2004 to search for stranded fish during down-ramping. The number and location of sites and specific methodologies will be refined in conjunction with the Aquatic TWG.

Grab samples and continuous recording of water temperatures in continuously wetted backwater, periodically isolated pool, and tributary stream areas will be taken (in 2004) at appropriate locations and time periods to assess impacts from fluctuating flow levels and timing, and to evaluate suitability of backwater conditions for stranded fish and/or amphibians.

If fish stranding is suspected of being a significant ecological issue, seasonally and site specific down-ramping rates will be evaluated. Development of ramping rate measures would be coordinated with other resource measures.

Amphibian habitat will be evaluated over a range of flows in areas of known breeding habitat along the river margins (based on the amphibian occurrence surveys), if special status amphibians are documented during the Visual Encounter Surveys.

A time-of-travel study will be conducted at three downstream sites (plus Chili Bar Dam) along the reach to evaluate the timing, duration, and magnitude of stage changes associated with releases from Chili Bar Dam. A single flow event (e.g., ramping up to 1,200+ cfs) will be evaluated, concurrent with other studies. The study will involve establishing temporary staff gages at three downstream locations, and monitoring stage at each gage throughout a day's flow fluctuation, at closely spaced time intervals. As part of the time-of-travel study, water movement through Chili Bar Reservoir (at full pool) from White Rock Powerhouse will be evaluated (from White Rock Powerhouse generation records, reservoir stage data, and spill records) to ascertain effects on timing of downstream flow fluctuations.

14.7 Data Analysis

Potential flow fluctuation effects on aquatic resources will be evaluated by analyzing data such as:

- Changes in base flow conditions will be evaluated as a means of reducing the magnitude of flow fluctuations
- Changes and inflection points in wetted perimeter vs. flow (from transect data collection)
- Estimates of travel time for changes in flow volume, in order to evaluate ramping rates
- Substrate composition (from geomorphology study and habitat mapping)
- Incipient motion thresholds for deposited fine sediment and larger material (from geomorphology study)
- Water temperature changes (hourly) and water quality changes (seasonally)
- Water temperature changes in backwater, periodically isolated pool, and tributary stream areas in relation to high flows and period of time since the last high flow.
- Fish stranding potential associated with slope and substrate, and actual stranding surveys
- Amphibian breeding habitat, if applicable, available under a range of flows
- Fish habitat and flow relationships
- Fish and amphibian survey results in tributaries
- Macroinvertebrate habitat (wetted perimeter) available under range of flows
- Results of CSBP metrics (from aquatic bioassessment study) in low flow channel and fluctuation zone
- Flow-related fish passage and access barriers at tributary confluences
- Suitability of current ramping rates with respect to public safety (up-ramping) and aquatic resource stranding (down-ramping)

Specific procedures for flow fluctuation analyses will be approved by the TWG during a workshop prior to completing the analyses.

14.8 Schedule

The proposed schedule includes the following elements.

- Develop detailed study plan in January to August
- TWG concurrence on 8 September 2003
- Plenary Group approval on 9 September 2003 or in October
- Site selection in September to October 2003, in coordination with site selection for other studies
- Most data collection in September to December 2003

14.9 Study Output

A draft and final report will be prepared in a format suitable for inclusion in Pacific Gas and Electric Company's license application and SMUD's Draft Environmental Assessment (DEA) for its Alternative Licensing Process. The draft report will be provided to the Aquatics TWG for review and discussion by April 2004. If indicated, additional study data will be collected during the 2004 field season. The final report will include issue questions, objectives, methods, results, discussion, and technical appendices (on CD). The study output may also include recommendations for other studies, as appropriate.

14.10 Preliminary Estimated Study Cost

[Aquatics TWG - A preliminary estimated study cost will be prepared after the Aquatics TWG approves of the plan and prior to presenting the plan to the UARP Plenary Group for consideration.]

14.11 TWG and Plenary Group Endorsement

Pending discussion and revision at the September 8, 2003 meeting, attendees at the April 14, 2003 Aquatic TWG meeting previously indicated they could all "live with" this study plan. Attendees at the September 19,2003 TWG meeting indicated they could all "live with" this study plan, as revised during both the September 8 and 19, 2003 Aquatic TWG meetings.

The Plenary Group approved this plan on February 4, 2004. The participants at the meeting who said they could "live with" the plan were Taxpayers Association of El Dorado County, Friends of El Dorado County, USFS, American River Recreation Association & Camp Lotus, El Dorado County Water Agency, Pacific Gas & Electric Company, SMUD, El Dorado County, El Dorado Irrigation District, NPS, SWRCB, USBLM, City of Sacramento, CDFG, and FOR. None of the participants at the meeting said they could not "live with" this study plan.

14.12 Literature Cited

Bovee, K.D. and R. Milhous. 1978. Hydraulic Simulation in Instream Flow Studies: Theory and Techniques. Instream Flow Information Paper No. 5. U.S. Fish and Wildlife Service, Fort Collins, CO.

Prewitt, C.M. and C. Whitmus. 1986. A Technique for Quantifying Effects of Daily Flow Fluctuations on Stranding of Juvenile Salmonids. Instream Flow Chronicle, Volume II, No. 4. Colorado State University. January.