Pacific Gas and Electric Company
Chili Bar Project
FERC Project No. 2155

Sacramento Municipal Utility District
Upper American River Project
FERC Project No. 2101

WATER QUALITY TECHNICAL REPORT

SUMMARY

From 2002 through 2004, the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric Company (jointly referred to as the Licensees) performed water quality studies to support the relicensing of SMUD's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project (jointly referred to as the Projects). The studies were conducted in the 10 UARP reservoirs, Rockbound Lake and Chili Bar Reservoir and in river reaches that could be affected by operations of the Projects, as well as many inflowing streams to the reservoirs. The studies were conducted in conformance to study plans developed by the UARP Relicensing Aquatic Technical Working Group and approved by the UARP Relicensing Plenary Group. This Water Quality Technical Report provides the results of that effort except for the complete sets of data for water temperature, dissolved oxygen, pH, specific conductance and Secchi disk depth that were collected during reservoir profiling; the reservoir profile data are summarized in this report and are provided in full in the Licensees' Water Temperature Technical Report.

SMUD is aware of five historic spills of hazardous material from the UARP. Four occurred in the Camino reach area and one in the Union Valley Dam area. Pacific Gas and Electric Company is unaware of any spills of hazardous materials at the Chili Bar Project.

Reservoirs

In general, waters in the 12 reservoirs are soft with hardness readings ranging from less than 1 to about 15 mg/l, and total alkalinity levels ranging from about 1 to 14 mg/l, indicating a low buffer capacity to changes in pH. The water is low in total suspended and dissolved solids (TSS/TDS); generally less than 4 mg/l and 20 mg/l, respectively. Mineral levels are low. All organic compounds (oil and grease, methyl-t-butyl ether [MTBE], total petroleum hydrocarbons [TPH], and gasoline range organics) are below detection limits. Based on Secchi disk depth, total nitrogen and total phosphorus readings, the reservoirs range in trophic status from mesotrophic (represented best by Chili Bar Reservoir) to oligotrophic (represented best by Junction Reservoir). The maximum nitrate concentration in each reservoir is well below the 1.0-mg/l nitrate standard typically used to characterize waters that can stimulate algal growth. The Licensees are unaware of any reports of floating material that would affect designated beneficial uses. All of the 12 reservoirs are generally well oxygenated. Dissolved oxygen (DO) concentrations in the upper portions of the reservoir in summer are typically greater than 85% saturation and 8.0 milligrams per liter (mg/l). None of the reservoirs showed bottom anoxic conditions, although lower DO concentrations (less than about 3 mg/l and 30% saturation) were found at the bottom of Ice House, Union Valley and Brush Creek reservoirs. The water is basic to slightly alkaline with pH readings ranging from about 6.0 to 8.0. Specific conductance showed an increasing trend from upstream reservoirs (readings ranging from about 6 to 13 µS/cm) to the downstream reservoirs (20 to 37 µS/cm), indicating increasing ion concentration from the upper to lower elevation reservoirs. Water in the reservoirs is relatively clear, with Secchi disk readings from about 10 to 30 feet.

With the exception of lead during the 2004 sampling events (i.e., during 2004 Spring Runoff, Summer Low Flow, First Major Rain and Fall Turnover), mercury during the 2003 Summer Low Flow sampling event, and iron during the 2003 Summer Low Flow sampling event, total metal concentrations in the reservoirs were less than Primary and Secondary Maximum Contaminant Levels (MCLs) established by the California Department of Health Services (DHS) pursuant to the California Safe Drinking Water Act. The Primary MCL for lead of 15 µg/l was exceeded in 46 reservoir samples (10 reservoirs: Rockbound, Buck Island, Loon Lake, Gerle Creek, Union Valley, Ice House, Junction, Brush Creek, Slab Creek and Chili Bar) during May to November 2004, ranging from 15-190 µg/l. It has since been confirmed by laboratory testing that the reservoir sampling equipment (Kemmerer sampler) used only during the 2004 sampling events was the source of elevated lead concentrations in reservoir samples during 2004. There were no other exceedences of lead MCLs except for samples collected with the 2004 Kemmerer reservoir sampler. Eight mercury samples exceeded the Primary MCL of 2 ug/l in five reservoirs (Loon Lake, Union Valley, Ice House, Slab Creek and Chili Bar) ranging from 2.1-5.7 ug/l. The reservoir sampling equipment (i.e., Van Dorn

and Kemmerer depth sampler) appear to be the source of elevated mercury levels in reservoir samples in 2003 as well as for elevated levels of lead in reservoir samples in 2004. The Van Dorn sampler that caused elevated mercury concentrations during 2003 was replaced with a Kemmerer sampler for the 2004 sampling events. Analysis of subsequent reservoir samples collected in 2004 with the new Kemmerer showed low mercury concentrations (<0.001 – 0.005 µg/l), however, lead concentrations jumped significantly in 2004 using the new Kemmerer sampler. A quality-assurance sample collected in the field (i.e., deionized water rinse of the Kemmerer sampler) during the 2004 Spring sampling event indicated the new Kemmerer sampler to be the likely source of lead in reservoir samples collected in 2004. Laboratory leaching tests conducted on the Kemmerer sampler during March 2005 confirmed that it was the source of elevated lead concentrations in the 2004 reservoir samples. The secondary MCL of 300 µg/l for total iron iron was exceeded in seven samples; in four reservoirs (Rubicon, Rockbound, Ice House and Chili Bar), ranging from 330-980 ug/l. Secondary MCLs do not have specific human health considerations, but are related to taste and odor.

SMUD collected fish from reservoirs that experience at least a moderate level of fishing pressure and analyzed filets for metals. Of the 30 filets examined, none had metal concentrations that exceeded SWRCB's Maximum Tissue Residue Levels (MTRL) guidelines. Two samples exceeded the USEPA Screening Value (SV) for arsenic of 0.026 ppm; at Union Valley Reservoir (brown trout, 0.06 ppm) and at Ice House Reservoir (rainbow trout, 0.16 ppm). Two samples exceeded the USEPA's SV guideline of 0.4 ppm for mercury, and an additional sample exceeded the USEPA (2002) guideline of 0.3 ppm for mercury; at Gerle Creek Reservoir (brown trout, 0.32 ppm), Union Valley Reservoir (smallmouth bass, 0.42 ppm), and Slab Creek Reservoir (brown trout, 0.59 ppm). Note that exceedence of USEPA's SV guidelines does not necessarily indicate a human health risk, but only that "*...more intensive site specific monitoring and/or evaluation of human health risk should be conducted.*" (USEPA 2000).

All of the fecal coliform samples collected by the Licensees in reservoirs met the Basin Plan Water Quality Objective for geometric mean (less than 200 organisms/100 ml). The single sample criterion (less than 400 organisims/100 ml) was exceeded in five samples in Union Valley Reservoir in June and July 2003 near the Camino Cove, Fashoda Beach and Jones Fork recreation areas. None of the *E. coli* samples collected by the Licensees in reservoirs exceeded the SWRCB staff's proposed Basin Plan water quality objective for *E. coli*, although exceedences occurred in upstream or downstream locations where high levels of dispersed recreational activities occur.

As requested by the Aquatic TWG, the Licensees collected additional information regarding total and dissolved metal concentrations for comparison with the California Toxics Rule (CTR) Criterion Maximum Concentrations (CMC) and Criterion Continuous Concentrations (CCC) for Freshwater Aquatic Life. The results of this sampling and the data analysis with respect to the CCC and CMC are included in this Water Quality Technical Report for dissolved metals concentrations in samples collected during the 2004 sampling events. The CCC and CMC for copper were exceeded in 15 UARP reservoir samples (Rockbound, Buck Island, Loon Lake, Gerle Creek, Union Valley, Ice House, Camino, and Slab Creek reservoirs) and four Chili Bar Reservoir samples. Two cadmium samples from UARP reservoirs (Loon Lake and Gerle Creek) exceeded the CCC and CMC, and two silver samples from UARP reservoirs (Rockbound and Ice House) exceeded the CMC (the CCC for silver has not been established). One cadmium and one zinc sample from Chili Bar Reservoir exceeded both criteria.

River Reaches

Alkalinity in waters in the UARP reaches and the Reach Downstream of Chili Bar, is low, with most readings less than 10 mg/l, indicating a low buffer capacity for changes in pH. The highest reading (110 mg/l) was recorded in the Reach Downstream of Chili Bar at a site downstream from the Salmon Falls/Highway 49 Bridge. Excluding this one reading, the alkalinity readings in this reach ranged from 9.6 to 28 mg/l. Turbidity and total suspended solids are also low, with mean values of less than 1 Nephelometric Turbidity Unit (NTU) and 1.3 mg/l, respectively. Total dissolved constituents, measured as total dissolved solids or individually as calcium, magnesium, potassium, sodium, chloride, and sulfate are also low. Values are generally below reporting limits, with minimal site or seasonal differences. All organic compounds (oil and grease, MTBE, TPH, and gasoline range organics) are below detection limits. All UARP reaches and the Reach Downstream of Chili Bar are well-oxygenated with dissolved oxygen concentrations greater than 85% saturation and 7.0 mg/l of oxygen except for five sampling occasions, two of which were in a UARP–affected reach (5.5 mg/l on October 8, 2002 in the outflow from Loon Lake Dam, and 4.7 mg/l on September 13, 2004 in the South Fork American River outflow from Slab Creek Reservoir), and one of which was in a Chili Bar-affected reach (6.1 mg/l on September 13, 2004 on the South Fork American River downstream of Greenwood Creek). The other two occasions were in stream reaches not affected by the UARP or Chili Bar Project: 3.1 mg/l in Jerrett Creek on October 8, 2002; and 3.7 mg/l in Rocky Basin Creek on September 17, 2003. The water is very soft with hardness readings ranging from less than 1 mg/l to 27 mg/l. Nutrients are also low. Total phosphorus and ortho-phosphorus each ranged from a low of less than 0.01 mg/l to a high of 0.22 mg/l for total phosphorus and a low of 0.003 mg/l to a high of 0.3 mg/l for orthophosphorus. Total Kjeldahl nitrogen ranged from less than 0.023 mg/l to 1.5 mg/l. Nitrate-nitrite ranged from less than 0.005mg/l to 3.0 mg/l. However, in general, the nitrate concentration in each reach is well below the 1.0-mg/l nitrate standard used to characterize source waters that can stimulate algal growth. As with the reservoirs, pH generally ranged from about 6.0 to 8.0 and mineral levels are low. Three pH values were measured below 6.0, all of which occurred in non-project affected reaches: 5.0 on September 17, 2003 at South Fork Rubicon inflow to Robbs Peak Forebay; and Highland Creek inflow to Rockbound Reservoir on June 11, 2003 and May 12, 2004 (5.75 and 5.83, respectively).

There were no values for total metals concentrations in the reaches that exceeded Primary MCLs. The Secondary MCL for aluminum of 200 µg/l was exceeded in three samples, ranging from 230 to 290 µg/l of total aluminum. Ten iron concentrations exceeded the Secondary MCL level of 300 µg/l of total iron, ranging from 300 to 990 µg/l of total iron. Secondary MCLs do not have specific human health considerations, but are related to taste and odor.

All bacteria samples collected by the Licensees met the Basin Plan Water Quality Objective for fecal coliform geometric mean and single sample criteria, as well as the SWRCB staff's proposed water quality objective for *E. coli*. However, fecal coliform concentrations in tributaries to Union Valley Reservoir exceeded single sample fecal coliform occasions at times during increased dispersed recreational use.

Fecal coliform and *E. coli* criteria were exceeded in the Reach Downstream of Chili Bar. The fecal coliform geometric mean criterion was exceeded at two sites: upstream of Hastings Creek (322 organisms/100 ml) and downstream of Weber Creek (327 organisms/100 ml). The single sample objective for *E. coli* exceeded in the Reach Downstream of Chili Bar at one site: below Chili Bar Dam (236 /100 ml). Fecal coliform single sample criterion was exceeded on a number of occasions, but did not follow an upstream to downstream pattern. While *E. coli* concentrations from the Licensees' sampling were low in the Reach Downstream of Chili Bar, sampling by El Dorado County in the Reach Downstream of Chili Bar from 1997 through 2002 included approximately 3 percent of the samples that would have exceeded the SWRCB staff's proposed *E. coli* water quality objective.

As with reservoirs, the Licensees collected additional information regarding dissolved metal concentrations during 2004 for comparison with the CTR's CCC and CMC for Freshwater Aquatic Life UARP project riverine samples exceeded criteria in three cadmium, 11 copper, 22 lead, one silver and three zinc samples. Chili Bar riverine samples exceeded criteria in three copper samples and one lead sample. Non-project riverine samples exceeded CCC/CMC criteria in one copper, ten lead and two silver samples at the following sampling sites: copper and lead criteria were exceeded at Highland Creek inflow to Rockbound Reservoir; lead criteria were exceeded at Rubicon River inflow to Rubicon Reservoir, Tells Creek inflow to Union Valley Reservoir, Big Silver Creek inflow to Union Valley Reservoir, and South Fork Silver Creek inflow to Ice House Reservoir; and silver criteria were exceeded at Jones Fork Silver Creek inflow to Union Valley Reservoir and Little Silver Creek inflow to Junction Reservoir.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell & Associates, Inc., (DTA) for the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric Company (jointly referred to as the Licensees) to support the relicensings of SMUD's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project (jointly referred to as the Projects). The Licensees intend to append this technical report to their respective applications to the Federal Energy Regulatory Commission (FERC) for new licenses. This report addresses water quality in UARP reservoirs and stream reaches affected by the UARP and in the Chili Bar Reservoir and in the Reach Downstream of Chili Bar. This report does not include the complete sets of data for water temperature, dissolved oxygen, pH, specific conductance and Secchi disk depth that were collected during reservoir profiling; the reservoir profile data are summarized in this report and are provided in full in the Licensees' Water Temperature Technical Report. The water quality technical report includes the following sections:

- **BACKGROUND** – Includes when the applicable study plans were approved by the UARP Relicensing Plenary Group; a brief description of the issue questions addressed, in part, by the study plans; the objectives of the study plans, and the study area. This section also includes agency requested information on historical water quality studies in the area and historical spill and waste discharge events.
- **METHODS** – A description of the methods used in the study, including a listing of study sites and sampling events.
- **RESULTS** – A description of the salient data results.
- **LITERATURE CITED** – A listing of all literature cited in the report.

This technical report does not include a detailed description of the UARP Alternative Licensing Process (ALP) or the UARP, which can be found in the following sections of SMUD's application for a new license: The UARP Relicensing Process, Exhibit A (Project Description), Exhibit B (Project Operations), and Exhibit C (Construction). Nor does this technical report include a detailed discussion of Pacific Gas and Electric Company's relicensing process for the Chili Bar Project.

This technical report does not attempt to characterize or conclude whether continued operation of the Projects is consistent with water quality policies and plans identified herein (ultimately, the State Water Resources Control Board (SWRCB) will make the final determination regarding consistency with such policies and plans). This technical report also does not include a detailed discussion regarding the long- or short-term effects of the continued operation of the Projects on water quality, or a discussion of appropriate protection, mitigation, and enhancement (PM&E) measures. Analysis of consistency and/or impacts regarding the operation of the UARP is included in SMUD's applicant-prepared preliminary draft environmental assessment (PDEA) document, which is part of SMUD's application for a new license for the UARP. Similarly, an impacts discussion regarding the Chili Bar Project will be included in Pacific Gas and Electric Company's Chili Bar Project license application. Development of PM&E measures will occur in settlement discussions in 2005, and will be reported on in the UARP application PDEA and the Chili Bar Project license application.

2.0 BACKGROUND

2.1 Water Quality Study Plan

On January 8, 2003, the UARP Relicensing Plenary Group approved a Water Quality Study Plan that was developed and initially approved by the relicensing Aquatic TWG on August 28, 2002, which was revised and again approved on December 2, 2002. The study plan was designed to address, in part, the following issues questions developed by the Plenary Group:

Issue Question 39.	How does the Project affect water quality (e.g. turbidity) and sedimentation, specifically at Slab Creek Reservoir, as operation of this reservoir affects sediment transport into Chili Bar Reservoir? How can we manage that impact if it exists? What are the historic events that have affected sedimentation?
Issue Question 41.	Do the waters below the Project reservoirs meet the water quality objectives of the Basin Plan? How can the Project be managed to help meet them?
Issue Question 45.	What type of long-term sediment and water quality strategies, operational practices and maintenance strategies exist?
Issue Question 46.	Do the waters within the reservoirs and the diverted reaches adequately protect all designated beneficial uses?
Issue Question 47.	Identify the Project-related pollution events that may have occurred in the watershed.
Issue Question 55.	What are the (Project-induced) effects of recreation (including on water and upslope activities) on water quality in the reservoirs and stream reaches (e.g. dispersed recreation and outhouses)?
Issue Question 60.	What is the location of all spoil piles within the Project area and what are the effects on water quality?

Specifically, the objectives of the study plan were:

- Characterize water quality under current operations of the Projects by direct monitoring of water quality, evaluation of historical information and evaluation of current ongoing studies in the area of the Projects such as the water temperature, channel morphology, Projects sources of sediment and aquatic bioassessment studies.
- Determine if Basin Plan water quality objectives (and other applicable water quality criteria) are met and assess whether Basin Plan-designated beneficial uses are protected.

The study area included all reservoirs associated with the Projects excluding Robbs Peak Reservoir due to its small size, and includes all stream reaches potentially affected by the UARP and Chili Bar Project, as well as a number of streams flowing into Project reservoirs.

2.2 Agency Requested Information

Following a review of the *Water Quality Technical Report* dated January 2004 (Version 0), the agencies forwarded a letter dated May 13, 2004 to the Licensees, in which the agencies requested that the technical report be revised to include the following information:

> Objectives of the Water Quality Study Plan focus on the collection of data adequate to determine if Basin Plan water quality objectives (and other applicable water quality criteria) are met and whether operation of the project provides for protection of all beneficial uses designated for project-affected waters. In reviewing the draft Water Quality Technical Report, the following concerns are noted and should be addressed - through edits to the draft Report or additional seasons of study and subsequent addendum to allow completion of a final Report.
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> 1. The Water Quality Study Plan was designed to address various Issue Questions, primary among these being: *Is operation of the Project protective of Basin Plan designated beneficial uses?* Although this question introduces section 3.6.1 of the study plan and is re-emphasized as Issue Question 46, nowhere in the draft Water Quality Report are the beneficial uses listed or levels of protection considered. A summary table should be prepared that displays the beneficial uses as designated in the Basin Plan for the following water bodies and stream segments: Desolation Valley Lakes, Middle Fork American River from the source to Folsom Lake (Rubicon drainage), South Fork American River (SFAR) from the source to Placerville, and SFAR from Placerville to Folsom Lake. This table should also provide a listing of water quality parameters that may have the potential to affect any (or all) of these beneficial uses. In the table, the range of values obtained for constituents sampled in each of the water bodies or stream segments should be applied to any beneficial use that may potentially be affected. A discussion of the applicability of the various constituents to each of the beneficial uses should be included with this table in the final Report.
>
> 2. Section 2.1 of the *Background* attempts to paraphrase the purpose of the Water Quality Study Plan, but in its brevity disregards the need to address Issue Questions 39, 47, 55 and 60. Regardless of the expectation that some information will be obtained from other studies to aid in answering these questions, the Water Quality Report must address the effects on surface water quality that may potentially occur as a result of sediment movement, run-off from spoils piles, historic pollution events, and project-induced recreation. Any data necessary to answer these Issue Questions must be summarized and presented in this stand-alone document. An analysis that integrates the appropriate data sets from this

and other studies should be conducted and provided within the final Report to answer the Issue Questions.

3. Limited data has been provided to document historic water quality conditions and spill or waste discharge events within the UARP (section 2.4). In the Water Quality Study Plan the TWG requested that interviews be conducted to identify any Project-related historic pollution events and any water quality data routinely collected by SMUD or others. It is unclear whether consultation regarding discharge events or ongoing sampling on project waters has been conducted between SMUD and any of the following: El Dorado County Health Department, El Dorado County Environmental Management, California Department of Fish and Game, El Dorado National Forest, Regional Water Quality Control Board or others. Informal discussions with some of these entities suggest that there may be turbidity data associated with a Slab Creek Reservoir monitoring program, that bacterial monitoring may have been conducted by the County, and that dredged spoils may have been discharged to land on a number of occasions with the potential to introduce sediments or contaminants into the water bodies downslope. A discussion of the scope of research on these issues should be provided, and if information sources have been overlooked, they should be investigated and findings included in this inventory of historic events.

4. Throughout the document, mean and median values are discussed and there are general conclusions drawn regarding specified constituents based on these values. In many cases these "mean values" appear to be the result of averaging across seasons and/or averaging of data from multiple sampling locations. Unless specified in regulatory standards, it is inappropriate to average constituent values or attempt to apply measures of central tendency across geographic or temporal space. Use of a median or mean value on a watershed scale is misleading and steps away from the intent of characterizing water quality on each project water body for determining levels of aquatic species protection. A global review of the draft Report should be made, and all references to median or mean values should be critically considered for applicability and either deleted or more clearly described.

5. To analyze compliance of the measured water quality parameters with regulatory criteria, the Report should provide for a comparison of the environmental data to Basin Plan objectives (numeric and narrative), California Toxics Rule Freshwater Aquatic Life Protection criteria, U.S. EPA National Ambient Water Quality Criteria, Code of California Regulations Title 22 Drinking Water Standards (maximum contaminant levels), Public Health Goals (OEHHA), and California Toxics Rule Human Health Protection levels as applicable for individual constituents. To facilitate this comparison, a table similar to Table 4.4-1 should be developed and expanded to include each sampling parameter (see Table 3.2-3) and any specific maximum thresholds allowable under appropriate regulatory criteria, objectives and goals listed above.

6. Although arsenic and cyanide data are reported to be total values (pp. 28-29), the draft document is silent on what concentrations were analyzed and reported for other constituents. Regulatory standards established for metals as objectives in the Basin Plan, as CTR Freshwater Aquatic Life Protection criteria, and as National Ambient Water Quality Criteria are mostly based on dissolved concentrations (with aluminum and iron being the exceptions). Maximum contaminant levels set forth in Title 22 and the California Toxics Rule Human Health Protection levels are provided as total recoverable concentrations. Metals criteria for the protection of aquatic life are generally more stringent than human health protection levels (with the exception of inorganic mercury, where the California Toxics Rule Human Health Protection level is more sensitive). This requires that values be reported as the dissolved fraction to allow for appropriate comparisons. The Report should be edited to clearly identify the concentration analyzed for each metal.

7. Summary discussions found in the draft Report indicate numerous exceedences of the metals criteria defined for Freshwater Aquatic Life Protection when comparisons are made between environmental values measured on UARP water bodies and these California Toxics Rule criteria. It is unclear whether data are reported as dissolved concentrations that allow for a direct comparison to aquatic life criteria or as total values that are not directly comparable to the dissolved metals criteria. A determination of follow-up measures necessary for completion of a final Report will depend on whether laboratory values for metals are reported as dissolved concentrations or as total recoverable concentrations. Follow-up and revisions to the draft Report must proceed as follows:

   - If laboratory analyses conducted on water column samples for 2002-2003 report data as total recoverable metals concentrations, it will be necessary to convert the California Toxics Rule criteria for Cd, Cu, Pb, Ni, Ag, and Zn to total recoverable expressions to allow for comparability. To salvage total metals data for consideration, California Toxics Rule aquatic life criteria must be converted from dissolved expressions to criteria expressed as total recoverable fractions using the California Toxics Rule recommended conversion factors (40 CFR Part 131.38). Following this exercise, measured total metal values and the converted criteria expressed as total recoverable fractions must be included in the Report, along with a complete discussion of the circumstances and the conversion process undertaken. A revised comparison of project data compliance with the converted criteria must be completed. In addition, another year of metals data must be collected and reported for all sampling stations in the Spring, Summer, Fall Turnover, and First Rain periods of 2004 for all metals. Laboratory analyses on these samples must be conducted to obtain both total and dissolved measured values (along with site-specific hardness) to allow direct comparison of environmental values to the established dissolved metals criteria for aquatic life and to compare total values for all metals to human health criteria.

- If the 2002-2003 values are reported as dissolved metals concentrations, direct comparison of the data to the established criteria indicates a continuing environmental problem. The number of samples that exceed the California Toxics Rule priority pollutant thresholds for metals trigger the need for another full year of sampling and appropriate analyses of all metals, at all sampling stations, in Spring, Summer, Fall Turnover, and First Rain periods of 2004. Laboratory analyses must provide measured values for both total and dissolved metals (along with site-specific hardness) to allow for appropriate comparisons with established state and federal regulatory criteria.

8. Mercury data sets provided in the draft Report are incomplete. Thirty-three of 68 samples collected during the Summer sampling period failed the laboratory QA/QC for Hg (Appendix A-30). In addition, Summer water column mercury data are missing for the Big Silver Creek site (#22), a tributary to Union Valley Reservoir where elevated mercury levels were reported in fish tissues. An additional Summer Hg data set should be provided in the final Report for all sampling stations; it is expected that these data will be collected through the 2004 water quality sampling effort discussed above.

9. The study conducted to screen for potential bioaccumulation of metals by resident fish was expanded in geographic scope from four reservoirs identified in the Water Quality Study Plan to six reservoirs actually sampled. Although TWG participants commend the Licensee's efforts to include Loon Lake and Gerle Creek Reservoir, it is unfortunate that small numbers of fish were collected at Gerle Creek, Union Valley, and Slab Creek Reservoirs (section 3.4). Based on discussion provided at section 3.4 and data presented at section 4.7 it is unclear whether the composite sample prepared for Slab Creek Reservoir included multiple species – the single data point suggests that Sacramento Pikeminnow and Brown Trout were mixed in that sample. Language to clarify the laboratory strategy taken on this sample should be added to the discussion. In addition, both total and fork lengths of all fish should be provided for appropriate analysis. Table 3.4-1 should be expanded to include total length (demonstrating "catchable size" of each individual), and Table 4.6-3 should be expanded to include fork length (demonstrating that composites follow the 75% rule) to allow for analysis of relative size/age class to body burden of the metal concentrations. Laboratory data sets for the fish tissue analysis should be provided as Appendix A-34.

10. The draft Water Quality Report includes no Laboratory QA/QC. A copy of the QA/QC report from each laboratory (ToxScan of Watsonville, Sequoia Analytical, El Dorado County Health Department Laboratory, and Moss Landing Marine Laboratory) should be referenced in the final Report and must be provided in electronic format on the Water Quality Report CD.

2.3 Water Year Type

The information in this subsection is provided for informational purposes, as requested by agencies. The UARP Relicensing Water Balance Model Subcommittee established five water year types to be applied to all preliminary analysis with the understanding that the UARP Relicensing Plenary Group, with cause, may modify the current water year types in the future. The five current water year types are triggered by the February 1, March 1, April 1 and May 1 California Department of Water Resources (CDWR) forecast for total water year unimpaired inflow into Folsom Reservoir. An additional trigger is CDWR's October 1 estimate of the actual total water year unimpaired inflow into Folsom Reservoir. The February 1 forecast determines the water year type applied for the period from February 10 through March 9: the March 1 forecast the period from March 10 through April 9; the April 1 forecast the period from April 10 through May 9; the May 1 forecast the period from May 10 through October 9; and the October 1 estimate the period from October 10 through February 9. The inflow levels are:

- Critically Dry (CD) Water Year: Less than 900,000 acre-feet
- Dry (D) Water Year: From 900,001 to 1,700,000 acre-feet
- Below Normal (BN) Water Year: From 1,700,000 to 2,600,000 acre-feet
- Above Normal (AN) Water Year: From 2,600,000 to 3,500,000 acre-feet
- Wet (W) Water Year: More Than 3,500,000 acre-feet

The fieldwork performed for this study occurred in 2002, 2003 and 2004. For this period, the CDWR forecasts and estimates were:

Table 2.3-1. CDWR Folsom Reservoir forecast for 2001-2004.

Year/Month	Feb	Mar	Apr	May	Oct
2001	1,400	1,440	1,100	1,200	1,022
2002	2,380	2,070	2,170	2,070	2,019
2003	2,120	1,760	1,600	2,190	2,287
2004	2,120	2,210	1,925	1,725	1,616

Applying this water year type scenario and the CDWR forecasts and estimates to the study period results in the following:

Table 2.3-2. Water year types applied to individual months of years 2001-2004.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2001	AN	D	D	D	D	D	D	D	D	D	D	D
2002	D	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN
2003	BN	BN	BN	D	BN	BN	BN	BN	BN	BN	BN	BN
2004	BN	BN	BN	BN	BN	BN	BN	BN	BN	D	D	D

3.0 METHODS

The methods for the water quality studies for general limnology, dissolved and suspended substances, organics, and metals sampling are discussed. The methods for the coliform sampling, both *Escherichia coli* (*E. coli*) and fecal coliform, and fish tissue analysis are discussed separately in Section 3.3 and Section 3.4. The study methods conformed to those approved by the Aquatic TWG Plenary Group.

3.1 Study Area

As described above, the study area included all reservoirs associated with the Projects excluding Robbs Peak Reservoir. Rockbound Lake, although associated with the UARP, is not a UARP project feature nor within the FERC-defined UARP Project Boundary. Robbs Peak Reservoir was excluded from sampling due to its small size (30 acre-feet). The reservoirs in the study area included:

Rubicon	Gerle Creek	Camino
Rockbound	Ice House	Brush Creek
Buck Island	Union Valley	Slab Creek
Loon Lake	Junction	Chili Bar

In addition, the study area included all stream reaches and those tributary inflows that were identified by the Aquatic TWG and Plenary Group. These stream reaches are listed below:

Rubicon Dam	Robbs Peak Dam	Camino Dam
Buck Island Dam	Ice House Dam	Brush Creek Dam
Loon Lake Dam	Union Valley Dam	Slab Creek Dam
Gerle Creek Dam	Junction Dam	Reach Downstream of Chili Bar

Additional samples were collected in sections of streams unaffected by the Projects. These included:

- Rubicon River upstream of Rubicon Reservoir
- Highland Creek upstream of Rockbound Lake
- South Fork Rubicon River Upstream of Robbs Peak Reservoir
- Tells Creek, Big Silver Creek, and Jones Fork Silver Creek upstream of Union Valley Reservoir
- South Fork Silver Creek upstream of Ice House Reservoir
- Jaybird Canyon Creek upstream of Camino Reservoir
- Little Silver Creek upstream of Junction reservoir
- Brush Creek upstream of Brush Creek Reservoir
- Slab Creek upstream of Slab Creek Reservoir

3.2 Sampling Methods and Parameters

The selected constituents were sampled using a triage sampling and contingency sampling plan as identified in Table 3.2-1. The triage sampling was designed to screen for elevated constituent levels within the Projects' study area. Water quality samples were collected immediately downstream of each UARP facility and the Chili Bar Dam, in each UARP reservoir and Chili

Bar Reservoir, and in the major unimpaired inflows to each reservoir. The contingency sampling focused on the specific water quality constituent(s) and areas where triage sampling data indicated a water quality problem might exist. It included near-term and long-term activities to explore the problem. The near-term steps included immediately directing the water quality lab to analyze the water quality samples taken from major inflows to the reservoirs for the constituent for which a problem was indicated. Because of the short laboratory holding times of certain constituents, the Licensees and the laboratory initiated special procedures to ensure that information was not lost due to expiration of the holding times. In other cases, samples that were to be held until a determination was made to analyze them were ultimately analyzed along with all other samples. Constituents with short holding times included certain nutrients (e.g., nitrate-nitrite and ortho-phosphorus have 48 hour holding times) and total suspended solids and total dissolved solids (7-day holding time). In these instances, the laboratory was directed either to analyze for the specific constituents immediately upon arrival or to chemically preserve the samples for later analyses.

Water quality sampling locations are shown on the maps in Appendix B. Appendix B-1 includes four map files on CD that show all study site locations for the water quality study as well as for other aquatic relicensing studies. Attached in Appendix B-2 is a map that shows all water quality sampling sites except for locations on the Reach Downstream of Chili Bar. The map in Appendix B-2 is included as a convenience to the reader in addition to the full set of maps in Appendix B-1.

Table 3.2-1. Water quality sampling locations for relicensing of Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.

		Triage Sampling	Contingency Sampling	
Water Quality Monitoring Station		Take & Analyze *	Obtain with Triage Samples, Analyze if Problem	Take & Analyze if Problem
1.	Rubicon River inflow to Rubicon Res.		X	
R-1.	Rubicon Res. mid-lake	X		
2.	Rubicon R. outflow from Rubicon Res.	X		
3.	Rubicon R. upstream of Rubicon Springs			X
3a.	Fox Lake reach flow from Rubicon Res.		X	
4.	Highland inflow to Rockbound Res.		X	
R-2.	Rockbound Lake mid-res.	X		
5.	Rubicon outflow from Rockbound Lk.	X		
R-3.	Buck Island Res. mid-lake	X		
6.	Little Rubicon outflow from Buck Is. Lk.	X		
R-4a	Loon Lake Res. near dam	X		
R-4b	Loon Lk. mid-res. in west body	X		
R-4c	Loon Lk. upper res. N-E body	X		
7.	Gerle Ck. outflow from Loon Lake	X		
8.	Jerrett Ck. upstream of Gerle Ck. con.			X
9.	Gerle Ck. downstream of Jerret confl.	In situ *only*		X
10.	Barts/Dellar Ck. upstream of Gerle Ck.			X
11.	Gerle Ck. dwnstrm of Barts/Dellar conf.			X
12.	Rocky Basin Ck. upstream of Gerle			X

Table 3.2-1. Water quality sampling locations for relicensing of Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.

		Triage Sampling	Contingency Sampling	
	Water Quality Monitoring Station	Take & Analyze *	Obtain with Triage Samples, Analyze if Problem	Take & Analyze if Problem
13.	Gerle Ck. dwnstrm of Rocky Basin conf	*In situ* only		X
14.	Gerle Ck. inflow to Gerle Ck. Res.	X		
R-5.	Gerle Ck. Reservoir mid-res.	X		
15.	Gerle Ck outflow from Gerle Ck Res	X		
16.	Gerle Ck Canal inflow to Robb's Frby	X		
17.	S.F. Rubicon inflow to Robb's Forebay		X	
18.	S.F. Rubicon upstream of Gerle Ck con.			X
19.	S.F. Rubicon dwnstrm of Gerle Ck con.			X
20.	S.F. Rubicon upstrm of Rubicon River	X		
21.	Tells Ck. upstrm of Union Valley Res.		X	
22.	Big Silver Ck. upstrm of Union Valley		X	
23.	Jones Fk Silver Ck inflow to Union Valley Res.		X	
R-6a	Union Valley Res. near dam	X		
R-6b	Union Valley Res. mid-res.	X		
R-6c	Union Valley Res. (near Robb's Pk. PH tailrace)	X		
R-6d	Union Valley Res. Jones Fork arma	X		
24.	S.F. Silver Ck. upstrm of Ice House Res.		X	
R-7a	Ice House Reservoir near dam	X		
R-7b	Ice House Reservoir mid-res.	X		
R-7c	Ice House Reservoir upper lake body	X		
25.	S.F. Silver Ck. Outflow from Ice House	X		
26a.	S.F. Silver 3-4 mi. dwnstrm of IH Res	*In situ* only		X
26b.	S.F. Silver upstrm of Big Hill Cnyn.			X
27.	S.F. Silver Ck inflow to Junction Res.	X		
28.	Little Silver Ck. Inflow to Junction Res		X	
R-8	Junction Reservoir, mid-resv btwn arms	X		
29.	Silver Ck. outflow from Junction Res.	X		
30.	Onion Ck. upstream of Silver Creek			X
31.	Silver Ck dwnstrm of Onion Ck confl.			X
32.	Silver Ck. inflow to Camino Res.	X		
33.	Jay Bird Ck. inflow to Camino Res.		X	
R-9.	Camino Reservoir mid-resv.	X		
34.	Silver Ck. outflow from Camino Res.	X		
36.	Silver Ck. Immediately upstrm of SFAR	X		
37.	SFAR upstream of Silver Ck confluence			X
38.	SFAR upstream of Camino Powerhouse		X	
39.	Brush Ck. inflow to Brush Ck. Res.		X	
R-10.	Brush Creek Res. mid-res. Site	X		
40.	Brush Ck. outflow from Brush Ck Res.	X		
41.	SFAR dwnstrm of Camino Powerhouse	X		
R-11a	Slab Creek Reservoir mid-res. site	X		
R-11b	Slab Creek Res. upper-res. site	X		

Table 3.2-1. Water quality sampling locations for relicensing of Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.

		Triage Sampling	Contingency Sampling	
Water Quality Monitoring Station		Take & Analyze *	Obtain with Triage Samples, Analyze if Problem	Take & Analyze if Problem
42.	Slab Ck. inflow to Slab Ck. Reservoir		X	
43.	SFAR outflow from Slab Ck Res – upstream of Iowa- Brushy Cnyn Ck confl.	X		
44.	SFAR between Slab Ck Res & Rock Ck			X
45.	Rock Creek upstream of SFAR confl.			X
46.	SFAR downstream of Rock Ck. confl.	X		
47.	SFAR downstream of White Rock P.H.	X		
R-12a	Chili Bar Reservoir near dam	X		
R-12b	Chili Bar Reservoir mid-res. Site.	X		
48.	SFAR below Chili Bar Dam	X		
49.	SFAR upstream of Dutch Creek			X
50.	SFAR at Coloma gaging station			X
51.	SFAR dwnstrm of Greenwood Creek, near ex-USGS 11445500	X		
52.	SFAR upstream of Weber Creek			X
53.	Weber Ck upstream of confl. w/ SFAR			X
54.	SFAR below Weber Creek confluence in a riverine environment	X		

* During periods of reservoir stratification, samples were collected within the upper epilimnion layer and also in the hypolimnion layer a few feet above the reservoir bottom. When the reservoir profile was mixed, samples were collected at a point below the water surface equivalent to approximately one-third the total water column depth.

The Water Quality Study Plan required the Licensees to conduct the water quality study efforts over four seasons: Spring Runoff, Summer Low-Flow, Fall Turnover and First Major Rain (Table 3.2-2). These samplings were conducted beginning in Fall 2002 through Fall 2003. In response to a request from the State Water Resources Control Board and Department of Fish and Game, the four seasons of sampling were repeated in 2004 for dissolved and total metals for all locations identified in the study plan. The Licensees obtained water temperature profiles in Fall 2002 and Fall 2004 to determine the specific timing of the fall turnover for the three storage reservoirs and associated regulation reservoirs. Profiling was conducted in Loon Lake Reservoir (representing Rubicon, Rockbound, Buck Island, Gerle and Loon Lake reservoirs), Union Valley Reservoir (Junction and Union Valley reservoirs), Ice House Reservoir, and Slab Creek Reservoir (Brush Creek, Camino, Chili Bar and Slab Creek reservoirs). For this purpose, turnover was assumed to have occurred when the thermocline had broken down: that is, when at nowhere in the reservoir was there a more than 1°C change in temperature per meter of depth. Reservoir profiling data indicate that complete turnover is a relatively slow process and can span several weeks.

The Fall 2002 Turnover sampling extended over a two-month period, as Ice House Reservoir and Union Valley Reservoir remained stratified through October. In the case of Ice House Reservoir, stratification persisted through the 2002 First Major Rain event. Timing of the 2002 First Major Rain event was triggered by more than 1 inch of precipitation.

Table 3.2-2. Sampling dates for UARP and Chili Bar Project Sites, 2002-2004.

Reservoir[1]	Fall 2002 Turnover	2002 First Major Rain	Spring 2003 Runoff	Summer 2003 Low Flow	Spring 2004 Runoff	Summer 2004 Low Flow	Fall 2004 Turnover	2004 First Major Rain
Rubicon	Oct. 7	**[2]	Jun. 11	Sep. 17	May 12	Sep. 21	--	--
Rockbound	Oct. 7	**[2]	Jun. 11	Sep. 17	May 12	Sep. 21	Nov. 2	**[2]
Buck Island	Oct. 7	**[2]	Jun. 11	Sep. 17	May 12	Sep. 21	Nov. 2	**[2]
Loon Lake	Oct. 8	Nov. 11	May 14	Sep. 16	May 6	Sep. 22	Nov. 10	**[2]
Gerle Creek	Oct. 8	Nov. 11	May 14	Sep. 19	May 6	Sep. 15	Nov. 10	**[2]
Union Valley	**[2]	Nov. 14[2]	May 7, 13	Sep. 18	May 5	Sep. 14	Nov. 8	**[2]
Ice House	Nov. 26[3]	Nov. 14	May 11, 13; Jun. 12	Sep. 18	May 11	Sep. 20	Nov. 1	Dec. 1
Junction	**[2]	Nov. 14[2]	May 11, 13	Sep. 16	May 5	Sep. 14	Nov. 8	**[2]
Camino	**[2]	Nov. 13[2]	May 6	Sep. 16	May 4	Sep. 12	Oct. 24	**[2]
Brush Creek	**[2]	Nov. 13	May 6	Sep. 16	May 4	Sep. 20	Nov. 1	**[2]
Slab Creek	Oct. 7-9	Nov. 12	May 5	Sep. 15	May 3	Sep. 13	Oct. 25	**[2]
Chili Bar	Oct. 9	Nov. 13	May 5	Sep. 15	May 3	Sep. 13	Oct. 25	**[2]

[1] Riverine sites, which include tributaries and reaches below the project reservoirs, were sampled at the same dates as the nearby reservoir.
[2] Fall Turnover sampling concurrent with First Rain sampling.
[3] Fall Turnover sampling occurred after the First Rain sampling. Ice House Reservoir remained stratified through mid-November.

Fifty-five water quality parameters were evaluated for samples taken in the UARP reservoirs and Chili Bar Reservoir, major tributaries, and main stem tributary reaches during the eight sampling events (Table 3.2-3). Selection of the water quality parameters was based on existing water quality objectives as defined by the Aquatic TWG and approved by the Plenary Group.

All procedures used for the purpose of collecting, preserving and analyzing samples followed established USEPA or Standard Methods protocol. All samples were collected manually into certified pre-cleaned, Nalgene or glass containers provided by the laboratory and placed on ice during transport. Samples processed for metals, certain nutrients and organics were shipped to ToxScan Laboratories of Watsonville, California at the end of the sampling week. Samples with constituents with short hold-times (e.g. turbidity, nitrate-nitrite, ortho-phosphorus and fecal coliform) were delivered to Sequoia Analytical Laboratories in Sacramento. *E. coli* samples were delivered to El Dorado County Health Department Laboratory in Placerville and processed within 24 hours of sampling.

At the stream reach sites, a single grab sample was obtained where sufficient turbulence provided good lateral and vertical mixing and when possible, near the approximate thalweg. Reservoir samples were obtained from a boat using Van Dorn and Kemmerer samplers. Camino Reservoir was usually sampled along the near-shore due to safety policy. When a reservoir was not temperature-stratified, water chemistry sampling consisted of one grab sample collected at one-third of the maximum depth. If a reservoir was stratified, a sample was obtained from both the epilimnion and hypolimnion, as determined by thermal profiling. Thermal stratification was defined as temperature change of more than 1.0°C per 1.0 meter of depth anywhere in the reservoir, which is referred to as the location of the thermocline (Horne and Goldman, 1994).

Dissolved oxygen (DO), pH, temperature and specific conductance were measured at each site at the time of nutrient sampling with a Yellow Springs Instrument (YSI) or Hydrolab Multiprobe meter. Instrument calibrations were performed for DO, temperature, pH and specific conductance prior to each sampling season. Transparency was measured in reservoirs with a standard 7.9-inch-diameter Secchi disk.

Table 3.2-3. Sampling Parameters, Methods, and Sampling Event.

		Sampling Event							
Constituent	**Method**	**Fall 2002 Turn-over**	**2002 First Rain**	**Spring 2003 Runoff**	**2003 Summer Low Flow[1]**	**2004 Spring Runoff**	**2004 Summer Low Flow[1]**	**Fall 2004 Turn-over**	**2004 First Rain**
General Limnology									
Water Temperature	Hydrolab/YSI	X	X	X	X	X	X	X	X
Dissolved Oxygen	Hydrolab/YSI	X	X	X	X	X	X	X	X
pH	Hydrolab/YSI	X	X	X	X	X	X	X	X
Specific Conductance	Hydrolab/YSI	X	X	X	X	X	X	X	X
Secchi Depth	Secchi Disk	X	X	X	X	X	X	X	X
General Limnology									
Nitrate-Nitrite	EPA 300.0	X	X	X	X				
Ammonia as N	EPA 350.2	X		X	X				
TKN as N	EPA 351.3	X			X				
Total phosphorous	EPA 365.2	X	X	X	X				
Ortho-phosphate	EPA 365.3	X			X				
TOC	EPA 415.1	X			X				
Turbidity, Total Suspended Solids, Total Dissolved Solids									
Turbidity		X	X	X	X				
Total Alkalinity	EPA 310.1	X	X	X	X				
TSS	EPA 160.2	X	X	X	X				
TDS	EPA 160.1	X		X	X				
Calcium	EPA 200.7	X		X	X				
Magnesium	EPA 200.7	X		X	X				
Potassium	EPA 200.7	X		X	X				
Sodium	EPA 200.7	X		X	X				
Chloride	EPA 200.7	X		X	X				
Sulfate	EPA 200.7	X		X	X				

Table 3.2-3. Sampling Parameters, Methods, and Sampling Event.

Constituent	Method	Sampling Event							
		Fall 2002 Turn-over	2002 First Rain	Spring 2003 Runoff	2003 Summer Low Flow[1]	2004 Spring Runoff	2004 Summer Low Flow[1]	Fall 2004 Turn-over	2004 First Rain
Organics									
Oil and grease	EPA 1664	X	X		X.				
MTBE	SW 5030B/SW 83260B	X[1]			X				
TPH	SW 5030B/SW 8021B/9015	X[1]			X				
Metals: Measured as Total Recoverable Metals									
Aluminum	EPA 200.8 and 245.7	X	X	X	X	X	X	X	X
Arsenic	EPA 200.8 and 245.7	X	X	X	X	X	X	X	X
Barium	EPA 200.8 and 245.7	X	X	X	X	X	X	X	X
Iron	EPA 200.8 and 245.7	X		X	X	X	X	X	X
Manganese	EPA 200.8 and 245.7	X			X		X	X	X
Mercury	EPA 245.7	X			X		X	X	X
Selenium	EPA 200.8 and 245.7	X			X		X	X	X
Total Cyanide[3]	EPA 335.2	X			X				
Metals-Hardness: Measured as Total Recoverable Metals									
Hardness	EPA 130.2	X	X	X	X	X	X	X	X
Barium	EPA 200.8 and 245.7	X		X	X	X	X	X	X
Cadmium	EPA 200.8 and 245.7	X		X	X	X	X	X	X
Copper	EPA 200.8 and 245.7	X		X	X	X	X	X	X
Lead	EPA 200.8 and 245.7	X	X	X	X	X	X	X	X
Nickel	EPA 200.8 and 245.7	X		X	X	X	X	X	X
Silver	EPA 200.8 and 245.7	X	X	X	X	X	X	X	X
Zinc	EPA 200.8 and 245.7	X			X		X	X	X
Metals: Dissolved									
Aluminum	EPA 200.8					X	X	X	X
Arsenic	EPA 200.8					X	X	X	X
Barium	EPA 200.8					X	X	X	X
Cadmium	EPA 200.8					X	X	X	X
Copper	EPA 200.8					X	X	X	X
Iron	EPA 200.7					X	X	X	X
Lead	EPA 200.8					X	X	X	X

Table 3.2-3. Sampling Parameters, Methods, and Sampling Event.

		Sampling Event							
Constituent	**Method**	**Fall 2002 Turn-over**	**2002 First Rain**	**Spring 2003 Runoff**	**2003 Summer Low Flow[1]**	**2004 Spring Runoff**	**2004 Summer Low Flow[1]**	**Fall 2004 Turn-over**	**2004 First Rain**
Manganese	EPA 200.8						X	X	X
Mercury	EPA 1631E & 245.7						X	X	X
Nickel	EPA 200.8					X	X	X	X
Selenium	EPA 200.8						X	X	X
Silver	EPA 200.8					X	X	X	X
Zinc	EPA 200.8					X	X	X	X
Coliform									
Coliform/E. coli	9221/9222D as available	X	X	X	X				
Fecal coliform	9222			X	X				

1. If the reservoir was stratified samples were obtained from the epilimnion and hypolimnion. If the reservoir was not stratified, samples were obtained from 1/3 depth.
2. At selected reservoir sites only during the fall turnover and spring sampling.
3. Although not a metal, cyanide is included in the metals section throughout this report. Cyanide was measured as total cyanide.

3.2.1 Data Reporting

The Licensees requested the analytical laboratories to obtain the lowest method detection limits (MDL) and reporting limits (RL) practicable for the water quality samples. The MDL is defined as the lowest concentration that can be detected by an instrument with correction for the effects of sample matrix and method-specific parameters. The RL was equivalent to the Practical Quantification Limit (PQL). The PQL is defined as the lowest quantifiable concentration that the laboratory can reliably determine within specified limits and accuracy during routine laboratory operating conditions.

Rather than list non-detect (ND) in the tables of this report (unless otherwise noted), the value is listed to the RL and is indicated by the less than (<) sign. In Appendix A, however, estimated values are listed and are marked with a "J." These are values that were below the RL, but above the MDL.

3.2.2 Data Analysis

Data analysis did not include statistical significance testing. The trophic status of the reservoirs, based on nitrogen, phosphorus and Secchi disk depth, were determined using the Trophic Status Indices (TSI). TSI were calculated for total phosphorus (TP) and Secchi Depth (SD) according to Carlson (1977). Total nitrogen (TN) TSI calculations were also included according to Kratzer and Brezonik (1981). TSI calculations are based on log-based regressions with values that range from 0 – 100 units. TSI values greater than 60 units are classified as eutrophic; 50 to 59 units as meso-eutrophic; 40 to 49 units as mesotrophic; and 30 to 39 as meso–oligotrophic (Carlson 1977).

3.3 Coliform Sampling

The Licensees performed two types of coliform sampling. The first involved screening for *E. coli* concurrent with the water quality sampling. The second included sampling for fecal coliform following regulatory procedures[1] at high-use recreation sites as determined by the Aquatic TWG in conjunction with participants of the Recreation TWG. The Licensees obtained *E. coli* samples at the water quality sites during the 2002 Fall Turnover and First Major Rain, and 2003 Spring Runoff sampling events (Table 3.2-1). *E. coli* sampling in the 2003 Summer Low Flow event was at selected near-shore sites at UARP reservoirs (Table 3.3-1) according to Attachment 5 of the Water Quality Sampling Plan. The samples were collected, placed on ice and processed within 24 hours of collection by El Dorado County Health Department Laboratory using EPA SM 9222D ("Colilert").

Table 3.3-1. Summer 2003 *E. coli* sampling sites.

E. coli Sampling Site	*E. coli* Sampling Site
R-3b. Buck Island Res. north shore	R-7e. Ice House Res. West of boat launch
R-4d. Loon Lake Res. Near shore at NE end of Point Pleasant Campground	26a. S.F Silver Ck. Downstream of Ice House Road.
R-4e. Loon Lake near shore west of main dam	R-8b. Junction Res. near boat ramp
R-4f. Loon Lake Res. east of Loon Lake Campground	R-9b. Camino Res. near boat Ramp
13a. Gerle Ck. Below Ice House Road	R-10b. Brush Ck. near boat ramp
R-6e. Union Valley Res. Near Wench Ck. Campground	R-11c. Slab Ck. near boat ramp
R-6f. Union Valley Res. Near Yellowjacket Campground	R-12c. Chili Bar near boat ramp
R-6g. Union Valley Res. Near West Point boat ramp	48. SFAR below Chili Bar Dam
R-6h. Union Valley Res. Near Fashoda Beach	51. SFAR at Coloma gage station
24. S.F. Silver Ck. upstream of Ice House Res.	54. SFAR downstream of Highway 49 Bridge
R-7d. Ice House Res. At Peninsula Cove on north shore	

During Summer 2003, the Licensees obtained fecal coliform samples within UARP reservoirs and in river reaches, generally near areas of high recreational use (Table 3.3-2) according to Attachment 5 of the Water Quality Sampling Plan. Sampling was targeted around the Independence Day weekend for the lower and middle reach reservoirs and the Labor Day weekend for reservoirs in the upper reach (Loon Lake and Buck Island), with repeat sampling consisting of five samples collected within a 30-day period for each location. Samples were collected near-shore in shallow water, placed on ice and processed within 24 hours of collection by Sequoia Analytical Laboratory using EPA SM 9222.

Table 3.3-2. Fecal Coliform Sampling Sites and Dates, 2003.

Site #	Location	Sampling Dates
FC-1	Gerle Ck. Res. between dock and day-use area	6/23, 7/1, 7/8, 7/15, 7/22
FC-2	Union Valley Reservoir at Camino Cove	6/23, 7/1, 7/8, 7/15, 7/22
FC-3	Union Valley Reservoir near shore at Fashoda Beach	6/23, 7/1, 7/8, 7/15, 7/22
FC-4	Union Valley Reservoir at Jones Fork Campground	6/23, 7/1, 7/8, 7/15, 7/22

[1] This sampling followed a "5 day in 30 day" sampling in which sampling periods preceded and directly followed the Fourth of July and Labor Day holidays

Table 3.3-2. Fecal Coliform Sampling Sites and Dates, 2003.		
Site #	**Location**	**Sampling Dates**
FC-5	Jones Fork Silver Creek at Ice House Road	6/23, 7/1, 7/8, 7/15, 7/22
FC-6	Big Silver Creek at bike bridge	6/23, 7/1, 7/8, 7/15, 7/22
FC-7	Ice House Res. at east end near day-use area	6/23, 7/1, 7/8, 7/15, 7/22
FC-8	Ice House Res near youth camp boat storage	6/23, 7/1, 7/8, 7/15, 7/22
FC-9	Ice House Res. on west end near day-use area	6/23, 7/1, 7/8, 7/15, 7/22
FC-10	Brush Creek boat ramp	6/23, 7/1, 7/8, 7/15, 7/22
FC-11	SFAR below Bridge at Camino Powerhouse	6/23, 7/1, 7/8, 7/15, 7/22
FC-12	SFAR at Coloma Gage Station below dam	6/23, 7/1, 7/8, 7/15, 7/22
FC-13	SFAR downstream of Miner's Cabin	6/25, 7/1, 7/8, 7/15, 7/22
FC-14	SFAR at County Park parking lot	6/23, 7/1, 7/8, 7/15, 7/22
FC-15	SFAR downstream of Greenwood Creek	6/23, 7/1, 7/8, 7/15, 7/22
FC-16	SFAR upstream of Hastings Creek	6/25, 7/1, 7/8, 7/15, 7/22
FC-17	SFAR downstream of Weber Creek	6/25, 7/1, 7/8, 7/15, 7/22
FC-18	Buck Island Near Dam at dispersed camp site	8/19, 8/26, 9/2, 9/17, 9/23
FC-19	Loon Lake Reservoir at Ellis Creek Inflow on west side of creek	8/19, 8/26, 9/2, 9/17, 9/23
FC-20	Loon Lake Reservoir near dam, Northshore Campground, and in a dispersed recreation area	8/19, 8/26, 9/2, 9/17, 9/23
FC-21	Gerle Creek below Loon Lake gaging station at USFS property boundary.	8/19, 8/26, 9/2, 9/17, 9/23

3.4 Bioaccumulation - Fish Tissue Analysis

Sampling and analytical methods were done according to the California State Water Resources Control Board Toxic Substances Monitoring Program (TSMP). The fish collection was conducted by California Department of Fish and Game (CDFG). Four species of fish - brown trout (*Salmo trutta*), smallmouth bass (*Micropterus dolomieu*), rainbow trout (*Oncorhynchus mykiss*) and Sacramento pikeminnow (*Ptychocheilus grandis)* - were collected at five UARP reservoirs and in Chili Bar Reservoir (Table 3.4-1). The fish selected were piscivorous fish, representing the top reservoirs level of the food chain in their respective reservoirs. These fish are most likely to have the highest tissue levels of metals (e.g. mercury) due to biomagnification via the food chain.

Table 3.4-1. UARP/ Chili Bar Reservoir fish tissue analysis in 2003: sampling location, date, species, and fork length.				
Site	**Sample Date**	**Composite Sample Number & Species**	**Fork Length (mm)**	**Weight (g)**
Loon Lake	9/18/03	6 Brown Trout	374	564.9
			342	475.8
			368	562.4
			350	453.1
			350	442.2
			350	442.7
Gerle Creek Reservoir	9/23/03	1 Brown Trout	510	1,716.9

Table 3.4-1. UARP/ Chili Bar Reservoir fish tissue analysis in 2003: sampling location, date, species, and fork length.

Site	Sample Date	Composite Sample Number & Species	Fork Length (mm)	Weight (g)
Union Valley Reservoir	6/26/03	4 Smallmouth Bass	340	620.7
			325	618.4
			300	414.4
			400	903.6
Ice House Reservoir	6/26/03	7 Rainbow Trout	340	400.8
			335	377.8
			278	281.4
			285	312.4
			308	301.1
			272	260.0
			214	144.4
Slab Creek Reservoir	8/14/03	1 Brown Trout	485	1,297.2
Chili Bar Reservoir	9/24/03	8 Sacramento Pikeminnow	325	357.9
			303	254.7
			301	276.9
			280	250.4
			275	220.8
			277	245.2
			257	193.0
			238	148.7

After collection, the fish were frozen for later analysis by the Moss Landing Marine Laboratories – Marine Pollution Studies Laboratory. A composite fish sample was obtained for each reservoir for analysis of trace metals in both the muscle (filet) and liver tissues. However, mercury, which tends to accumulate in the muscle tissue, was not analyzed from the liver tissue. In an earlier version of this report, it was erroneously reported in Table 3.4-1 that the fish sampled for Slab Creek Reservoir included three Sacramento pike minnows and one brown trout. Only the brown trout was sampled and analyzed. The three pike minnows from Slab Creek Reservoir were archived by the lab but not analyzed.

The constituents, method, method detection limit and reporting limit are listed in Table 3.4-2.

Table 3.4-2. Metals, methods, detection limits and reporting limits for the fish tissue analysis.

Metal	EPA Method	Method Detection Limit (ppm)	Reporting Limit (ppm)
Aluminum	EPA 1638	0.02	0.06
Arsenic	EPA 1638	0.02	0.06
Cadmium	EPA 1638	0.0004	0.0012
Copper	EPA 1638	0.0006	0.0018
Lead	EPA 1638	0.0004	0.0012
Manganese	EPA 1638	0.0006	0.0018
Mercury	EPA 1638	0.001	0.003
Nickel	EPA 1638	0.001	0.003
Selenium	EPA 1638	0.02	0.06

Table 3.4-2. Metals, methods, detection limits and reporting limits for the fish tissue analysis.

Metal	EPA Method	Method Detection Limit (ppm)	Reporting Limit (ppm)
Silver	EPA 1638	0.002	0.006
Zinc	EPA 1638	0.004	0.012
Chromium	EPA 1638	0.006	0.018

4.0 RESULTS

4.1 Historical Spill/Waste Discharge Events

SMUD reported that historic non-permitted waste discharge events resulting from construction, operation and maintenance of the UARP are infrequent. Five events have occurred since 1997, before which records are not well-documented. Pacific Gas and Electric Company was unaware of any similar events for the Chili Bar Project. Each of the five UARP events is discussed below.

4.1.1 Camino Powerhouse Transformer Oil Spill

On January 1, 1997 the Camino Powerhouse transformer oil spilled into the South Fork American River (SFAR) as a result of flood flows in the river estimated to be as high as 80,000 cfs. The transformer reservoir of one of two transformers located on the service deck of the powerhouse was lost as a result of the high flows. Since the event was of such high volume, no remediative action was possible nor recommended by state agencies. The content of the transformer was certified non-poly chlorinated bi-phenyl (PCB). SMUD reported this incident to the Central Valley Regional Water Quality Control Board (RWQCB) and the CDFG. No action was taken by the RWQCB or CDFG.

4.1.2 Concrete Spills During Camino Penstock Stabilization Project

The Camino Penstock Stabilization Project was initiated in Fall 1996 to protect the Camino Powerhouse penstock from damage by geomorphic movement of the hillside on which it is located. A component of the work was to pump Portland cement into holes drilled deep (60 – 100 feet) into the hillside. On three occasions during July 23 and September 4, 1997 grout coursed with underground springs to migrate 500 to 600 feet to the base of the hillside and into the SFAR. SMUD reported these incidents to the RWQCB and the CDFG. A Notice of Violation was issued by the RWQCB for the incidents, with the major concern by the RWQCB being the hexavalent chrome (Cr VI+) fraction of the cement. Grouting operations ceased until leak issues were addressed. Remedial and mitigative efforts were implemented to prevent subsequent reoccurrences of the leakage, including use of straw bales, geotextile fabric, "baker" holding tanks, pumping spring water to the top of the hillside (~800 feet) to settling ponds and continuous monitoring and reporting to the RWQCB. This work was completed in 2001.

4.1.3 Mass Wasting into Camino Reservoir

Following the flood of 1997, Camino Reservoir was the recipient of a mass-wasting event, which resulted in an estimated 250,000 cubic yards of mountain earth sliding into the reservoir. Following this event, SMUD implemented a phased sediment removal program over the course of one year (October 1999 to October 2000) to remove about 100,000 cubic yards of the sediment. An application to the RWQCB to complete the sediment removal was made and approved. As a condition of the work, Reports of Waste Discharge were submitted to the RWQCB for review. All best management practices and mitigation requirements as promulgated by the RWQCB were followed. A component of the sediment removal work was providing sediment sample analyses to the RWQCB for review. No subsequent action on behalf of the RWQCB was required as a result of this work.

4.1.4 Release of Turbid Water from Union Valley Power Tunnel

Approximately 19,680 gallons of water, with an estimated total suspended solids concentration of 86 mg/l, was released into Silver Creek from the Union Valley Powerhouse tunnel on December 8 and 9, 2002. The source of suspended solids was preparation work within the tunnel penstock for a protective coating application, which involved washing the outside of the penstock with a high-pressure washer. This release was diluted by an estimated 678 million gallons of water that coursed through the Union Valley Dam. SMUD reported this incident to the RWQCB.

Although SMUD had notified the RWQCB with a Notice of Intent to proceed with the work, the RWQCB had not notified SMUD that a permit would be required. Subsequent to receipt of a Notice of Violation, SMUD implemented a monitoring program to ensure subsequent releases did not exceed the maximum instantaneous limits established for total suspended solids. No further action was taken on behalf of the RWQCB.

4.1.5 Release of Sewage at Camino Powerhouse

On September 17, 2003 approximately 10 gallons of sewage was discharged into a 4,000-gallon sump, which was eventually discharged into the SFAR. The cause of the discharge was a malfunctioning toilet float-valve. SMUD reported this incident to the RWQCB. No action was taken by the RWQCB. Remedial action was taken by SMUD to ensure future events as such at all powerhouses would not occur.

4.2 Basin Plan Designated Beneficial Uses

Section 401 of the Clean Water Act (CWA) requires that all applicants for a federal license or permit must seek certification that the proposed project is in compliance with established water quality standards, which consist of designated beneficial uses and water quality objectives to support those beneficial uses. Certification may be conditioned with other limitations to assure compliance with various CWA provisions. In California, the SWRCB is the administrator of the CWA. Water quality certificates were not issued for the initial FERC licenses for the UARP and Chili Bar Project because licenses were issued prior to the enactment of the CWA. SMUD and

Pacific Gas and Electric Company must submit applications for water quality certificates (or the certificates themselves) to the SWRCB (not obtain the permit) within 60 days of FERC publishing a notice in the Federal Register that SMUD's and Pacific Gas and Electric Company's license applications are ready for environmental analysis.

The beneficial uses established for the general areas affected by the Projects, as stated in the Sacramento River and San Joaquin River Basin Plan (RWQCB 2004), are shown in Table 4.2-1. Note that the Basin Plan was developed and first published in 1971, more than 10 years after the UARP and Chili Bar Project were licensed by FERC and began commercial operations.

Table 4.2-1. Designated Beneficial Uses of the Desolation Valley Lakes (Hydro Unit Number 514.4.46), Middle Fork American River, Source to Folsom Lake (514.4.45), South Forks American River, Source to Folsom Lake (514.3.48) and South Fork American River, Placerville to Folsom Lake (514.32.49) in the vicinity of the Upper American River Project and the Chili Bar Project as designated by the Central Valley Regional Water Quality Control Board in the Sacramento River and San Joaquin Basin Plan. (SOURCE: Table II-1, Basin Plan, RWQCB 2004.)

Designated Beneficial Use	Description	Desolation Valley Lakes	Middle Fork to Folsom	South Fork to Placerville	South Fork to Folsom
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	-----	Existing	Existing	Existing
Agriculture (AGR)	Use of water for farming, horticulture, or ranching including but not limited to irrigation, stock watering or support of vegetation for range grazing.	-----	Existing	-----	Existing
Hydropower Generation (POW)	Use of water for hydropower generation.	-----	Existing	Existing	Existing
Water Contact Recreation (REC-1)	Use of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing or use of natural hot springs.	Existing	Existing	Existing	Existing

Table 4.2-1. Designated Beneficial Uses of the Desolation Valley Lakes (Hydro Unit Number 514.4.46), Middle Fork American River, Source to Folsom Lake (514.4.45), South Forks American River, Source to Folsom Lake (514.3.48) and South Fork American River, Placerville to Folsom Lake (514.32.49) in the vicinity of the Upper American River Project and the Chili Bar Project as designated by the Central Valley Regional Water Quality Control Board in the Sacramento River and San Joaquin Basin Plan. (SOURCE: Table II-1, Basin Plan, RWQCB 2004.)

Designated Beneficial Use	Description	Desolation Valley Lakes	Middle Fork to Folsom	South Fork to Placerville	South Fork to Folsom
Non-Contact Water Recreation (REC-2)	Use of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beach-combing, camping, boating, tide-pool and marine life study, hunting, sightseeing or aesthetic enjoyment in conjunction with the above activities.	Existing	Existing	Existing	Existing
Warm Freshwater Habitat[1] (WARM)	Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	-----	Potential	Potential	Existing
Cold Freshwater Habitat (COLD)	Uses of water that support coldwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	Existing	Existing	Existing	Existing
Cold Freshwater Spawning (SPWN)	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.	Existing	Existing	-----	-----
Wildlife Habitat (WILD)	Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation or enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	Existing	Existing	Existing	Existing

[1] Table II-1, footnote 2 in the Basin Plan states, "Any stream segment with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of the water quality objectives."

Those Designated Beneficial Uses established for the Desolation Valley Lakes apply to Rubicon Reservoir and the surface waters in the vicinity of the reservoir since Rubicon Reservoir is located in the Desolation Valley Wilderness. The Middle Fork American River Designated Beneficial Uses apply to Buck Island, Loon Lake, Gerle Creek and Robbs Peak reservoirs and the surface waters in the vicinity of these reservoirs since they occur in the Middle Fork American River watershed. The uses in the SFAR, from its source to Folsom Reservoir, apply to Union Valley, Ice House, Junction and Camino reservoirs and the surface waters in their vicinity. The SFAR from Placerville to Folsom Reservoir Designated Beneficial Uses apply to Brush Creek, Slab Creek and Chili Bar reservoirs and the surface waters in their vicinity.

Also, note that Section 303 of the CWA requires that every two years each state must submit to the USEPA a list of rivers, lakes and reservoirs in the state for which pollution control or requirements have failed to provide for water quality. No surface waters in the vicinity of the Projects are included on California's Revised 2002 CWA 303(d) List of Water Quality Limited Segments and TMDL Priority Schedule, as shown at the SWRCB's web page on February 23, 2005 (http://www.swrcb.ca.gov/tmdl/docs/2002_tmdl_comp_list_020403.pdf).

4.3 Basin Plan Water Quality Objectives

The Basin Plan (RWQCB 2004) includes 18 Water Quality Objective for the protection of various Designated Beneficial Uses. Seven of the 18 Objectives contain specific numerical criteria. These Objectives are:

- Bacteria
- Chemical Constituents
- Dissolved Oxygen
- pH
- Salinity
- Temperature
- Turbidity

Each of the remaining 11 Water Quality Objectives in the Basin Plan are narrative in nature in that the objective does not include a specific numerical criteria. These objectives are:

- Biostimulatory Substances
- Color
- Floating Material
- Oil and Grease
- Pesticides
- Radioactivity
- Sediment

- Settleable Material
- Suspended Material
- Tastes and Odors
- Toxicity

For the purpose of the discussion below, the Licensees have presented data for each UARP reservoir and the Chili Bar Reservoir, and have combined stream-reach information into upper elevation reaches (Rubicon, Rockbound, Buck Island, Loon Lake and Gerle Creek reaches), middle elevation reaches (Union Valley, Ice House, Junction and Camino reaches), lower elevation reaches (Brush and Slab creek reaches) and the Reach Downstream of Chili Bar. Where appropriate, reservoir data are also presented for combined reservoir areas defined as the upper reservoirs (Rubicon, Buck Island and Loon Lake reservoirs), middle reservoirs (Gerle Creek, Union Valley, Ice House and Junction reservoirs), lower reservoirs (Camino, Brush Creek and Slab Creek reservoirs) and Chili Bar Reservoir. More detailed information is presented, where appropriate.

In addition, since the Licensees collected numerous water quality samples and analyzed each for a wide range of parameters, the range of values for each reservoir and reach is presented in this section. While ranges, rather than the mean or median, were considered more appropriate to report water quality data, SMUD realizes that ranges can sometimes distort the distribution and/or severity of water quality data. For this reason, detailed values are provided in Appendix A, with analytical results organized in chronological order of sampling events (i.e., 2002 Fall Turnover, 2002 First Major Rain, 2003 Spring Runoff, etc.). In cases of an isolated and abnormally high value (well above the range in which the majority of the values occurs), the range of values is given followed by the high value (e.g., <1-22, 44 mg/l). Additionally, it is possible that all samples were below the reporting limit, but the reporting limit varied during the four sampling events. In this case, the high range value is also listed to the reporting limit (e.g. <0.2 - <1.0 µg/l).

4.3.1 Numerical Water Quality Objectives

4.3.1.1 Bacteria

The Basin Plan (RWQCB 2004) includes one Water Quality Objective for Bacteria. The portion of the objective that pertains to surface waters in the vicinity of the Projects is:

> In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples in any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than 10 percent of the total number of samples taken during the 30-day period exceed 400/100 ml.

Bacteria are normally present in large numbers in the intestinal tracts of humans and other animals. When humans ingest water containing these bacteria, illness can result. Since ingestion is most likely during water contact recreation, bacteria levels in water are of interest primarily during high recreational periods; however, human activity during high recreational periods are the primary contributory source of bacteria (citation). Natural sources of bacteria in water include wildlife-related sources such as goose droppings, which have caused a large increase in bacterial contamination particularly at parks and beaches (reference). Anthropomorphic sources of bacteria can include human activity and sewage effluent. Increased water temperature can increase the concentration of bacteria.

The Licensees are unaware of any historical data for fecal coliform sampling. The Licensees did, however, obtain historical bacteria data from El Dorado County for *E. coli* during the 5-year period of August 1997 to September 2002. These historical *E. coli* data are presented later in this section along with the results of sampling by the Licensees for *E. coli*.

The Licensees collected 5 fecal coliform samples within a 30-day period at 21 different locations in 2003, for a total of 105 samples. All of the Licensee's 2003 fecal coliform samples were taken from June 23 through July 22, 2003, except at four sites. At Buck Island Reservoir (1 site), Loon Lake Reservoir (2 sites) and in Loon Lake Dam Reach below the dam (1 site), five samples were taken from August 19 through September 23, 2003. Table 4.3.1-1 summarizes the results of this sampling effort by location and includes a list of fecal coliform values that were equal to or greater than the Basin Plan 10 percent criterion (since five samples were taken at each site, an exceedence of the 400/100 ml criterion in any one sample was considered an exceedence of the 10 percent criterion). Note that for the purpose of calculating the geometric mean of the five samples, a value of one was assumed where the value was less than the reporting limit of one organism/100 ml.

Table 4.3.1-1. Range of fecal coliform in UARP reservoirs and reaches and in the Reach Downstream of Chili Bar based on five samples collected during a 30-day period in summer 2003. The sampling period included samples on either the Independence Day or Labor Day weekends.

Location	Site	Number of Samples	Range (#/100 ml)	Geometric Mean (#/100 ml)	Samples in Excess of 10% / 400/100 ml Criterion (#/100 ml)
RESERVOIRS					
Buck Island	Buck Island near Dam, dispersed campsite	5	2-27	7	None
Loon Lake	Loon Lake Reservoir at Ellis Creek Inflow on west side of creek	5	<1-24	5	None
	Loon Lake Res. near Northshore Campground near dam and in dispersed recreation area	5	2-40	7	None
Gerle Creek	Gerle Ck. Res. between dock and day-use area	5	<1-350	10	None

Table 4.3.1-1. Range of fecal coliform in UARP reservoirs and reaches and in the Reach Downstream of Chili Bar based on five samples collected during a 30-day period in summer 2003. The sampling period included samples on either the Independence Day or Labor Day weekends.

Location	Site	Number of Samples	Range (#/100 ml)	Geometric Mean (#/100 ml)	Samples in Excess of 10% / 400/100 ml Criterion (#/100 ml)
Union Valley	Union Valley Reservoir at Camino Cove	5	<1-3,180	38	3,180 (6/23) 1,200 (7/1)
	Union Valley Reservoir at Fashoda Beach	5	<1-600	10	600 (6/23)
	Union Valley Reservoir at Jones Fork Campground	5	<1-2,900	17	550 (6/23) 2,900 (7/1)
Ice House	Ice House Res. at east end near day-use area	5	4-110	10	None
	Ice House Res near youth camp boat storage	5	<1-170	6	None
	Ice House Res. west end near day-use area	5	<1-200	19	None
Brush Creek	Brush Creek Boat Ramp	5	<1-9	2	None
REACHES					
Gerle Creek	Gerle Creek below Loon Lake gaging station at USFS property boundary.	5	<1 – 26	7	None
Upstream of Junction	Jones Fork Silver Creek at Ice House Road	5	165 – 1,500	468	730 (6/23) 400 (7/15) 1,500 (7/22)
	Big Silver Creek at Bike Bridge	5	37 – 1,160	133	1,160 (7/22)
Camino Dam	SFAR below Bridge at Camino Powerhouse	5	<1 – 44	8	None

Table 4.3.1-1. Range of fecal coliform in UARP reservoirs and reaches and in the Reach Downstream of Chili Bar based on five samples collected during a 30-day period in summer 2003. The sampling period included samples on either the Independence Day or Labor Day weekends.

Location	Site	Number of Samples	Range (#/100 ml)	Geometric Mean (#/100 ml)	Samples in Excess of 10% / 400/100 ml Criterion (#/100 ml)
Reach Downstream of Chili Bar	SFAR at Coloma Gage, below dam	5	<1 – 195	8	None
	SFAR downstream of Miner's Cabin	5	<1 – 6,100	159	6,100 (7/1) 438 (7/8)
	SFAR at County Park parking lot	5	<1 – 368	34	None
	SFAR downstream of Greenwood Creek	5	<1 – 728	31	578 (7/1) 728 (7/8)
	SFAR upstream of Hastings Creek	5	28 – 3,900	322	3,900 (7/1) 462 (7/8)
	SFAR downstream of Weber Creek	5	<1 – 9,300	327	660 (6/25) 9,300 (7/1) 1,350 (7/8) 450 (7/22)

The 5-day geometric mean of the fecal coliform concentrations were less than the Basin Plan Bacteria Water Quality Objective regarding the geometric mean criterion (less than 200 organisms/100ml) at 18 of the 21 sites sampled. Two of the three sites that contained fecal coliform concentrations greater than the 5-day geometric mean Water Quality Objective of 200 organisms/100ml were in the lower portion of the Reach Downstream of Chili Bar: one site located upstream of Hastings Creek and the other site located downstream of Weber Creek had geometric means of 322 and 327 organisms/100ml, respectively. The third site was located at a non-UARP affected reach, on the Jones Fork of Silver Creek upstream from Union Valley Reservoir near Ice House Road. The geometric mean at this site was 468 organisms/100ml, the highest geometric mean value recorded during the Licensees' study (Table 4.3.1-1.).

Of the 105 fecal coliform samples collected during a 30-day period, 86 samples contained less than the Basin Plan Bacteria Water Quality Objective requiring that no more than ten percent of the total number of samples taken during the 30-day period may exceed 400 organisms/100 ml (82% of the samples). Of the remaining 19 samples, five samples (4.8%) were in a UARP–affected reservoir, four samples (3.8%) were in non-UARP affected reaches, and 10 samples (9.5%) were in the Reach Downstream of Chili Bar, as described below.

Five of the samples with concentrations greater than 400 organisms/100 ml occurred on two of the five sampling days at the three Union Valley Reservoir sites. On June 23, 2003 the fecal coliform concentrations at the Camino Cove, Fashoda Beach and Jones Fork Campgrounds were

3,180, 600 and 550 organisms/100 ml, respectively, and on July 1, 2003 the concentrations at Camino Cove and Jones Fork campgrounds were 1,200 and 2,900 organisms/100 ml, respectively. Fecal coliform concentrations at these three sites in the other 10 samples collected were generally low (<1 to 172 organisms/100 ml).

Four samples with concentrations greater than 400 organisms/100 ml occurred on tributaries upstream of Union Valley Reservoir (i.e., above UARP reservoirs and reaches), as follows: Three of the four samples were collected from Jones Fork of Silver Creek at Ice House Road, with fecal coliform concentrations of 730, 400 and 1,500 organisms/100 ml on June 23, July 15 and July 22, 2003, respectively (Table 4.3.1-1). The fourth sample from this area was collected from Big Silver Creek at Bike Bridge, with a fecal coliform concentration of 1,160 organisms/100 ml on July 22, 2003.

The remaining 10 samples with concentrations greater than 400 organisms/100 ml occurred at four sites in the Reach Downstream of Chili Bar (Table 4.3.1-1). However, the concentrations did not follow an upstream to downstream pattern each day. For example, on July 1, 2003, from upstream to downstream in the Reach Downstream of Chili Bar, fecal coliform concentrations were: 195 organisms/100 ml at the Coloma gage; 6,100 downstream of Miners Cabin, 83 at the County Park; 578 downstream of Greenwood Creek; 3,900 upstream of Hastings Creek and 9,300 downstream of Weber Creek. The other three sampling days where a sample result was greater than 400 organisms/100 ml at one or more sampling locations on the Reach Downstream of Chili Bar, the concentrations varied considerably; however, the trend was similar from upstream to downstream as described above for July 1, 2003 (Table 4.3.1-1).

While not formally adopted in the Basin Plan, SWRCB staff has proposed an amendment to the Basin Plan for bacteria (Staff Report and Functional Equivalent Document dated May 2002) to "...better protect human health by using a more reliable indicator to reflect the risk of illness associated with exposure to water containing disease-causing bacteria." Staff recommended that the current fecal coliform Water Quality Objective be replaced (except in Folsom Lake) with the USEPA Ambient Water Quality Criteria for Bacteria – 1986 (USEPA 1986), which is based on concentrations of *E. coli*. Specifically, the objective would be:

> In waters designated for contact recreation (REC-1), the *E. coli* concentration, based on a minimum of not less than five samples equally spaced over a 30-day period, shall not exceed a geometric mean of 126/100 ml and shall not exceed 235/100 ml in any single sample.
>
> If any single samples are exceeded for *E. coli*, the Regional Water Board may require repeat sampling on a daily basis until the sample falls below the single sample limit or for 5 days, whichever is less, in order to determine the persistence of the exceedence.
>
> When repeat sampling is required because of an exceedence of any one single sample limit, values from all samples collected during the 30-day sampling period will be used to calculate the geometric mean.

As mentioned previously, the Licensees obtained historical coliform data from El Dorado County for *E. coli* sampling during the 5-year period of August 1997 to September 2002. Five sampling locations, all located in the Reach Downstream of Chili Bar, were generally sampled monthly during October to March and bi-weekly during May to September with a total of 731 samples analyzed. Historical *E. coli* sampling locations are listed below from upstream to downstream on the SFAR.

- Nugget: located below the Chili Bar Dam (same as sampling location 48)
- State Park
- County Park
- Turtle Pond (same as sampling location 51)
- Salmon Falls: (same as sampling location 54)

The data were not collected such that a 5-day geometric mean can be calculated, but one can compare the results to the 235 organisms/100 ml single sample criterion. Twenty-one of the 731 historical samples collected (2.9%) had concentrations above this criterion at the following locations, listed from upstream to downstream in the Reach Downstream of Chili Bar:

- State Park: four samples with *E. coli* concentrations of 1,553/100 ml (September 16, 1999), 344/100 ml (October 30, 2001), 325/100 ml (June 7, 2001) and 236/100 ml (August 1, 2002).
- County Park: four samples with *E. coli* concentrations of 548/100 ml and 461/100 ml (July 14, 2001), 361/100 ml (August 18, 2001) and 228/100 ml (August 11, 2002).
- Turtle Pond (also known as Greenwood Creek): five samples with *E. coli* concentrations of 980 /100 ml and 410/100 ml (October 30, 2001), 441/100 ml and 276/100 ml (January 19, 1999) and 308/100 ml (November 22, 1999).
- Salmon Falls (also known as Skunk Hollow): eight samples with *E. coli* concentrations of 1,986/100 ml (May 7, 1998), 1,553/100 ml (May 24, 2001), 649/100 ml (May 23, 2002), 548/100 ml (January 19, 1999), 435/100 ml and 270/100 ml (March 5, 2001), 378/100 ml (June 7, 2001) and 260/100 ml (June 3, 1998).

The historical *E. coli* data are included in Appendix C.
The Licensees performed *E. coli* screening (one sample collected) throughout the study area during the Fall 2002 Turnover, 2002 First Rain, Spring 2003 Runoff and Summer 2003 Low Flow sampling events (Table 4.3.1-2). The Summer 2003 samples were collected near shore adjacent to high-use recreation areas, per Attachment 5 of the Water Quality Sampling Plan, to evaluate the highest risk conditions associated with contact recreation areas during the summer season.

Table 4.3.1-2. Range of *E. coli* concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the 2002 Fall Turnover, 2002 First Major Rain, 2003 Spring Runoff and 2003 Summer Low Flow events.

Location	Number of Samples	Range of *E. coli* Values (# of Organisms/100 ml)			
		Fall 2002 Turnover	2002 First Rain	Spring 2003	Summer 2003[1]
RESERVOIRS					
Upper Reservoirs	24	0 – 1	0 – 38	0 - 3	0
Middle Reservoirs	47	0-2	0 – 34	0 – 2	0 - 4
Lower Reservoirs	14	0 – 11	44 – 172	1 – 6	0
REACHES					
Upper Elevation	30	0- 6	4 – 68	0 – 6	6
Middle Elevation	15	0-1	0-31	0 – 2	1 - 6
Lower Elevation	15	0 – 3	96 – 172	0 – 4	*
Reach Downstream of Chili Bar	12	3– 21	142 – 236	0 - 26	0

[1] Sampling sites differed from the previous three sampling periods.
* Not sampled

As noted above, the data were not collected so that a 5-day organisms/100 ml geometric mean can be calculated, but one can compare the results to the 235 organisms/100 ml single sample criterion. As observed in Table 4.3.1-2, only one of the 157 samples collected by the Licensees (0.6%) had a concentration above this criterion: in the Reach Downstream of Chili Bar on November 12, 2002, an *E. coli* concentration of 236/100 ml was recorded below Chili Bar Dam.

The Licensees also measured total coliform concentration throughout the study area during the Fall 2002 Turnover, 2002 First Rain, Spring 2003 Runoff and Summer 2003 Low Flow sampling events. There are no water quality objectives for total coliform; however, at the request of the SWRCB, total coliform data are presented by sampling event and location in Table 4.3.1-3. Total coliform concentrations range from 0 organisms/100ml to greater than 2,419 organisms/100 ml, with the highest concentrations occurring during the First Rain sampling event. There are no clear trends in total coliform concentrations from upstream to downstream locations.

Table 4.3.1-3. Range of Total Coliform concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the 2002 Fall Turnover, 2002 First Major Rain, 2003 Spring Runoff and 2003 Summer Low Flow events.

Location	Number of Samples	Range of Total Coliform Values (# of Organisms/100 ml)			
		Fall Turnover 2002	First Rain 2002	Spring 2003	Summer 2003
RESERVOIRS					
Upper Reservoirs	26	3-1046	6 - >2419	1-192	0-130
Middle Reservoirs	43	180-290	200 - >2419	0-261	0 - >2419
Lower Reservoirs	12	142-1299	1119 - >2419	135-290	0

Table 4.3.1-3. Range of Total Coliform concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the 2002 Fall Turnover, 2002 First Major Rain, 2003 Spring Runoff and 2003 Summer Low Flow events.

Location	Number of Samples	Range of Total Coliform Values (# of Organisms/100 ml)			
		Fall Turnover 2002	First Rain 2002	Spring 2003	Summer 2003
REACHES					
Upper Elevation	30	10-1426	60 - >2419	31-307	866
Middle Elevation	31	130-220	130 - >2419	5-248	345-387
Lower Elevation	13	461-1733	613 - >2419	51-866	*
Reach Downstream of Chili Bar	9	461-866	>2419	218 - >2419	0

* Not sampled

4.3.1.2 Chemical Constituents

The Basin Plan (RWQCB 2004) contains one Water Quality Objective for Chemical Constituents. The portion of the Objective that pertains to surface waters in the vicinity of the Projects is:

> Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.
>
> At a minimum, water designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the maximum containment levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Tables 64449-A (Secondary Maximum Containment Levels-consumer Acceptance Limits) and 64449-B (Secondary Maximum Containment Levels-Ranges) of Section 64449. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. At a minimum, water designated for use as domestic or municipal supply (MUN) shall not contain lead in excess of 0.015 mg/l. The Regional Water Board acknowledges that specific treatment requirements are imposed by state and federal drinking water regulations on the consumption of surface waters under specific circumstances. To protect all beneficial uses the Regional Water Board may apply limits more stringent than MCLs.

The MCLs in Title 22 were adopted by the California Department of Health Services (DHS) pursuant to the California Safe Drinking Water Act and are established for the protection of public water systems (*i.e.*, water suppliers) and drinking water at the tap or point-of-use (see 22 Cal, Code. Regs. §§64431 and 64444). Primary MCLs are derived from health-based criteria by the DHS from Public Health Goals, or from a one-in-a-million incremental cancer risk estimate for carcinogens and threshold toxicity levels for non-carcinogens. Secondary MCLs are adopted for constituents that may adversely affect the taste, odor, or appearance of drinking water, and are directly related to consumer "acceptance" or "dissatisfaction" with supplied drinking water (see 22 Cal, Code. Regs. §64449). Secondary MCLs do not imply a human health risk.

Reporting of both Primary and Secondary MCLs are in total recoverable concentrations, which are expressed in this *Water Quality Technical Report* in micrograms per liter, or µg/l, unless otherwise indicated. For information purposes, one million µg equals one thousand mg, which equals one gram. Table 64431-A of Title 22 provides Primary MCLs for the following seven metals that were sampled by the Licensees: aluminum (Primary MCL of 1,000 µg/l), arsenic (50 µg/l), barium (1,000 µg/), cadmium (5 µg/l), mercury (2 µg/l), nickel (100 µg/l) and selenium (50 µg//l). The table also provides a Primary MCL for total cyanide (200 µg//l), which includes free cyanide (CN^-) and hydrogen cyanide (HCN) as well as metal-cyanide complexes. Table 64672.3 of Title 22 provides a Primary MCL for lead (15 µg/l). Table 64449-A of Title 22 provides Secondary MCLs for the following five metals that were sampled by the Licensees: aluminum (Secondary MCL of 200 µg//l), copper (1,000 µg//l), iron (300 µg//l), manganese (50 µg//l), silver (100 µg//l) and zinc (5,000 µg//l).

The Licensees are aware of two instances of historic water quality sampling for metals in the surface waters in the vicinity of the Projects. The first was performed by the SWRCB over about a 2-year period (1959-1961) during the initial construction of the UARP. The SWRCB collected monthly samples and analyzed them for a number of parameters including metals directly downstream of Ice House and Union Valley dams as they were under construction. The data are available in the USEPA STORET system and the Licensees downloaded the data from the USEPA web page for presentation in Table 4.3.1-4. No information is available regarding specific sampling locations or dates, conditions during sampling, quality control/quality assurance, laboratory analysis, chain-of-custody, cause of elevated values or if the SWRCB considered the values to be a problem and initiated corrective actions. Note that in 1960, MCLs had not been established.

Table 4.3.1-4. Values for aluminum (Al), arsenic (As), boron (B), copper (Cu), iron (Fe), lead (Pb), manganese (Mn) and zinc (Zn) reported by the State Water Resources Control Board during initial construction of Union Valley and Ice House dams from 1959 through 1961. A dash indicates that no data are available. (SOURCE: USEPA STORET.)

Date	Al (µg/l)	As (µg/l)	B (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (µg/l)	Zn (µg/l)
SILVER CREEK DOWNSTREAM OF UNION VALLEY DAM CONSTRUCTION								
August 1959	0	0	0	0	50	0	0	0
September 1959	0	0	30	10	0	0	0	0
October 1959	0	0	10	0	0	20	0	30
November 1959	0	0	0	0	100	0	0	0
May 1960	0	0	10	0	30	0	0	0
June 1960	0	0	0	0	10	0	0	0
July 1960	-----	-----	170	-----	-----	-----	-----	-----
August 1960	-----	-----	40	-----	-----	-----	-----	-----
September 1960	-----	-----	20	-----	-----	-----	-----	-----
October 1960	-----	-----	0	-----	-----	-----	-----	-----
November 1960	-----	-----	0	-----	-----	-----	-----	-----
January 1961	-----	-----	0	-----	-----	-----	-----	-----

Table 4.3.1-4. Values for aluminum (Al), arsenic (As), boron (B), copper (Cu), iron (Fe), lead (Pb), manganese (Mn) and zinc (Zn) reported by the State Water Resources Control Board during initial construction of Union Valley and Ice House dams from 1959 through 1961. A dash indicates that no data are available. (SOURCE: USEPA STORET.)

Date	Al (µg/l)	As (µg/l)	B (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (µg/l)	Zn (µg/l)
February 1961	-----	-----	40	-----	-----	-----	-----	-----
March 1961	-----	-----	10	-----	-----	-----	-----	-----
SOUTH FORK SILVER CREEK DOWNSTREAM OF ICE HOUSE DAM CONSTRUCTION								
August 1959	0	0	0	0	800	0	0	0
September 1959	140	-----	-----	-----	-----	0	0	0
October 1959	120	0	30	10	270	20	20	20
November 1959	100	0	0	50	130	0	100	10
December 1959	0	0	30	0	690	0	0	0
March 1960	0	0	30	0	80	10	40	0
April 1960	0	0	0	0	80	0	0	0
May 1960	0	0	10	10	60	0	0	0
June 1960	0	0	0	0	30	0	0	0
July 1960	-----	1,180	-----	-----	-----	-----	-----	-----
August 1960	-----	30	-----	-----	-----	-----	-----	-----
September 1960	-----	20	-----	-----	-----	-----	-----	-----
October 1960	-----	0	-----	-----	-----	-----	-----	-----
November 1960	-----	130	-----	-----	-----	-----	-----	-----
January 1961	-----	0	-----	-----	-----	-----	-----	-----
February 1961	-----	40	-----	-----	-----	-----	-----	-----
March 1961	-----	30	-----	-----	-----	-----	-----	-----

Information is not available at this time to indicate whether these values measured by the SWRCB in 1959 through 1961 represented natural conditions or caused by dam construction.

The second period of water quality sampling for metals (as well as other parameters) occurred on November 2, 1992, upstream and downstream of Slab Creek Reservoir. The purpose of this sampling program undertaken by SMUD was to assess the condition of the reservoir following two significant events. The first was the lowering of the reservoir to lower than typical water elevation levels in 1991, which mobilized sediment in the reservoir. The second was the Cleveland Fire in summer 1992. This fire resulted in a significant increase of sediment and increased turbidity in all waterways downstream of the fire, but particularly in Slab Creek Reservoir. Two sampling stations were used in the sampling program: one at the upstream end of Slab Creek Reservoir by the Forebay Road bridge and one downstream of Slab Creek Reservoir Dam. The results of the sampling for various elements, including metals, are presented in Table 4.3.1-5.

Table 4.3.1-5. Results of water quality sampling for various elements including metals by SMUD upstream and downstream of Slab Creek Reservoir on November 2, 1992.

Element	Upstream of Slab Creek Reservoir (µg/l)	Downstream of Slab Creek Dam (µg/l)
Aluminum	32	64
Arsenic	6	7

Table 4.3.1-5. Results of water quality sampling for various elements including metals by SMUD upstream and downstream of Slab Creek Reservoir on November 2, 1992.

Element	Upstream of Slab Creek Reservoir (µg/l)	Downstream of Slab Creek Dam (µg/l)
Barium	10	14
Boron	<2	<250
Cadmium	<1	1
Calcium	2,808	5,033
Chromium	1	0
Cobalt	5	6
Copper	3	3
Iron	271	383
Lead	<5	<5
Magnesium	497	903
Manganese	9	2
Mercury	0.85	0.3
Molybdenum	3	5
Nickel	<2	<2
Selenium	7	<5
Silicon	2,815	4,308
Silver	4	3
Sodium	1,878	4,727
Strontium	36	75
Titanium	1	1
Vanadium	3	4
Zinc	8	1

None of the reported values were greater than Primary or Secondary MCLs.

The Licensees analyzed water quality samples for metals, total hardness and total cyanide in 2002, 2003 and 2004. The number of values for each metal, total hardness and total cyanide are shown by sampling period in Table 4.3.1-6.

Table 4.3.1-6. Number of water quality samples by metal, total cyanide, total hardness and sampling period analyzed by the Licensees in 2002, 2003 and 2004.

Metal/ Total Cyanide	2002 Fall Turnover	2002 First Major Rain	2003 Spring Runoff	2003 Summer Low Flow	2004 Spring Runoff*	2004 Summer Low Flow*	2004 First Rain/ Fall Turnover*	Total
	Number of Samples							
Aluminum	27	47	69	68	55	64	68	398
Arsenic	27	21	69	68	55	64	68	372
Barium	27	21	60	68	55	64	68	363
Cadmium	27	21	68	69	55	64	68	372
Copper	27	27	68	69	55	64	68	378
Iron	29	29	69	68	55	64	68	382
Lead	27	55	68	69	55	64	68	406
Manganese	29	29	0	67	0	64	68	257
Mercury	27	21	0	35	0	64	68	215
Nickel	27	21	68	69	55	64	68	372

Table 4.3.1-6. Number of water quality samples by metal, total cyanide, total hardness and sampling period analyzed by the Licensees in 2002, 2003 and 2004.

Metal/ Total Cyanide	2002 Fall Turnover	2002 First Major Rain	2003 Spring Runoff	2003 Summer Low Flow	2004 Spring Runoff*	2004 Summer Low Flow*	2004 First Rain/ Fall Turnover*	Total
	Number of Samples							
Selenium	27	21	0	68	0	64	68	248
Silver	27	55	68	69	55	64	68	406
Zinc	27	21	68	69	0	64	68	317
Total Cyanide	27	21	0	69	0	0	0	117
Total Hardness	27	48	70	70	55	64	68	402
Total	382	410	675	925	560	896	952	5,005

* Samples analyzed for total recoverable and dissolved metals

Table 4.3.1-7 provides the range of values (total recoverable) for each metal and for total cyanide by reservoir and by reach as measured by the Licensees in 2002, 2003 and 2004. Samples collected by the Licensees during 2004 Spring Runoff, Summer Low Flow and First Major Rain/Fall Turnover events were analyzed for dissolved and total recoverable metals; total recoverable concentrations are included in Table 4.3.1-7 and dissolved concentrations are shown by reservoir and by reach in Table 4.3.1.8.

Table 4.3.1-7. Range of aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag) and total cyanide (TC) expressed in total recoverable concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during: Fall Turnover and First Major Rain events in 2002; Spring Runoff and Summer Low Flow conditions in 2003; and Spring Runoff, Summer Low Flow, Fall Turnover and First Major Rain events in 2004.

Locations	Al (µg/l)	As (µg/l)	Ba (µg/l)	Cd (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (µg/l)	Hg (µg/l)	Ni (µg/l)	Se (µg/l)	Ag (µg/l)	Zn (µg/l)	TC (µg/l)[1]
RESERVOIRS														
Rubicon	<50-64, 48J	<1.0-1.1, 0.13J	1.9J-<20	0.015J- <0.05-<0.2	0.22-<1.0	<100-540	0.025J-0.31	7.2J-<10	0.001J-0.58	0.14J-<2	<2	0.018J-0.14	0.58J-1.3J	<5
Rockbound	<50-61 17J	0.035J-<1.0	1.5J-<20	0.011J-0.05-<0.2	0.34-<1.0	30-<100	<0.2-54	0.9J-<10	0.0028J-1.2	0.043J-<2	<2	0.0078J-0.15	0.39J-0.74J	<5
Buck Island	<50-80, 17J	0.011J-<1.0	1.9J-<20	0.012J-0.42	0.20-0.94	40-120	0.031J -97	4.2J-<10	0.0029J-1.7	0.13J-<2	<2	0.0068J - 0.052	0.41J-0.72J	<5
Loon Lake	<50-80, 7.7J	0.049J-<1.0	2.0J-<20	0.011J- <0.019- <0.05-<0.2	0.15-1.5	34-<100	0.014J-190	1.9J-40	<0.001-5.7	0.066J-<2	<2	0.026J -0.13	0.46J-3.7J	<5
Gerle Creek	<50-69, 13J	0.049J-<1.0	3.3J-<20	0.018J- <0.019- <0.05-0.27	0.23-0.39	60-<210	0.022J-59	2.7J-10	<0.001-0.92	0.13J-<2	<2	0.022J	0.50J-1.0J	<5
Union Valley	<50-56, 11J	0.044J-<1.0	4.4J-<20	0.014J- <0.019- <0.05-<0.1	0.18-6.8	<25-200	0.012J-150	3.4J-76J	<0.001-2.1	0.068J-<2	0.08J-<2.0	0.0090J-0.86	0.11J-2.5J	<5-16
Ice House	<50-160, 6.9J	0.048J-1.0	3.9J-<20	0.0056J- <0.04- <0.05-<0.1	0.12-2.2	<30-980	0.02J-120	3.1J-400J	<0.001-3.4	0.030J-<2,	0.08J-<2.0	0.012J-0.072	0.15J-7.8	<5
Junction	13J-<50	0.053J-1.0	7.0J-<20	0.019J- <0.04- <0.05-<0.1	0.2-1.9	88-120	0.014J -68	23J-43J	<0.005-0.7	0.12J-<2	<2	<0.04-0.1	0.84J-1.1J	<5
Camino	<50-53, 11J	<1.0	6.7J-<20	0.0097J- <0.05-<0.1	0.28-<1.0	30-110	0.031J-0.27	8J-75J	0.0020J	0.14J-<2	0.08J-<2.0	0.0098J-<0.04	0.43J-1.0J	<5
Brush Creek	0.99J-<50	<1.0	<20-31, 7.9J	<0.019- <0.05-<0.1	0.12-1.6	<25-200	0.044J -85	4.4J-140J	0.0012-1.7	0.10J-<2	<2	0.013J-0.15	0.67J-1.40J	<5
Slab Creek	<50-120 11J	0.12J-<1.0	6.9J-<20	0.012J-0.061	0.27-50	27-70	0.027J-110,	4.4J-39J	0.0016-5.6	0.052J-<2	<2	0.019J-0.16	0.53J-27	<5
Chili Bar	<50-130, 15J	0.051J-<1.0	7.0J-<20	<0.05-<0.2	0.32-<1.0	54-79	0.028J-46,	8.8J-21J	<0.0010-4.1	0.020J-<2	<2	0.014J-0.096	0.75J-30.J	<5
REACHES														
Upper Elevation	8.2J-230	0.03J-6.0	1.6J-20	<0.05-0.13	<0.10-2.3	5J-500	0.016J-0.37	0.9J-18	<0.001-0.016	0.066J-3.2	0.12J-<2.0	0.015J-0.28	0.5J -7	<5

Table 4.3.1-7. Range of aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag) and total cyanide (TC) expressed in total recoverable concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during: Fall Turnover and First Major Rain events in 2002; Spring Runoff and Summer Low Flow conditions in 2003; and Spring Runoff, Summer Low Flow, Fall Turnover and First Major Rain events in 2004.

Locations	Al (µg/l)	As (µg/l)	Ba (µg/l)	Cd (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (µg/l)	Hg (µg/l)	Ni (µg/l)	Se (µg/l)	Ag (µg/l)	Zn (µg/l)	TC (µg/l)[1]
Middle Elevation	1.5J-140	0.027J-0.16J	3.0J-28	0.0088J-0.12	<0.1-2.5	8.7J-990	0.014J-0.83	0.23J-290J	<0.005-0.79	0.014J-0.48J	0.067J-0.47J	0.0076J-0.24,	0.16J-9.3	<5
Lower Elevation	2.7J-230	0.11J-0.31J	6.3J-20	0.021J-0.66	<1.0, <0.1-1.4	22J-310	0.017J-0.29	0.47J-63J	<0.001-0.66	0.038J-0.46J	0.13J-0.24J	0.012J-0.096	0.229J-03.1J	<5
Reach Downstream of Chili Bar	13J-290	0.057J-1.3	6.3J-27	0.011J-0.12	0.26-3.4	<50-200	0.027J-1.4	5.7J-21J	0.0013J-0.0187	0.096J-2.5	<2.0	0.017J-0.12	0.48J-13	<5
Reporting Limits	50, 100, 1	1.0, 0.2	20, 0.04	0.05, 0.2, 0.04, 0.1	0.1, 1.0	25, 50, 100	0.05, 0.2, 0.1	500, 10	0.005, 0.001, 0.01	2.0, 0.2	2.0	0.04, 0.2, 0.008	5.0	5.0

[1] No TC samples were collected for 2004 Summer Low Flow or First Major Rain/Fall Turnover sampling events.

Table 4.3.1-8. Aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se) and silver (Ag) expressed in dissolved concentrations for UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the Spring Runoff, Summer Low Flow and First Major Rain/Fall Turnover events in 2004.

Locations	Al (µg/l)	As (µg/l)	Ba (µg/l)	Cd (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (ug/l)	Hg (ug/l)	Ni (µg/l)	Se (ug/l)	Ag (µg/l)	Zn (ug/l)
RESERVOIRS													
Rubicon[1]	22J-44J	0.13J-1.1	2.1J-2.6J	0.015J-0.034J	0.23-0.45	<50-180	0.13-0.15	7.8J	<0.001	0.07J-0.82J	<2.0	<0.04	1.5J
Rockbound	14J-49J	0.14J-0.27J	1.7J-2.6J	0.014J-0.019J, <0.05	0.14-0.50	19J, <50	1.1-26	0.6J-5.0J	0.001-0.003	0.12J, <2.0	0.20J, <2.0	<0.04	0.6J-1.7J
Buck Island	6.7J-48J	0.26J-0.29J	2.0J-2.9J	0.012J-0.034J	0.17-0.62	26J, <50	8.8-50	1.6J-5.1J	0.001-0.003	0.10J-0.15J, <2.0	0.13J, <2.0	0.012J, <0.04	1.3J-2.3J
Loon Lake	3.3J-31J	0.13J-0.35J	2.3J-2.9J	0.01J-0.063, <0.05	0.16-0.52	7.4J, <25, <50	17-98, 200	1.4J-2.0J	0.001-0.005	0.12J-0.45J, <2.0	0.08J, <2.0	<0.04	0.6J-1.0J
Gerle Creek	5.5J-28J	0.21J-0.27J, <1.0	3.5J-6.0J	<0.05-0.073	0.21-0.29	12J, <25, <50	<0.05-21, 200	2.6J-2.9J	0.001-0.005	0.13J-0.16J, <2.0	<2.0	<0.04	0.7J-1.3J

Table 4.3.1-8. Aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se) and silver (Ag) expressed in dissolved concentrations for UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the Spring Runoff, Summer Low Flow and First Major Rain/Fall Turnover events in 2004.

Locations	Al (µg/l)	As (µg/l)	Ba (µg/l)	Cd (µg/l)	Cu (µg/l)	Fe (µg/l)	Pb (µg/l)	Mn (ug/l)	Hg (ug/l)	Ni (µg/l)	Se (ug/l)	Ag (µg/l)	Zn (ug/l)
Union Valley	2J-18J	0.08J-0.20J, <1.0	4.4J-6.1J	0.018J-0.021J, <0.05	0.15-0.31,56	<25, <50	0.11-44	0.7J-43.0J	0.002-0.011	0.08J-0.16J, <2.0	0.11J, <2.0	<0.04	0.3J-1.7J
Ice House	1.8J-30J	0.063J-0.23J	3.7J-10.0J	0.006J-0.056, <0.05	0.12-0.49	6.2J-77J, <25, <50	0.27-52	0.8J-610.0	0.001-0.004	0.02J-0.11J, <2.0	0.08J-0.36J, <2.0	0.005J-0.016J, <0.04	0.3J-2.8J
Junction	4.2J-10J	0.09J-0.19J	5.7J-9.5J	<0.05	0.19-0.24	29, <25, <50	12-64	16J-26J	0.004-0.011	0.06J-0.14J	<2.0	<0.04	0.6J-0.7J
Camino	3J-10J	0.041J-0.098J, <1.0	5.8J-11.0J	0.034J, <0.05	0.22-0.50	74, <25, <50	0.012J-0.058, <0.05	6.4J-72.0J	0.004	0.13J, <2.0	0.1J, <2.0	<0.04	0.5J-1.3J
Brush Creek	3.7J-5.4J, <50	0.08J-0.17J, <1.0	7.3J-14.0J	<0.05	0.07J-0.17	<25, <50	0.09-28	0.06J-2.3J	0.001-0.003, <0.001	0.36J, <2.0	<2.0	<0.04	0.4J-1.9J
Slab Creek	6.8J-17J	0.12J-0.29J	6.8J-9.3J	0.011J-0.034J, <0.05	0.25-0.45	26-56, <25, <50	0.2-67	3.3J-35.0J	0.003-0.009	0.14J-0.26J, <2.0	<2.0	<0.04	0.7J-2.0J
Chili Bar	6.9J-14J [1]	0.12J-0.25J	6.8J-10.0J	0.017J-0.078, <0.05	0.29-0.92	34-37, <25, <50	0.18-14	4.9J-10.0J	0.003-0.03	0.14J-0.27J	<2.0	0.011J, <0.04	0.5J-8.5
REACHES													
Upper Elevation	4.2J-87	0.03- 0.9J, <1.0	1.7J-22	0.005J-0.1, <0.5	0.13-1.6	5J-200, <25	0.016J-0.4, <0.05	0.8J-270J	0.001-0.015, <0.001	0.09J-1.3J, <2.0	0.08J-0.3J, <2.0	<0.005J-<0.018J	0.6J-8.1
Middle Elevation	0.2J-55.0J	0.029J-0.27J, <1.0	3.2J-22	0.01J-0.09, <0.05	0.08J-0.68	<25-240	<0.012J-0.35, <0.05	0.18J-270J	0.001-0.015, <0.001	0.03J-1.3J, <2.0	0.09J-0.3J	0.02J, <0.04	0.06J-7.1
Lower Elevation	0.027J-30J, <50	0.03J-0.41J, <1.0	6.3J-18J	<0.05-0.07	0.08J-0.52	<25-50	0.012J-0.048J, <0.05	0.4J-14J	0.001J-0.007J, <2.0	0.07J-0.55J, <2.0	0.097J, <2.0	<0.009, <0.04	0.38J-4.8J
Reach Downstream of Chili Bar	1.8J-10.0J	0.09J-0.21J	5.7J-11J	0.009J-0.11	0.28-1.4	28-33	0.016J-0.095	1.1J-8.8J	0.004J-0.008J	0.09J-0.51J	<2.0	0.01J, <0.04	0.98J-8.1
Reporting Limits	50	1.0, 0.2	20	0.05	0.10	25, 50	0.05	500	0.005, 0.001	2.0	2.0	0.04	5.0

[1] Rubicon Reservoir was not sampled during 2004 First Major Rain/Fall Turnover.

Of the 5,005 metals and total cyanide samples, 54 samples (1.1%) were equal to or greater than the Primary MCLs, 46 of which were for lead and the remaining 8 were for mercury. Three aluminum samples and 17 iron samples were found to be greater than the Secondary MCLs, as detailed below.

Lead

Forty-six of the 406 lead samples (11.3% of the lead samples) were greater than the Primary MCL for lead (15 µg/l). All 46 occurred in reservoirs during the 2004 sampling events - 2004 Spring Runoff, 2004 Summer Low Flow, and 2004 Fall Turnover and First Major Rain:

- On May 3, 2004 (during the Spring Runoff sampling event) in the Slab Creek Reservoir (65 and 86 µg/l) and in the Chili Bar Reservoir (20 µg/l).
- On May 5, 2004 (Spring Runoff) in the Union Valley Reservoir (15, 25 and 47 µg/l) and in the Junction Reservoir (15 µg/l).
- On May 6, 2004 (Spring Runoff) at Loon Lake Reservoir (47, 48 and 91 µg/l).
- On May 11, 2004 (Spring Runoff) at Ice House Reservoir (18 and 54 µg/l).
- On May 12, 2004 (Spring Runoff) at Rockbound Reservoir (19 µg/l) and Buck Island Reservoir (97 µg/l).
- On September 13, 2004 (Summer Low Flow) in Slab Creek Reservoir (66, 110 and 110 µg/l) and in Chili Bar Reservoir (33, 42, 42 and 46 µg/l).
- On September 14, 2004 (Summer Low Flow) in Union Valley Reservoir (24, 47 and 28 µg/l) and Junction Reservoir (68 µg/l).
- On September 15, 2004 (Summer Low Flow) in Gerle Creek Reservoir (59 µg/l).
- On September 20, 2004 (Summer Low Flow) in Brush Creek Reservoir (48 and 85 µg/l) and Ice House Reservoir (47, 33, 47, 36 and 120 µg/l).
- On September 21, 2004 (Summer Low Flow) in Rockbound Reservoir (39 and 54 µg/l) and Buck Island Reservoir (49 µg/l).
- On September 22, 2004 (Summer Low Flow) in Loon Lake Reservoir (51, 100, 140 and 190 µg/l).
- On October 25, 2004 (First Major Rain/Fall Turnover) in Slab Creek Reservoir (31 µg/l).
- On November 1, 2004 (First Major Rain/Fall Turnover) in Brush Creek Reservoir (53 µg/l) and Ice House Reservoir (47µg/l).
- On November 2, 2004 (First Major Rain/Fall Turnover) in Rockbound Reservoir (43 µg/l).
- On November 8, 2004 (First Major Rain/Fall Turnover) in Union Valley Reservoir (150 µg/l).
- On November 10, 2004 (First Major Rain/Fall Turnover) in Loon Lake Reservoir (41 µg/l).

Mercury

Eight of the 215 mercury samples (3.7% of the mercury samples) were equal to or exceeded the Primary MCL (2.0 µg/l). All eight occurred in reservoirs samples collected during 2003:

- On September 15, 2003 (Summer Low Flow) in Slab Creek Reservoir (2.4 and 5.6 µg/l) and Chili Bar Reservoir (3.3 and 4.1µg/l).
- On September 16, 2003 (Summer Low Flow) in Loon Lake Reservoir (5.7 and 2.2 µg/l).
- On September 18, 2003 (Summer Low Flow) in Union Valley Reservoir (2.1 µg/l) and Ice House Reservoir (3.4µg/l).

<u>Aluminum</u>
Three of the 398 aluminum samples (0.7 % of all aluminum samples) were greater than the Secondary MCL for aluminum (200 µg/l). All three occurred in stream reaches:

- On October 7, 2002 (Fall Turnover) in the Rubicon Dam Reach downstream from the dam (230 µg/l).
- On November 12, 2002 (First Rain) in the Reach Downstream of Chili Bar downstream from the dam (290 µg/l).
- On May 11, 2003 (Spring Runoff) in the Slab Creek Dam Reach downstream from the Rock Creek confluence (230 µg/l).

<u>Iron</u>
Seventeen of the 382 iron samples (4.4% of all iron samples) were equal to or greater than Secondary MCL for iron (300 µg/l). Ten of these occurred in river-reach samples and seven in reservoir samples:

- On September 17, 2003 (Summer Low Flow) in the Rubicon Reservoir and in the Rubicon Dam Reach downstream of the dam (390 and 340 µg/l, respectively).
- On September 18, 2003 (Summer Low Flow) in the South Fork Silver Creek reach downstream from Ice House dam (300 µg/l).
- On May 4, 2004 (Spring Runoff) in the SFAR upstream of the Camino Powerhouse and downstream of the Camino Powerhouse (500 and 460 µg/l, respectively).
- On May 5, 2004 (Spring Runoff) in the South Fork Silver Creek reach downstream from Junction dam (440 µg/l).
- On May 5, 2004 (Spring Runoff) at a non-project affected reach; in the SFAR at Highway 50 and Ice House Road (310 µg/l).
- On September 13, 2004 (Summer Low Flow) in Chili Bar Reservoir (380 µg/l).
- On September 14, 2004 (Summer Low Flow) in the South Fork Silver Creek outflow from Junction Dam (440 µg/l).
- On September 15 2004 (Summer Low Flow) in the South Fork Silver Creek outflow from Ice House Reservoir (380 µg/l).
- On September 20, 2004 (Summer Low Flow) in Ice House Reservoir (340 µg/l).

- On Spetember 21, 2004 (Summer Low Flow) in Rockbound Reservoir (330 µg/l), Rubicon Reservoir (540 µg/l) and in the Rubicon River outflow from Rubicon Reservoir (340 µg/l).
- On October 27, 2004 (First Major Rain) in the South Fork Silver Creek outflow from Ice House Reservoir (990 µg/l).
- On November 1, 2004 (First Major Rain) in Ice House Reservoir (980 and 570 µg/l

Elevated mercury concentrations in 2003 and elevated lead concentrations in 2004 appear to be related to the sampling equipment used to collect the reservoir samples. Reservoir samples were collected in 2002 using a rented Van Dorn sampler, and none of 2002 reservoir samples exceeded MCLs for any metal. For 2003, the Licensee decided to purchase, rather than rent, a Van Dorn sampler. Laboratory analysis of the 2003 reservoir samples resulted in a substantial increase in mercury concentrations compared to 2002. The Licensee evaluated the potential sources of increased mercury levels from 2002 to 2003, and contacted the supplier of the Van Dorn sampler to inquire about the sampler as a source of mercury. The supplier confirmed that the sampling cups sold for use with the Van Dorn sampler at that time were a source of mercury. To avoid further equipment-related contamination of reservoir samples, the Licensee then purchased a new Kemmerer sampler for use in collecting reservoir samples in 2004. Laboratory analysis of 2004 reservoir samples collected with the new sampler show that mercury concentrations decreased to background levels, however, lead concentrations increased significantly, exceeding the MCL for lead for the first time and only in reservoir samples, as discussed above. A quality-assurance sample collected in the field (i.e., deionized-water rinse of the new Kemmerer sampler) during the 2004 Spring sampling event yielded a lead concentration of 7.7 µg/l, which suggested the new Kemmerer sampler to be the source of elevated lead concentrations in 2004 reservoir samples. Laboratory testing of Kemmerer sampler during March 2005 confirmed this, and the laboratory report is attached in Appendix D. Additional evidence to support this conclusion is that all riverine samples collected below reservoirs have lead concentrations that range from non-detect to 0.3 µg/l. Collection of riverine sampling entails filling sample bottles directly from the stream and therefore does not require the use of the Kemmerer depth sampler. If lead concentrations were truly elevated in the reservoirs as suggested by the 2004 analytical data, then 2004 riverine samples collected below the dams should have similar lead concentrations as found in the reservoirs, but this is not the case (i.e., lead results for riverine samples are about four orders of magnitude less than the reservoir samples, and well below the MCL).

The Basin Plan also contains Water Quality Objectives for trace elements for Folsom Lake. Although the Folsom Lake objectives clearly do not apply to the waters in the vicinity of the Projects, at the request of the SWRCB, the Licensees agreed to analyze water samples for dissolved concentrations of trace elements during the 2004 Spring sampling event for comparison to the Water Quality Objectives at the downstream reservoir of Folsom Lake. According to the Basin Plan, Table III-1, the Water Quality Objectives for trace elements at Folsom Lake are not to exceed the following levels of dissolved concentrations:

Arsenic 0.01 mg/l (10 µg/l)

Barium	0.1 mg/l (100 µg/l)
Copper	0.01 mg/l (10 µg/l)
Cyanide	0.01 mg/l (10 µg/l)
Iron	0.3 mg/l (300 µg/l)
Manganese	0.05 mg/l (50 µg/l)
Silver	0.01 mg/l (10 µg/l)
Zinc	0.1 mg/l (100 µg/l)

None of the 275 samples analyzed for dissolved trace elements exceeded the Water Quality Objectives for Folsom Lake. Cyanide, manganese, and zinc were not analyzed for dissolved concentrations since there are no water quality objectives for these elements in the vicinity of the Project.

4.3.1.3 Dissolved Oxygen

The Basin Plan contains one Water Quality Objective for Dissolved Oxygen (DO). The portion of the Objective that pertains to the waters in the vicinity of the Projects is:

> For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily dissolved oxygen concentrations shall not fall below 85% of saturation in the main water mass, and the 95% concentration shall not fall below 75% of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:
>
> Waters designated as WARM 5.0 mg/l
> Waters designated as COLD 7.0 mg/l
> Waters designated as SPWN 7.0 mg/l

Dissolved oxygen is measured in milligrams per liter (mg/l, which is equivalent to parts per million, or ppm) and percent saturation. The amount of oxygen that can be dissolved in water is a function of both water temperature (colder water holds more oxygen than warmer water) and atmospheric pressure (water at a lower elevation holds more oxygen than water at a higher elevation). Therefore, the least oxygen concentration is found in water in summer at the highest elevation and the greatest oxygen concentration is in winter at the lowest elevation. In reservoirs, DO is generally highest on the surface and decreases with depth, depending on primary plant production (which produces oxygen) and decomposition (which consumes oxygen). A reservoir can become locally anoxic (no dissolved oxygen); however, this condition was not found in any reservoir surveyed. Other natural conditions that affect DO include wind mixing and circulation.

The Licensees are unaware of any historic DO data in the vicinity of the Projects.

The Licensees measured DO *in situ* on 375 occasions, 227 of which were riverine measurements and 148 were reservoir profile measurements (Table 4.3.1-9). The reservoir profiles recorded DO measurements at sub-meter intervals from the surface to the bottom of the reservoir. Since

DO readings were not taken continuously over a month, the Basin Plan's percent saturation criteria cannot be directly tested. However, an inference can be made regarding the extent to which waters in the vicinity of the Projects compare to Basin Plan DO criteria.

Table 4.3.1-9. Range of dissolved oxygen (DO) concentrations in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during Fall Turnover and First Major Rain events in 2002, Spring Runoff and Summer Low Flow events in 2003, and Spring Runoff, Summer Low Flow, Fall Turnover and First Major Rain in 2004.

Location	Number of Samples	Range of DO Values	
		mg/l	% Saturation
RESERVOIRS			
Rubicon	4 Vertical Profiles with YSI meter	8.3-12.0	77.0-101.5
Rockbound	5 Vertical Profiles with YSI meter	4.1-12.9	41.8-110.3
Buck Island	6 Vertical Profiles with YSI meter	5.4-11.7	52.9-99.1
Loon Lake	21 Vertical Profiles with YSI meter	5.6-12.7	57.2-104.1
Gerle Creek	7 Vertical Profiles with YSI meter	7.6-12.1	71.5-124.9
Union Valley	33 Vertical Profiles with YSI meter	0.8-13.9	6.1-118.6
Ice House	29 Vertical Profiles with YSI meter	2.3-13.2	19.5-117.3
Junction	5 Vertical Profiles with YSI meter	3.4-12.6	29.4-110.3
Camino[1]	2 Vertical Profiles with YSI meter	9.4-41.0[1]	82.3-102.5[1]
Brush Creek	6 Vertical Profiles with YSI meter	1.6-10.4	13.6-103.0
Slab Creek	17 Vertical Profiles with YSI meter	4.8-14.0	46.4-116.4
Chili Bar	13 Vertical Profiles with YSI meter	4.9-14.3	50.7-122.7
REACHES			
Upper Elevation	75	3.7-13.1	31.8-113.6
Middle Elevation	88	7.5-14.7	61.4-127.0
Lower Elevation	42	4.7-13.5	45.1-123.8
Reach Downstream of Chili Bar	22	6.1-14.5	62.6-140.5

[1] Data available for fall turnover 2002 and summer low flow 2004 only.

Of the 227 riverine DO measurements, only five measurements (2%) were below 7 mg/l. Two of these were in a UARP–affected reach (5.5 mg/l on October 8, 2002 in the outflow from Loon Lake Dam, and 4.7 mg/l on September 13, 2004 in the South Fork American River outflow from Slab Creek Reservoir), and one was in a Chili Bar-affected reach (6.1 mg/l on September 13, 2004 on the South Fork American River downstream of Greenwood Creek). The other two occasions were in stream reaches not affected by the UARP or Chili Bar Project: 3.1 mg/l in Jerrett Creek on October 8, 2002 (although the sampler noted malfunction of the DO probe for this measurement) and 3.7 mg/l in Rocky Basin Creek on September 17, 2003.

Of the 148 reservoir profile measurements, DO was usually greater than 7 mg/l in the upper portions of all reservoirs. As expected, DO periodically dropped below 7 mg/l in 5 of the 12 reservoirs in the lower portions of the reservoir. At Rockbound Reservoir, DO values were below 7 mg/l on October 7, 2002, in the bottom five meters of the reservoir, with a lowest value of 4.1 mg/l at the bottom depth of 20.5 meters. At Loon Lake Reservoir, DO values were below 7 mg/l on September 16, 2003, at a depth interval of 13.2 to 16.7 meters with the lowest value of 5.6 mg/l (total depth was 18.2 meters). DO values were below 7 mg/l at another location on

Loon Lake Reservoir on September 16, 2003, at a depth interval of 16 to 17.8 meters with the lowest value of 6.0 mg/l (total depth was 21.3 meters).

At Union Valley Reservoir, DO values dropped below 7 mg/l only during October and November 2002, and September 2004. DO values below 7 mg/l started at depths of 20 to 38 meters in October 2002, 46 to 56 meters in November 2002, and 0 to 28 meters in September 2004. DO values were generally lowest near the bottom of the reservoir, with minimum values in October 2002 as follows: 3.6 mg/l at the total depth of 84 meters on October 1; 6.6 mg/l at 24 meters on October 8 (total depth was 41 meters); 0.8 mg/l at the total depth of 69 meters on October 16; 5.0 at 57 meters on October 24 (total depth was 69 meters); and 1.3 mg/l at 73.5 meters on October 31 (total depth was 75 meters). Minimum DO values during November 2002 were 1.0 mg/l at 57.2 meters (total depth of profile was 63 meters) on November 6; 1.5 mg/l at total depth of 49 meters on November 12; 2.5 mg/l at the total depth of 70.0 meters on November 14; 5.1 mg/l at at the total depth of 50 meters on November 14; 3.8 mg/l at the total depth of 68.8 meters on November 14; and 3.4 mg/l at the bottom depth of 23.7 meters on November 14. Minimum DO values in September 2004 were 5.8 mg/l at total depth of 43 meters; 5.9 mg/l at 6.7 meters (total depth was 11.0 meters); and 3.0 mg/l at the total depth of 29 meters on September 14.

Similar to Union Valley Reservoir, Ice House Reservoir DO values dropped below 7 mg/l only during October and November 2002 and September and November 2004. During these four months, DO values below 7 mg/l began at Ice House Reservoir at depths ranging from 10.5 to 20.8 meters. DO values were generally lowest near the bottom of the reservoir, with minimum values in October 2002 as follows: 3.2 mg/l at the total depth of 30.7 meters on October 16; 2.5 mg/l at 20.8 meters (total depth 30.8 meters) on October 8; and 3.6 mg/l at 20 meters (total depth 24 meters) on October 16. Minimum DO values in November 2002 were 4.1 mg/l at 21.8 meters (total depth 25.5 meters) on November 6; 3.7 mg/l at 30.3 meters (total depth 31.1 meters) on November 11; and 3.1 mg/l at 30.3 meters (total depth 31.4 meters) on November 14. Minimum DO values in September 2004 were 4.1 mg/l at 16.4 meters (total depth was 19.7 meters); and 3.86 mg/l at 26.3 meters (total depth was 28.4 meters). Minimum DO values in November 2004 were 3.2 mg/l at 19.4 meters (total depth was 24.2 meters); 2.3 mg/l at 19.7 meters (total depth was 25.8 meters).

Several reservoirs, including Brush Creek, Junction, Slab Creek and Chili Bar only had one or two occasions where DO dropped below 7 mg/l. At Brush Creek Reservoir a minimum DO value of 1.6 mg/l at the total depth of 29 meters was recorded on September 16, 2003; and 3.7 mg/l at 26.3 meters (total depth was 27.6 meters) on November 1, 2004. At Junction Reservoir, a minimum value of 3.4 mg/l was recorded at 30.2 meters (total depth was 31.0 meters) on September 14, 2004. At Slab Creek Reservoir, a minimum DO value of 4.8 mg/l was recorded at the total depth of 35.6 meters. Furthermore, at Chili Bar Reservoir, a minimum DO value of 4.9 mg/l was recorded at 0.8 meters (total depth was 24.9 meters); this profile had consistently low values in its entirety.

For more detailed information regarding the vertical profiles of DO in the twelve reservoirs, DO versus depth data tables are available in the *Water Temperature Technical Report* along with all temperature data that was collected during the relicensing studies (*Water Temperature Technical Report*: DTA 2005a).

4.3.1.4 pH

The Basin Plan contains one Water Quality Objective for pH. The portion of the Objective that pertains to the waters in the vicinity of the Projects is:

> The pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated COLD or WARM beneficial uses. In determining appropriate averaging periods for pH, appropriate averaging periods may be applied, provided that beneficial uses will be fully protected.

The pH value is the logarithm of the reciprocal of the hydrogen ion concentration in water, and is usually expressed in pH units. The pH affects the solubility of metals in sediment and suspended material as well as toxicity of some compounds. A pH value of 7 is neutral while a low pH value is acidic and a high pH value is alkaline. Most aquatic biota require a pH range of 6.5 to 8.5. Natural conditions that affect pH include runoff and rainfall.

The Licensees are unaware of any historic pH data in the vicinity of the Projects other than those collected by the SWRCB from 1959 through 1961 during construction of the Union Valley and Ice House dams as described in Section 4.3.1.2. All the pH values measured by the SWRCB fell between 6.5 and 8.5 except for one value of 6.2 in the May 1960 sampling downstream of Union Valley Dam. As stated above, information is not available to determine if this low reading represented natural conditions in the river or was caused by construction activities.

The Licensees measured pH on 354 occasions, 221 of which were riverine measurements and 133 were reservoir profiles (Table 4.3.1-10). The reservoir profiles recorded pH measurements at sub-meter intervals from the surface to the bottom of the reservoir.

Table 4.3.1-10. Range of pH values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during Fall Turnover and First Major Rain events in 2002, Spring Runoff and Summer Low Flow events in 2003, and Spring Runoff, Summer Low Flow, Fall Turnover and First Major Rain/Fall Turnover 2004.

Location	Number of Samples	Range of pH Values
RESERVOIRS		
Rubicon	4 Vertical Profiles with YSI meter	6.7-7.8
Rockbound	5 Vertical Profiles with YSI meter	6.1[1]-7.7
Buck Island	6 Vertical Profiles with YSI meter	6.5-7.9
Loon Lake	21 Vertical Profiles with YSI meter	5.8[1]-7.7
Gerle Creek	7 Vertical Profiles with YSI meter	6.3-7.4
Union Valley	33 Vertical Profiles with YSI meter	5.7-7.9
Ice House	29 Vertical Profiles with YSI meter	6.0[1]-8.5
Junction	5 Vertical Profiles with YSI meter	6.2-7.7

Table 4.3.1-10. Range of pH values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during Fall Turnover and First Major Rain events in 2002, Spring Runoff and Summer Low Flow events in 2003, and Spring Runoff, Summer Low Flow, Fall Turnover and First Major Rain/Fall Turnover 2004.

Location	Number of Samples	Range of pH Values
Camino	2 Vertical Profiles with YSI meter	6.8-7.2
Brush Creek	6 Vertical Profiles with YSI meter	6.1[1]-7.7
Slab Creek	17 Vertical Profiles with YSI meter	6.5-7.8
Chili Bar	13 Vertical Profiles with YSI meter	6.7-7.8
REACHES		
Upper Elevation	69	4.9-8.3
Middle Elevation	90	6.2-8.5
Lower Elevation	41	6.7-8.7
Reach Downstream of Chili Bar	21	6.8-7.7

[1] Value from the hypolimnion.

Of the 221 riverine pH measurements, 25 measurements (11%) were below 6.5 and two (<1%) were greater than 8.5. Of the 25 pH measurements below 6.5, 21 occurred at sites in the Upper Reaches and 4 occurred in the Middle Reaches. The lower pH values occurred in reaches not affected by either the UARP or Chili Bar Project. The lowest pH value was 5.0 on September 17, 2003 at South Fork Rubicon inflow to Robbs Peak Forebay. The sampler noted that flow on this occasion was very low, similar to flow from a 1-inch garden hose. The next two lowest pH values both occurred at Highland Creek inflow to Rockbound Reservoir on June 11, 2003 and May 12, 2004 (5.75 and 5.83, respectively). The remaining 21 values below 6.5 ranged from 6.02 to 6.49.

Of the 133 reservoir profile measurements, pH values were occasionally measured below 6.5 on six of the twelve reservoirs (Rockbound, Loon Lake, Union Valley, Ice House, Junction, and Brush Creek reservoirs), and pH values greater than 8.5 occurred at one reservoir (Ice House Reservoir).

At Rockbound Reservoir, pH values dropped below 6.5 on October 7, 2002 and May 12, 2004, with minimum pH values of 6.1 and 6.3, respectively. The trend for pH at Rockbound is pH greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

At Loon Lake, pH values dropped below 6.5 during September 2003 at two locations: Loon Lake west end near the boat ramp, with a pH of 6.45 at the surface of the reservoir and decreasing to 5.8 at the bottom five meters of the reservoir (total depth 21 meters); and at Loon Lake northeast water body with pH decreasing from 6.5 to 6.0 at a depth interval from 16.5 meters to total depth of 18.2 meters. In May 2003 pH dropped below 6.5 at three locations: at Loon Lake near the dam with pH of approximately 6.2 throughout the water column to a total depth of 19.5 meters;

at Loon Lake west end near the boat ramp, with a pH range of 6.3 at the surface and decreasing to approximately 6.0 at total depth of 24 meters; and at Loon Lake northeast water body with pH decreasing from 6.5 to 6.2 at a depth interval of 4.0 meters to total depth of 27 meters. In November 2004 pH values dropped below 6.5 at the northeast portion of the water body at a depth of 17.3 meters and continued to decrease to 6.4 at the bottom of the reservoir (20.5 meters).

At Union Valley Reservoir, pH values dropped below 6.5 during October 2002, September 2003, May 2004 and November 2004, with a minimum pH value of 5.7. The trend at Union Valley Reservoir is pH greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

At Ice House Reservoir, pH values dropped below 6.5 during October 2002, November 2002, September 2003, May 2004 and November 2005, with a minimum pH value of 6.0. The trend at Ice House Reservoir is pH greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth. In December 2004, a pH value of 8.51 was recorded at/near the reservoir surface and gradually decreased with depth.

At Junction Reservoir, pH values dropped below 6.5 during September 2003, May 2004 and November 2004, with a minimum pH value of 6.2. The trend at Junction Reservoir is pH greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

At Brush Creek Reservoir, pH values dropped below 6.5 in September 2003 at a depth interval of 15 to 29.6 meters (total depth), with a minimum pH value of 6.1. The trend at Brush Creek Reservoir is pH values greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

For more detailed information regarding the vertical profiles of pH in the twelve reservoirs, pH versus depth data tables are available in the Water Temperature Report along with all temperature data that was collected during the relicensing studies (*Water Temperature Technical Report*: DTA 2005a).

4.3.1.5 Salinity

The Basin Plan (RWQCB 2004) contains one Water Quality Objective for salinity. Specifically, the Objective states that Total Dissolved Solids (TDS) shall not exceed 125 mg/l in the South Fork of the American River from its source to Folsom Lake.

Salinity in freshwater is normally measured as TDS, which is a measure of the amount of material dissolved in water. This material is mostly inorganic salts (e.g. chlorides, sulfates, phosphates, calcium, magnesium, sodium, potassium), carbonates, bicarbonates, and other anions and cations, all of which are typically measured in mg/l. Calcium, magnesium and carbonate levels can be affected by pH extremes. Calcium is the fifth most common element on earth, an essential macronutrient, considered non-toxic, present in most natural systems and introduced into surface water as runoff passes over calcium-rich formations. Calcium contributes considerably to hardness and may range from 0 to 200 mg/l naturally. Sodium is the sixth most abundant element on earth, present in most waters naturally and has low toxicity. Magnesium is the eighth most common element, an essential macronutrient and a primary component in photosynthetic pigments. Magnesium is present in most natural systems, contributes considerable to hardness and may range from 0 to several hundred mg/l naturally. The chloride ion, unlike free chlorine (which is toxic), is required by cells during photosynthesis. Potassium plays a minor role in aquatic plant growth and is needed for enzyme activation.

Total alkalinity (mg/l) is a measure of water's ability to neutralize acids (buffer capacity) and reduces the toxicity of some metals. Levels above 400-600 mg/l may be harmful to crops and humans. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates, carbonates and occasionally borates, silicates and phosphates.

The Licensees are unaware of any historic salinity data in the vicinity of the Projects other than alkalinity data collected by the SWRCB from 1959 through 1961 during construction of the Union Valley and Ice House dams, as described in Section 4.3.1.2. Total alkalinity ranged from 4 to 31 mg/l during those measurements.

Table 4.3.1-11. Range of total dissolved solids (TDS), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), chloride (Cl), sulfate (SO_4) and total alkalinity (TA) values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the Fall Turnover and First Major Rain events in 2002 and Spring Runoff and Summer Low Flow events in 2003.

Locations	Number of Samples[1]	TDS (mg/l)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	Cl (mg/l)	SO_4 (mg/l)	TA (mg/l)
RESERVOIRS									
Rubicon	3	<1-12	1.3-2.1	<0.5	<0.5	<0.5	<1.0	<0.4-0.6	4.7-9.1
Rockbound	4	<1-12	1-1.3	<0.5	<0.5	<0.5	<1.0	<0.4-0.5	4.2-6.0
Buck Island	3	<1-10	1.1-1.4	<0.5	<0.5	<0.5	<1.0	<0.4-1.3	3.2-6.7
Loon Lake	11-14	<1-22, 44	0.9-1.2	<0.5	<0.5	<0.5-0.6	<0.5	<1	3.6-6.0
Gerle Creek	3-4	<1-14	1.0-1.5	<0.5	<0.5	<0.5-0.7	<0.1-0.6	<1	4.5-6.7
Union Valley	15	<1-18	1.1-1.4	<0.5	<0.5	0.6-0.9	<0.3-0.9	<0.4-3.7	5.0-8.2
Ice House	17-23	<1-24	0.9-1.3	<0.5	<0.5	<0.5-1.0	<1	<0.4-<1.0	4.5-8.0
Junction	3	<1-18	1.2-1.4	<0.5	<0.5	0.8-1.0	0.3-0.9	<0.4-1.6	6.4-8.7
Camino	3	<1-8	1.4-1.5	<0.5	<0.5-0.5	0.7-1.0	0.4-1.1	0.5-1.6	6.4-9.2
Brush Creek	4	<1-22	1.7-2.3	0.6-0.8	<0.5-0.5	1.0-1.5	0.6-1.2	0.4-1.6	8.4-14.0
Slab Creek	6-8	10-28	1.5-3.0	<0.5-0.8	<0.5-0.5	1.3-1.9	1.2-2.5	<0.4-<1.2	5.6-12.0
Chili Bar	7-9	6-22	2.0-3.5	<0.5-1.0	<0.5-0.6	1.2-2.1	1.2-1.6	<0.4-1.1	1-13.0
REACHES									
Upper Elevation	30-36	<1-30	<0.5-3.0	<0.5-0.8	<0.5	<0.5-2.2	<0.1-0.7	<0.4-1.2	1.6-14.0
Middle Elevation	42-48	<1-66	0.8-5.4	<0.5-1.8	<0.5-1.1	0.6-3.9	<0.5-5.2	<0.4-2.1	5.1-26.0

Table 4.3.1-11. Range of total dissolved solids (TDS), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), chloride (Cl), sulfate (SO_4) and total alkalinity (TA) values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the Fall Turnover and First Major Rain events in 2002 and Spring Runoff and Summer Low Flow events in 2003.

Locations	Number of Samples[1]	TDS (mg/l)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	Cl (mg/l)	SO_4 (mg/l)	TA (mg/l)
Lower Elevation	19-25	6-114	1.5-5.2	<0.5-2.4	<0.5-0.8	1.0-2.7	<0.1-1.8	<0.4-2.2	6.6-24.0
Reach Downstream of Chili Bar	9-13	<1-68	2.0-15.0	<0.5-9.9	<0.5-1.6	1.3-17.0	<0.1-14.0	<0.4-12.0	9.6-28.0, 110.0

[1] For a range of samples, the lower number indicates all parameters were analyzed and the higher number indicates the number of times a reduced set of parameters were analyzed for that sampling location.

As observed in Table 4.3.1-11, the concentration of TDS in the surface waters in the vicinity of the Projects is less than the Basin Plan Salinity Water Quality Objective of 125 mg/l.

4.3.1.6 Temperature

The Basin Plan contains one Water Quality Objective for Temperature. The portion of the Objective that pertains to the waters in the vicinity of the Projects is:

> The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.
>
> At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F [3.1° C] above natural receiving water temperature.

In determining compliance with water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected. Note that during the June 14, 2004, Aquatic TWG meeting, the SWRCB and CDFG said they normally do not apply this specific Temperature Water Quality Objective to hydro-relicensings. This may be due to the fact that comparison of the Temperature Water Quality Objective to surface water in the vicinity of the Projects is difficult for two reasons. First, in many instances and especially in summer, releases or spills from the dams may constitute all the flow in the "receiving water," limiting the ability to measure the effect of the dam release on the receiving water's temperature. Second, the Projects have already modified "natural receiving water temperature" throughout the basin, so it may be difficult, if not impossible, to measure quantitative changes to "natural receiving water." Similar regulatory challenges exist in low-flow or effluent-dependent water bodies. Thus, the SWRCB has endorsed evaluating qualitatively whether an activity has an adverse affect on existing beneficial uses, rather than rely on a quantitative analysis of temperature increases. SWRCB Order WQO 2002-0015 and 2002-0016.

For this reason, it is important to note that no federal or State of California threatened or endangered aquatic species occur in the UARP reaches or the Reach Downstream of Chili Bar. The only special-status aquatic species that occur besides trout (a Forest Service Management Indicator Species, or MIS) is hardhead and foothill yellow-legged frog. Both of these species are California species of concern (referred to as "CSC" in this technical report), an administrative term applied by the CDFG to special concern species because CDFG believes that the species are vulnerable to extinction due to declining populations, limited range and/or continued threats. The designation offers no legal protection to the species. In addition, the foothill yellow-legged frog is a federal species of concern (referred to as "FSC" in this technical report). This, too, is a term-of-art and offers no legal protection to the species. FSC species are established by the USFWS and may include species that were former category 2 candidates for listing under the ESA, are included on state list of protected species, and are identified as imperiled by State Natural Heritage Programs or one of many conservation organizations. Hardhead are found in the SFAR Reach and downstream portion of Slab Creek Dam reach (both warmwater sections) and in the Slab Creek and Chili Bar reservoirs (*Stream Fisheries Technical Report*, DTA and Stillwater 2005a). Foothill yellow-legged frogs were found in the SFAR (coolwater) and Camino Dam (coldwater/coolwater) reaches. (*Amphibian and Aquatic Reptiles Technical Report*, DTA and Stillwater 2005b.)

An explanation of water temperature data collected during the relicensing studies and corresponding analysis is set forth in *Water Temperature Technical Report* (DTA 2005a).

4.3.1.7 Turbidity

The Basin Plan contains one Water Quality Objective for Turbidity. The portion of the Objective that pertains to the waters in the vicinity of the Projects is:

> Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:
>
> - Where natural turbidity is between 0 and 5 NTUs, increases shall not exceed 1 NTU.
> - Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%.

Turbidity is the inverse of water clarity (most often measured in NTUs) which is based on a logarithmic scale.

In this case, the Turbidity Objective is difficult to apply; therefore, the Licensees performed a more general evaluation.

Limited turbidity data has been recorded since the mid-1990s at three locations in the Slab Creek reach. The monitoring was established in response to the 1992 Cleveland Fire and low reservoir elevation that resulted in turbid water in the SFAR below Slab Creek Dam. Monitoring is not recorded during the winter season (usually November 15 through July 1). Exceedences above 25 NTUs result in an alarm in the Energy Management System (EMS), which is followed by a field investigation to determine the cause of elevated turbidity. Annual reports of the monitoring are provided to California Department of Fish and Game following each reporting period. In a typical water year, the majority of days have turbidity readings of 0.1 to 1.0 NTUs; a dozen or so days have levels of not more than 2 NTUs. Occasionally levels may reach as high as 14-15 NTUs. Alarm situations are rare.

Turbidity monitoring was also done during SMUD's November 2, 1992 sampling at Slab Creek Reservoir when turbidity ranged from 1 to 3 NTUs.

During the water quality sampling effort conducted during 2002 and 2003, the Licensees measured turbidity on 248 occasions (Table 4.3.1-12).

Table 4.3.1-12. Range of turbidity values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during 2002 Fall Turnover and First Major Rain events and 2003 Spring Runoff and 2003 Summer Low Flow events.

Location	Number of Samples	Range of Turbidity Values NTU
RESERVOIRS		
Rubicon	1	0.7
Rockbound	1	0.2
Buck Island	1	2.4
Loon Lake	11	0.3-0.5
Gerle Creek	3	0.4-0.6
Union Valley	15	0.5-1.2
Ice House	17	0.7-2.3
Junction	3	0.4-1.2
Camino	3	0.4-1.2
Brush Creek	4	0.5-0.9
Slab Creek	6	0.7-2.0
Chili Bar	7	0.8-2.4
REACHES		
Upper Elevation	22	0.1-0.7
Middle Elevation	42	0.1-2.0, 42.0
Lower Elevation	18	0.3-6.4
Reach Downstream of Chili Bar	9	0.7-5.4

Based on this sampling, the Licensees characterized turbidity as low for all reaches and reservoirs, as shown in Table 4.3.1-12. The single outlier value of 42 NTU occurred at South Fork Silver Creek upstream of Ice House Reservoir, a non-Project affected reach, on November 26, 2002 during the First Major Rain sampling event.

4.3.2 Narrative Water Quality Objectives

4.3.2.1 Biostimulatory Substances

The Basin Plan contains one Water Quality Objective for Biostimulatory Substances, which states:

> Water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses.

Biostimulatory substances are primarily nitrogen, phosphorus and carbon in forms that can be utilized by aquatic life. Nitrogen is usually measured as nitrate-nitrite, ammonia and total Kjeldahl nitrogen (in mg/l). Nitrogen enters a watercourse naturally in rain. The nitrate form results from normal decomposition of organic matter and is a common form in which nitrogen is added to fertilizer. In rivers with little human activity, total nitrogen is around 0.12 mg/l with nitrate representing about 85 percent of the nitrogen. Ammonia, the form of nitrogen that can readily be utilized by plants, occurs as a result of organic decomposition. Ammonia is converted to nitrate in the presence of oxygen. Total Kjeldahl nitrogen is the total concentration of nitrogen present as ammonia or bound in organic compounds. In lakes and reservoirs, nitrogen form is closely related to redox potential (E_h). Where E_h is about 500 millivolts (mV), DO is at about 100 percent saturation, and nitrate predominates. As E_h falls to about 450-300 mV, ammonia is favored over nitrate or nitrite.
Phosphorus is usually measured as total phosphorus and dissolved ortho-phosphate (in mg/l). Phosphorus enters a watercourse naturally by runoff in the watershed and by release from sediments under anaerobic conditions (e.g., anoxic hypolimnions). Total phosphorus measures the total amount of phosphorus both biologically available and bound in organic compounds. In lakes, a nitrogen-to-phosphorus ratio greater than 16:1 indicates that phosphorous, rather than nitrogen, is limiting for production, which is typical in oligotrophic lakes in the Sierras. Phosphorus can be released from sediments under anaerobic conditions (e.g., anoxic hypolimnia), which could increase tailrace and reservoir production.

Carbon is usually measured as total organic carbon in mg/l, and enters the watershed due to runoff and primary production in the watercourse.

In addition, Secchi depth (normally measured in feet or meters) can be a useful indicator of biostimulation in reservoirs since algal blooms reduce water clarity. As a general rule, Secchi depth is about one-third the depth of the euphotic zone (the depth to which light dims to about 1% of the surface, and can be used by phytoplankton for primary production) (Horne and Goldman 1994).

The Licensees are unaware of any historic biostimulatory substances data in the vicinity of the Projects other than those collected by the SWRCB from 1959 through 1961 during construction of the Union Valley and Ice House dams and by SMUD in November 1992, as described in Section 4.3.1.2. All the nitrate values measured by the SWRCB fell between 0 and 1.2 mg/l except for values downstream of the Ice House Dam construction in August 1959 (8.5 mg/l), September 1959 (16.0 mg/l) and October 1959 (7.2 mg/l). Nitrate and ammonia measurements by SMUD in November 1992 were less than 0.01 and 0.02 mg/l, respectively.

In 2002 and 2003, the Licensees collected 210 water quality samples from the UARP reservoirs and reaches and the Chili Bar Reservoir and Reach Downstream of Chili Bar and measured the concentrations of total phosphorus, ortho-phosphorus, total Kjeldahl nitrogen, nitrate-nitrite, ammonia and total organic carbon in each of these. In addition, the Licensees took Secchi depth readings in the UARP reservoirs and the Chili Bar Reservoir. These data are presented in Table 4.3.2-1.

Table 4.3.2-1. Range of total phosphorus (P), ortho-phosphorus (PO_4), total Kjeldahl nitrogen (TKN), nitrate-nitrite (NO_3-NO_2), ammonia (NH_3) and total organic carbon (TOC) in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the 2002 Fall Turnover and First Major Rain events and 2003 Spring Runoff and Summer Low Flow events. Mean Secchi depth is also provided. Numbers following a comma are abnormal values that were above the typical range for the parameter.

Location	Number of Samples[1]	P (mg/l)	PO_4 (mg/l)	TKN (mg/l)	NO_3-NO_2 (mg/l)	NH_3 (mg/l)	TOC (mg/l)	Mean Secchi (m)
RESERVOIRS								
Rubicon	2-3	<0.01-0.03	<0.01	0.39-0.51	<0.02	<0.05, <0.1	2.4-2.7	2.0
Rockbound	2-4	<0.01-0.01	<0.01	0.17-0.24	<0.02	<0.05, <0.1-0.08	1.3-1.5	9.2
Buck Island	2-3	<0.01-0.01	<0.01	0.24-0.32	<0.02	<0.05, <0.1-0.07	1.8-2.1	7.3
Loon Lake	8-14	<0.01-0.02	<0.01	0.12-0.27	<0.02-0.03	<0.05, <0.1-0.08	1.4-1.6	10.7
Gerle Creek	2-4	<0.01	<0.01	<0.10-0.27	<0.02	<0.05, <0.1-0.07	1.2-1.5	7.4
Union Valley	11-15	<0.10, <0.01-0.04	<0.01-0.07	0.12-0.30	<0.02-0.03	<0.05, <0.1-0.07	1.8-2.0	6.7
Ice House	8-23	<0.01-0.02	<0.01-0.29	<0.1-0.24	<0.03-0.13	<0.05, <0.1-0.12	1.6-2.1	6.0
Junction	2-3	<0.01, <0.10	<0.01, <0.1	0.11-0.19	<0.02-0.03	<0.05, <0.1	1.8-2.3	6.4
Camino	2-3	<0.01, <0.1	<0.01-0.02	<0.1-0.15	<0.02-0.14	<0.05, <0.1	1.3-2.8	3.3
Brush Creek	3-4	<0.10-0.05	<0.01-0.01	0.12-0.32	<0.02	<0.05, <0.1	<1.0-1.4	7.8
Slab Creek	4-8	<0.10, <0.01-0.05	<0.01-0.01	0.19-0.44	<0.02-0.11	<0.05, <0.10	1.1-1.6	4.9
Chili Bar	5-9	<0.10, <0.01-0.06	<0.01-0.03	0.16-0.33	<0.02-0.16	<0.05, <0.1	1.2-1.6	4.3
REACHES								
Upper Elevation	18-36	<0.01-0.03	<0.01-0.011	0.1-0.4	<0.02-0.28	<0.05, <0.1-0.07	1.1-2.7	-----
Middle Elevation	27-45	<0.01-0.04	<0.01-0.27	<0.1-0.39	<0.02-0.29, 3.0	<0.05-0.05, <0.10	<1.0-5.1	-----

Table 4.3.2-1. Range of total phosphorus (P), ortho-phosphorus (PO_4), total Kjeldahl nitrogen (TKN), nitrate-nitrite (NO_3-NO_2), ammonia (NH_3) and total organic carbon (TOC) in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during the 2002 Fall Turnover and First Major Rain events and 2003 Spring Runoff and Summer Low Flow events. Mean Secchi depth is also provided. Numbers following a comma are abnormal values that were above the typical range for the parameter.

Location	Number of Samples[1]	P (mg/l)	PO_4 (mg/l)	TKN (mg/l)	NO_3-NO_2 (mg/l)	NH_3 (mg/l)	TOC (mg/l)	Mean Secchi (m)
Lower Elevation	11-23	<0.01-0.03	<0.01-0.03	0.12-0.55	<0.02-0.17	<0.05-0.05 <0.1	<1-2	-----
Reach Downstream of Chili Bar	6-13	<0.01-0.22	<0.01-0.02	<0.1-0.29, 1.5	<0.02-0.05	<0.05, <0.1	1.0-1.7	-----

[1]For a range of samples, the lower number indicates all parameters were analyzed and the higher number indicates the number of times a reduced set of parameters were analyzed for that sampling location.

These data suggest that the concentration of these biostimulatory substances are generally low, with nitrate concentrations well below the 1.0 mg/l nitrate standard typically used to characterize source waters that can stimulate algae growth.

In addition, the Licensees are unaware of any instances of aquatic growths in the UARP reservoirs and reaches, Chili Bar Reservoir or Reach Downstream of Chili Bar that caused a nuisance or adversely affect beneficial uses, except for possibly in the Reach Downstream of Chili Bar. Bill Center from Camp Lotus and Stafford Lehr of CDFG have reported in the past that, prior to 1997, algal blooms were common in the summer in the Reach Downstream of Chili Bar and were perceived by many recreationists as a problem. The Licensees are unaware of any water quality sampling or narrative records related to this reported occurrence.

In addition, Stafford Lehr reported that there appeared to be an unusual amount of diatomaceous algae in the Junction Dam Reach.

Classification of the UARP reservoirs and the Chili Bar Reservoir by trophic status supports the finding that production is low in the reservoirs. Based on Secchi depth, nitrogen and phosphorus readings, the reservoirs range in trophic status from mesotrophic (moderate nutrient input and organic production) represented best by Chili Bar Reservoir, to oligotrophic (low in nutrient input with low organic production) represented best by Junction Reservoir (Table 4.3.2-2).

Table 4.3.2-2. Trophic Status Index (TSI) based on Secchi Disk, Total Phosphorus, and Total Nitrogen for UARP and Chili Bar Reservoirs, 2002-2003.

Reservoir	TSI Secchi Disk[1]	TSI Total Phosphorus	TSI Total Nitrogen
Rubicon	**[2]	Meso-Oligotrophic	Mesotrophic
Rockbound	Oligotrophic	Oligotrophic	Meso-Oligotrophic
Buck Island	Meso-Oligotrophic	Meso-Oligotrophic	Meso-Oligotrophic
Loon Lake	Oligotrophic	Meso-Oligotrophic	Meso-Oligotrophic
Gerle Creek	Meso-Oligotrophic	Oligotrophic	Oligotrophic
Ice House	Meso-Oligotrophic	Meso-Oligotrophic	Oligotrophic

Table 4.3.2-2. Trophic Status Index (TSI) based on Secchi Disk, Total Phosphorus, and Total Nitrogen for UARP and Chili Bar Reservoirs, 2002-2003.

Reservoir	TSI Secchi Disk[1]	TSI Total Phosphorus	TSI Total Nitrogen
Union Valley	Meso-Oligotrophic	Meso-Oligotrophic	Meso-Oligotrophic
Junction	Meso-Oligotrophic	Oligotrophic	Oligotrophic
Camino	**[3]	Oligotrophic	Oligotrophic
Brush Creek	Meso-Oligotrophic	Mesotrophic	Meso-Oligotrophic
Slab Creek	Meso-Oligotrophic	Mesotrophic	Meso-Oligotrophic
Chili Bar	Mesotrophic	Mesotrophic	Meso-Oligotrophic

1. It should be noted that Secchi depth readings are dependent on other conditions such as cloud cover, wind and rain.
2. Secchi disk was on bottom at Rubicon Reservoir during all sampling events (<3.0 m).
3. One sampling event for Secchi depth at Camino Reservoir.

4.3.2.2 Color

The Basin Plan contains one Water Quality Objective for Color, which states:

> Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

The Aquatic TWG did not require that the Licensees directly measure color, and the Licensees are unaware of any instances where the color of the water in the vicinity of the Projects has been reported as a potential problem.

4.3.2.3 Floating Material

The Basin Plan contains one Water Quality Objective for floating material, which states:

> Water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses.

The Aquatic TWG did not require that the Licensees directly measure floating material, and the Licensees are unaware of any instances where floating material in the vicinity of the Projects has been reported as a potential problem. Note that, as required in the current FERC license for the Projects, the Licensees are required to keep all reservoirs free of floating material.

4.3.2.4 Oil and Grease/MTBE

The Basin Plan contains one Water Quality Objective for Oil and Grease, which states:

> Water shall not contain oils, greases, waxes or other material in concentrations that cause nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

Oils, greases, waxes or other material that can result in a visible film or coating of material in water can be measured as oil and grease (mg/l), gasoline range organics (mg/l), Methyl-t-butyl ether or MTBE (µg/l) and total petroleum hydrocarbons or TPH (µg/l).

The Licensees sampled for oil and grease in all reservoirs during fall turnover and spring sampling periods, and in all reservoirs and stream reaches in the summer. Although, sampling from the reservoir hypolimnia was excluded for oil and grease; as requested by the SWRCB, the hypolimnion was sampled for MTBE. During the sampling events, no evidence of surface sheens that might indicate the presence of oil or grease was observed. All 136 samples analyzed by the Licensees were below the reporting limit of 5 mg/l for oil and grease (Table 4.2.3-3).

Table 4.3.2-3. Summary of Selected Organic Compounds, UARP and Chili Bar, 2002-2003.

Reservoir & Stream	Oil & Grease (mg/l)	MTBE (µg/l)	Gasoline Range Organics (mg/l)	Total Petroleum Hydrocarbons (µg/l)
Number of Samples	136	84	70	14
Percent of Samples Below Reporting Limit	100%	100%	100%	100%
Reporting Limit	<5	<0.5	<0.05	<1

During the fall and spring sampling, the Licensees sampled MTBE from reservoirs on which the use of boat engines is permitted. These included Loon Lake, Union Valley, Ice House and Slab Creek reservoirs. During the summer low flow sampling, the Licensees obtained samples for MTBE from all sampling-sites (reservoir and stream reaches). All 84 samples analyzed by the Licensees were below the reporting limit of <0.5 µg/l for MTBE (Table 4.3.2-3). For comparison, present water quality goals for drinking water (primary maximum contaminant limit) is 13 µg/l (SWRCB 2003).

Total petroleum hydrocarbons were sampled at all reservoir-sites with boat use during the fall turnover and spring sampling events. Gasoline Range Organics were sampled at all sites during the summer sampling. All samples for both parameters were below the reporting limit set at 1.0 µg/l for TPH and 0.05 mg/l for Gasoline Range Organics (Table 4.3.2-3).

4.3.2.5 Pesticides

The Basin Plan includes a lengthy Water Quality Objective for pesticides. However, the Aquatic TWG did not require that the Licensees collect and analyze water quality samples for pesticides. The Licensees would not expect pesticides to be present in the surface waters upstream of Slab Creek Dam Reach since most of this watershed is remote, with little urbanization. The watershed from downstream portion of Slab Creek Dam Reach to Folsom Reservoir receives runoff from urban and commercial areas and pesticides may be present. However, the Licensees do not use pesticides in the operation and maintenance of the Projects, and it is unlikely that the operation of the Projects in any way contribute to pesticides concentration in surface waters.

4.3.2.6 Radioactivity

The Basin Plan includes a lengthy Water Quality Objective for Radioactivity. As with pesticides, the Aquatic TWG did not require that the Licensees collect and analyze water quality samples for radioactivity. The Licensees would not expect radioactivity to be present in the surface waters in the vicinity of the Projects since there are no known sources of radioactivity in the watershed.

4.3.2.7 Sediment

The Basin Plan contains one Water Quality Objective for sediment, which states:

> The suspended sediment load and suspended sediment discharge of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.

In 2002 and 2003, the Licensees collected 208 water quality samples from the UARP reservoirs and reaches and the Chili Bar Reservoir and Reach Downstream of Chili Bar and measured the concentrations of total suspended sediment (TSS) in each of these. In addition, the Licensees recorded Secchi depth readings in the UARP reservoirs and the Chili Bar Reservoir. These data are presented in Table 4.3.2-4.

Table 4.3.2-4. Range of Total Suspended Sediment (TSS) values in UARP reservoirs and reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar based on sampling during 2002 Fall Turnover and First Major Rain events and 2003 Spring Runoff and Summer Low Flow events.

Location	Number of Samples	Range of Total Suspended Sediment Values mg/l
RESERVOIRS		
Rubicon	3	<1-2
Rockbound	4	<1
Buck Island	3	<1
Loon Lake	14	<1
Gerle Creek	4	<1
Union Valley	15	<1-2
Ice House	23	<1-4
Junction	3	<1-2
Camino	3	<1
Brush Creek	3	<1
Slab Creek	7	<1-2
Chili Bar	9	<1-4
REACHES		
Upper Elevation	36	<1-4,18[1]
Middle Elevation	45	<1-6
Lower Elevation	23	<1-2
Reach Downstream of Chili Bar	13	<1-6

[1] Value is above the typical range for the parameter.

Based on this sampling, the Licensees characterized turbidity as low for all reaches and reservoirs, as shown in Table 4.3.2-4. A single outlier value of 18 mg/l occurred on September 17, 2003 on the Rubicon River at the outflow from Rubicon Reservoir. The TSS data is available in Appendix A for each sampling event.

TSS is also related to turbidity, which was also characterized as low, as discussed in Section 4.2.1-7. The Licensees also evaluated project-related sources of sediment in a separate study which identified a limited number of road areas that may require more than normal maintenance to mitigate these areas as potential sources of sediment to project watercourses (Project Sources of Sediment Technical Report, DTA 2005b). Another sediment-related study conducted by the Licensees was a broad geomorphic characterization of the stream reaches affected by the two projects, including the Reach Downstream of Chili Bar (*Channel Morphology Technical Report,* DTA and Stillwater 2005c).

4.3.2.8 Settleable Material

The Basin Plan contains one Water Quality Objective for Settleable Material, which states:

> Waters shall not contain substances in concentrations that result in the deposition of material that causes a nuisance or adversely affects beneficial uses.

The Licensees are not aware of any settleable material in the project-related reaches or reservoirs or of any project-related operations that result in settleable material that could adversely affect beneficial uses. No samples were collected for settleable material.

4.3.2.9 Suspended Material

The Basin Plan contains one Water Quality Objective for Suspended Material, which states:

> Waters shall not contain suspended material in concentrations that cause a nuisance or adversely affect beneficial uses.

The Licensees are not aware of any suspended material in the project-related reaches or reservoirs or of any project-related operations that result in suspended material that could adversely affect beneficial uses. No samples were collected for suspended material; however, the Licensees sampled for turbidity and TSS that are related to suspended material. Turbidity and TSS were both characterized as low in project-affected reservoirs and reaches. Turbidity is discussed in Section 4.2.1-7 and TSS is discussed above in this section.

4.3.2.10 Tastes and Odor

The Basin Plan contains one Water Quality Objective for Tastes and Odor, which states:

> Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.

While no specific criteria attach to this Water Quality Objective, taste and odor criteria are concurrently addressed by Secondary MCLs incorporated by reference via the Chemical

Constituents Water Quality Objective. As discussed in Section 4.3.1, the Licensees analyzed for 5,005 metal values and total cyanide values, of which only 20 of the sampling values (0.3%), three for aluminum and 17 for iron, were greater than the Secondary MCLs. Recall that an additional 46 lead values were above the Primary MCLs.

4.3.2.11 Toxicity

The Basin Plan contains one Water Quality Objective for Toxicity, which states, in part:

> All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Board. The Regional Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, and U.S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective.

To examine whether surface water in the vicinity of the Projects is consistent with this objective, the Licensees examined potential toxicity to aquatic life, and bioaccumulation of metals in fish which could pose a human risk.

Toxicity to Aquatic Life

The USEPA, under 40 CFR § 131.38, has established Criterion Maximum Concentrations (CMC) and Criterion Continuous Concentrations (CCC) for freshwater aquatic life for 23 priority toxic pollutants for the State of California. While these criteria are not included into the Basin Plan directly, they might be inferred under the Toxicity Water Quality Objective. The USEPA (40 CFR § 131.38) defines CMC as the highest concentration to which aquatic life can be exposed for a short period of time without deleterious effects. In comparison, CCC is defined as the highest concentration to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. Both CMCs and CCCs are reported in micrograms per liter (µg/l) of dissolved metal concentrations. Ten of the 14 metals for which SMUD performed analyses have CMC and/or CCC values established under 40 CFR § 131.38. The criteria for six of the metals (cadmium, copper, lead, nickel, silver and zinc) are calculated values based on hardness of the water when the sample was collected since the concentration at which each of these metals is reportedly toxic to aquatic life is lower at lower hardness levels. CMC and CCC levels for these metals in 5 mg/l increments of hardness are presented in Table 4.3.2-5, calculated per 40 CFR § 131, to show the sensitivity of the CMC and CCC to variations in hardness for the six metals.

Table 4.3.2-5. USEPA CCC and CMC freshwater criteria for metals based on hardness. For further explanation and specific equations see 40 CFR §131.38 of the California Toxics Rule.

Metal	Hardness (mg/l)	Dissolved (µg/l) CCC	Dissolved (µg/l) CMC
Cadmium	5	.21	0.15
	10	0.37	0.32
	15	0.50	0.50
	25	0.75	0.89
	50	1.30	1.95
Copper	5	0.69	0.80
	10	1.25	1.54
	15	1.77	2.25
	25	2.74	3.64
	50	4.95	6.99
Lead	5	0.06	1.43
	10	0.13	3.44
	15	0.22	5.77
	25	0.43	11.06
	50	1.04	26.72
Nickel	5	4.12	37.14
	10	7.41	66.75
	15	10.45	94.07
	25	16.10	144.92
	50	28.93	260.49
Silver[1]	5	NA	0.02
	10	NA	0.07
	15	NA	0.13
	25	NA	0.32
	50	NA	1.05
Zinc	5	9.33	9.26
	10	16.79	16.66
	15	23.68	23.48
	25	36.50	36.20
	50	65.66	65.13

1 Criterion for silver is based on the instantaneous maximum, not the CMC.

40 CFR § 131.38 provides absolute criteria (i.e., not calculated as a function of hardness) for arsenic, selenium and cyanide. The 40 CFR § 131.38 CCC and CMC values for mercury as well as CMC values for selenium are "reserved" (i.e., not established by 40 CFR § 131.38 at this time). These criteria are shown in Table 4.3.2-6.

Table 4.3.2-6. USEPA CCC and CMC freshwater criteria for metals and cyanide whose toxicity is not a function of hardness. SOURCE: 40 CFR § 131.38 of the California Toxics Rule.

Parameter	Dissolved (µg/l) CCC	Dissolved (µg/l) CMC
Arsenic	150	340
Mercury	Reserved	Reserved

Table 4.3.2-6. USEPA CCC and CMC freshwater criteria for metals and cyanide whose toxicity is not a function of hardness. SOURCE: 40 CFR § 131.38 of the California Toxics Rule.

Parameter	Dissolved (µg/l)	
	CCC	CMC
Selenium	5.0	Reserved
Cyanide	5.2	22.0

In 2004 water samples from UARP reservoirs, UARP project and non-Project reaches, Chili Bar Reservoir and Reach Downstream of Chili Bar were analyzed for six dissolved metal concentrations (cadmium, copper, lead, nickel, silver and zinc) and hardness. During the 2004 spring, summer and fall sampling events, SMUD collected 56, 64, and 65 water samples, respectively, and analyzed them for dissolved metals for comparison to CCC and CMC criteria. The percent of samples during 2004 measured as dissolved metal concentrations that exceeded the dissolved CCC/CMC criteria are summarized in Table 4.3.2-7. Hardness in UARP reservoirs and Chili Bar Reservoir ranged from approximately 1-9 mg/l. The percent of UARP reservoir samples that exceeded the CCC and/or CMC ranged from 21.7 percent of copper samples, 2.9 percent of cadmium and silver samples (CMC only for silver) to zero percent of nickel or zinc samples exceeding either criteria (Table 4.3.2-7). The percent of Chili Bar Reservoir samples that exceeded the CCC and/or CMC ranged from 50 percent of copper samples, 16.2 percent of zinc samples, 12.5 percent of cadmium samples to zero percent of nickel or silver samples. One snow sample was analyzed in 2004 and it exceeded the CCC and CMC for cadmium, copper, and lead.

Reservoir lead results are not included in Table 4.3.2-7 because the Kemmerer water sampler used to for reservoir sampling in 2004 was confirmed to be a source of lead contamination. The history regarding reservoir sampling devices is as follows. In 2002, reservoir samples were collected using a rented Van Dorn sampler and none of 2002 reservoir samples exceeded MCLs for any metals. In 2003, SMUD purchased, rather than rented, a Van Dorn sampler. Laboratory analysis of the 2003 reservoir samples resulted in a substantial increase in mercury concentrations compared to 2002. To evaluate the potential sources of increased mercury levels from 2002 to 2003, SMUD contacted the supplier of the Van Dorn sampler to inquire about the sampler as a possible source of mercury since elevated mercury levels were present only in 2003 reservoirs samples and not in any reaches. The supplier confirmed that the sampling cups sold for use with the Van Dorn sampler at that time were a source of mercury. To avoid further equipment-related contamination of reservoir samples, the Licensee purchased a new Kemmerer sampler for use in collecting reservoir samples during 2004. Laboratory analysis of 2004 reservoir samples collected with the new sampler show that mercury concentrations decreased to levels similar to that found in streams, however, lead concentrations increased significantly, exceeding the MCL for lead for the first time. A quality-assurance sample collected in the field (i.e., de-ionized-water rinse of the new Kemmerer sampler) during the 2004 spring sampling event yielded a lead concentration of 7.7 µg/l, which suggested the source of elevated lead concentrations in 2004 reservoir samples to be the new Kemmerer sampler. The Kemmerer sampler has since undergone laboratory testing and analysis to confirm this. The laboratory report is attached in Appendix D. Additional evidence to support this observation is that all riverine samples collected below reservoirs have lead concentrations that range from non-detect to 0.3 µg/l, well below MCL limits. Collection of riverine sampling entails filling sample bottles directly from the stream and therefore does not require the use of the Kemmerer depth sampler. If lead concentrations were truly elevated in the reservoirs, as suggested by the 2004 analytical data, then 2004 riverine samples collected just below the dams should have similar lead concentrations as found in the reservoirs, but this is not the case (i.e., lead results for riverine samples are about four orders of magnitude less than the reservoir samples, and well below MCL limits).

Hardness in UARP Project-affected reaches and non-Project reaches ranged from approximately 1-20 mg/l. Hardness in the Reach Downstream of Chili Bar ranged from approximately 7.4 - 12 mg/l. The percent of UARP project reach samples that exceeded the CCC and/or CMC ranged from 33 percent of lead samples to 16.6 percent of copper, 4.5 percent of zinc, 1.5 percent of silver (CMC only), 1.5 percent of cadmium samples to zero percent of nickel samples exceeding either criteria (Table 4.3.2-7). The percent of non-Project reach samples exceeding the CCC and/or CMC ranged from 33 percent of lead samples (CCC only), 3.3 percent of copper, and 6.6 percent of silver (CMC only) samples to zero percent of cadmium, nickel and zinc samples (Table 4.3.2-7). One snow sample was anlyzed in 2004 and it exceeded the CCC and CMC for cadmium, copper, and lead. The percent of samples in the Reach Downstream of Chili Bar exceeding the CCC and/or CMC criteria ranged from 33.3 percent of copper samples and 11 percent of lead samples, to zero percent of cadmium, nickel and zinc samples.

Table 4.3.2-7. Total number of 2004 samples (measured as dissolved concentrations) that exceedthe CCC or CMC criteria for cadmium, copper, lead, nickel, silver, and zinc in UARP Reservoirs and Reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar.

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
		Reservoirs		
UARP Reservoirs				
Cadmium	2	2	69	2.9/2.9
Copper	15	15	69	21.7/21.7
Lead[1]	--	--	69	
Nickel	0	0	69	0/0
Silver	NA	2	69	NA/2.9
Zinc	0	0	49	0/0
Chili Bar Reservoir				
Cadmium	1	1	8	12.5/12.5
Copper	4	4	8	50/50
Lead[1]	--	--	8	
Nickel	0	0	8	0/0
Silver	NA	0	8	NA/0
Zinc	1	1	6	16.2/16.2

Table 4.3.2-7. Total number of 2004 samples (measured as dissolved concentrations) that exceedthe CCC or CMC criteria for cadmium, copper, lead, nickel, silver, and zinc in UARP Reservoirs and Reaches and in Chili Bar Reservoir and the Reach Downstream of Chili Bar.

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
		Riverine		
UARP Project Affected Reaches				
Cadmium	1	3	66	1.5/4.5
Copper	11	11	66	16.6/16.6
Lead	22	0	66	33.3/0
Nickel	0	0	66	0/0
Silver	NA	1	66	NA/1.5
Zinc	3	3	44	4.5/4.5
Non-Project Affected Reaches				
Cadmium	0	0	30	0/0
Copper	1	1	30	3.3/3.3
Lead	10	0	30	33.3/0
Nickel	0	0	30	0/0
Silver	NA	2	30	NA/6.6
Zinc	0	0	20	0/0
Reach Downstream of Chili Bar				
Cadmium	0	0	9	0/0
Copper	3	3	9	33.3/33.3
Lead	1	0	9	11.1/0
Nickel	0	0	9	0/0
Silver	NA	0	9	NA/0
Zinc	0	0	6	0/0

[1] Reservoir samples were contaminated with lead from the Kemmerer sampler and thus lead results showing exceeded values are not valid.

A complete listing of sample dates and locations for exceedences of the CCC and CMC for dissolved metals data are shown in Appendix A-50a for cadmium, copper and lead, and in Appendix A-50b for nickel, silver and zinc.

During the 2002 Fall, 2003 Spring, and 2003 Summer sampling events, the Licensees collected 64, 62, and 66 water samples, respectively, and analyzed them for hardness and for total recoverable concentrations of cadmium, copper, lead, nickel, silver, and zinc. The resulting total recoverable metal concentrations for 2002 and 2003 are compared below to the CCC and CMC criteria which are based on dissolved concentration criteria. Concentrations reported as total recoverable include both the dissolved and particulate fractions of a given metal analyte, therefore, this comparison of total recoverable metal concentrations versus dissolved metal criteria is likely to represent an overestimate of exceedences but is provided here as a conservative indicator of potential CCC and CMC exceedences since dissolved metals data are unavailable for 2002 and 2003.

The percent of samples during 2002 and 2003 measured as total recoverable metal concentrations that exceeded the dissolved CCC/CMC criteria are summarized in Table 4.3.2-8. Hardness in UARP reservoirs and Chili Bar Reservoir during the 2002 and 2003 sampling events ranged from approximately 1-15 mg/l. The percent of UARP reservoir samples exceeding the CCC and/or CMC ranged from 35 percent of lead samples, 21.4 percent of silver (CMC only), and 11 percent of copper samples to zero percent of cadmium, nickel or zinc samples exceeding either criteria. The percent of Chili Bar Reservoir samples exceeding either or both criteria ranged from 22 percent for lead to zero percent for cadmium, copper, nickel, silver or zinc samples (Table 4.3.2-8).

Hardness in UARP Project-affected reaches, non-Project reaches and the Reach Downstream of Chili Bar ranged from approximately 2-20 mg/l. The percent of UARP Project reach samples exceeding the CCC/CMC criteria ranged from 29.5 percent of lead samples to 9.8 percent of copper, 4.2 percent of silver (CMC only), 3.3 percent of cadmium to zero percent of nickel or zinc samples exceeding either criteria (Table 5.3.1-18). The percent of non-project reach samples exceeding criteria ranged from 31.5 percent of lead samples to 10.5 percent of copper, 5.3 percent of cadmium to zero percent of nickel, silver or zinc samples exceeding either criteria (Table 4.3.2-8). The percent of samples from the Reach Downstream of Chili Bar that exceeded the CCC/CMC ranges from 23 percent of lead samples, 20 percent of copper samples and 15.3 percent of silver (CMC only) samples, to zero percent of cadmium, nickel or zinc samples.

Table 4.3.2-8. Total number of 2002-2003 samples (measured as total recoverable concentrations) of cadmium, copper, lead, nickel, silver, and zinc from UARP reservoirs and reaches and Chili Bar Reservoir and Reach Downstream of Chili Bar that exceed CCC or CMC criteria.

Metal	Number of Samples Exceeding CCC[1]	Number of Samples Exceeding CMC[1]	Total Samples	Percent of Samples Exceeding CCC/CMC[1]
Reservoirs				
UARP Reservoirs				
Cadmium	0	0	72	0/0
Copper	8	7	72	11.1/9.7
Lead	29	2	83	35/2.4
Nickel	0	0	72	0/0
Silver	NA	18	84	NA/21.4
Zinc	0	0	47	0/0
Chili Bar Reservoir				
Cadmium	0	0	7	0
Copper	0	0	7	0
Lead	2	0	9	22/0
Nickel	0	0	7	0/0
Silver	NA	0	9	NA/0
Zinc	0	0	5	0/0

Table 4.3.2-8. Total number of 2002-2003 samples (measured as total recoverable concentrations) of cadmium, copper, lead, nickel, silver, and zinc from UARP reservoirs and reaches and Chili Bar Reservoir and Reach Downstream of Chili Bar that exceed CCC or CMC criteria.

Metal	Number of Samples Exceeding CCC[1]	Number of Samples Exceeding CMC[1]	Total Samples	Percent of Samples Exceeding CCC/CMC[1]
		Riverine		
UARP Project Affected Reaches				
Cadmium	0	2	61	0/3.3
Copper	6	5	61	9.8/8.2
Lead	21	0	71	29.5/0
Nickel	0	0	61	0/0
Silver	NA	3	71	NA/4.2
Zinc	0	0	39	0/0
Non-Project Affected Reaches				
Cadmium	0	1	19	0/5.3
Copper	2	1	19	10.5/5.3
Lead	6	0	19	31.5/0
Nickel	0	0	19	0/0
Silver	NA	0	19	0/0
Zinc	0	0	10	0/0
Reach Downstream of Chili Bar				
Cadmium	0	0	10	0
Copper	2	1	10	20/10
Lead	3	0	13	23/0
Nickel	0	0	10	0/0
Silver	NA	2	13	NA/15.3
Zinc	0	0	5	0/0

[1] Total recoverable metal concentrations are compared to the dissolved CCC and CMC.

The complete listing of exceedences of total recoverable metal concentrations compared to the dissolved CCC and CMC are shown in Appendix A-51a for cadmium, copper and lead, and in Appendix A-51b for nickel, silver and zinc.

Bioaccumulation of Metals in Fish

There is no definitive standard for levels of metals concentrations in fish tissue that would pose a human health risk. However, the USEPA and the SWRCB have developed some informal guidelines. The USEPA's guidelines are in the form of screening values (SVs) related to recreational fishing (the form of fishing that occurs throughout the Projects area). One SV is for Target Analytes and one for Defining Green Areas (USEPA 2000). Both are measured as total concentration of metal in fish tissue (filet). The SV for Target Analytes is the *"...concentration of target analytes (in fish or shellfish tissue) that are of potential public health concern and that are used as threshold values against which levels of contamination in similar tissue collected* *from the ambient environment can be compared. Exceedence of these SVs should be taken as an indication that more intensive site specific monitoring and /or evaluation of human health risk should be conducted."* (USEPA 2000). The SV for Defining Green Areas are used to denote areas for unrestricted fish consumption (USEPA 2000). In addition, the National Recommended Water Quality Criteria (USEPA 2002) provides a recommended human health-based criterion for mercury in fish tissue.

The SWRCB's guideline, called Maximum Tissue Residue Levels (MTRL), is similar to the USEPA's Target Analyte SV. The SWRCB uses MTRL as *"...alert levels or guidelines indicating water bodies with potential human health concerns, and are an assessment tool and not compliance or enforcement criteria."* (TSMP 1995). Like SVs, MTRLs are used for comparison to filet (edible tissue) samples only. Criteria for the USEPA and SWRCB guidelines are shown in Table 4.3.2-9.

Table 4.3.2-9. Criteria for trace metals in fish tissue (filet) from USEPA 2000 and 2002, and TSMP 1995.

Constituent	Concentration (ppm)
Arsenic – SV Recreational	0.026 (inorganic)
Arsenic – SV Green Area Recreational	0.026 (inorganic)
Arsenic – MTRL	0.2
Aluminum[1]	
Cadmium – SV Recreational	4.0
Cadmium – MTRL	0.64
Chromium[1]	
Copper[1]	
Lead[1]	
Mercury[2] – SV Recreational	0.4
Mercury[2] – SV Green Area Recreational	0.4
Mercury – MTRL	1.0
Mercury[2] – USEPA 2002	0.3 mg/kg (300 ng/g)
Manganese1	
Nickel – MTRL	28
Selenium – SV Recreational	20
Selenium – SV Green Area Recreational	20
Zinc[1]	

[1] No guideline criteria available from selected literature sources.
[2] Mercury levels for the EPA screening values are for methylmercury.

At least a moderate level of recreational fishing occurs at 6 of the 13 reservoirs: Loon Lake, Gerle Creek, Union Valley, Ice House, Slab Creek and Chili Bar. SMUD collected fish from these reservoirs and analyzed filets for metals covered by the USEPA SVs for recreation (arsenic, cadmium, mercury and selenium) and/or by the SWRCB MTRLs (arsenic, cadmium, mercury, and nickel). Of the 30 filets examined, none had metal concentrations equal to or greater than the SWRCB MTRL values. Two samples exceeded the USEPA SV of 0.026 ppm for arsenic; at Union Valley Reservoir (0.06 ppm) and Ice House Reservoir (0.16 ppm). Two samples exceeded the USEPA SVs for both the Target Analytes and Green Areas of 0.4 ppm for mercury, and three samples exceeded the National Recommended Water Quality Criteria

(USEPA 2002) of 0.3 ppm for mercury: at Gerle Creek Reservoir (brown trout, 0.32 ppm), Union Valley Reservoir (smallmouth bass, 0.42 ppm) and Slab Creek Reservoir (brown trout, 0.59 ppm). However, none of the mercury samples exceeded the SWRCB's MTRL (a value of 1.0 ppm of total mercury). The results of fish tissue metals analysis for the six Project reservoirs are shown in Table 4.3.2-10.

Table 4.3.2-10. Concentration of trace metals in the fillet tissue of fish from selected project reservoirs[1]. Values are reported in parts per million (ppm).

	Silver	Aluminum	Arsenic	Cadmium	Chromium	Copper
Loon Lake	<0.002	0.37	<0.02	0.0080	0.094	0.48
Gerle Creek	<0.002	<0.02	0.028[2]	0.0008[2]	0.093	0.52
Union Valley	<0.002	<0.02	0.06	<0.0004	0.086	0.47
Ice House	<0.002	<0.02	0.16	<0.0004	0.080	0.46
Slab Creek	<0.002	<0.02	<0.02	<0.0004	0.089	0.44
Chili Bar	<0.002	<0.02	<0.02	0.0013	0.066	0.39
	Manganese	**Nickel**	**Lead**	**Selenium**	**Zinc**	**Mercury**
Loon Lake	0.037	<0.001	<0.0004	0.32	4.92	0.137
Gerle Creek	0.0009[2]	<0.001	<0.0004	0.39	3.53	0.321
Union Valley	0.13	0.009	<0.0004	0.21	4.19	0.419
Ice House	0.12	<0.001	<0.0004	0.19	4.32	0.036
Slab Creek	0.012	<0.001	<0.0004	0.086	3.60	0.595
Chili Bar	<0.0006	<0.001	0.0043	0.14	8.05	0.075

1. < denotes the value is below the method detection limit.
2. Value is below the reporting limit but above the method detection limit.

The are no USEPA or SWRCB guidelines for metal concentrations in fish liver tissue. However, the Licensee performed liver-metals analysis for the same fish collected from the six Project reservoirs, and the results are included in Table 4.3.2-11.

Table 4.3.2-11. Concentration of trace metals in the fish liver tissue from selected project reservoirs. Values are parts per million (ppm).

	Silver	Aluminum	Arsenic	Cadmium	Chromium	Copper
Loon Lake	1.74	<0.02	0.38	0.62	0.139	87.8
Gerle Creek	1.86	6.55	1.19	0.83	0.121	126
Union Valley	0.013	21.2	0.12	0.64	0.161	4.11
Ice House	0.22	<0.02	0.099	0.025	0.156	35.3
Slab Creek	0.17	<0.02	0.038	0.029	0.09	9.74
Chili Bar	<0.002	<0.02	0.051	0.019	0.118	2.12
	Manganese	**Nickel**	**Lead**	**Selenium**	**Zinc**	**Mercury**
Loon Lake	1.11	0.015	<0.0024	9.14	25.0	No data
Gerle Creek	0.43	0.034	0.012	30.6	52.6	No data
Union Valley	0.97	<0.001	0.015	0.99	17.8	No data
Ice House	1.47	<0.001	0.0018	0.91	22.9	No data
Slab Creek	1.17	0.007	<0.0004	1.31	27.8	No data
Chili Bar	0.41	0.006	<0.0004	0.72	12.0	No data

5.0 OTHER RELATED STUDIES

5.1 Whitewater Boating Studies

The Licensee conducted three whitewater boating studies for relicensing purposes: on the Slab Creek Reach of the SFAR; on the Ice House Reach of the South Fork Silver Creek; and on the Camino Reach of the South Fork Silver Creek. During the three studies, water temperature, turbidity, and total suspended solids (TSS) were monitored before, during and after the whitewater boating releases. In addition, dissolved oxygen (mg/L) was monitored during the Camino Reach study. The results of water quality monitoring during the whitewater boating studies are summarized below.

5.1.1 Slab Creek Reach Whitewater Boating Flow Study

The 3-day study on the Slab Creek Reach was conducted on October 31, November 1 and 2, 2003, with whitewater flows set at three different levels: 616, 1,068 and 1,597 cfs. Four water quality monitoring sites were selected along the 8.0-mile long Slab Creek Reach. Increases in turbidity, TSS, and temperature were observed as the flows increased, and were followed by a decrease in turbidity and TSS as the flow stabilized at the peak daily flow. Temperature was observed to increase with increasing distance downstream during the study, ranging from an increase of approximately 3°F at the upstream-most monitoring site to an increase of 4.7°F at the downstream-most monitoring site. Turbidity, TSS and temperature decreased as the whitewater flows receded to normal base flows. However a rainstorm occurring the evening prior to and the first day of the study may have influenced the results of the study

The complete water quality results are available in Appendix I of the *Slab Creek Reach Whitewater Boating Flow Study Technical Report* (DTA and LBG, 2005a).

5.1.2 Ice House Dam Reach Whitewater Boating Flow Study

The Ice House Dam Reach study was conducted on May 1, 2004, and whitewater flows were set at approximately 400 cfs. Four water quality monitoring sites were selected along the 11.2-mile Ice House Reach. The monitoring sites located nearest to Ice House Dam experienced a small increase in turbidity and total suspended solids while the lower monitoring sites (i.e., in the Cleveland Fire burn area) showed significant increases in these two parameters. However, the total suspended solids and turbidity decreased as the whitewater flows peaked and as flows receded to normal base flows. Water temperature initially decreased as the test flows began (due to cold water releases from the low-level outlet) but temperature then slowly increased throughout the day with the elevated flows and with increasing distance from Ice House Dam increased due to the effects of diurnal solar heating.

The complete water quality results are available in Appendix I of the *Ice House Reach Whitewater Boating Flow Study Technical Report* (DTA and LBG, 2004).

5.1.3 Camino Reach Whitewater Boating Flow Study

The Camino Reach study was conducted between September 8th and 20th 2004, and whitewater flows were set at approximately 650 cfs during the whitewater boating flow study on September 15th. Three water quality monitoring sites were selected along the 9.0-mile Camino Reach. Samples collected directly below Camino Dam showed that the release did not greatly influence the turbidity near the dam. However, samples taken further downstream just below the Camino Adit and just above the SFAR and SFSC confluence did show significant increases in turbidity. With regards to total suspended solids, samples were taken at two of the three locations (i.e., below Camino Dam and at the Camino Adit site). The total suspended solids measured at the Camino Adit site were 1461% greater than those measured below the dam. Once the flows decreased after peak flows turbidity and total suspended solids returned to pre-boating flow values. There was little difference in the dissolved oxygen concentrations measured before, during, and after the boating flows. During the elevated flows the average water temperature dropped between 4 and 5°F at the Camino Adit and SFAR and SFSC sample sites when compared to the average daily temperatures recorded before and after the study. At the Camino Dam site the average temperature remained consistent with the average temperatures recorded before and after the study. Upon the return of normal flows to the reach, the water temperature within the reach resumed its diurnal pattern.

The complete water quality results are available in Appendix G of the *Camino Reach Whitewater Boating Flow Study Technical Report* (DTA and LBG, 2005b).

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