15.0 Coloma-Camp Lotus Fish Tissue Mercury Analysis Study Plan

This Coloma-Camp Lotus Fish Tissue Mercury Analysis Study Plan (plan) is designed to evaluate whether target species of fish in the South Fork American River in the vicinity of Camp Lotus contain mercury. The study would be conducted in three phases. First, a consultation meeting would be held among the Sacramento Municipal Utility District (Licensee for the Upper American River Project, or UARP), Pacific Gas and Electric Company (Licensee for the Chili Bar Project), the State Water Resources Control Board (SWRCB) and Central Valley Regional Water Quality Control Board (RWQCB). The purpose of the meeting would be to agree on the detailed methods to be employed in this plan. As requested by the SWRCB, Licensees have also consulted (see Section 1.5) with the Office of Environmental Health Hazard Assessment (OEHHA). In the second phase, the Licensees would fund performance of sampling and tissue analysis for mercury through contract with an approved third-party to collect the necessary fish for the analysis, perform the laboratory analysis, and report the results. In the third phase, the Licensees would provide a report of the results to the SWRCB.

Note: There has been no data developed at this time to link the transport of mercury in the Chili Bar Reach of the SFAR with operations of either the UARP or Chili Bar Projects. By agreeing to fund the performance of this plan, SMUD and Pacific Gas and Electric Company do not admit or imply in any way, and no person or party should interpret or infer, that the operation of the UARP or Chili Bar Project causes, or in any way contribute to, the possible occurrence of mercury in fish in the South Fork American River. SMUD and Pacific Gas and Electric Company deny any relationship or responsibility of their projects to any occurrence of mercury in fish tissue samples, should such be discovered.

15.1 Pertinent Issue Question

Is mercury uptake occurring in fish species which reside in the South Fork American River reach downstream of the Chili Bar impoundment?

15.2 Background

As described in the September 5, 2003 letter from the SWRCB, the SWRCB staff has recently confirmed the presence of elemental mercury in substrate of the South Fork American River channel in the vicinity of Coloma and Camp Lotus. The Coloma-Camp Lotus section of the river is used for recreation, including fishing. To evaluate the potential for bioaccumulation of mercury within the aquatic food chain and the associated risks to human health, the SWRCB staff requested that a fish tissue sampling station be added to the existing Water Quality Study program associated with relicensing the UARP and Chili Bar Project. The Licensee's have developed this Coloma-Camp Lotus Fish Tissue Mercury Analysis Study Plan to address SWRCB's one-time request for background data.

As part of other studies, the Licensees snorkeled six habitat types in the Coloma-Camp Lotus area in 2003, and electrofished in the stream margin. Electrofishing captured 67 fish: riffle and prickly sculpin (62%), Sacramento sucker (23%), Sacramento pikeminnow (12%), and green sunfish, rainbow trout and brown trout (1% each). Seventy-three fish were observed during snorkeling including Sacramento pikeminnow (58%), rainbow trout (33%), and brown trout, Sacramento sucker and speckled dace (3% each).

15.3 Study Objective

The study objective is to obtain fish tissue samples and perform mercury analysis for the target species in accordance with methods in this plan.

15.4 Study Area and Sampling Locations

The study area would include the South Fork American River in the Camp Lotus area, which extends through Section 13 of T11N, R9E, of the Coloma, CA USGS 7.5 minute Topographic Quad map. This area is a well-known center for historic mining operations in California. Fishes would be collected throughout the study area to ensure a broad sampling of the target population.

15.5 Information Needed From Other Studies

Information needed from other studies include: 1) water quality information in the Reach Downstream of Chili Bar Project; and 2) fish tissue analyses information from Chili Bar and UARP reservoirs.

15.6 Study Methods, Analyses, And Schedule

As described above, the plan would be performed in three sequential phases, each of which is described below.

Agency Consultation to Finalize Sampling Methods and Analysis

The Licensees consulted with the OEHHA and the CDFG Lab to determine preferences for sample size and methodology. The methods described here are consistent with input form OEHHA and CDFG Lab.

The sampling effort will focus specifically on body burden (filet tissue) of methyl mercury (measured as total mercury) in resident trout and Sacramento pikeminnow, assuming that the appropriate number and sizes of these fishes can be reasonable captured in the study area.

On March 15, 2004, the Licensees' consultant (Jim Lynch, DTA) spoke with Bob Brodberg, Senior Toxicologist with OEHHA (916 358-2900) regarding this study plan. Mr. Brodberg suggested that, if possible, from 9 to 12 individuals of rainbow trout and Sacramento pikeminnow each be collected. He said that the fish should be of a size that would be caught and eaten, and that if 9 to 12 rainbow trout of catchable-size could not be caught, brown trout of that size could make up the remainder of the catch. He said he would prefer resident trout, but if none could be found, stocked trout would be acceptable. To provide an estimate of variation, he suggested that the total mercury content of each fish be analyzed using the Cold Vapor Atomic Absorption Spectrometry method, or a similar method. Mr. Brodberg said that he has used the California Department of Fish and Game Water Pollution Control Laboratory in Rancho Cordova to perform these types of analyses in the past and this lab would be acceptable to him. On March 16, Mr. Lynch spoke with Dave Crane (Laboratory Director, CDFG Lab) regarding these methods. Mr. Crane concurred with the methods, but suggested that sampling for total mercury (rather than methyl mercury) would be adequate.

The Licensees assume that coordination with the RWQCB will be performed by the SWRCB.

Collection and Analysis

Upon agreement of the methods by the above parties, the Licensees would contract with an approved third-party to collect the necessary fish for the analysis, perform the laboratory analysis, and report the results to the Licensees. At the present time, the CDFG Lab is the Licensees' first choice to perform the analysis. The CDFG Lab has performed similar analyses for the UARP and Chili Bar relicensings.

Provide Results to SWRCB and RWQCB

The Licensees would provide the results of the analyses to the SWRCB. This agency will then coordinate the results with any other agencies at its discretion.

The Licensees would initiate this plan upon approval by the UARP Relicensing Plenary Group. Contingent on the CDFG Water Pollution Lab being available to collect the fish and perform the analyses in a timely manner, the Licensees would target having data results provided to the SWRCB by September 1, 2004 or sooner.

15.7 Aquatic TWG And Plenary Group Endorsement

The Aquatics TWG approved this plan on March 25, 2004. The participants at the meetings who said they could "live with" this study plan were CDFG, USFS, BLM, SWRCB, Camp Lotus, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. This study plan will be presented to the April 7, 2004 Plenary Group meeting for consideration for approval.

The study plan was approved by the Plenary Group on April 7, 2004 without modification. There was no one present at the meeting who objected to the study plan going forward for implementation.

15.8 Literature Cited

None.

16.0 Chili Bar Reservoir Incremental Storage Modification Study Plan

This study is designed to investigate the feasibility, benefits and costs associated with improving water management between the UARP and Chili Bar Project by increasing Chili Bar Reservoir storage capacity using two alternatives: 1) adding a seasonally-operated crest-gate to Chili Bar Dam; and 2) potential sediment removal in Chili Bar Reservoir. The study would be conducted in two phases.

Phase One will be an initial modeling analysis using the UARP/Chili Bar Water Balance Model (and possibly spreadsheet models) that would quantify improvements in water management associated with increased storage at Chili Bar Reservoir. All improvements would be quantified against current operating assumptions, and would include items such as: 1) reductions in spill events at Chili Bar Reservoir; 2) increases in water available for power generation at White Rock or Chili Bar powerhouses; and 3) increased potential for controlled releases for beneficial uses in the Reach Downstream of Chili Bar, including whitewater recreation. Unless the R&A and Aquatics TWGs agree that the analysis in Phase 2 is not needed, the study would move to Phase Two.

In Phase Two, a feasibility analysis will be performed. The analysis would focus on the two alternatives for increasing storage at Chili Bar Reservoir. Consistent with the potential benefits provided by the two alternatives, the study will conclude with an evaluation of operational coordination between White Rock and Chili Bar Powerhouses in a manner to provide similar water management benefits. The feasibility analysis will include but not be limited to developing costs related to engineering, procurement, construction and maintenance of the storage capacity alternatives. This analysis will also address potential environmental considerations; jurisdictional implications; dam safety, financial feasibility, and impacts to the Chili Bar Project and UARP (land use and operations).

16.1 Pertinent Issue Questions

The Chili Bar Reservoir Incremental Storage Modification Study Plan would be used to address the following Issue Questions reviewed by the Aquatic Technical Working Group (TWG) on March 11, 2004:

- Has PG&E looked into the alternative of raising Chili Bar Reservoir?
- How does the idea of raising Chili Bar Dam cross-jurisdictional boundaries with the UARP?
- What are viable options for increasing Chili Bar Reservoir storage capacity to allow for more flexibility in the management of flows from the UARP? The study should consider increase in dam height.

16.2 Background

Interested parties in SMUD's UARP Relicensing and Pacific Gas and Electric Company's Chili Bar Relicensing have postulated that increasing storage in Chili Bar Reservoir would allow the Licensees to better coordinate UARP and Chili Bar operations, thereby improving water management of the two projects. This has been raised as a possibility because, at times, releases by SMUD from White Rock Powerhouse have resulted in uncontrolled spills over Chili Bar Dam. The parties felt that if additional storage capability occurred in Chili Bar Reservoir, the operators might have been able to capture some or all of the spilled water and release it in a controlled fashion. Also, the parties postulated that at times in the future Pacific Gas and Electric Company might not have adequate water stored in Chili Bar Reservoir to meet requests for future water releases. Therefore, the interested parties would like to know the potential benefits, costs and feasibility of increased storage in Chili Bar Reservoir and/or improving operational coordination.

16.3 Study Objective

The study objectives are to: 1) determine if a reasonable increase in storage at Chili Bar Reservoir could result in improvements in water management between the projects that would protect beneficial uses, 2) if so, evaluate how this increase in storage could be best accomplished, and 3) determine whether the cost and other considerations (e.g., generation impacts to Whiterock powerhouse) make the increased storage a viable option compared to operational coordination as an alternative.

16.4 Study Area

The study area would include the entire UARP and Chili Bar projects for the purpose of modeling (Phase One). The feasibility analysis (Phase Two) will focus on Chili Bar Dam and reservoir related-storage enhancements and potential water management improvements of the South Fork American River in the Reach Downstream of Chili Bar.

16.5 Information Needed From Other Studies

Information needed from other studies includes runs of the UARP/Chili Bar CHEOPS™ Water Balance Model, the results from the Chili Bar Reservoir Sediment Study (i.e., reservoir bathymetric information), and various environmental reports. Note that all analyses will be compared against the current operating assumptions model run.

16.6 Study Methods, Analyses, and Schedule

As described above, the study would be described in two sequential phases, each of which is described below.

Phase One - Model Analysis

Using historical records, Pacific Gas and Electric Company estimates that the current Chili Bar Reservoir usable storage volume is 1,339 acre-feet (ac-ft). In this context, "usable" means the volume of water between the preferred minimum operating elevation of 984 feet and the spill crest elevation of 997.5 feet that can be used by the Chili Bar Powerhouse during routine, unattended operation.). The Licensees acknowledges that another 320 ac-ft of water is potentially available between the preferred 984 feet water elevation and mandatory Powerhouse-shutdown water elevation of 980 feet. There is an additional 1,480 ac-ft of storage between 980 feet water elevation and the 5-foot diameter, low-level outlet, but this storage is not available for routine operation. Note that this Chili Bar Reservoir usable storage volume is the volume currently included in current operating assumptions runs (one with and one without the Iowa Hill Development) of the UARP/Chili Bar CHEOPS™ Water Balance Model. To perform the Phase One Analysis, the Licensees would make four runs of the model with the Iowa Hill Development to simulate increasing storage in approximately 225 ac-ft increments. The only difference from the current operating assumptions run will be that the Chili Bar Reservoir usable storage will be 1,563 ac-ft in Run 1, 1,792 ac-ft in Run 2, 2,027 ac-ft in Run 3, and 2,268 ac-ft in Run 4. The Licensees will then repeat this analysis using the model without the Iowa Hill Development. The maximum usable storage (2,268 ac-ft, or 929 ac-ft more than the current usable storage) to be included in the final model run would equate to the usable storage when the Chili Bar Reservoir was constructed (based on project drawings) plus the additional storage associated with raising Chili Bar Dam by approximately 8 feet. The output from each model run would be compared to the current operating assumptions by Agencies' Proposed Water Types and overall, and include: 1) gains in the amount of water (daily median, minimum and maximum) that would be available for downstream releases from Chili Bar Powerhouse; 2) changes in White Rock and Chili Bar powerhouses' generation; and 3) number of Chili Bar Dam spill days and magnitude of spills. The effect of the recovery of lost storage capacity due to potential sediment removal from Chili Bar Reservoir would be evaluated based on the same three criteria and based on reasonable incremental sediment volume estimates derived from the results from the Chili Bar Reservoir Sediment Study**.**

A feasibility analysis will be performed in Phase Two, unless the Aquatic and Recreation TWGs agree that the analyses in Phase Two is not needed.

Phase Two - Feasibility Analysis

The feasibility analysis would focus on alternatives to increase usable storage in Chili Bar Reservoir to a level that the Phase One analysis indicated reasonable benefits. The analysis would include dam safety, financial feasibility and environmental considerations (i.e. permitting, impacts, effects on privately owned lands and impacts due to inundation of additional riverine habitat upstream of Chili Bar Reservoir); jurisdictional implications (i.e. affect to BLM land and impacts on the UARP); and affects on electrical generation at the White Rock and Chili Bar powerhouses. The feasibility analysis may include results from the Chili Bar Reservoir Sediment Study Plan and other engineering investigations to better assess potential impacts caused by the inundation of the White Rock Powerhouse tailrace and operational coordination approaches. The analysis would consist of a comparison of the frequency and magnitude of spills and volume of available water between each model run and the current operating

assumptions, including the cost of providing equal water management benefits in the Downstream Reach through coordinated operations between White Rock Powerhouse and Chili Bar Powerhouse without project modifications.

The Licensee would implement the study plan upon approval by the UARP Relicensing Plenary Group, and expects to complete the study in about 90 days, if no unforeseen complications arise.

16.7 Study Output

The study plan output would be a technical report prepared in the same format as the UARP Relicensing technical reports have been prepared to date, unless requested to be revised by the TWGs. It is anticipated that the report would be summarized in SMUD's UARP license application and Pacific Gas and Electric Company's Chili Bar Project license application, and appended to each application.

16.8 Aquatic TWG And Plenary Group Endorsement

The Aquatics TWG approved this plan on March 25, 2004. The participants at the meetings who said they could "live with" this study plan were CDFG, BLM, SWRCB, Camp Lotus, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. Other TWG participants have been requested to provide email comments prior to April 1, 2004.

As requested at the Aquatic TWG meeting, this study plan was also presented to the Recreation TWG for consideration and approval at their April 6, 2004 meeting. With non-substantive changes, this study plan was approved at the meeting. None of the participants at the meeting said they could not "live with" this study plan.

The study plan was approved by the Plenary Group on April 7, 2004 without modification. There was no one present at the meeting who objected to the study plan going forward for implementation.

16.9 Literature Cited

Pacific Gas and Electric Company, May 2003. Chili Bar Project, FERC No. 2155, First Stage Consultation Document for Application for New License.

17.0 Chili Bar Reservoir Sediment Deposition Study Plan

This study is designed to investigate the quantity and general composition of sediment that has been deposited in Chili Bar Reservoir since the Chili Bar Dam was constructed in 1964, and the potential impacts of this sediment deposition on the 20-mile-long section of the South Fork American River from Chili Bar Dam to Folsom Reservoir (Reach Downstream of Chili Bar). The study would be conducted in three phases. Phase One would include a reservoir bathymetric study to determine the amount of deposition within the reservoir. Phase Two would occur concurrently with Phase One and would include sampling in the upper end of Chili Bar Reservoir at low water levels to characterize sediment composition. In Phase Three, the Licensees would then evaluate the significance of reduced sediment supply to the Reach Downstream of Chili Bar in context of the ongoing relicensing environmental studies. The results of the study would be reported to the UARP Relicensing Aquatic TWG and included in both the Sacramento Municipal Utility District's Upper American River Project (UARP) license application and Pacific Gas ad Electric Company's Chili Bar Project license application. For the purpose of this study plan, SMUD and Pacific Gas and Electric Company are referred to jointly as the Licensees.

17.1 Pertinent Issue Questions

The UARP Relicensing Aquatic Technical Working Group (TWG) has not developed specific issue questions for this study plan. At the March 11, 2004 Aquatic TWG Meeting, the Licensees agreed to develop this plan in response to a September 9, 2003, letter from Banky Curtis of the CDFG to Randal Livingston of Pacific Gas and Electric Company, which transmitted the CDFG's comments on Pacific Gas and Electric Company's Chili Bar Project First Stage Consultation Document (FSCD). Specifically, CDFG's comment was:

> Bathymetry and Reservoir Sediment Composition: The Department is concerned that disruption of natural bedload movement needs to be studied. The Department would like to discuss appropriate bathymetric sampling protocols to determine the quantity and composition of material being trapped behind the Chili Bar Dam and other upstream impoundments.

Also, in Pacific Gas and Electric Company's Chili Bar Relicensing Joint Meeting B, questions were raised by Bill Center of Camp Lotus:

> What are the effects of sediment in Chili Bar Reservoir? How is PG&E going to address the sediment that is in the reservoir?

17.2 Background

Interested parties in SMUD's UARP Relicensing and Pacific Gas and Electric Company's Chili Bar Relicensing have postulated that deposition in Chili Bar Reservoir impacts ecological resources in the Reach Downstream of Chili Bar. This Chili Bar Reservoir Sediment Deposition Study Plan assumes that sediment would deposit in Chili Bar Reservoir in a fashion typical to long sinuous reservoirs. Deposition is a function of sediment size and water velocity. Sediment that is mobilized in streams at high water velocities is deposited in reservoirs as water velocities decrease. Typically, the larger-sized sediment deposits in the upper portion of the reservoir where water velocities decrease rapidly, usually resulting in a depositional fan and sediment bars near the inlet, which are conspicuous when the reservoir is low. Finer-sized sediment, such as silt, remain mobilized at lower velocities and move further into the reservoir before depositing, or pass through the reservoir entirely. This often results in a layer of fine silt and sand on the bottom of the reservoir with the greatest depth of deposition near the toe of the dam where velocities are lowest. This general pattern of deposition was observed at SMUD's Slab Creek Reservoir during a 1992 bathymetric and sediment survey. At Slab Creek Reservoir, most of the sediment was found in the upper portions of the reservoir. Sediment deposition in the lower portion of the reservoir was generally less 10 inches deep and composed chiefly of silt or mud.

Note that Pacific Gas and Electric Company has not dredged or otherwise made special efforts to reduce sediment deposition in Chili Bar Reservoir since the dam was constructed, nor has Pacific Gas and Electric Company needed to alter Project operations due to sediment behind the dam.

17.3 Study Objective

The study objectives would be to: 1) estimate the amount of sediment deposition in Chili Bar Reservoir; 2) generally characterize the composition of the deposited sediment; and 3) place Chili Bar Reservoir sediment deposition in context with environmental conditions observed in the Reach Downstream of Chili Bar.

17.4 Study Area

The study area would include Chili Bar Reservoir and the Reach Downstream of Chili Bar. This study plan does not propose any additional fieldwork in the Reach Downstream of Chili Bar.

17.5 Information Needed From Other Studies

Information needed from other studies includes the Licensees' various environmental studies being performed in the Reach Downstream of Chili Bar. Information from SMUD's Slab Creek Reservoir Sediment/Turbidity Study may also be useful. In addition, the results from this study would be used in other relicensing studies. For instance, the change in Chili Bar Reservoir usable storage would be used in the Chili Bar Reservoir Incremental Storage Study, and the updated Chili Bar Reservoir area-capacity may be incorporated in the UARP/Chili Bar CHEOPS™ Water Balance Model, if appropriate.

17.6 Study Methods, Analyses, and Schedule

As described above, the study would be performed in three phases, each of which is described below.

Phase One – Estimate Quantity of Deposition in Chili Bar Reservoir

In Phase One, the Licensees would estimate the mount of sediment deposition currently in Chili Bar Reservoir by 1) comparing a current reservoir area-capacity curve to the project as-built area-capacity curve, and 2) examining existing aerial photographs, if available.

To develop a current Chili Bar Reservoir area-capacity curve, the Licensees would first prepare a bathymetric map of Chili Bar Reservoir. A Trimble Pro XRS differential Global Positioning System (GPS) and a digital depth sounder would be mounted on a motorboat to collect depth soundings at regular intervals according to a predetermined survey plan. Mapping would occur when Chili Bar Reservoir is at full pool. The GPS data logger would record sub-meter horizontal accuracy. Water surface elevations (and depth) would be monitored using a Solinst levelogger pressure transducer (accuracy of about 4 cm) that would be installed to reference a local benchmark and surveyed to a known United States Geological Survey (USGS) elevation. If a local USGS benchmark does not exist, one would be installed. Depths and positions would be collected in a predetermined grid pattern (about 150 feet between transects). Areas of greater sediment deposition concern, such as at the upstream end of the reservoir and near the toe of the dam, might require smaller grids to better map the changes in sediment levels. This determination would be made in the field as sampling is performed. The Licensees would generate a bottom profile map, and from this a current Chili Bar Reservoir area-capacity curve. To determine the net amount of deposition that has occurred since the Chili Bar Dam was constructed, the current area-capacity curve would be compared to the reservoir's as-built drawings. Due to typical inaccuracies in as-built drawings of this type, the Licensees would assume an error of at least plus or minus 10 percent in the as-built drawings.

The Licensees would compute the difference in gross storage (total volume of the reservoir) and the difference in usable storage (from the minimum operating level of 984 feet to the spill crest elevation of 997.5 feet) in Chili Bar Reservoir. The latter information would be incorporated into the Chili Bar Reservoir Incremental Storage Study to determine the extent to which sediment deposition has reduced usable storage (and the feasibility of reclaiming this storage capacity).

During Phase One, the Licensees would also take digital aerial photos of Chili Bar Reservoir at surface water elevation level of 984 feet, minimum operating pool. Photos at full pool are currently available. The Licensees would compare these photos to historic photos, if available, to determine any changes to the depositional pattern that has occurred over time.

Phase Two – Characterize Deposited Sediment

Concurrently with Phase One, the Licensees would generally characterize the composition of the material deposited in Chili Bar Reservoir. As discussed above, in reservoirs such as Chili Bar, most sediment deposits in fans or in sediment bars near the stream inlet. Therefore, the Licensees will focus study efforts in this area. The investigations would include:

- Generally estimating the depth of deposited sediment in the fan and sediment bars at the upstream end of Chili Bar Reservoir Dam. When the reservoir is drawn down, the Licensees would establish about five transects across each major fan and sediment bar, and estimate the depth of sediment along each transect at 50 foot intervals by pounding a graduated metal bar into the ground. The sediment depth would be considered to be the depth at which the bar meets firm resistance.

- Estimating sediment composition by performing at each location where depth is estimated as described above. At each of these locations, the Licensees would estimate streambed particle size by conducting Wolman (1954) pebble counts. In addition, the Licensees will make a good faith effort to use a standard, hollow-core, hand auger along the transects to determine the sediment composition in the fan and sediment bars at depths. All sediment size information will be presented using the Wentworth scale (Wentworth 1922).

Phase Three – Evaluate Effect of Chili Bar Dam Sediment Deposition on Ecological Effects in the Reach Downstream of Chili Bar

In Phase Three and using the information gathered in Phases One and Two and in the Licensees' relicensing studies in the Reach Downstream of Chili Bar, the Licensee will evaluate the significance of reduced sediment supply to the Reach Downstream of Chili Bar.

17.7 Study Output

The study plan output would be a technical report prepared in the same format as the UARP Relicensing technical reports have been prepared to date, unless requested to be revised by the TWGs. It is anticipated that the report would be summarized in SMUD's UARP license application and Pacific Gas and Electric Company's Chili Bar Project license application, and appended to each application.

17.8 Aquatic TWG And Plenary Group Endorsement

The Aquatics TWG approved this plan on March 25, 2004. The participants at the meetings who said they could "live with" this study plan were CDFG, USFS, BLM, SWRCB, Camp Lotus, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. This study plan will be presented to the April 7, 2004 Plenary Group meeting for consideration for approval.

The study plan was approved by the Plenary Group on April 7, 2004 without modification. There was no one present at the meeting who objected to the study plan going forward for implementation.

17.9 Literature Cited

Wentworth, C. K., 1922. A scale of grade and class terms for clastic sediments. Journal of Geology 30:377-392.

Wolman, M. G., 1954. A method of sampling coarse river-bed material. EOS Transactions. American Geophysical Union 35: 951-956.

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.