Aquatic, Water Quality, Geomorphology, & Hydrology Resources

Technical Working Group Meeting

Date: December 4, 2003

Time: 9:00 AM to 4:00 PM

Location: SMUD Customer Service Center
Sequoia 2 & 3
6301 S Street
Sacramento, California

Directions

Parking: 12 Spaces in the CSC South Lot

Discussion Topic:

Agenda

Attendees

Summary

Handouts, Attachments & Presentations

Draft Iowa Hill Fish Entrainment Potential

Draft Slab Creek Reservoir Sediment Sampling Study Plan

Draft Iowa Hill Pumped Storage Development Water Temperature Study

Directions to SMUD's Customer Service Center

SMUD has two four-story buildings located adjacent to Highway 50 on the north side, between 59th Street exit and 65th Street exit. The Customer Service Center (CSC) is the newer building of the two located at 6301 S Street, and houses the Rubicon Room, Forestview 1,2, & 3, Sequoia 1,2,& 3, Timberline 1,2, & 3, and the HRL Conference Room located on the third floor (Northwest wing). The Headquarters building is located at 6201 S Street, directly west of the CSC. It houses the Headquarters' Customer Center (HCC), the Auditorium and several other conference rooms.

The Field Reporting Facility (aka FRF) is located behind the SMUD Headquarters building: go under the Light Rail overpass, then to the left about 150 yards.

Directions:

Heading East: From downtown Sacramento, head east on Highway 50, exit at **59th Street.** This exit will take you up-and-over Highway 50. Go straight at the first intersection, travel about a half mile. On your left (north) is the SMUD Headquarters building, the next building is the Customer Service Center.

Heading West: From Placerville, take Highway 50 to Sacramento and exit at **65th Street.** Go straight about one block after the first intersection. The Customer Service Center is the four-story building on your right (north).

You should be able to find parking spaces for visitors located in the area between the two buildings. There is also parking available in a parking lot on Folsum Blvd. behind the SMUD complex.

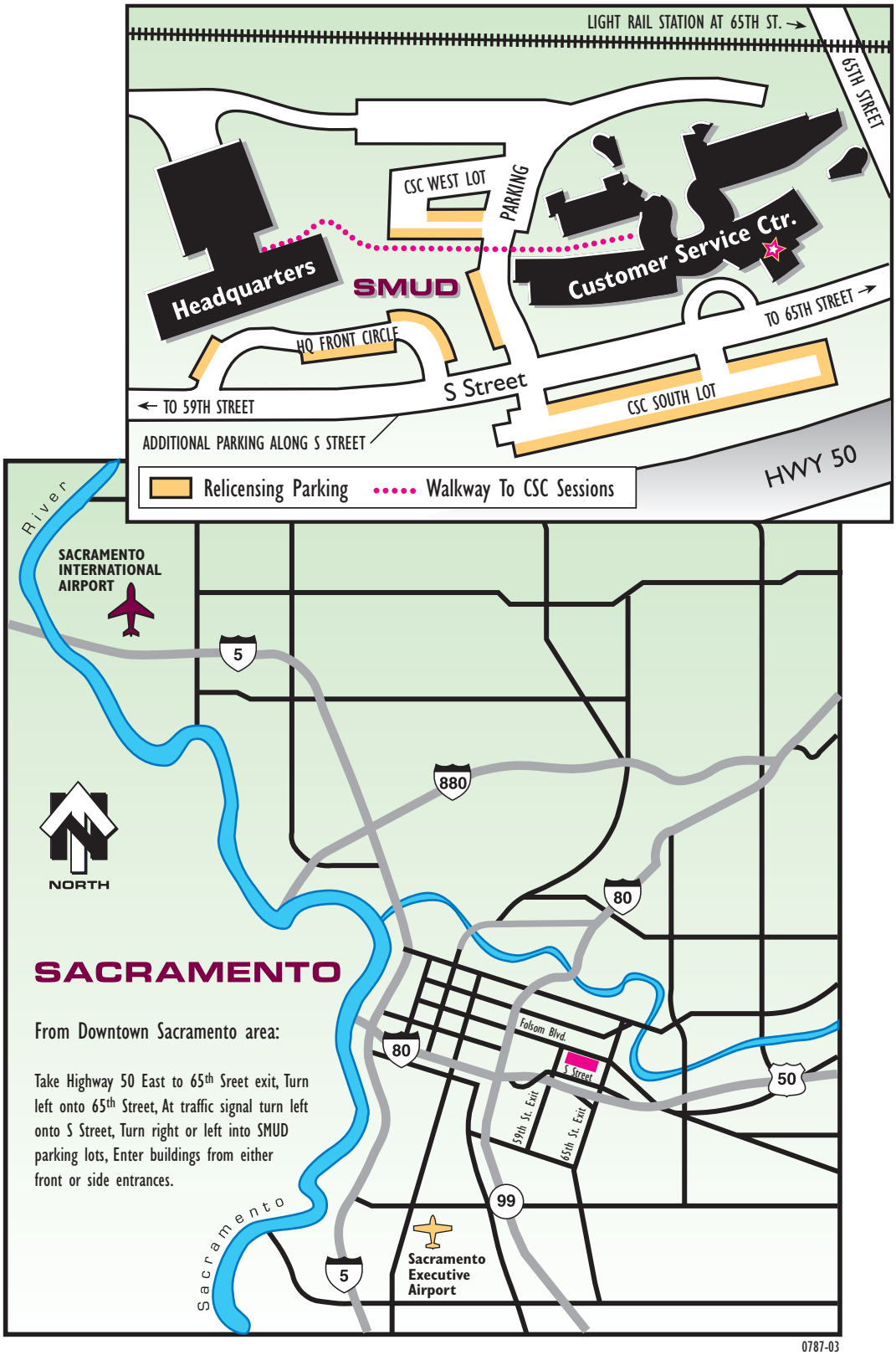
If you need assistance to find the Rubicon Room, Timberline 1,2,& 3, Sequoia 1,2,& 3, Forestview 1,2, & 3, and the Hydro Relicensing's Conference Room located on the third floor of the Northwest wing, see the guard at the lobby desk. The Headquarters Customer Center (HCC) room is located in the Headquarters building opposite the board of directors Auditorium in the first floor. Drive Safely.

Note: Downloadable maps can be found at hydrorelicensing.smud.org/meetings/meet_loc.htm

Maps To

SMUD HEADQUARTERS AND CUSTOMER SERVICE CENTER

Relicensing Parking Lot Locations



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Sacramento Municipal Utility District (SMUD)
Upper American River Project (UARP) Hydro Relicensing Project

Aquatic Resources, Water Quality, Geomorphology and Hydrology Technical Work Group Meeting

Sacramento Municipal Utility District (SMUD)
Customer Service Center (CSC) Sequoia 1 & 2
6301 "S" Street Sacramento, California

December 4, 2003
9:00 a.m. - 4:00 p.m.

Agenda

Time	Topic
9:00 a.m.	Introductions
9:05	Review meeting agenda
9:10	Key and timely issues
9:20	Amphibian survey update (Indian Creek)
9:30	Discussion and consideration for approval the draft Slab Creek Reservoir Sediment Sampling Study Plan (Action Item from last meeting: approval of document)
10:30	Discussion and consideration for approval the draft Iowa Hill Fish Entrainment Study Plan (Action Item from last meeting: approval of document)
11:30	Discussion and consideration for approval the draft Iowa Hill Temperature Study Plan. (Action Item from last meeting: approval of document)
12:30 p.m.	Lunch (on your own or see Karen for lunch order)
1:30	UARP water temperature monitoring results
2:45	UARP water temperature modeling proposal (South Fork Silver Creek below Ice House Reservoir, Silver Creek below Camino Reservoir, South Fork American River below Slab Creek Reservoir)
3:50	Next meeting agenda items
4:00	Adjourn

DATE: 12/4/2003 **LOCATION:** SMUD ~ CSC BUILDING ~ SEQUOIA 2 & 3 ~ 9:00 AM to 4:00 PM

UARP Hydro Relicensing

Aquatic/Water Quality/Hydrology/Geomorphology Technical Working Group

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Upper American River Project (UARP)
Aquatic/Water Quality/Geomorphology/Hydrology Resources Technical Working Group (TWG) Meeting Summary

December 4, 2003 9:00 a.m. to 4:00 p.m.

Sacramento Municipal Utility District (SMUD)
Customer Service Center (CSC), Sequoia 2 & 3
6301 "S" Street, Sacramento, California

Summary

The Aquatic/Water Quality/Geomorphology/Hydrology ("Aquatic") Resources Technical Working Group (TWG) met on December 4, 2003 at the at SMUD's Customer Service Center (CSC). Participants included:

- Beth Paulson, US Forest Service (USFS) (a.m. only)
- Bill Center, Camp Lotus
- Cheryl Mulder, USFS
- Dave Hanson, Sacramento Municipal Utility District (SMUD)
- Dudley Reiser R2 Resource Consultants (a.m. only)
- Ed Cheslak, Pacific Gas and Electric (PG&E)
- Jim Lynch, Devine Tarbell and Associates, Inc. (DTA)
- Kent Doughty, EES Consulting (p.m. only)
- Lonn Maier, SMUD
- Parvez Mody, SMUD (p.m. only)
- Peggy Cranston, Bureau of Land Management
- Robert Hughes, California Department of Fish and Game (CDFG)
- Sapna Khandwala, Stillwater Sciences (a.m. only)
- Scott Wilcox, Stillwater Sciences
- Sharon Stohrer, State Water Resources Control Board
- Stafford Lehr, CDFG
- Yantao Cui, Stillwater Sciences

The Aquatic TWG met to accomplish the following tasks:

1. Review agenda
2. Discuss key and timely issues
3. Amphibian survey update.
4. Discuss and consider for approval the draft Slab Creek Reservoir Sediment Sampling Study Plan
5. Discuss and consider for approval the draft Iowa Hill Fish Entrainment Potential Study Plan
6. Discuss and consider for approval the draft Iowa Hill Pumped Storage Development Water Temperature Study Plan
7. Discuss water temperature monitoring results for 2002-2003
8. Discuss water temperature modeling proposal for three reaches

During the meeting, the following topics/questions were addressed.

Review agenda. Items 7 and 8 were addressed only briefly due to time limitations.

Key and timely issues. CDFG has provided examples of study outputs, and the resource agencies have agreed to prepare a "joint agency" letter describing data/format needs for studies being completed. It was emphasized that the earlier the letter was received by SMUD the better, since the amount of data to be prepared is voluminous.

It was also noted that the 2003 macroinvertebrate data collected by Tom King would not be available until February 2004. A suggestion was also made that that reports should be in draft form so agency comments can be incorporated to the final document. Other suggestions were made as to the format of fish population data (to be reported in total biomass, species biomass and density calculations for rainbow trout and brown trout).

A question was raised during the meeting relative to the ability to model the streamflow and fluctuation studies being conducted (now in January 2004). It was confirmed that generally modeling up to two and one-half times the base flow is possible to quantify habitat area, hence using flows of 1500-1600 could be used to determine outcomes of ~4,000 cfs. Regression statistics will be used to determine if the extrapolations are correct or not.

SWRCB requested that data reports be in such a format that can be used in negotiations.

Survey crews are still having difficulty accessing some sites downstream of Chili Bar. Some landowners are not amenable to permitting access.

Amphibian survey update. Stillwater Sciences surveyed the mouth of Indian Creek in mid-November to assess habitat quality and suitability for foothill yellow-legged frogs, given that they have been found 1-mile upstream from the confluence. It was reported that the stream is extremely overgrown in this lower portion, mostly with blackberry, and generally does not seem very suitable for breeding. Frogs were not observed in the area surveyed, although the survey was not completed up to the one-mile mark. The FYLF found farther upstream (approximately 1 mile from the mouth) by BLM several weeks ago were of all size classes and numbered approximately 50 frogs, according to BLM. It was agreed that further investigation is needed, especially to understand how far downstream this population occurs. It is generally presumed that FYLF do not currently use the mainstem SFAR for breeding.

The following was proposed: 1) Conduct ground habitat evaluations of the four major tributaries of low gradient not already surveyed this year within the reach downstream of Chili Bar (Big Canyon, Indian, Jacobs, and Norton Ravine creeks) up to one-mile (to the extent possible) from the SFAR confluence for suitable habitat for FYLF. During the habitat evaluation, both adjacent mainstem locations and the tributary itself would be evaluated. 2) If potentially suitable habitat is identified on the mainstem, then a VES

protocol-level survey of the mainstem as identified in the Amphibian and Aquatic Reptile Study Plan would be conducted (with 3-4 surveys). 3) If suitable habitat is not found on the mainstem (at the confluence of each of the 4 tributaries), then only suitable sub-reaches on the tributary would be identified for a single presence/absence mid-season survey in June-July. This second survey would only be conducted if no frogs were found during the habitat evaluation. CDFG noted that backwater habitat near the mouth of tributaries was a primary focus. Overall, this proposal was acceptable to the TWG.

Action item: The TWG will be apprised of schedules to conduct future surveys if interested persons would like to observe the survey areas.

Iowa Hill Fish Entrainment Potential Study Plan. The revised draft Fish Entrainment Potential Study Plan was presented for approval by the TWG. The study would examine the likelihood of fish entrainment at the intake structure within Slab Creek Reservoir for the proposed Iowa Hill Pumped Storage Project. Discussion included the following.

- The study would be phased; Phase I will encompass intensive gill-netting and electrofishing /seining surveys, which would be conducted to characterize the locations of the greatest fish activity. This work would be done in the spring (May), early summer (July-August) and late fall (November). Sampling would occur over a three-day period (and two night-time periods).
- Phase 2 of the study would be based on results of Phase 1. Depending on fish species, populations and life stages, a fish screen would be designed by engineering staff and biologists (including CDFG screening criteria). Phase 2 will be concluded in mid-2004.
- During sampling, screen mesh size will be important to capture smaller fish (e.g., Swedish nets); CDFG may be able to loan nets for work.
- Area to be sampled needs to be quantified
- A technical report will be issued prior to preparing the license application

Agreement: It was agreed that the study plan would be revised as per discussions at the meeting and re-distributed; comments are to be received by December 12; the plan will be submitted to the Plenary Group for the January 7th meeting.

Slab Creek Reservoir Sediment Sampling Study Plan. This study plan will address the potential for operation of the project to effect turbidity changes in Slab Creek Reservoir and the South Fork American River below the dam. TWG participants noted that there have been occurrences of sediment deposition in Slab Creek Reservoir over the years. Examples were the 1992 Cleveland fire and reservoir low elevation events and the 1997 New Year's Day flood event. Concern was noted that operation of the Iowa Hill project might exacerbate sediment problems in the reservoir.

Yantao Cui from Stillwater Sciences was present to answer questions. Discussion included the following.

- Iowa Hill operations need to be assessed and overlain with reservoir operations to determine effects on turbidity.
- How HEC RAS will be used
- More complicated models do not necessarily give more accurate information
- A phased and analytical approach is needed
- Post project monitoring would be needed
- Existing bathymetric data needs to be reviewed
- Turbidity alarms have all been related to turbid flows entering Slab Creek Reservoir.
- Fine sediments near the Iowa Hill intake structure are a concern

Agreement: It was agreed that the study plan would be re-drafted and distributed to participants for comments.

Iowa Hill Pumped Storage Development Water Temperature Study Plan. This study plan is designed to assess the effects of the Iowa Hill Project operations on water temperature changes to Slab Creek Reservoir. Kent Doughty from EES Consulting joined the group to discuss this study plan. As requested by the TWG at the previous meeting, no approval action was taken on this study plan since SWRCB could not attend.

Discussion of this study plan included the following:

- Changes to any cold water pool that may exist in Slab Creek Reservoir.
- Model validation and calibration
- Additional water temperature sampling
- Water year types, meteorological and solar radiation data need to be accounted for. Warm/dry vs. cool/wet conditions need to be assessed.

Agreement: With the changes as noted in the study plan, the document was approved by participants.

Water temperature modeling efforts. The temperature modeling software SN Temp is being used for three reaches within the UARP- South Fork Silver Creek below Ice House Dam, Silver Creek below Camino Dam, and South Fork American River below Slab Creek Dam. Software problems encountered in running the models are being corrected. Modeling data should be available concurrent with delivery of the water temperature data report.

Future dates for data report distribution:

Date	Subject(s)
January 8, 2004	Water quality and water temperature
January 14, 2004	Fish surveys and habitat Mapping
January 22, 2004	Amphibians and aquatic reptiles
January 29, 2004	Hydrology
February 5, 2004	Channel Morphology and PHABSIM
February 16, 2004	Deepwater Entrainment
February 18, 2004	Hydrology data presentation and discussion

Meeting dates and locations may be found on SMUD's web page at http://www.smud.org/relicensing/index.html

Ongoing commitments:

- Field schedules will be provided to the TWG on a monthly basis. The schedules are tentative. Contact Lonn Maier if attendance is desired for any of the fieldwork underway.
- SMUD will advise participants of any particular focus that an upcoming meeting may have, and develop an agenda for the meeting.
- SMUD commits to sending out draft study plans at least five working days before meeting to discuss the plans.

Attachments available with this summary. Attachments are available on the SMUD UARP "Bulletin Board" located at http://eurekasw.sharepoint.bcentral.com/uarp/

- Draft Iowa Hill Pumped Storage Development Fish Entrainment Study Plan
- Draft Iowa Hill Pumped Storage Development Water Temperature Study Plan
- Draft Slab Creek Reservoir Sediment Sampling Study Plan

If you would like copies of any past document, please e-mail lmaier@smud.org with your request or visit the SMUD relicensing web page at http://www.smud.org/relicensing/index.html.

These summaries are not intended to be a transcript of the meeting, but only to serve as a brief synopsis. Please provide any comments you may have regarding these summaries to lmaier@smud.org

1.1 Iowa Hill Fish Entrainment Potential

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This study is designed to assess the likelihood of fish entrainment at the intake structure located in Slab Creek Reservoir associated with the proposed Iowa Hill Pumped Storage Development. As identified in the Iowa Hill Pumped Storage Development (IHPSD) project description, the intake/outlet facility in Slab Creek Reservoir will consist of a multi-port intake, approximately 80 feet below the Slab Creek Reservoir maximum water level elevation of 1,850 feet. In the pumping mode, the estimated discharge capacity of the intake would range between 3,600 and 4,200 cfs. This study will consist of a species at risk assessment and intake/screen design phase. The species at risk analysis will examine the species composition in Slab Creek Reservoir and their distribution within the reservoir, both laterally and vertically within the water column. Working from information on species distribution, the design evaluation phase will bring engineers and biologists together into a collaborative setting to discuss options for design of the intake and appurtenant screen facilities.

1.1.1 Pertinent Issue Questions

This IHPSD entrainment study plan addresses the following fisheries and engineering design questions:

- What fish species are found in varying portions of the water column in the vicinity of the proposed Iowa Hill pump intake?
- Which fish species and life stages are found in various locations at all shallow edges of the reservoir (reservoir margins and upstream end of the reservoir) and what effects would daily water fluctuations from Iowa Hill have on those species and life stages?
- Are hardhead distributed throughout the reservoir, or concentrated in shallower areas and/or at the upstream end?
- What design options exist for the intake/outlet structure to avoid or minimize entrainment of species at risk?
- Is a fish screen needed as part of the final design of the intake/outlet structure, and if so, what are the design features of the screen?

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1.1.2 Background

The Iowa Hill Pumped Storage Project is proposed as an addition to UARP facilities at Slab Creek Reservoir. The reservoir is known to support hardhead, a large minnow species of special concern. Hardhead are not generally considered to be a pelagic species that would be evenly distributed throughout the reservoir, but their distribution within Slab Creek Reservoir has not been fully documented. Previous studies of species composition were performed as part of the UARP relicensing studies. The species at risk phase of this study will build off of the UARP relicensing study foundation. This study focuses on the distribution of hardhead within the reservoir, in order to provide data for assessment of potential entrainment risk.

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1.1.3 Study Objectives

The objective of this study is to identify species at risk to entrainment of the intake by describing the occurrence and distribution of hardhead and other fish species between the deeper, center portion of Slab Creek Reservoir and other areas of the reservoir (particularly the upstream end and shallow edges on the sides). Once this information has been developed, the second phase of the study will involve a design assessment of the intake structure, with the objective of developing a intake and/or screen design that avoids or minimizes entrainment of species that are determined to be at risk.

1.1.4 Study Area

The study area will include Slab Creek Reservoir.

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1.1.5 Information Needed From Other Studies

Information needed from other studies includes: 1) the fish species that occur in Slab Creek Reservoir from the UARP relicensing Fish Surveys Study.

1.1.6 Study Methods And Schedule

The study will be conducted in two phases, each of which is described below.

Phase 1 – Field Studies to Identify Distribution of Fish Species in Slab Creek Reservoir

- As a first step, the Licensee will conduct an intensive gill-netting and electrofishing and/or seining surveys of the reservoir to characterize the locations of greatest fish activity in spring (May), summer (July-August), and late fall (November).
- Two primary sampling zones will be established: 1) the upstream end of the reservoir, including shallow areas, and 2) the deepwater zone of the reservoir, including the shallow the shallower reservoir margins, in the vicinity of the proposed intake.
- Each zone will be sampled with six variable-mesh gill nets. Two nets in each zone will be set near the shoreline to sample shallow water. Two nets will set further away from shore, and suspended so that they sample the mid-water column. Two nets will be set in the deepest water, and suspended to sample near the bottom.
- Sampling will occur over three days, and will include portions of three daytime and two nighttime sampling periods.
- Gill nets will be serviced as often as possible but at least once per day or at least every eight hours during daylight hours to minimize mortality of sampled fish.
- Figure 1 presents a conceptual net placement approach for the sampling.

Phase 2 –Intake/Screen Conceptual Design

- Engineering staff and biologists, working with results of species at risk and with CDFG fish screening criteria, will identify alternative designs and vertical locations of intake structure.
- Alternative designs will be evaluated relative to their level of protection for the species at risk, engineering and construction feasibility, and cost, to determine a preferred alternative design for inclusion in the license application.

It is anticipated that Phase 1 field studies will occur in November of 2003, May 2004, and July 2004. Phase 2 will occur between January-June of 2004.

1.1.7 Analysis

Fish distribution data analysis will include quantifying and describing the catch at each location, including an approximate catch per unit effort, the time period when fish were captured, and the distribution of species and sizes. Distribution of different species and life stages at all the sampling points will be presented.

1.1.8 Study Output

A preliminary presentation of Phase 1 species at risk study results will be made to the Aquatics TWG in June 2004. A written report including the issues addressed, objectives, description of study area and sampling locations, methods, results, discussion and conclusions will be prepared for inclusion in the license application. The intake/screen design assessment will generate a preferred conceptual design for the IHPSD intake facility. This design will be presented in the license application.

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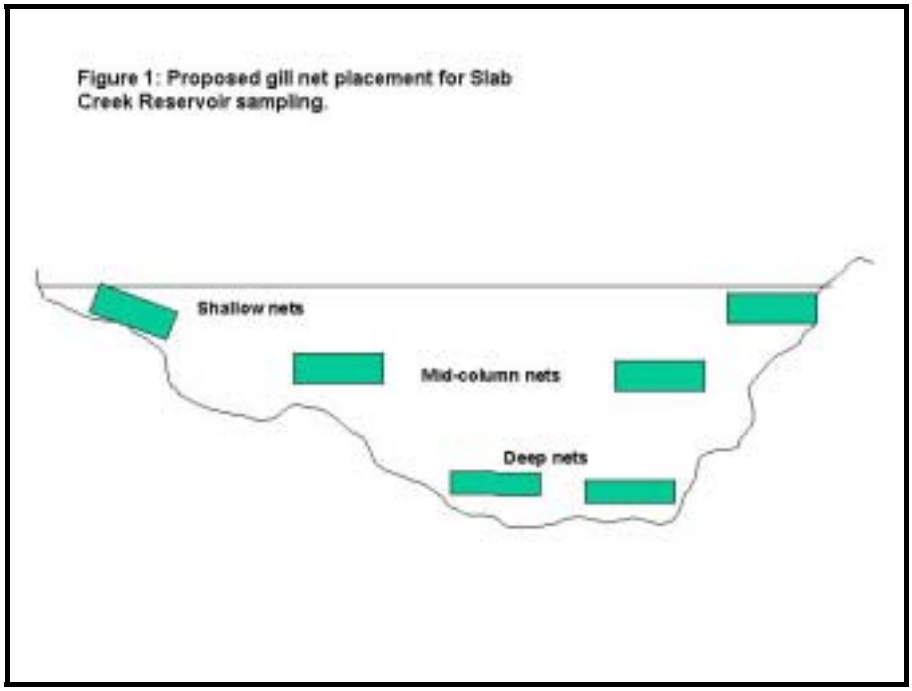

Figure 1: Proposed gill net placement for Slab Creek Reservoir sampling.

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1.1 Slab Creek Reservoir Sediment Sampling Study Plan

This study is designed to assess the potential for operation of the Iowa Hill facility to negatively affect turbidity levels in Slab Creek Reservoir.

1.1.1 Pertinent Issue Questions

This Slab Creek Reservoir Sediment Sampling Study Plan addresses the following questions:

- What is the potential for operation of the Iowa Hill facility to cause significantly increased turbidity in Slab Creek Reservoir?

1.1.2 Background

The Iowa Hill Pumped Storage Project is proposed as an addition to UARP facilities at Slab Creek Reservoir. The reservoir has historically experienced periodic turbidity problems associated with drawdown of the reservoir and resultant scour of exposed fine sediment deposits at the upstream end of the impoundment.

1.1.3 Study Objectives

The objective of this study is to describe the potential for operation of the Iowa Hill facility to significantly increase turbidity in, and downstream of, Slab Creek Reservoir as a result of facility operations.

1.1.4 Study Area

The study area will include Slab Creek Reservoir.

1.1.5 Information Needed From Other Studies

Information needed from other studies includes: 1) bathymetry of the reservoir, 2) water quality sampling results from the reservoir, 3) turbidity monitoring data for the reservoir, 4) reservoir level records, 5) inflow records, 6) past operation records of Slab Creek Reservoir, 7) projected operation rule for Slab Creek Reservoir (including Iowa Hill facility), 8) reservoir water velocity profiles from the reservoir temperature model, and 9) reservoir side slopes and substrates.

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1.1.6 Study Methods And Schedule

The study will be conducted in three steps, each of which is described below.

Step 1 – Field Studies to Characterize Sediment Composition of Slab Creek Reservoir

As a first step, we will identify any missing data as listed in section 1.1.5, make substitutions as appropriate for missing data, and conduct field surveys to characterize sediment in and around Slab Creek Reservoir. The scope of this step will be revised based on available data, but will include field reconnaissance to characterize sediment size and arrangement at the upstream end of the reservoir (i.e., within the zone affected by drawdown operations past and present), and may require characterization of in-reservoir sediment if disturbance to sediments on the bed of the reservoir is anticipated. Reconnaissance will also characterize the present interaction between flow processes and reservoir-marginal sediment at the upstream end of the reservoir, and compilation of any historical records which provide information helpful in achieving a conceptual understanding of the mechanics of sediment-flow processes in the area.

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If useful information can be gained from continuing turbidity monitoring at Slab Creek Reservoir during the winter months, the feasibility of leaving the monitoring equipment installed at that time of the year will be investigated.

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Step 2 – Evaluation of Past Operating Record to Identify Conditions Under Which Turbidity Problems Occurred

Information collected in Step 1 will be used to identify conditions under which water quality problems (turbidity) occurred. This will involve analysis of water surface profiles at various reservoir level and inflow conditions, and cross-sectionally averaged velocities at critical locations under those conditions. The critical locations will be identified based on bathometry data and the analyzed water surface profiles. The analysis may involve a series of HEC-RAS unsteady flow analyses as the basis for correlating episodes of known high turbidity with hydraulic conditions at the time. This correlation would be expected to highlight conditions critical for creating periods of high turbidity. A lack of clear correlation in this analysis may indicate that extraneous factors, likely linked to sediment supply dynamics (i.e., discrete inputs of sediment from upstream), have been more important than reservoir operations in creating conditions of high turbidity. Under this scenario, alternative analyses may be required to satisfactorily explain the periods of high turbidity.

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Step 3 – Evaluation of Projected Operating Rule of Slab Creek Reservoir, Including Iowa Hill Pumping Storage Facility, to Identify Conditions for Potential Turbidity Problems in the Future

If the bathymetry of the reservoir has not changed significantly, and assuming that local conditions and/or operations do control turbidity episodes, it is anticipated that the turbidity issues would occur at the same locations under similar conditions (velocity in particular) before and after the construction of the Iowa Hill Pump Storage Facility. By analyzing the projected operating rule of the project and the anticipated hydrological condition (inflow), we will be able to identify the time and year when potential turbidity problems would likely occur. The analysis may involve a series of HEC-RAS unsteady flow analyses. Any necessary modifications to the projected operating rule to minimize turbidity issues will be investigated.

The evaluation will include analysis of changes in the rate and frequency of water surface elevation changes in Slab Creek Reservoir, as well as changes in overall surface area, as a result of Iowa Hill Facility operation. The potential changes in sediment deposition (i.e., "settling") during episodic events resulting from Iowa Hill facilities will be evaluated, in order to determine if potential attenuation of turbidity through the reservoir would be affected by Iowa Hill operations (e.g., does Iowa Hill operation continue to "stir up" fine sediment contained in Slab Creek Reservoir inflows, thereby propagating turbidity effects downstream). This evaluation will include situations where White Rock Powerhouse might be generating at the same time that Iowa Hill pump back is occurring, thereby minimizing residence time of water flowing through Slab Creek Reservoir.

Slopes and substrates adjacent to Slab Creek Reservoir will be evaluated qualitatively to describe the potential for mass wasting events or erosion processes that may be affected by changes in reservoir fluctuation from Iowa Hill operations. Data for this evaluation will come from photos of the reservoir, and mapping conducted for the reservoir fish habitat study.

Substrate materials, bank conditions, and watershed characteristics for the Iowa Hill reservoir facility will be evaluated to assess the potential for the facility to be a source of turbidity to Slab Creek Reservoir.

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It is anticipated that Step 1 will occur in December-January, Step 2 will occur in January-February, and Step 3 will occur in February-March.

1.1.7 Study Output

A presentation of study progress will be made to the Aquatics TWG in April. A written report including the issues addressed, objectives, description of study area and sampling locations, methods, results, discussion and conclusions will be prepared after field visits and analyses are complete.

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1.1 Iowa Hill Pumped Storage Development Water Temperature Study

This study is designed to assess the effects of water temperature changes from the upper storage reservoir and lower basin (Slab Creek Reservoir) of the Iowa Hill Pumped Storage Project. As identified in the Iowa Hill Pumped Storage Development (IHPSD) Project Description, SMUD is proposing to construct and operate a 6,400 acre ft reservoir for power production. Water would be pumped from Slab Reservoir through a multi-port intake at a depth of approximately 80 ft (well below the historic stratified thermocline) below the Slab Creek Reservoir maximum water level elevation of 1,850 feet. In the pumping mode, the estimated discharge capacity of the intake would range between 3,600 and 4,200 cfs. The water would then be held for later release back through a powerhouse and return to Slab Creek Reservoir.

This study is proposed to assist in determining the possible effects on water temperature in Slab Creek Reservoir resulting from this new pumped storage facility and describe an approach to analyze potential temperature effects.

1.1.1 Pertinent Issue Questions

1. What are the temperature regimes (daily min, mean, max) relative to duration of storage period in Iowa Hill Reservoir during the summer months? Would this maximum temperature result in a significant increase in temperature for the return flow to Slab Reservoir?

2. Will the Iowa Hill Reservoir stratify, and how long will stratification take? Will water quality impairments (e.g., decreased dissolved oxygen from higher temperatures) result for the return flow?

3. Does the water withdrawn and/or released from Iowa Hill Reservoir into Slab Creek Reservoir have the potential to significantly alter or otherwise destabilize the temperature stratification in Slab Creek Reservoir, assuming velocity currents for the intake and return flow are not a significant factor?

4. Will the operation of the Iowa Hills pump storage facility result in altered summer temperature for the release flow from Slab Creek Reservoir to downstream waters?

1.1.2 Background

The IHPSD is proposed as an addition to UARP facilities at Slab Creek Reservoir. The reservoir is known to support primarily Sacramento sucker, hardhead (a USFS species of special concern), brown trout and Sacramento pikeminnow (SMUD, 2003). Reservoir temperatures in 2003 ranged as follows in the vicinity of the proposed intake (SMUD, 2003 unpublished data).

Temperature (in C°)→	**Near surface**	**Near bottom**
Month ↓		
June	17.0 –18.5	14.7 – 15.7
July	18.2 – 20.0	11.0 - 13.4
August	18.2 – 20.0	13.5 – 15.0
September	15.0 – 16.5	12.8 – 14.0
October	12.6 – 13.2	11.3 – 11.6

1.1.3 Study Assumptions and Analyses Objectives

1. Several assumptions are made to initially investigate temperature issues relevant to the proposed pumped storage project. These assumptions facilitate the assessment. Velocity

patterns around the intake and outlet structures are assumed to only have a vertical and longitudinal component. Velocities at the intakes and outlets are provided as boundary conditions.

2. The model uses the hydrostatic assumption and therefore does not account explicitly for vertical momentum effects. Even though the model is able to track density inflows and surface cooling accurately, the vertical momentum equation is not used to compute vertical velocities. Vertical velocities are determined by a flow balance over each cell.
3. The analysis will initially assume temperature changes within the penstock and flow lines of the pump storage facility are negligible due to the short travel time. Tunnels can be expected to have cooling effects since the ambient environment is at a groundwater temperature equivalent; however, a short travel time does not allow penstock flow to reach equilibrium with the tunnel ambient temperature.
4. Velocity, water temperature and other water quality factors are assumed to not differ significantly in a lateral direction within either the Iowa Hills or the Slab Creek reservoirs.
5. The wind sheltering coefficient is a correction on the measured wind velocity but is not based on theory.
6. Calibration of the model is restricted to available temperature data, which consists of limited instantaneous temperature profiles. Slab Creek Reservoir is assumed to be homothermous throughout the reservoir at the initiation of the time period modeled.
7. A static turbidity level within Slab Creek Reservoir will be applied and evaluated for its potential to influence water temperature regimes. If predicted turbidity levels as affected by the Iowa Hills project can be provided from other assessment efforts, then these turbidity levels will be incorporated into the model. Algal growth and its influence on temperature is assumed to be minimal for both the current condition and all operating scenarios for the Iowa Hills Project. The CE-QUAL-W2 model can model algal dynamics for multiple algal species but calibration data are not available.

1.1.4 Study Area

The study area will include Slab Creek Reservoirand the as-planned design for the Iowa Hills Reservoir. Flowlines, penstocks and power generation facilities for the Iowa Hills pump storage project are included in the model setup but only as conduits for water transfer; i.e. modeling of water quality within the flowlines is not considered necessary due to short residence times.

1.1.5 Information Needed From Other Studies

Data from the Water Temperature Study will be used in identifying temperature versus time curves from between below Camino Powerhouse (located upstream of Slab Creek Reservoir) and below Slab Creek Reservoir Dam. Data from monthly temperature profiles will also be used in the analysis. SMUD has increased the frequency of thermal profiles taken in Slab Creek Reservoir to monthly measurements throughout the summer of 2003 in anticipation of this study plan. Data from nearby climate stations will be used. Bathymetric data for the Slab Creek Reservoir and the design bathymetry for Iowa Hills Reservoir will be used. Water surface elevation data for the Slab Creek Reservoir for the current condition is available from operations records. Volume elevation rating curves are also available as well as generated from the model. Volume – elevation rating curves for the Iowa Hills reservoir are required and can be provided from the engineering design. Pump rates are provided as a user specified boundary condition.

1.1.6 Study Methods Analysis, and Schedule

A dynamic 1-D reservoir temperature model is suitable for analyzing temperature regimes within the Iowa Hills reservoir but a dynamic 2-D model is most suitable for modeling both the Slab Creek Reservoir and the Iowa Hills reservoir. The model should be capable of analyzing vertical stratification in the pump storage reservoir and both longitudinal and vertical temperature gradients within the Slab Creek Reservoir. An hourly or smaller model time step is needed.

It is recommended that CE-QUAL-W2 model be applied for modeling the pump storage reservoir and its effect on temperature dynamics within Slab Creek Reservoir. The CE-QUAL-W2 River Basin Model Version 3 (as schematized in Figure 4.3) was selected as most appropriate for modeling the Slab Creek Reservoir/ Iowa Hills Pump Storage Project temperature assessment This is a two-dimensional (vertical and longitudinal) water quality and hydrodynamic model that was originally developed for deep, long and narrow water bodies. This model has been under development for many years and is a public-domain code maintained by the Corps of Engineers, Waterways Experiments Station (WES), located in Vicksburg, Mississippi. The current version, Version 2 (Cole and Buchak 1995), has been superceded by Version 3 developed by WES and Wells (1997). Version 2 of the model has been successfully used in more than 200 river and reservoir applications. Version 3 has undergone rigorous testing and has been successfully applied to many river basin systems; applications include a 244 km section of the Lower Snake River, a multi-reservoir-river system on the Bull Run watershed, a series of 33 lakes and estuary segments in the Columbia Slough, and several other/lake/reservoir systems. Version 3 can be applied to both the density stratified environment of the reservoirs and sloping river channel sections. The W2 model uses a state-of-the-art numerical scheme, called Ultimate Quickest, which minimizes numerical dispersion problems. The use of an implicit numerical solution scheme for the water surface and vertical momentum equation minimizes the time step limitations for numerical stability.

Primary physical processes modeled by CE-QUAL-W2 include surface heat transfer, short-wave and long-wave radiation and penetration, convective mixing, wind and flow induced mixing, entrainment of ambient water by pumped-storage inflows, inflow density stratification as impacted by temperature and dissolved and suspended solids. Major chemical and biological processes in CE-QUAL-W2 include: the effects of DO of atmospheric exchange, photosynthesis, respiration, organic matter decomposition, nitrification, and chemical oxidation of reduced substances; uptake, excretion, and regeneration of phosphorus and nitrogen and nitrification-denitrification under aerobic and anaerobic conditions; carbon cycling and alkalinity-pH-CO_2 interactions; trophic relationships for six algal types; accumulation and decomposition of detritus and organic sediment; and coliform bacteria mortality. This application of the CE-QUAL-W2 model focuses on water temperature.

Modeling development and application will follow the following work elements:

- Data Collection and Analysis (use existing information),
- Develop boundary conditions,
- Discretization of the system into river and reservoir model segments,
- Develop model bathymetry,
- Develop Boundary condition,
- Model Calibration/Verification, and
- Model Application

Discretization of the basin involves partitioning the river and reservoir into model segments for the computational domain. The drainage basin is digitized and entered into a Geographic Information System (GIS). Reservoir bathymetry is used to identify fairly homogeneous segments. Typical reservoir segments are approximately ¼ mile in length or less, dependent upon bathymetry. Channel geometry and reservoir bathymetry can initially be developed from existing USGS maps and Project drawings showing pre-project conditions. Once the system is discretized, these geometry files are prepared that are compatible with CE-QUAL-W2 Version 3.

The next step in modeling is to prepare the boundary condition data in a format compatible with CE-QUAL-W2 Version 3. These files include flow and temperature for each point source, non-point source, and upstream flow boundary condition. Boundary conditions for this study include the inflow and outflow for Slab Creek Reservoir and the inflow and outflow for the Iowa Hills Project. Temperature response within the penstock and flowlines is assumed to be minimal and therefore will not be modeled. Even though the pumpback storage uses the same flowlines for withdrawal and return flow, separate boundary

ports for each will be defined in the model. A system model check will be preformed ensuring that input files are correct. Model preprocessor will be run for error-trapping.

Model predictions for water quality parameters are compared to field data in order to calibrate the model. The calibration will first evaluate the water levels (and/or flow rate and velocities) predicted by the model and then temperatures. Other water quality constituents including organic matter (soluble and particulate labile and refractory), nutrients (ammonia, nitrate, PO_4-P), algae, dissolved oxygen, bacteria, pH, carbonate cycle, and sediment are not being modeled in this assessment. If substantial alteration of temperature regimes within the Slab Creek Reservoir due to operation of the pumpback storage facility are predicted, then the same model could be expanded to evaluate effects on other water quality constituents. The calibration will be performed by iterating on the choice of model coefficients as well as re-examining assumptions of boundary conditions. Calibration will be based on the available data, which consists of instantaneous vertical profiles within the reservoir and continuous thermograph data for the Slab Creek Reservoir tailrace. A statistical evaluation of the calibrated model's performance is based on the absolute mean error (AME) which gives and indication of how close, on average, computed values are to observed values for a given water quality parameter at a given sampling station.

Once the model is calibrated for the existing current condition within Slab Creek Reservoir, then the temperature response for various operating scenarios for the Iowa Hills Project can be modeled. The results of these comparative modeling scenarios will be analyzed and reported including statistics and graphical comparisons of model alternatives with base conditions.

Modeling will focus on summer conditions. The reservoir geometry file will use 0.5 m layers so that stratification can be assessed. Bathymetry data for both the Iowa Hills Reservoir (design drawings) and the Slab Creek Reservoir will be utilized. Water surface elevation data for the Slab Creek Reservoir for the current condition is available from operations records. Volume elevation rating curves are also available as well as generated from the model. Volume – elevation rating curves for the Iowa Hills reservoir are required and can be provided from the engineering design. Pump rates are provided as a user specified boundary condition. Climate data are available as on-site air temperature data plus locally available meteorological stations including the nearby Camino station. The same climate data used in SNTEMP modeling is also applicable to this modeling effort.

It is expected that the analyses will be completed in early 2004.

1.1.7 Study Output

A presentation of study results will be made to the Aquatics TWG in early 2004. A written report including the issues addressed, objectives, description of study area, methods, results, discussion and conclusions will be prepared for inclusion in the license application, to evaluate the effects of the IHPSD on water temperature in Slab Creek Reservoir.

1.1.8 Literature Cited

Cole, T. and Buchak, E. (1995) "CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 2.0," Tech. Rpt. EL-95-May 1995, Waterways Experiments Station, Vicksburg, MS

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