Application for a New License Major Project – Existing Dam

Upper Yuba River Aquatic Monitoring Plan

Security Level: Public

Yuba River Development Project

FERC Project No. 2246

April 2014

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GLOSSARY - DEFINITION OF TERMS, ACRONYMS AND ABBREVIATIONS

BLM	United States department of Interior, Bureau of Land Management
Cal Fish and Wildlife or CDFW	California Department of Fish and Wildlife, formally California Department of Fish and Game, or CDFG
C.F.R.	Code of Federal Regulations
cm	centimeters
CNDDB	California Natural Diversity Database
DO	Dissolved Oxygen
CFGC	California Fish and Game Code
g	gram
FL	fork length (millimeters)
FLA	Final license application
FPA	Federal power act
FERC	Federal Energy Regulatory Commission
Forest Service	United States Department of Agriculture, Forest Service
ft	feet
FYLF	Foothill yellow-legged frog
GIS	Global Information System
GPS	Global Positioning System
mi	miles
NFS	National Forest System
Plan	Upper Yuba River Aquatic Monitoring Plan
NIST	National Institute of Technology and Standards
NOI	Notice of Intent
PHABSIM	Physical HABitat SIMulation system, part of Instream Flow Incremental Methodology
PNF	Plumas National Forest
Project	Yuba River Development Project, FERC Project No. 2246
QAPP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RSD	Relative stock densities
SWRCB	State Water Resources Control Board
TL	Total length
TNF	Tahoe National Forest
Upper Yuba River	Collectively, the following stream segments: Middle Yuba River from Our House Diversion Dam to the confluence with the North Yuba River; Oregon Creek from Log Cabin Diversion Dam to the confluence with the Middle Yuba River; the North Yuba River from New Bullards Bar Dam to the confluence with the Middle Yuba River and the Yuba River from the North and Middle Yuba rivers to the normal maximum water surface elevation (NMWSE) of Englebright Reservoir.
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VES	Visual encounter surveys
WY	Water year
YCWA	Yuba County Water Agency
YOY	Young-of-year

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SECTION 1.0
INTRODUCTION

In April 2014, the Yuba County Water Agency (YCWA), pursuant to Section (§) 5.18 of Title 18 of the Code of Federal Regulations (C.F.R.), filed with the Federal Energy Regulatory Commission (FERC or Commission) an Application for a New License for Major Project – Existing Dam – for YCWA's 361.9 megawatt (MW) Yuba River Development Project, FERC Project No. 2246 (Project). The initial license for the Project was issued by the Federal Power Commission (FERC's predecessor) to YCWA on May 16, 1963, effective on May 1, 1963. The Federal Power Commission's May 6, 1966, Order Amending License changed the license's effective date to May 1, 1966, for a term ending on April 30, 2016.

YCWA included in its Application for a New License this Upper Yuba River[1] Aquatic Monitoring Plan (Plan).

The United States Department of Agriculture, Forest Service's (Forest Service) Federal Power Act (FPA) Section 4(e) authority only applies in this Plan to monitoring sites on National Forest System (NFS) land. The Forest Service administers the Plumas National Forest (PNF) in conformance with the PNF Land and Resource Management Plan (USDA 1988), as amended, and administers the Tahoe National Forest (TNF) in conformance with TNF Land and Resource Management Plan, as amended (USDA 1990).

1.1 Background

1.1.1 Yuba River Development Project

The Project is located in Yuba, Sierra and Nevada counties, California, on the main stems of the Yuba River, the North Yuba River and the Middle Yuba River, and on Oregon Creek, a tributary to the Middle Yuba River. Major Project facilities, which range in elevation from 280 feet to 2,049 feet, include: 1) New Bullards Bar Dam and Reservoir; 2) Our House and Log Cabin diversion dams; 3) Lohman Ridge and Camptonville diversion tunnels; 4) New Colgate and Narrows 2 power tunnels and penstocks; 5) New Colgate, New Bullards Minimum Flow and Narrows 2 powerhouses; and 6) appurtenant facilities and features (e.g., administrative buildings, switchyards, roads, trails and gages). The existing Project does not include any aboveground open water conduits (e.g., canals or flumes) or any transmission lines.

In addition, the Project includes 16 developed recreation facilities. These include: 1) Hornswoggle Group Campground; 2) Schoolhouse Campground; 3) Dark Day Campground; 4)

[1] For the purposes of this Plan, "Upper Yuba River" means the collective stream segments: Middle Yuba River from Our House Diversion Dam to the confluence with the North Yuba River; Oregon Creek from Log Cabin Diversion Dam to the confluence with the Middle Yuba River; the North Yuba River from New Bullards Bar Dam to the confluence with the Middle Yuba River and the Yuba River from the North and Middle Yuba rivers to the normal maximum water surface elevation (NMWSE) of Englebright Reservoir.

Cottage Creek Campground;[2] 5) Garden Point Boat-in Campground; 6) Madrone Cove Boat-in Campground; 7) Frenchy Point Boat-in Campground; 8) Dark Day Picnic Area; 9) Sunset Vista Point; 10) Dam Overlook; 11) Moran Road Day Use Area; 12) Cottage Creek Boat Launch;[3] 13) Dark Day Boat Launch, including the Overflow Parking Area; 14) Schoolhouse Trail; 15) Bullards Bar Trail; and 16) floating comfort stations.[4] All of the recreation facilities are located on NFS land, with the exception of the Dam Overlook, Cottage Creek Boat Launch and small portions of the Bullards Bar Trail, which are located on land owned by YCWA. All of the developed recreation facilities are located within the existing FERC Project Boundary, except for a few short segments of the Bullards Bar Trail to the east of the Dark Day Boat Launch. In addition, the Project includes two undeveloped recreation sites at Our House and Log Cabin diversion dams, both located on NFS land and within the existing FERC Project Boundary.

Figure 1.1-1 shows the Project Vicinity,[5] proposed Project, and proposed FERC Project Boundary.[6]

[2] Cottage Creek Campground was burned in 2010 and has not been rebuilt. YCWA is in discussions with the Forest Service regarding rebuilding the burned campground.

[3] Emerald Cove Marina provides visitor services at Cottage Creek Boat Launch, including houseboat and boat rentals, boat slips and moorings, fuel and a general store. The marina is operated under a lease from YCWA by a private company.

[4] The Project recreation facilities included one campground that is no longer part of the Project. Burnt Bridge Campground was closed initially by the Forest Service in 1979 due to low use levels. FERC, in an August 19, 1993 Order, which approved YCWA's Revised Recreation Plan, directed YCWA to remove all improvements and restore the Burnt Bridge Campground to the condition it was in prior to development of the facility. YCWA consulted with the Forest Service and all that remains of Burnt Bridge Campground today is the circulation road and vehicle spurs; all other facilities were removed.

[5] For the purpose of this Plan, "Project Vicinity" refers to the area surrounding the proposed Project on the order of United States Geological Survey (USGS) 1:24,000 quadrangles.

[6] The FERC Project Boundary is the area that YCWA uses for normal Project operations and maintenance. The Boundary is shown in Exhibit G of YCWA's Application for New License, and may be changed by FERC with cause from time to time during the term of the new license.

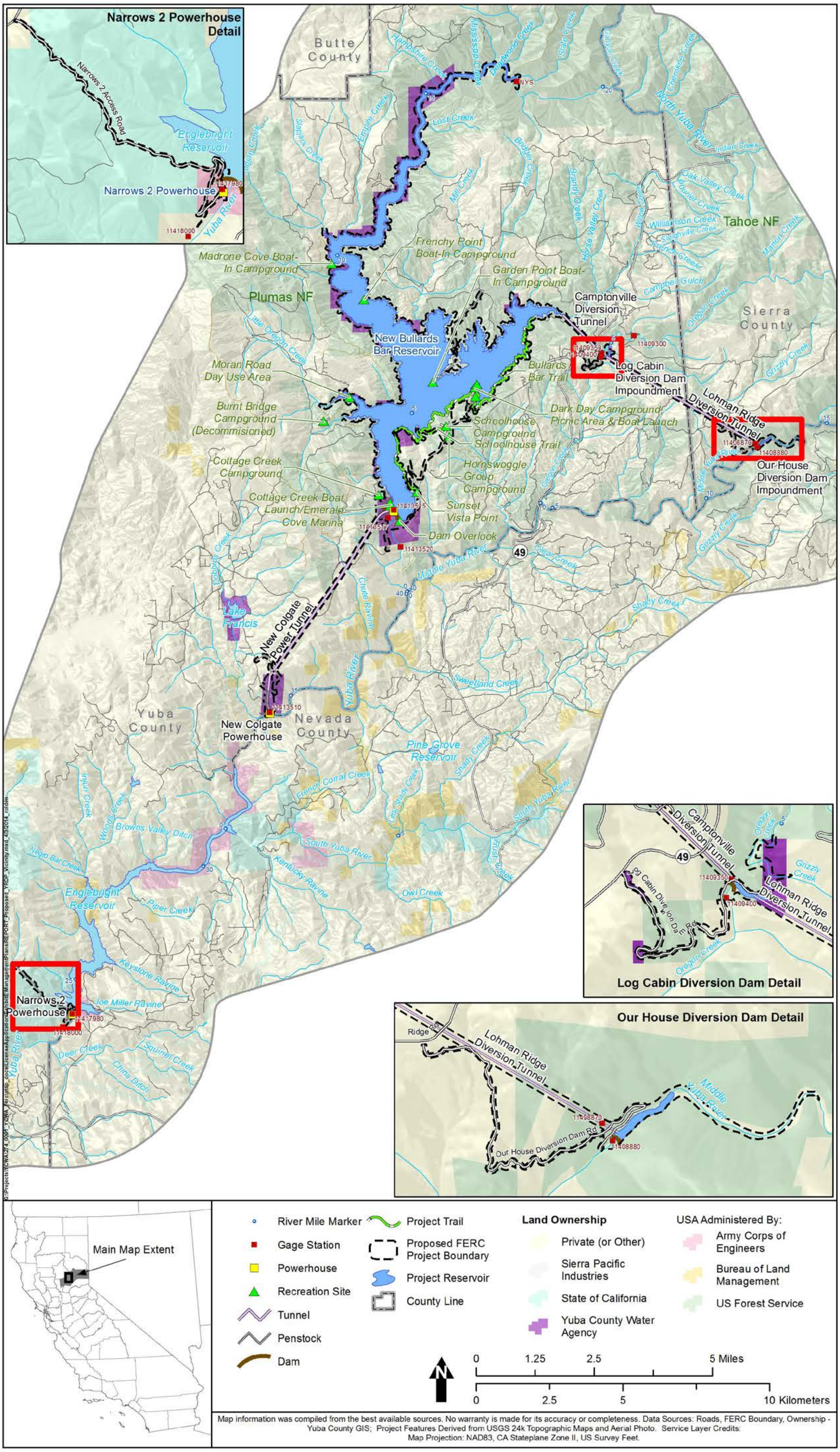

Figure 1.1-1. Yuba County Water Agency's Yuba River Development Project and Project Vicinity.

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1.2 Purpose of the Upper Yuba River Aquatic Monitoring Plan

The Project will operate under new requirements as part of the new license. The purpose of the Plan is to develop information regarding aquatic resources in response to changes in flow conditions from the initial license to the new license.

The Plan does not include adaptive management: that is, the Plan does not provide a mechanism to change terms and conditions in the license based on the results of the aquatic monitoring conducted under the Plan. Since the methods contained in this Plan are similar, the response of aquatic resources to the new license conditions can be inferred by comparing the results of studies performed under this Plan to the results of relicensing studies.

YCWA will coordinate, to the extent appropriate, the efforts required under this Plan with other Project resource efforts, including implementation of other resource management plans and measures included in the new license.

1.3 Goals and Objectives of the Upper Yuba River Aquatic Monitoring Plan

The primary goal of the Plan is to collect data under the new license, relative to previous license conditions, on the distribution, abundance, and condition of stream fish, especially rainbow trout (*Oncorhynchus mykiss*), foothill yellow-legged frogs (FYLF, *Rana boylii*), water temperature, water quality, channel morphology and riparian vegetation. The Plan includes the following objectives to help achieve this goal:

- Describe the Project's river reaches where monitoring will occur
- Identify the resources that will be monitored and the frequency that monitoring will occur
- Describe the methods YCWA will follow to monitor identified resources
- Describe how the collected data will be analyzed to meet the Project goal
- Describe how the data will be made available to agencies and the public
- Describe how this Plan may be revised, as needed

1.4 Contents of the Upper Yuba River Aquatic Monitoring Plan

This Plan includes the following:

- <u>Section 1.0. Introduction.</u> This section includes introductory information, including the purpose and goals of the Plan.

- Section 2.0. Methods. This section describes the methods that will be used to monitor aquatic resources. The methods are divided into the following resource areas: 1) stream fish; 2) FYLF; 3) water temperature; 4) water quality; 5) channel morphology; and 6) riparian vegetation.
- Section 3.0. Monitoring Locations and Frequency. This section describes the location and frequency of monitoring for each resource area.
- Section 4.0. Consultation, Reporting and Plan Revisions. This section details consultation and reporting commitments under the Plan, and how revisions to the Plan, if needed, would be made.
- Section 5.0. References Cited. This section provides a list of the references cited in the Plan.

SECTION 2.0

MONITORING METHODS AND ANALYSIS

This section describes, by resource area, the methods that will be used to monitor aquatic resources.[7]

2.1 Concepts That Apply to All Aquatic Monitoring

The following concepts and practices apply to all aquatic monitoring:

- Personal safety is the most important consideration of each fieldwork team.
- Prior to performing fieldwork, YCWA will obtain all necessary permits and approvals required to perform the fieldwork (e.g., scientific collection permits). All fieldwork will be performed by individuals who hold the necessary current permits to perform the fieldwork.
- All fieldwork will occur under normal operating flow conditions (i.e., requests for variance to minimum streamflow requirements not needed).
- YCWA will make a good faith effort to obtain permission to access private property, where needed, well in advance of entering the property.
- Prior to performing fieldwork, YCWA shall notify the Forest Service; United States Department of Interior, Bureau of Land Management (BLM); USDOI, Fish and Wildlife Service (USFWS); California Department of Fish and Wildlife (Cal Fish and Wildlife); and State Water Resources Control Board (SWRCB).
- YCWA's performance of the monitoring does not presume that YCWA is responsible in whole or in part for measures that may arise from the monitoring.
- Where required, Global Positioning System (GPS) data will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3 meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and YCWA's GIS analyst. Metadata will be developed for GIS data sets.
- YCWA's field crews will record incidental observations of aquatic and wildlife species observed during the performance of the monitoring. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition the specific field tasks identified for

[7] Besides the aquatic monitoring described in this Plan, YCWA's Log Cabin and Our House Diversion Dams Sediment Management Plan requires that, prior to excavating sediment from the Log Cabin Diversion Dam impoundment and the Our House Diversion Dam impoundment, YCWA samples the sediment to be removed for hazardous metals; and that, during sediment excavation in the impoundment, YCWA monitor water entering the creek form the impoundment for turbidity and dissolved oxygen.

the specific study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of the study. In particular, all incidental observations of Western pond turtle (*Actinemys marmorata*) and American bullfrogs (*Lithobates catesbeianus*) will be recorded, and field crews will be trained on the identification of these two species. Any fish species easily distinguishable, but previously not observed in the study reaches will also be noted. The incidental observation records will include the species, location, and an estimate of number of individuals per observation. Records of special-status species observations will be submitted to the California Natural Diversity Database (CNDDB), and included in the appropriate monitoring reports.

- Field crews will be trained on and provided with materials (e.g., Quat) for decontaminating their boots, waders, and other equipment between monitoring sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*). Field crews will adhere to accepted decontamination guidelines to minimize the likelihood of transmitting diseases (USFWS 2005), as appropriate.

- During each monitoring event at each site monitored, except for continuous water temperature monitoring, YCWA will collect *in situ* water quality measurements in flowing water in the center of the stream at one location within the monitoring site. Water temperature (±0.1°C), DO (±0.2 mg/L), and specific conductance (±0.001 micromhos per centimeter [µomhos/cm]) will be measured using a Hydrolab DataSonde 5 or other similar instrument that has equivalent precision and accuracy. Prior to and after each use, the instrument will be calibrated using manufacturer's recommended calibration methods. Any variances will be noted on the field data sheet and final report and recalibration or repair done as necessary. In addition, at the *in situ* site, YCWA will collect water temperature readings using the Hydrolab at the beginning and end of the sampling effort at the monitoring site if the monitoring took more than 3 hours.

2.2 Resources Monitored

2.2.1 Stream Fish

To allow for comparison of post-license issuance stream fish information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling.

2.2.1.1 Field Methods

It is anticipated that all fieldwork will occur in the late September/early October period during daylight hours. For each sampling, general information and habitat/channel metrics will be collected, and transcribed on the appropriate field data sheet. General information will include site identification, crew members, number of shockers and/or snorkelers, date and time, air and water temperature, dissolved oxygen (DO) concentration, specific conductance, weather conditions, and GPS location. Other recorded information will include meso-habitat type, estimated average and maximum depth, estimated average wetted and bankfull width, dominant cover type, estimated percent gradient, estimated percent canopy, estimated flow, dominant and subdominant substrate. Air temperature will be measured by a field thermometer.

Stream fish monitoring will be conducted using a combination of backpack electrofishing and snorkeling methods. The same methods used at a site sampled during relicensing will be used to sample the site during monitoring, as detailed below.

2.2.1.1.1 Electrofishing

In general, electrofishing field methods will use procedures identified by Meador et al. (1993), Reynolds (1996), and Temple and Pearsons (2007). Electrofishing manpower needs will follow Temple and Pearsons (2007), who recommend one backpack electrofishing crew for streams less than 7.5 meters (m) wide and two backpack electrofishing crews for streams from 7.5 to 15 m wide. In streams wider than 15 m, the number of electrofishing crews will be increased as necessary to ensure effective fish sampling. Multiple pass depletion sampling (i.e., generally a minimum of three passes, with a maximum of six passes if judged necessary by the field crew leader and if that can be accomplished at the site in the same day) with backpack electrofishing equipment will be used with the goal of obtaining population estimates with less than a 10 percent standard error.[8] The backpack electrofishing units used will be Smith-Root Model Type 12 and Model 24, or similar equipment.

The upstream and downstream ends of the sample sites will be blocked with 0.25- or 0.37-inch (in) diameter mesh block nets spanning the full width and depth of the stream, except where an upstream fish passage barrier obviates the need for head-end blocking. If necessary, salt blocks will be placed in the stream immediately above the electrofishing station to increase electrical conductivity. Salt blocks will generally be used when fish are observed escaping the direct path of the electric field generated by the electrofishing unit at elevated settings or when specific conductivity is below 40 to 50 µomhos/cm.

Collected fish will be retained in aerated buckets or plastic tubs until each pass is completed. When encountered with large numbers of fish where sedation is necessary for safe and efficient handling, a sedative will be used. Measures to ensure that sampling activities minimize the potential for injury or mortality to aquatic organisms will include aeration, addition of PolyAqua® (i.e., a water conditioner and complex polymucosaccharide) to the holding water, frequent water changes, and strict limits on maximum fish holding densities. Numbers of any fish that die during collection and holding will be recorded.

All collected fish will be identified to species and counted. Each fish will be measured to the nearest millimeter fork length (FL) or total length (TL), if appropriate, and weighed with a digital scale to the nearest 0.1 gram (g). Fish will then be held in small portable net pens until

[8] The intent is to conduct at least three passes and obtain good population estimates for the dominant fish species. In situations where a poor removal pattern occurs for a given species (e.g., 1 fish in pass one, 0 fish in pass two, and 1 fish in pass three) YCWA is not required to conduct four or more passes. The field crew leader will be responsible for determining the total number of passes.

ready for release in the vicinity of the sampling area. Fish condition (e.g., spinal trauma, burning and parasites) will be recorded prior to release.

The first time electrofishing occurs at a site, YCWA will collect scale samples from a subsample of rainbow trout and brown trout each for validating length-age indices. Specifically, YCWA will collect scale samples from up to three fish of that species in the 75-140 FL range, up to three fish in the 150 to 220 FL range, up to three fish in the 221 to 300 FL range, and from all fish larger than 301 FL. Thereafter, YCWA will repeat this process every fourth sampling event at that site.

2.2.1.1.2 Snorkeling

Snorkeling will be conducted at fish population sites that are not conducive to electrofishing because of water depth, current velocity, and other physical considerations (e.g., safe access). Snorkeling will also be conducted in addition to electrofishing at locations where the entire sampling site cannot be surveyed by electrofishing alone, primarily due to excessive depths of some pools. To census fish at combined method sites, the electrofished and snorkeled sections will be blocked off and separated from one another with block nets; therefore, the two differently surveyed sections can be considered independent sample units for subsequent abundance estimation and analysis.

In general, snorkeling techniques will follow those outlined by Thurow (1994), Dolloff et al. (1996), and O’Neal (2007). The snorkeling surveys will be scheduled during the middle of the day to minimize periods when canyon walls or riparian vegetation shade the stream. The number and width of snorkeling lanes will be determined by the width of the wetted channel and visibility at each sample site. Sites will range from 4 m to 24 m in width, which generally will have 1 to 5 lanes of snorkelers. Snorkeling lanes will run the full length of the sample site. One observer will be assigned to a single lane to record species, size, and abundance. Fish will be identified, counted, and visually categorized into predefined 2-in length classes (e.g., ≤2, 2–4, >4–6, …, >14 in). Observers will calibrate their fish length determination by viewing painted wooden dowels with 2-in-length increments underwater and periodically comparing length estimations with other crew members and crew leads. Visual estimates of fish lengths in inches will later be converted to millimeters during data entry for comparison with measured FL and reporting.

Maximum visual distance for accurate determination of fish species will be recorded on the field data forms. Three or more replicate snorkeling surveys will be performed using the same observers to assess efficiency, obtain an estimate of survey variance, and determine a level of confidence for use in abundance estimation (Hankin and Reeves 1988; Slaney and Martin 1987; Snedecor and Cochran 1980). In most cases, replicate surveys will be conducted no sooner than 1 hour after the initial survey to allow for fish to resume undisturbed positions and activity within the site. An exception to the 1-hour interval between survey passes may be made for smaller, isolated pools where fish movement is unlikely, or when light conditions limit the period of maximum visibility.

2.2.1.2 Data Analysis

Following a quality assurance/quality control (QA/QC) review, field data will be entered into and organized in a Microsoft™ Excel spreadsheet, or a similar spreadsheet format, and will have an additional QA/QC review after data entry. Some parameters may be analyzed in Excel, or a similar spreadsheet format, while other parameters will be analyzed using published public domain scientific software for calculating stream fish population statistics. While all species will be recorded, small sample sizes of some species may limit some statistical analyses. Specific metrics are described below.

Each site will be compared with prior sampling results for that site. The discussion will focus on changes in fish composition, density, and age-class structure in relation to water year (WY) type as defined in the license for the reach in which the monitoring occurred, water temperature, operations, or other pertinent Project-related factors. Attachments to the monitoring report will include datasheets, maps of sample locations, and a digital database of entered data.

2.2.1.2.1 Age Structure

Analysis matrices will be based on age classes. Existing length-age indices and scale samples will be used to determine the age class. Length-age indices are relatively accurate for smaller fish; however, confidence intervals reduce with larger fish. Regression analysis will be used to analyze the data and if necessary, adjust the indices. All age classes will be indicated to the extent possible based on the length-frequency histograms and scale samples.

2.2.1.2.2 Fish Populations and Biomass

Standing stock estimates in terms of fish population numbers and biomass will be calculated by species, including young-of-the-year (YOY) and age 1 and older age groups for each monitoring station and analyzed by age class. Electrofishing data will be analyzed using a scientific software package (e.g., Microfish or other similar program). Capture probabilities (i.e., the proportion of fish captured on a given electrofishing pass), size statistics, and biomass will be generated for each sample site using fish capture data. Biomass will be calculated based upon total weight measured for each species. Standing stock estimates will be reported as: 1) numbers and weight (g) of fish by species per 100 m of stream; 2) numbers of fish by species per mi; 3) pounds of fish by species per acre of stream surface; and 4) kilograms of fish by species per hectare of stream surface.

Fish population analysis will include species composition, relative abundance, and an analysis of size structure based on relative stock densities. To provide an index of size structure for each site, traditional relative stock densities (RSD) of each species will be calculated. The RSD will be presented on a scale of 0 to 100 (Anderson and Neumann 1996). RSD will be calculated as the proportion of fish sampled greater than 6 in (i.e.: RSD = (# of fish >6-in in sample) / (# of fish in sample) x 100). The 6-in length was chosen because it is often used as the smallest size of fish that is desired by anglers.

2.2.1.2.3 Fish Size and Condition

Fish size and weight data will be summarized by species and by sample site. Standard scientific software outputs including minimum, maximum, and mean FL and weight will be calculated. Length and weight data will be used to calculate a relative condition factor (K_n) (Anderson and Gutreuter 1983) and to provide a general indication of the health of individuals, where factors greater than 1 indicate more healthy individuals. Relative condition factors for electrofishing sites will be calculated for length and weight data collected at all quantitative electrofishing sites.

2.2.2 Foothill Yellow-Legged Frog

To allow for comparison of post-license issuance FYLF information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling.

2.2.2.1 Field Methods

At each location selected, VES will be conducted to determine the distribution and relative frequency of FYLF individual detections. Surveys will generally follow the VES protocols described in Seltenrich and Pool (2002), except that microhabitat data will be collected as shown in the data sheets in Attachment D.

Specifically, two surveyors working in tandem will search stream banks, back channel areas, and potential instream habitats for FYLF walking slowly while one observer scans ahead 30 to 60 ft. To aid in the detection of FYLF eggs and larvae, surveyors will use a viewing box in shallow margin areas. In water too deep to survey by wading, snorkeling will be employed in appropriate habitats during searches where safely accessible. Observations of post-metamorphic individuals (i.e., juveniles and adults) will be recorded during each survey, and the surveyors will scan upstream for frogs basking on exposed substrates or partially hiding under cover, although cover objects will not be routinely turned during searches.

The surveyors will record the number, size or estimated size, life stage, and geographic coordinates of each FYLF observed, except where the number of tadpoles or post-metamorphic young-of-year occur are too numerous to measure individually. In the latter cases, a subset of tadpoles will be measured in TL with a hand ruler and classified by developmental stage according to the 46-stage Gosner (1961) system simplified stages as follows: 1) no legs; 2) rear legs; 3) rear legs and front limb buds; or 4) legs fully grown, but with tail. At least 10 post-metamorphic YOY from different parts of the site, will be measured, if found.

The locations of site boundaries (i.e., start and end points of sampling areas) will be recorded using a GPS instrument. To document representative conditions at the site, during each survey at least one photograph will be taken from the top of the site looking downstream; one from the bottom of the site looking upstream; and several facing upstream and downstream from the middle of the site. The geographic locations of these photo-points will be recorded. Additional photographs will be taken to document typical edgewater and backwater habitats, examples of breeding habitat (i.e., occupied or otherwise), and any other interesting or unique habitat features. Photo file names will include the stream reach, time, date, and the mean daily streamflow as recorded for that date from the nearest upstream gage. This file name data will be included with photos published in the report.

Three survey visits will be conducted at each site during a year when monitoring occurs: two visits in the spring/early summer will be for the detection of eggs and early tadpoles, and one in the late summer/early fall to detect older tadpoles and recently metamorphosed frogs. To ensure that the survey schedule coincides with the FYLF breeding season in stream reaches where surveys will occur, stream temperatures will be monitored at selected locations, including at least some of the survey sites, prior to the anticipated commencement of surveys. In addition, one or more inspections for evidence of impending FYLF breeding will be performed at the same or other selected locations at which FYLF breeding had been previously documented. These "sentinel site" inspections will include searches for egg masses and FYLF in breeding condition. The specific location of the sentinel sites will be determined by YCWA. The first spring survey visit will occur after water temperature monitoring data indicate that temperatures have reached a daily average of 10º Celsius (ºC) in the reach to be monitored and there is a corresponding reduction in spring high flows.

2.2.2.2 Data Analysis

VES results will be summarized after each sampling season. At a minimum, the following summaries/data presentations will be provided, along with the supporting data (in Excel spreadsheet, or a similar spreadsheet format, and GIS layers, as appropriate):

- Information on survey effort (length and area surveyed, and duration of each survey) and timing
- Number of FYLF by lifestage (egg mass, early stage tadpole, late stage tadpole, YOY, juvenile, and adult) at each site during each survey visit and total numbers each year
- Number of egg mass detections and stage of development (Gosner 1960) plotted by survey date
- GIS maps showing the number and locations of FYLF detections
- Tables and graphs that relate FYLF survey results to the nearest available streamflow, stage and water temperature data for individual survey dates and the survey year

A discussion of the findings will be presented from the data analysis. The discussion will focus on observed changes or trends in the abundance and population structure, and life stage timing from current and past monitoring for each site in relation to water year, water temperature, operations, or other pertinent Project-related factors. This will include reviewing flow information for high-flow fluctuations based using the nearest streamflow monitoring gage to the monitoring site.

2.2.3 Water Temperature

To allow for comparison of post-license issuance water temperature information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling at selected sites.

In addition, YCWA staff will collect instantaneous *in situ* water temperature readings as part of the Stream Fish monitoring (Section 2.2.1) and FYLF monitoring (Section 2.2.2). Readings will be taken once at each sampling location.

2.2.3.1 Field Methods

YCWA will maintain continuous water temperature recorders at USGS stream flow gaging sites downstream of Project dams. The water temperature recorder probe will be located in the gage pool, in moving water, and will be mounted in a galvanized steel conduit running from the gage house to the gage pool. Data will be collected at 15-minute intervals by means of a Waterlog H-350 XL Instrument, or similar instrument. The water temperature probe will be calibrated monthly using a hand-held digital thermometer. If the temperature difference is greater than ±0.3°C, the water temperature recorder will be adjusted to match the hand-held thermometer reading. Data will be stored in the water temperature recorder and downloaded monthly to a USB or CF card and backed up in the field. Data will be uploaded to YCWA's servers upon returning to the office for analysis and QA/QC.

2.2.3.2 Data Analysis

2.2.3.2.1 Perform QA/QC Review of Data

Following data collection, YCWA will subject all data to QA/QC procedures including, but not limited to: 1) spot-checking data; and 2) reviewing recorder readings and electronic data for completeness. The datasets will also be reviewed graphically to check for errors. If any data seems inconsistent during the QA/QC procedures, YCWA will investigate the problem. Values that are determined to be anomalous will be removed from the database if the reason for the reading cannot be identified.

If data are unavailable for brief periods of the record, the missing data will be synthesized into the record using a straight line interpolation method, and the data will be indicated as "synthesized" in the record and all subsequent summaries.

The raw data files will be retained by YCWA in their unaltered state for future QA/QC reference, for a minimum period of 3 years. Any data modified in the final record will be so indicated in the record.

2.2.3.2.2 Data Analysis

Water temperature monitoring results will be summarized after each water year (i.e., after October 1). At a minimum, the following summaries/data presentations will be provided, along with the supporting data (in Excel, or similar spreadsheet format, and GIS layers, as appropriate):

- Information on monitoring effort: date when monitoring started and stopped (i.e. monitoring devices were installed and removed, if applicable) and description of any time periods when monitoring devices were not functioning, during the expected monitoring period
- Graphs comparing water temperature, streamflow and air temperature from the nearest appropriate streamflow gage or weather station
- A discussion of the findings will be presented from the data analysis in relation to water year type, operations, or other pertinent Project-related factors. The discussion will also include any anomalous events.

2.2.4 Water Quality

To allow for comparison of post-license issuance water quality information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling at selected monitoring sites.

In addition, YCWA will collect instantaneous *in situ* water quality readings as part of the Stream Fish monitoring (Section 2.2.1) and FYLF monitoring (Section 2.2.2) using a Hydrolab DataSonde 5 or other similar instrument that has the same precision and accuracy. Parameters to be recorded will include temperature, DO, specific conductance, pH, and turbidity.

2.2.4.1 Field Methods

Water quality samples will be analyzed for the analytes listed in Table 2.2-1.

Table 2.2-1. List of chemical parameters to be sampled at each site including method, reporting limit and hold time.

Analyte		Method	Target Reporting Limit/ Method Detection Limit ug/L (or other)	Hold Time
BASIC WATER CHEMISTRY- IN SITU				
Stream Flow (at stream monitoring sites only)	--	USGS/Licensees measured flow, or estimate if measured flow not available	--	--
Temperature	--	170.1	0.1 °C	Field
Dissolved Oxygen	DO	SM 4500-O	0.1 mg/L	Field
Specific conductance	--	SM 2510A	0.001 µmhos	Field
pH	--	SM 4500-H	0.1 su	Field
Turbidity	--	SM 2130 B	0.1 NTU	Field
BASIC WATER CHEMISTRY—LABORATORY				
Total Organic Carbon	TOC	SM 5310 D	0.5/0.1	28 d
Dissolved Organic Carbon	DOC	SM 5310 D	0.5/0.1	28 d

Table 2.2-1. (continued)

Analyte		Method	Target Reporting Limit/ Method Detection Limit ug/L (or other)	Hold Time
BASIC WATER CHEMISTRY—LABORATORY (continued)				
Total Dissolved Solids	TDS	SM 2540 C	1 mg/L	7d
Total Suspended Solids	TSS	SM 2540 D	1 mg/L	7d
INORGANIC IONS				
Total Alkalinity	--	SM 2320 B	1000/846	14 d
Hardness (measured value; as $CaCO_3$)	--	SM 2540 C	2000/990	14 d
Calcium	Ca	USEPA 6010 B	100/9	180 d
Magnesium	Mg	USEPA 6010 B	100/3.2	180 d
Potassium	K	USEPA 6010 B	500/56	180 d
Sodium	Na	USEPA 6010 B	500/19	180 d
Chloride	Cl	USEPA 300.0	1000/54	28 d
NUTRIENTS				
Nitrate-Nitrite	--	USEPA 300.0	100/27	28 d <pH 2
Total Ammonia as N	--	SM 4500-NH3	100/94	28 d <pH 2
Total Kjeldahl Nitrogen as N	TKN	SM 4500 N	500//455	28 d <pH 2
Total phosphorous	TP	SM4500 P	30/22	28 d <pH 2
Dissolved Orthophosphate	PO_4	USEPA 300.0	100/52	48 h at 4 °C
METALS (total and dissolved)				
Arsenic (total and dissolved)	As	USEPA 200.8/1638	0.5/0.17	180 d
Cadmium (total and dissolved)	Cd	USEPA 200.8/1638	1/0.015	180 d
Copper (total and dissolved)	Cu	USEPA 200.8/1638	1/0.02	180 d
Chromium, Total (total and dissolved)	Cr	USEPA 200.8/1638	1.0/0.02	180 d
Iron (total and dissolved))	Fe	USEPA 200.8/1638	100/2.1	180 d
Aluminum (total and dissolved))	Al	USEPA 200.8/USEPA 1638	50/1.9	180 d
Lead (total and dissolved))	Pb	USEPA 200.8/USEPA 1638	1/0.013	180 d
Mercury (total)	Hg	YSEPA 1631	0.0002	28 d
Methylmercury (total and dissolved)	CH_3Hg	USEPA 1630	0.005	90 d
Nickel (total and dissolved))	Ni	USEPA 200.8/1638	1.0 /0.02	180 d
Selenium (total)	Se	USEPA 200.8/1638	1/0.78	180 d
Silver (total and dissolved))	Ag	USEPA 200.8/1638	1/0.02	180 d
Zinc (total and dissolved))	Zn	USEPA 200.8/1638	5/0.34	180 d

The Quality Assurance Program Plan (QAPP) prepared by YCWA for relicensing shall be used during data acquisition and synthesis and is provided as part of Attachment G. Both field and laboratory methods will be used to collect the data. Water temperature (±0.1°C), DO (±0.2 mg/L), pH (±0.2 standard unit, or su), specific conductance (±0.001 μomhos/cm), and turbidity (± 1 NTU), will be measured *in situ* using a Hydrolab DataSonde 5 or other similar instrument that has the same precision and accuracy. Prior to and after each use, the instrument will be calibrated using manufacturer's recommended calibration methods. Any variances will be noted on the field data sheet and final report and recalibration or repair done as necessary. Field staff will note relevant conditions during each sampling event on the field data sheet (i.e., air temperature, flow, description of location, floating material, and evidence of oil and grease) and will take photographs documenting the sampling location. Sampling equipment will be thoroughly cleaned between sampling sites.

Laboratory samples will be grab-samples collected into laboratory-supplied clean containers. Water samples to be analyzed for metals will be taken using "clean hands" methods consistent with the United States Environmental Protection Agency's (USEPA) Method 1669 sampling protocol *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria* (USEPA

1995). Samples requiring filtration before metals analysis will be filtered in accordance with standard protocols; whether filtering is done in the field or the laboratory, samples will be filtered with a 0.45 micro millimeter (µm) diameter pore-membrane filter, prior to preservation. All sample containers will be labeled with the date and time that the sample is collected, sampling site or identification label, and handled in a manner consistent with appropriate chain-of-custody protocols. The sample container will be preserved (as appropriate), stored and delivered to the laboratory for State of California-certified analyses (as appropriate) of the parameters listed in Table 2.2-1 in accordance with maximum holding periods for each parameter. A chain-of-custody record will be maintained with the samples at all times. The sampling site location will be recorded using a GPS unit and the coordinates will be recorded in a field logbook. Sampling equipment will be thoroughly cleaned between sampling sites.

As part of the field quality assurance program, field blanks and equipment rinsates will also be collected and submitted to the State-certified laboratory for analysis. A field blank is a sample of analyte-free water poured into the container in the field, preserved and shipped to the laboratory with samples. A rinsate is a sample of analyte-free water poured over or through decontaminated field sampling equipment prior to the collection of samples.

Laboratory analyses will be conducted using USEPA Standard Methods or the equivalent, sufficiently sensitive to detect and report at levels necessary for evaluation against State and federal water quality standards. For analytical methods certified by the State of California, a State-certified laboratory will prepare and analyze water samples for the surface water analytical parameters described in Table 2.2-1. All monitoring results will be reported at or above the reporting limit: no "J qualified" or estimated quantities will be reported.

2.2.4.2 Data Analysis

All data will be verified and/or validated in accordance with the QAPP. In brief, following field surveys and laboratory analysis, which includes the laboratories' own QA/QC analysis, YCWA will subject all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of GIS maps with field notes on locations; comparison of results to field blank and rinsate results; and identification of any data that seem inconsistent. If such inconsistent data is found, YCWA will consult with the laboratory to identify any potential sources of error before concluding that the data is correct. Assembled data and supporting QA information will be organized into tables and attachments.

2.2.5 Channel Morphology

To allow for comparison of post-license issuance channel morphology information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling at selected sites.

2.2.5.1 Field Methods

2.2.5.1.1 Establish Cross Sections

YCWA will locate channel morphology sampling sites where previously established during YCWA's relicensing channel morphology or instream flow studies by identifying original re-bar or headpins or GPS coordinates of headpins used to measure cross-sections at the monitoring site, to the extent possible. If "permanent" cross-sections were not established at the site during relicensing studies, YCWA will establish "permanent" transects by monumenting ends of the cross section with bedrock headpins or rebar and taking a GPS coordinate of each headpin. In addition, YCWA will establish a benchmark for each transect so that if headpins or tailpins are lost, elevations can be still be re-established. The cross sections will incorporate the width of the alluvial valley. The floodprone zone (i.e., the width of the water level at twice the maximum bankfull depth) will be included as part of the cross section (Dunne and Leopold 1978; Rosgen 1996). The cross sections established during the initial setup and monitoring will be used during subsequent monitoring. Additional data collected at each cross section will include: 1) water surface elevation; 2) thalweg; 3) breaks in slope; 4) bankfull location; 5) floodprone location; and 6) at least 30 locations between bankfull and every 4 ft beyond bankfull to edge of the alluvial valley, unless there is a restriction that inhibits the extent of the survey, e.g., private land.

2.2.5.1.2 Wolman Pebble Count on Transect

YCWA will measure at least 200 particles within the bankfull channel at each cross section using a gravelometer to measure the particle, so that particles will be recorded as "finer than" (i.e., each particle will fall through an opening; the size of the opening the particle falls through will be recorded). The location from which each particle was measured will be recorded.

2.2.5.1.3 To-scale Site and Facies Map

YCWA will, from 30 ft below the most downstream cross section to 30 ft above the uppermost cross section at the site, draw a to-scale map identifying locations of transects, bedrock, bankfull flow, and facies (i.e., areas with collections of like-particles). Facies will be defined by dominant and sub-dominant particle type (e.g., boulder, cobble, gravel) according to the modified Wentworth scale. YCWA will perform a Wolman pebble count on each facies.

2.2.5.1.4 Residual Pool Depth

YCWA will measure residual depth in pools within the site that meet the minimum criteria set by Pleus et al. (2009).

2.2.5.1.5 Bank Erosion

YCWA will assess bank erosion using stream bank erosion methods as set out in Rosgen (1996). YCWA will establish types of banks by classifying into categories (e.g., vertical, silt, vegetated; or 45 degree angle, cobble, sparse vegetation) and assess variables that include the ratio of streambank height to bankfull stage, ratio of riparian vegetation rooting depth to streambank height, rooting density, the composition of streambank materials, streambank angle, bank material stratigraphy and presence of soil lenses, and bank surface protection afforded by debris and vegetation. YCWA will note the location of the bank types on the site map.

2.2.5.1.6 Channel Stability

YCWA will classify the channel into form types (e.g., alluvial and self-formed or bedrock and imposed channel form) and evaluate channel stability using the Pfankuch (1975) checklist. A numerical value will be assigned based on the answers to a suite of questions about upper and lower banks, and the stream substrate. This numerical value will be converted to a bank condition by stream type (i.e., "Excellent" to "Poor"); each site would then have a range of values that represent the site condition. YCWA will note the location of the channel types on the site map.

2.2.5.1.7 Photographs

YCWA will take digital photographs from each endpoint of each transect (i.e., from valley wall and near-channel endpoints) from downstream looking upstream at each transect, and from upstream looking downstream at each transect. Additional photo points may be established at features particularly likely to change over time, such as mid-channel or lateral bars composed of 64 mm particles or less. YCWA will monument the photo point and state the azimuth the camera is pointed from photo point to object, and describe what is shown in the photo.

2.1.5.1.8 Fine Particles in Spawning-size Gravel

Particle size distribution and fine sediment content of potential resident rainbow trout spawning gravels will be determined using bulk sampling techniques (McNeil and Ahnell 1960). Three bulk samples will be collected within suitable gravel patches using a modified McNeil sampler (i.e., bottomless bucket; based on design presented by Watschke and McMahon [2005]). Samples will be taken to a depth of 10 to 15 centimeters (cm), which approximates the depth of a rainbow trout egg pocket in a redd (Watschke and McMahon 2005). All sampled sediments will be placed in a woven plastic bag that allows drainage of water and a slight amount of the wash load (i.e., particles less than 2 mm), and delivered to a lab for dry-sieve analysis.

2.2.5.2 Data Analysis

Cross section, pebble count, bank erosion, channel stability, and residual pool depth data will be entered into and organized in a Microsoft™ Excel workbook. The area that is contained within each facies will be quantified using the to-scale map. Reach-average D_{50} and D_{50} of each facies and transect will be estimated, along with a particle size distribution. Reach-averaged D_{50} will be calculated by estimating the area for each facies, multiplying the fractional area of the facies by the D_{50} of that facies, and summing the products for the reach.

Particle size composition of spawning-size gravel samples will be plotted as cumulative distribution curves and frequency histogram. Particle size composition as represented by the D_{16}, D_{50}, and D_{84} will be determined from the frequency histogram and cumulative distribution curve. Raw data results for each sample (i.e., three per site; taken from one to three locations within the site) will be presented in the graphs and tables. Photographs will be organized into a Microsoft™ Word document.

Each site will be compared with prior sampling results for that site, but comparisons will not be made among sites. The comparison will focus on changes in cross section, channel location and orientation, substrate, channel or bank stability, pool depth, fine material in spawning-sized gravel, or other pertinent Project-related factors that affect the site.

2.2.6 Riparian Vegetation

To allow for comparison of post-license issuance channel morphology information with pre-license issuance information, the post-license issuance monitoring will use the same methods as the pre-license issuance sampling at selected sites.

2.2.6.1 Field Methods

Information collected along each vegetation transect will include two types of plots: 1) herbaceous vegetation (a plot 1 meter square), and 2) woody vegetation (trees and shrubs) (a plot 5 by 2 meter). Plots will be nested, with herbaceous and other cover plots occurring within the woody vegetation plots. More than one herbaceous and other cover plot may be located within a woody plot. Both the woody and herbaceous cover plots will be located perpendicular to transects, and located on the downstream side of the transect. At a minimum, each transect will have at least two nested plots: one woody plot on each side of the stream at the start of vegetation, and within each woody plot, two herbaceous plots located side by side. Additional fluvial features (i.e., floodplains and terraces) that are at least two meters wide and are intersected by a vegetative transect will have a minimum of one nested plot. The following information will be collected in the plots:

- Herbaceous vegetation
  - All vascular plant species cover in percent; woody species to be estimated at base of trunk/stem
  - List all species present in each plot and provide an indication of whether they are native and/or special-status or rated as an A or B species by California Integrated Pest Control
  - Woody riparian species seedlings (less than one meter tall) or recruits (greater than one meter tall but less than three inches in diameter at breast height (dbh)
  - USACE national wetland indicatory status of each species
- Woody vegetation
  - Over-story canopy coverage class in percent
  - Dominant species coverage in percent
  - Stem count per species
  - Tree (greater than three inches at dbh, regardless of height) dbh

- Dominant species relative decadence in percent
- Open ground or other cover in percent (i.e., boulders, open water, or large woody material)
- USACE national wetland indicatory status of each species
- Photograph of the plot

2.2.6.2 Data Analysis

The data collected for monitoring will require the comparison of the percent coverage of the woody riparian strata from each year to the first year of monitoring to determine if changes greater than 20 percent occurred during the time period since the last monitoring. All of the information collected from the vegetation transects will be used to determine changes over time in lateral distribution of riparian species; richness; and abundance, by comparing the species lists from each nested plot. Different flow stages that occurred during the time period since the last monitoring will be graphically illustrated along the surveyed transects with the results of the vegetation composition data. The ratio of woody riparian seedlings/young to mature individuals will be calculated as one measure of riparian health. Other observations of riparian health, such as premature leaf drop, insect infestation, trampling from animals or people, and disease will also be documented and reported. Of particular interest will be the presence/absence of woody riparian recruits in areas with substrates capable of supporting them (e.g., a bedrock bank is unlikely to support recruits, whereas a sandy bank is more likely to allow for germination).

During each monitoring period, the hydrology, climate, and other environmental factors that may affect the trends in riparian resource condition, (upward or downward) since the previous sampling period will be assessed. Climate trends will also be evaluated, such as distribution of particularly wet or dry years, as defined in the license for that monitoring reach, in between sampling periods. Other activities or changes in the magnitude of activities within the watersheds, such as recreation and fire will also be assessed. Other trends also will be evaluated, such as the distribution of high and non-spill years in between sampling periods.

In addition to the data analysis, an observational description will be developed to illustrate the general state of the riparian community. The description will be inclusive of the data captured in the vegetation transects (i.e. richness and abundance), but will also focus on factors considered in riparian assessments, including the lateral and horizontal distribution of plant groups, diversity in age of woody riparian species, presence or absence of invasive or special-status plants, bank protection (e.g., tree roots or sod-forming herbaceous plants), and the general vigor of the plant community. Any additional factors contributing to the condition of the riparian community (e.g., impacts from recreational users or sediment from an upslope fire) will be included in the description.

A discussion of the findings will be presented from the data analysis. The discussion will focus on observed changes or trends in the abundance, richness, vegetation community structure, and past monitoring for each site in relation to water year, operations, or other pertinent Project-related factors.

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SECTION 3.0

MONITORING LOCATIONS AND FREQUENCIES

This section describes, by resource area, the locations and frequency at which aquatic monitoring will occur. Figure 3.1-1 at the end of this section shows the monitoring locations by resource area.

3.1 River Reaches, Co-Location of Sites and License Years

3.1.1 Description of River Reaches

For reference, Table 3.1-1 describes the stream reaches, in which aquatic monitoring will occur under this Plan.

Table 3.1-1. Stream reaches in which aquatic monitoring will occur under this Plan.

River	Reach Name	Description
Middle Yuba River	Our House Diversion Dam Reach	7.9 mi of the Middle Yuba River from Our House Diversion Dam at RM[1] 12.6 (El. 1,970 ft) to the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,442 ft). The average gradient in the reach is 1.4 percent. Six tributaries are distributed along Our House Diversion Dam Reach, including the perennial tributary Grizzly Gulch near the upstream end of the reach.
Oregon Creek	Log Cabin Diversion Dam Reach	4.3 mi of Oregon Creek from Log Cabin Diversion Dam at RM 4.3 (El. 1,965 ft) to the confluence of Oregon Creek with the Middle Yuba River at RM 0.0 (El. 1,442 ft). The average gradient in the reach is 2.5 percent. Eleven seasonal or intermittent tributaries are located along the reach; none are named and five of them occur between RM 1.9 and RM 3.0.
North Yuba River	New Bullards Bar Dam Reach	2.4 mi of the North Yuba River from New Bullards Bar Dam and Minimum Flow Release Powerhouse at RM 2.4 (El. 1,320 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 0.0 (El. 1,124 ft). The average gradient in the reach is 2.2 percent. There are no substantial tributaries along the reach.
Yuba River	Middle/North Yuba River Reach	5.8 mi of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,124 ft) to the New Colgate Powerhouse at RM 34.2 (El. 548 ft). The average gradient in the reach is 1.9 percent. Eleven tributaries occur along the reach, one of which, Sweetland Creek, is perennial.

[1] RM refers to the river mile at a specific location. RMs are calculated from the downstream end of the river, which is RM 0.0.

3.1.2 Co-Location of Monitoring Sites

To allow for comparison of post-license issuance aquatic resources information with pre-license issuance information, the post-license issuance monitoring locations include some sites that were sampled during relicensing.

To the extent possible, this Plan co-locates monitoring locations for stream fish, FYLF, channel morphology and riparian vegetation. That is, each FYLF monitoring location typically encompasses a stream fish monitoring location, which is shorter in length. The channel morphology and riparian vegetation monitoring locations overlap almost completely. On the Middle Yuba River and North Yuba River, they also overlap with the FYLF and stream fish monitoring locations. The channel morphology and riparian vegetation monitoring locations on

Oregon Creek do not overlap with other aquatic monitoring locations. The Oregon Creek channel morphology and riparian vegetation monitoring locations are located in the middle of the reach, while the stream fish and FYLF monitoring locations are at the downstream of end of the reach.

Similarly, water temperature and water quality monitoring locations overlap. Since these were located at streamflow gages downstream of dams, water temperature and water quality monitoring locations are at the upstream end of a reach.

Wherever possible, the Plan uses monitoring locations on NFS land for ease of access and to provide direct information to the Forest Service regarding conditions on NFS land.

3.1.3 Use of License Years

The monitoring frequencies in this Plan use "License Years." License Year 1 is the first full calendar year after license issuance. This Plan assumes FERC will issue a new license with a term of 30 years, so License Year 30 is the last full calendar year in which the new license is effective. Further, all monitoring under this Plan will cease when YCWA files with FERC a Notice of Intent (NOI) to File an Application for New License, which, under existing FERC regulations, would occur in License Year 25 assuming a new license with a term of 30 years. If FERC issues a new license with a term greater than 30 years, the frequency of monitoring would continue at the pattern described below for each resource until YCWA files its NOI.

3.2 Resources Monitored

3.2.1 Stream Fish

In 2012 and 2013, YCWA sampled fish populations in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. Eleven sites were sampled using both quantitative snorkeling and quantitative electrofishing methods. Four fish species were found: rainbow trout; smallmouth bass (*Micropterus dolomieu*); Sacramento pikeminnow (*Catostomus occidentalis*); and Sacramento sucker (*Ptychocheilus grandis*). A summary of data collected during by site during the relicensing study can be found in Attachment A, and detailed information is provided in YCWA's relicensing Technical Memorandum 3-8, *Stream Fish Populations*, which is included in Appendix E6 of YCWA's Final License Application (FLA).

3.2.1.1 Locations

The following four sites will be monitored for stream fish using the methods described in Section 2.2.1 once in the September/October period:

- Middle Yuba River 7.6 mi downstream of Our House Diversion Dam – The site was named "*Upstream of Oregon Creek*" in the relicensing Stream Fish Populations Study. Specifically, the site is located on NFS land at RM 5.0, 0.3 mi upstream of Oregon Creek.

The site is about 363 ft long, and was sampled by quantitative electrofishing in 2012 and 2013. The nearest downstream Project facility is New Colgate Powerhouse, 10.9 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2079310 and Easting 692065.2.

- Oregon Creek 4.0 mi downstream of Log Cabin Diversion Dam – The site was named "*Upstream of Middle Yuba River*" in the relicensing Stream Fish Populations Study. Specifically, the site is located on NFS land at RM 0.25, approximately 0.25 mi upstream of the Middle Yuba River. The site is about 230 ft long, and was sampled by quantitative electrofishing in 2012 and 2013. The nearest downstream Project facility is New Colgate Powerhouse, 10.9 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2079134 and Easting 692584.
- North Yuba River 2.1 mi downstream of New Bullards Bar Dam – The site was named "*Upstream of Middle Yuba River*" in the relicensing Stream Fish Populations Study. Specifically, the site is located on private property at RM 0.2, approximately 0.2 mi upstream of the Middle Yuba River. The site is about 391 ft long, and was sampled by quantitative snorkeling in 2012 and 2013. The nearest downstream Project facility is New Colgate Powerhouse, 6.1 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2074172 and Easting 689391.5.
- Yuba River 5.2 mi downstream of the confluence of the North and Middle Yuba rivers. The site was named "*Upstream of Colgate Powerhouse*" in the relicensing Stream Fish Populations Study. Specifically, the site is located on private property at RM 34.9, approximately 0.7 mi upstream of New Colgate Powerhouse. The site is about 341 ft long, and was sampled by quantitative snorkeling in 2012 and 2013. The UTM coordinates for the downstream end of the site are Northing 2070375 and Easting 685526.3.

3.2.1.2 Frequencies

YCWA will monitor stream fish: once in License Year 1; once in License Year 5; once in License Year 10; and then once every 10 years thereafter (i.e., License Year 20, License Year 30, etc.), until YCWA files with FERC its NOI.

3.2.2 Foothill Yellow-Legged Frog

In 2011 and 2012, YCWA conducted FYLF VES at 10 sites in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. No FYLF of any life stage were found at five sites. Detections of one or more life stages of FYLF were recorded at all other sites. Incidental observations of FYLF recorded during performance of YCWA's other relicensing studies and historical records of FYLF largely conformed to the patterns documented by FYLF surveys. A summary of data collected during the relicensing study can be found in Attachment C, and detailed information is provided in YCWA's relicensing Technical Memorandum 3-4, *Special-Status Amphibians – Foothill Yellow-Legged Frog Surveys*, and Technical Memorandum 3-13, *Special-Status*

Amphibians – Focused 2013 Foothill Yellow-Legged Frog Surveys, which are included in Appendix E6 of YCWA's FLA.

3.2.2.1 Monitoring Locations

The following four sites will be monitored for FYLF using the methods described in Section 2.2.2:

- Middle Yuba River 7.8 mi downstream of Our House Diversion Dam – The site was named "*MYR-3B*" in the relicensing Special-Status Amphibians – Foothill Yellow-Legged Frog Surveys Study. Specifically, the site is located on NFS land at RM 4.8 (downstream end of site), is about 5,229 ft long, and was sampled by VES in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 10.7 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2079010 and Easting 692144.6.
- Oregon Creek 3.5 mi downstream of Log Cabin Diversion Dam – The site was named "*OC-1*" in the relicensing Special-Status Amphibians – Foothill Yellow-Legged Frog Surveys Study. Specifically, the site is located on NFS land at RM 0.0 (downstream end of site), at the confluence of the Middle Yuba River. The site is about 3,313 ft long, and was sampled by VES in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 10.6 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2078939 and Easting 692262.7.
- North Yuba River 1.8 mi downstream of New Bullards Bar Dam – The site was named "*NYR-1*" in the relicensing Special-Status Amphibians – Foothill Yellow-Legged Frog Surveys Study. Specifically, the site is located on private property at RM 0.0, at the confluence with the Middle Yuba River. The site is about 2,723 ft long, and was sampled by VES in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 5.9 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2074396 and Easting 689248.2.
- Yuba River 5.8 mi downstream of the confluence of the North and Middle Yuba rivers. The site was named "*YR-1*" in the relicensing Special-Status Amphibians – Foothill Yellow-Legged Frog Surveys Study. Specifically, the site is located on private property at RM 34.3, approximately 0.1 mi upstream of New Colgate Powerhouse. The site is about 3,464 ft long, and was sampled by VES in 2012. The UTM coordinates for the downstream end of the site are Northing 2069842 and Easting 685001.6.

3.2.2.2 Frequencies

YCWA will monitor FYLF: once in License Year 1; once in License Year 5; once in License Year 10; and then once every 10 years thereafter (i.e., License Year 20, License Year 30, etc.), until YCWA files with FERC its NOI.

3.2.3 Water Temperature

From 2009 to 2012, YCWA monitored water temperature at eight locations in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. Average daily temperatures exceeded 20°C at seven locations, mostly from June through September. A summary of data collected during the relicensing study can be found in Attachment E, and detailed information is provided in YCWA's relicensing Technical Memorandum 2-5, *Water Temperature Monitoring*, which is included in Appendix E6 of YCWA's FLA.

3.2.3.1 Locations

The following three locations will be continuously monitored for water temperature using the methods described in Section 2.2.3:

- Middle Yuba River 0.05 mi downstream of Our House Diversion Dam – The site was named "*Downstream of Our House Diversion Dam – T30*" in the relicensing Water Temperature Study. Specifically, the site is located on NFS land at RM 12.55, and is at the existing streamflow gage 11408880, and was sampled by continuous water temperature loggers from 2008 through 2012. The nearest downstream Project facility is New Colgate Powerhouse, 18.5 mi downstream. The UTM coordinates for the site are Northing 2086225 and Easting 694061.2.
- Oregon Creek 0.1 mi downstream of Log Cabin Diversion Dam – The site was named "*Downstream of Log Cabin Diversion Dam – T60*" in the relicensing Water Temperature Study. Specifically, the site is located on NFS land at RM 4.25, approximately 4.25 mi immediately upstream of the Middle Yuba River. The site is at the existing streamflow gage 11409400, and was sampled by continuous water temperature loggers from 2008 through 2012. The nearest downstream Project facility is New Colgate Powerhouse, 14.9 mi downstream. The UTM coordinates for the site are Northing 2080972 and Easting 697237.3.
- North Yuba River 0.1 mi downstream of New Bullards Bar Dam – The site was named "*At Low Flow Releases from New Bullards Bar Dam – T70a and T70b*" in the relicensing Water Temperature Study. Specifically, the site is located on private property at RM 2.35, approximately 2.35 mi upstream of the Middle Yuba River. The site is at the existing streamflow gage 11413547, and was sampled by continuous water temperature loggers from 2008 through 2012. The nearest downstream Project facility is New Colgate Powerhouse, 8.3 mi downstream. The UTM coordinates for the site are Northing 2073936 and Easting 691919.2.

3.2.3.2 Frequencies

YCWA will monitor water temperature continuously beginning within 3 months of license issuance until YCWA files with FERC its NOI.

3.2.4 Water Quality

In summer 2012, YCWA collected stream surface water samples from five locations in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. Most analytes were reported at non-detectable levels to just above reporting limit concentrations. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives. A summary of data collected during the relicensing study can be found in Attachment F, and detailed information is provided in YCWA's relicensing Technical Memorandum 2-3, *Water Quality,* which is included in Appendix E6 of YCWA's FLA.

3.2.4.1 Locations

The following three locations will be monitored for water quality using the methods described in Section 2.2.4 once in the September/October period:

- Middle Yuba River 0.6 mi downstream of Our House Diversion Dam – The site was named "*Below Our House Diversion Dam*" in the relicensing Water Quality Study. Specifically, the site is located on NFS land at RM 12.55, is at the existing streamflow gage 11408880, and was sampled once in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 18.5 mi downstream. The UTM coordinates for the site are Northing 2086225 and Easting 694061.2.
- Oregon Creek 0.1 mi downstream of Log Cabin Diversion Dam – The site was named "*Below Log Cabin Diversion Dam*" in the relicensing Water Quality Study. Specifically, the site is located on NFS land at RM 4.25, approximately 4.2 mi immediately upstream of the Middle Yuba River. The site is at the existing streamflow gage 11409400, and was sampled by continuous water temperature loggers from 2008 through 2012. The nearest downstream Project facility is New Colgate Powerhouse, 14.9 mi downstream. The UTM coordinates for the site are Northing 2080972 and Easting 697237.3.
- North Yuba River 0.1 mi downstream of New Bullards Bar Dam – The site was named "*Below New Bullards Bar Dam*" in the relicensing Water Quality Study. Specifically, the site is located on private property at RM 2.35, approximately 2.35 mi upstream of the Middle Yuba River. The site is at the existing streamflow gage 11413547, and was sampled by continuous water temperature loggers from 2008 through 2012. The nearest downstream Project facility is New Colgate Powerhouse, 8.3 mi downstream. The UTM coordinates for the site are Northing 2073936 and Easting 691919.2.

3.2.4.2 Frequencies

YCWA will monitor water quality: once in License Year 1; once in License Year 5; once in License Year 10; and then once every 10 years thereafter (i.e., License Year 20, License Year 30, etc.), until YCWA files with FERC its NOI.

3.2.5 Channel Morphology

In 2011, YCWA conducted a channel morphology study at six intensive study sites in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. A summary of data collected during the relicensing study can be found in Attachment H, and detailed information is provided in YCWA's relicensing Technical Memorandum 1-1, *Channel Morphology Upstream of Englebright Reservoir,* which is included in Appendix E6 of YCWA's FLA.

3.2.5.1 Locations

The following three locations will be monitored for channel morphology using the methods described in Section 2.2.5:

- Middle Yuba River 7.8 mi downstream of Our House Diversion Dam – The site was named "*Middle Yuba River Upstream of Oregon Creek – Intensive Study Site No. 2*" in the relicensing Channel Morphology Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 2, 9 and 12). Specifically, the site is located on NFS land at RM 4.8, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 10.7 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2079010 and Easting 692144.6.
- Oregon Creek 2.0 mi downstream of Log Cabin Diversion Dam – The site was named "*Oregon Creek Celestial Valley Sub-Reach – Intensive Study Site No. 5*" in the relicensing Channel Morphology Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 8, 10 and 12). Specifically, the site is located on NFS land at RM 2.2, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 12.8 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2080270 and Easting 694360.2.
- North Yuba River 2.1 mi downstream of New Bullards Bar Dam – The site was named "*North Yuba River*" in the relicensing Channel Morphology Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 7, 8 and 10). Specifically, the site is located on private property at RM 0.25, approximately 0.25 mi upstream of the Middle Yuba River, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 6.2 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2074103 and Easting 689433.9.

All monitoring will occur following the spring runoff and before October 15 of the calendar year in which the low level outlet valve is opened for the purpose of sediment passage.

3.2.5.2 Frequencies

YCWA will monitor channel morphology in the Middle Yuba River before October 15 of the same year following the first time the Our House Diversion Dam low level outlet is opened for the purposes of sediment passage, as described in YCWA's Log Cabin and Our House Diversion Dams Sediment Management Plan, and then before October 15 following every fifth year the dam low level outlet is opened for the purposes of sediment passage until YCWA files with FERC its NOI.

In Oregon Creek, YCWA will monitor channel morphology before October 15 of the same year following the first time the Log Cabin Diversion Dam low level outlet is opened for the purposes of sediment passage, as described in YCWA's Log Cabin and Our House Diversion Dams Sediment Management Plan, and then before October 15 of every fifth year following every fifth year the dam low level outlet is opened for the purposes of sediment passage until YCWA files with FERC its NOI.

YCWA will monitor channel morphology in the North Yuba River on the same frequency as described for riparian vegetation monitoring: once in License Year 1; once in License Year 5; once in License Year 10; and then once every 10 years thereafter (i.e., License Year 20, License Year 30, etc.), until YCWA files with FERC its NOI.

3.2.6 Riparian Vegetation

In 2012, YCWA surveyed 11 riparian assessment sites in the Middle Yuba River, Oregon Creek, North Yuba River and Yuba River downstream of Project dams and upstream of Englebright Reservoir. All riparian assessment sites supported woody species in various life stages including mature trees, recruits (i.e., saplings), and seedlings, although the abundance of each often depended on the dominant substrates of the site. A summary of data collected during the relicensing study can be found in Attachment I, and detailed information is provided in YCWA's relicensing Technical Memorandum 6-1, *Riparian Habitat Upstream of Englebright Reservoir*, which is included in Appendix E6 of YCWA's FLA.

3.2.6.1 Locations

The following three locations will be monitored for riparian vegetation using the methods described in Section 2.2.6:

- Middle Yuba River 7.8 mi downstream of Our House Diversion Dam – The site was named "*Upstream (~0.1 mi) of Oregon Creek*" in the relicensing Riparian Habitat Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 2, 9 and 12). Specifically, the site is located on NFS land at RM 4.8, is 416 ft long, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 10.7 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2079010 and Easting 692144.6.
- Oregon Creek 1.7 mi downstream of Log Cabin Diversion Dam – The site was named "*Downstream of Log Cabin Diversion Dam, Celestial Valley Sub-reach*" in the relicensing Riparian Habitat Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 8, 10 and 12). Specifically, the site is located on NFS land at RM 2.5, is 257 ft long, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 12.3 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2080270 and Easting 694360.2.

- North Yuba River 2.1 mi downstream of New Bullards Bar Dam – The site was named "*Upstream of Middle Yuba River*" in the relicensing Riparian Habitat Upstream of Englebright Reservoir Study, and it included three PHABSIM transects (Nos. 7, 8 and 10). Specifically, the site is located on private property at RM 0.25, is 327 ft long, and was sampled in 2012. The nearest downstream Project facility is New Colgate Powerhouse, 6.2 mi downstream. The UTM coordinates for the downstream end of the site are Northing 2074103 and Easting 689433.9.

3.2.6.2 Frequencies

YCWA will monitor riparian vegetation in the Middle Yuba River, Oregon Creek, and the North Yuba River: once in License Year 1; once in License Year 5; once in License Year 10; and then once every 10 years thereafter (i.e., License Year 20, License Year 30, etc.), until YCWA files with FERC its NOI.

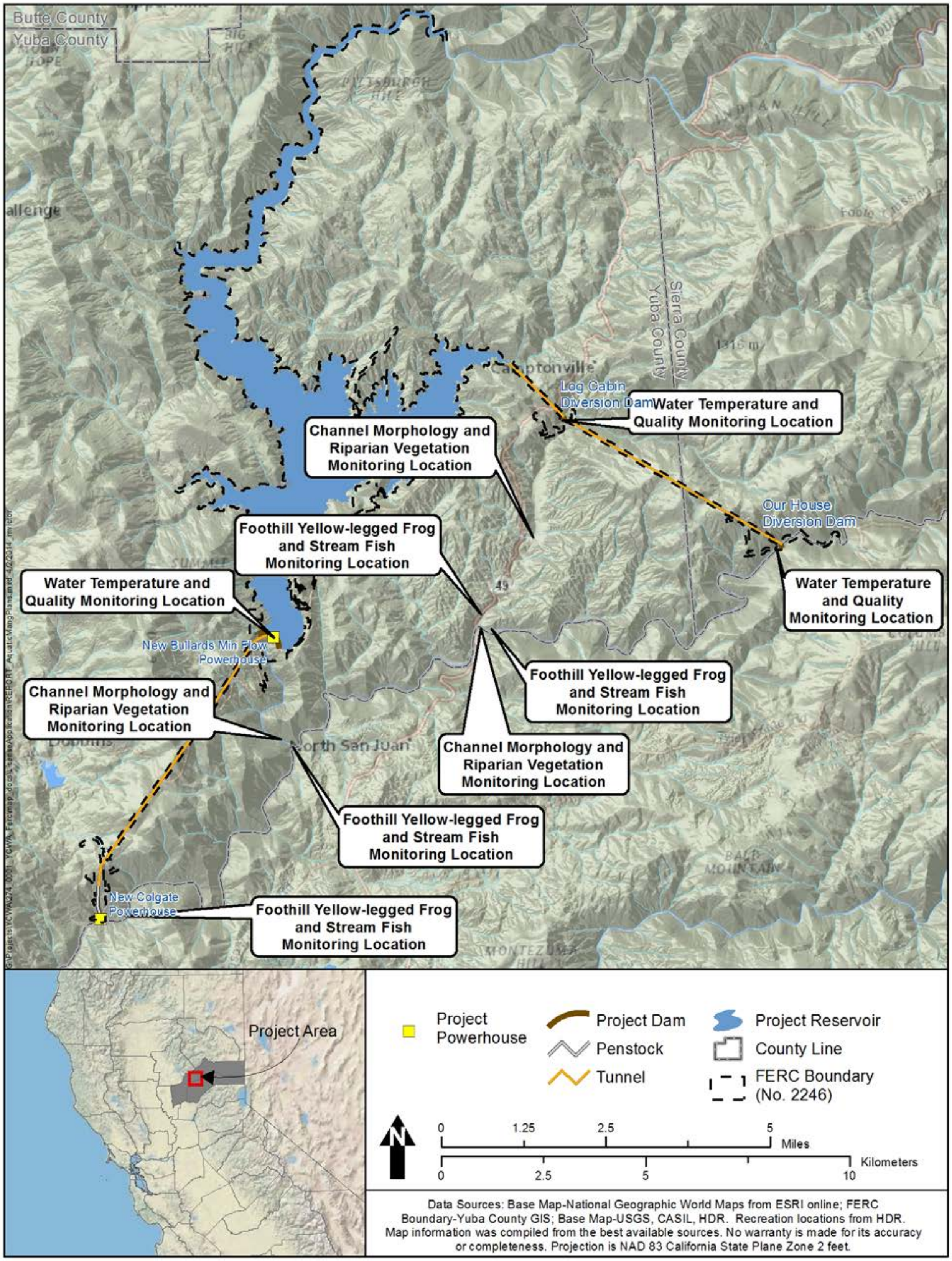

Figure 3.2-1. Upper Yuba River aquatic monitoring locations by resource area.

SECTION 4.0
REPORTING, CONSULTATION AND PLAN REVISIONS

4.1 Consultation

Each year during the term of the license, YCWA shall meet with the Forest Service, BLM, USFWS, Cal Fish and Wildlife and SWRCB to discuss Upper Yuba River aquatic monitoring results from the previous calendar year and planned monitoring in that calendar year. The meeting will occur as described in YCWA's Proposed Condition GEN1.

4.2 Reporting

Each calendar year in which YCWA performs monitoring as described in this Plan, YCWA will provide a draft Upper Yuba River Aquatic Monitoring Report to the Forest Service, BLM, USFWS, Cal Fish and Wildlife and SWRCB for a 30-day written comment period. The draft report shall fully describe the monitoring efforts under the Plan for that calendar year. The report shall also document non-compliance with this Plan during the performance of the monitoring surveys, if any. At least 30 days in advance of the meeting described in YCWA's Proposed Condition GEN1, YCWA shall file with the Commission the final annual report. If YCWA does not adopt a particular written recommendation by the Forest Service, BLM, USFWS, Cal Fish and Wildlife or SWRCB, the filing will include the reasons for not doing so. YCWA shall make the final annual report available to the Forest Service, BLM, USFWS, Cal Fish and Wildlife and SWRCB.

4.3 Plan Revisions

YCWA, in consultation with the Forest Service, BLM, USFWS, Cal Fish and Wildlife and SWRCB will review, update, and/or revise the Plan, as needed, when significant changes in the existing conditions occur. Sixty days will be allowed for Forest Service, BLM, USFWS, Cal Fish and Wildlife and SWRCB to provide written comments and recommendations before YCWA files the updated Plan with FERC for FERC's approval. YCWA will include all relevant documentation of coordination/consultation with the updated Plan filed with FERC. If YCWA does not adopt a particular recommendation by Cal Fish and Wildlife, Forest Service, USFWS, or SWRCB, the filing will include the reasons for not doing so. YCWA will implement the Plan as approved by FERC.[9]

[9] The Plan will not be considered revised until FERC issues its approval.

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SECTION 5.0
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Upper Yuba River Aquatic Monitoring Plan

Attachment A

Fish Populations

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

Fish population monitoring will be conducted in representative stream reaches where game fish (i.e. rainbow trout) were identified and sufficient water exists for flow management to occur. To allow for comparison in these representative reaches to conditions prior to new license measure implementation, monitoring sample sites will strive to use the same methods at the same locations with the same boundaries as relicensing Stream Fish Population (Study 3.8) sites.

In 2012 and 2013, Yuba County Water Agency (YCWA) monitored fish populations at 11 sites using both quantitative snorkeling and quantitative electrofishing methods. Four fish species were found: rainbow trout (*Oncorhynchus mykiss*); smallmouth bass (*Micropterus dolomieu*); Sacramento pikeminnow (*Catostomus occidentalis*); and Sacramento sucker (*Ptychocheilus grandis*). A summary of data collected during the relicensing study in the proposed future monitoring areas are below.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

The Our House Diversion Dam Reach is a 7.9 mile (mi)-long section of the Middle Yuba River from the base of Our House Diversion Dam (elevation, or El., 2,032 ft) at RM 12.6 to the upstream confluence of the Middle Yuba River and Oregon Creek (El. 1,430 ft) at RM 4.7. The reach has a gradient of 1.2 percent.

In 2012 and 2013, YCWA sampled fish at two sites in this reach: RM 12.5, which is 0.1 mi downstream of Our House Diversion Dam, and RM 5.0, which is 7.6 mi downstream of the dam and 0.3 mi upstream of Oregon Creek. Because of deep water (up to 10 ft), at the RM 12.5 site, sampling was by quantitative snorkeling, whereas the RM 5.0 site was sampled by quantitative electrofishing. Four fish species were found: rainbow trout (*Oncorhynchus mykiss*); smallmouth bass (*Micropterus dolomieu*); Sacramento pikeminnow (*Catostomus occidentalis*); and Sacramento sucker (*Ptychocheilus grandis*). Tables 2.1-1 and 2.1-2 summarize sampling results.

Table 2.1-1. Summary of YCWA's 2012 and 2013 fish population information from quantitative snorkeling observations for the Middle Yuba River Downstream of Our House Diversion Dam Site (RM 12.5).

Species		Rainbow Trout		Smallmouth Bass		Sacramento Pikeminnow		Sacramento Sucker	
Year		2012	2013	2012	2013	2012	2013	2012	2013
Abundance	no. counted by pass	41-40-43	38-39-42	6-6-12	55-65-67	0-0-0	2-1-0	0-0-0	2-1-0
	% of total fish counted	83.7%	38.4%	16.3%	59.6%	0.0%	1.0%	0.0%	1.0%
	estimated section abundance	41	40	8	62	0	1	0	1
	95% confidence interval	40-42	38-42	5-11	56-69	--	0-2	--	0-2
	Relative Stock Density	76	45	21	20	--	100	--	100
	fish/100m	28	28	5	44	0	1	0	1
	fish/mi	453	450	88	708	0	11	0	11

Table 2.1-1. (continued)

Species		Rainbow Trout		Smallmouth Bass		Sacramento Pikeminnow		Sacramento Sucker	
Year		2012	2013	2012	2013	2012	2013	2012	2013
Fork length (51 mm size groups)	min	51-102	103-152	51-102	51-102	--	153-203	--	153-203
	max	357+	255-305	153-203	204-254	--	153-203	--	204-254
	mean	153-203	153-203	103-152	103-152	--	153-203	--	204-254
Condition factor[1]	relative condition range	1.07-1.07	n/a	0.89-0.94	0.98-1.10	--	--	--	0.95-0.95
Age class frequency in fish/mile (% of total)	0	4 (0.8%)	0 (0.0%)	7 (8.3%)	151 (21.4%)	--	0 (0.0%)	--	0 (0.0%)
	1	106 (23.4%)	246 (54.6%)	62 (70.8%)	413 (58.3%)	--	0 (0.0%)	--	0 (0.0%)
	2 and older	344 (75.8%)	204 (45.4%)	18 (20.8%)	144 (20.3%)	--	11 (100.0%)	--	11 (100.0%)

[1] Condition factor for snorkeled sites was calculated from fish captured by qualitative electrofishing at the site. In some instances, a species was observed by snorkeling, but not captured during electrofishing and therefore a condition factor was not calculated.

Table 2.1-2. Summary of YCWA's 2012 and 2013 fish population information collected by quantitative electrofishing for the Middle Yuba River site at RM 5.0.

Species		Rainbow Trout		Sacramento Sucker		Smallmouth Bass	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. collected by pass (total)	6-2-2-1 (11)	2-2-1-1 (6)	5-4-1-0 (10)	0-3-0-0	54-30-26-9 (119)	23-19-14-8 (64)
	% of fish collected	7.9%	8.2%	7.1%	4.1%	85.0%	87.7%
	estimated section abundance	11	6	10	3	136	85
	95% confidence interval	11-13	6-9	10-11	3-6	119-153	64-114
	Relative Stock Density	83	91	67	30	11	3
	fish/100m	10	6	9	3	119	80
	fish/mi	155	90	141	45	1,915	1,282
Fork length (mm)	mean (range)	177 (144-213)	169 (135-218)	135 (49-294)	173 (147-196)	85 (42-181)	91 (55-195)
Biomass	weight of fish collected (g)	695.5	334.4	550.8	193.5	1461.6	918.4
	mean weight (g) (range)	63.2 (32.3-110.5)	55.7 (27.9-111.5)	55.1 (1.5-304.4)	64.5 (41.6-82.6)	12.3 (1.0-72.5)	14.4 (3.1-91.8)
	estimated section biomass (g)	695.5	34.4	551.0	193.5	1,672.8	1,219.8
	g/100m	608.3	313.4	481.9	181.0	1,463.1	1,143.0
	lbs/ac	4.0	1.9	3.2	1.1	9.7	7.2
	kg/ha	4.5	2.2	3.6	1.3	10.9	8.1
Condition factor	relative condition range	0.79-1.14	0.81-1.03	0.76-1.08	0.81-1.02	0.67-1.34	0.69-1.54
Age class frequency in fish/mile (% of total)	0	0 (0.0%)	0 (0.0%)	42 (30.0%)	0 (0.0%)	1,577 (82.4%)	1,102 (86.0%)
	1	14 (9.1%)	15 (16.7%)	28 (20.0%)	15 (33.3%)	322 (16.8%)	140 (10.9%)
	2 and older	141 (90.9%)	75 (83.3%)	70 (50.0%)	30 (66.7%)	16 (0.8%)	40 (3.1%)

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the

Middle Yuba River with the North Yuba River at RM 0.0 (El. 1,120 ft). The reach has a gradient of 1.2 percent.

In 2012 and 2013, YCWA sampled fish at two sites in this reach: RM 3.3 (Downstream of Moonshine Creek), which is 1.4 mi downstream of the Middle Yuba River and Oregon Creek confluence, and RM 1.0 (Downstream of Yellowjacket Creek), which is 3.7 mi downstream of the Middle Yuba River and Oregon Creek confluence. Because of deep water at the RM 3.3 and RM 1.0 sites, sampling was by quantitative snorkeling. The site at RM 1.0 also had quantitative electrofishing. Four fish species were found: rainbow trout (*Oncorhynchus mykiss*); smallmouth bass (*Micropterus dolomieu*); Sacramento pikeminnow (*Catostomus occidentalis*); and Sacramento sucker (*Ptychocheilus grandis*). Tables 2.2-1 through 2.2-3 summarize sampling results.

Table 2.2-1. Summary of 2012 and 2013 fish population information from quantitative snorkeling observations for the Middle Yuba River Downstream of Moonshine Creek Site (RM 3.3).

Species		Rainbow Trout		Sacramento Sucker		Smallmouth Bass	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. counted by pass	78-74-63	36-47-36	8-9-15	8-6-8	8-15-21	16-26-30
	% of total fish counted	73.5%	55.7%	11.2%	10.0%	15.3%	34.3%
	estimated section abundance	72	40	11	7	15	24
	95% confidence interval	64-79	33-46[1]	8-14[1]	6-8	8-21	17-31
	Relative Stock Density	31	86	6	55	5	47
	fish/100m	38	22	6	4	8	13
	fish/mi	613	350	91	65	126	212
Fork length (51 mm size groups)	min	0-50	0-50	0-50	103-152	0-50	51-102
	max	255-305	204-254	255-305	153-203	153-203	204-254
	mean	103-152	153-203	103-152	153-203	51-102	153-203
Condition Factor[2]	condition factor range	0.79-1.13	1.04-1.42	0.86-1.11	0.82-1.26	n/a	1.07-1.28
Age class frequency in fish/mile (% of total)	0	86 (14.0%)	6 (1.7%)	9 (9.4%)	0 (0.0%)	80 (63.6%)	38 (18.1%)
	1	337 (54.9%)	41 (11.9%)	77 (84.4%)	30 (45.5%)	40 (31.8%)	74 (34.7%)
	2 and older	191 (31.2%)	303 (86.4%)	6 (6.3%)	35 (54.5%)	6 (4.5%)	100 (47.2%)

[1] The lower range of the 95 percent confidence interval was less than the lowest pass and as a result, the lowest pass was used.
[2] Condition factor for snorkeled sites was calculated from fish captured by qualitative electrofishing at the site. In some instances, a species was observed by snorkeling, but not captured during electrofishing and therefore a condition factor was not calculated.

Table 2.2-2. Summary of 2012 and 2013 fish population information from quantitative snorkeling observations for the Middle Yuba River Downstream of Yellowjacket Creek Site (RM 1.0).

Species		Rainbow Trout		Sacramento Pikeminnow		Smallmouth Bass	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. counted by pass	12-15-10-10	1-1-1	1-1-1-1	0-0-0	7-11-19-13	36-36-35
	% of total fish counted	46.2%	2.7%	3.8%	0.0%	50.0%	97.3%
	estimated section abundance	12	1	1	0	13	36
	95% confidence interval	10-14[2]	1	1-1	--	8-18	35-36
	Relative Stock Density[1]	30	n/a	n/a	--	5	3
	fish/100m	29	2	2	0	32	84
	fish/mi	470	38	40	0	520	1,345
Fork length (51 mm size groups)	min	0-50	103-152	103-152	--	0-50	0-50
	max	204-254	103-152	103-152	--	153-203	153-203
	mean	103-152	103-152	103-152	--	103-152	103-152
Age class frequency in fish/mile (% of total)	0	90 (19.1%)	0 (0.0%)	0 (0.0%)	--	303 (58.2%)	918 (68.2%)
	1	170 (36.2%)	38 (100.0%)	40 (100.0%)	--	186 (35.8%)	339 (25.2%)
	2 and older	210 (44.7%)	0 (0.0%)	0 (0.0%)	--	83 (16.0%)	88 (6.6%)

[1] Relative stock density was calculated for the entire site (snorkeling and electrofishing combined).
[2] The lower range of the 95 percent confidence interval was less than the lowest pass and, as a result, the lowest pass was used.

Table 2.2-3. Summary of 2012 and 2013 fish population information collected by quantitative electrofishing for the Middle Yuba River Downstream of Yellowjacket Creek Site (RM 1.0).

Species		Rainbow Trout		Sacramento Sucker		Smallmouth Bass	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. collected by pass (total)	3-7-4-4-1 (19)	0-0-0-0	0-0-0-0-0	1-0-1-0 (2)	20-14-10-12-5 (61)	41-26-27-15 (109)
	% of fish collected	23.8%	0.0%	0.0%	1.8%	76.2%	98.2%
	estimated section abundance	26	0	0	2	79	154
	95% confidence interval	19-45	--	--	2-9	61-104	109-202
	Relative Stock Density[1]	30	--	--	n/a	5	3
	fish/100m	39	0	0	2	119	143
	fish/mi	633	0	0	30	1,922	2,297
Fork length (mm)	mean (range)	105 (68-225)	--	--	91 (76-105)	103 (62-185)	85 (57-179)
Biomass	weight of fish collected (g)	490.5	--	--	20.6	1,161.8	1115.1
	mean weight (g) (range)	25.8 (5.3-121.0)	--	--	10.3 (6.3-14.3)	19.0 (3.7-83.6)	10.2 (2.8-75.8)
	estimated section biomass (g)	670.80	0	0	20.6	1,501.0	1575.5
	g/100m	1,013.9	0	0	19.0	2,268.8	1,459.8
	lbs/ac	4.3	0	0	0.1	9.6	7.0
	kg/ha	4.8	0	0	0.1	10.7	7.9
Condition factor	relative condition (range)	0.93-1.55	--	--	1.02-1.25	0.79-1.68	0.85-1.22
Age class frequency in fish/mile (% of total)	0	333 (52.6%)	--	--	15 (50.0%)	1,796 (93.4%)	3,704 (97.2%)
	1	166 (26.3%)	--	--	15 (50.0%)	63 (3.3%)	35 (0.9%)
	2 and older	133 (21.1%)	--	--	0 (0.0%)	63 (3.3%)	70 (1.9%)

[1] Relative stock density was calculated for the entire site (snorkeling and electrofishing combined).

2.3 Middle/North Yuba River Reach

The Middle/North Yuba River Reach is a 5.8 mi long section of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,120 ft) to the New Colgate Powerhouse at RM 34.2 (El. 540 ft). The overall gradient is less than 2 percent, though there are steeper sections with a map-gradient of near 5 percent.

In 2012 and 2013, YCWA sampling by quantitative snorkeling (due to deep water) two sites in this reach: one at RM 39.6 downstream of the North and Middle Yuba rivers and the other at RM 35.0 upstream of the New Colgate Powerhouse. Three fish species were found: rainbow trout; smallmouth bass; and Sacramento sucker. Tables 2.3-1 and 2.3-2 summarize sampling results.

Table 2.3-1. Summary of 2012 and 2013 fish population information from quantitative snorkeling observations for the Yuba River Downstream of Middle Yuba River Site (RM 39.6).

Species		**Rainbow Trout**		**Sacramento Pikeminnow**		**Smallmouth Bass**	
Year		**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
Abundance	no. counted by pass	29-58-44-38	20-19-18	0-1-0-1	0-0-0	13-29-21-42	70-73-65
	% of total fish counted	61.2%	21.5%	0.7%	0.0%	38.1%	78.5%
	estimated section abundance	42	19	1	0	26	69
	95% confidence interval	30-54	18-20	0-1	--	14-39	65-73
	Relative Stock Density	53	75	n/a	--	4	43
	fish/100m	34	15	1	0	21	55
	fish/mi	543	243	13	0	337	889
Fork length (51 mm size groups)	min	0-50	51-102	103-152	--	0-50	0-50
	max	306-356	255-305	103-152	--	153-203	204-254
	mean	153-203	253-203	103-152	--	51-102	103-152
Condition factor[1]	condition factor range	n/a	n/a	n/a	--	0.84-1.12	0.84-1.09
Age class frequency in fish/mile (% of total)	0	58 (10.7%)	4 (1.8%)	0 (0.0%)	--	212 (62.9%)	184 (20.7%)
	1	199 (36.7%)	55 (22.8%)	13 (100.0%)	--	119 (35.2%)	320 (36.0%)
	2 and older	286 (52.7%)	184 (75.4%)	0 (0.0%)	--	6 (1.9%)	384 (43.3%

[1] Condition factor for snorkeled sites was calculated from fish captured by qualitative electrofishing at the site. In some instances, a species was observed by snorkeling, but not captured during electrofishing and therefore a condition factor was not calculated.

Table 2.3-2. Summary of 2012 and 2013 fish population information from quantitative snorkeling observations for the Yuba River Upstream of New Colgate Powerhouse Site (RM 35.0).

Species		**Rainbow Trout**		**Smallmouth Bass**	
Year		**2012**	**2013**	**2012**	**2013**
Abundance	no. counted by pass	4-9-9	1-1-1	95-97-95	76-78-76
	% of total fish counted	6.8%	1.3%	93.2%	98.7%
	estimated section abundance	7	1	96	77
	95% confidence interval	4-10	1	95-97	76-78
	Relative Stock Density	86	100	9	4
	fish/100m	7	1	88	78
	fish/mi	108	16	1,409	1,257

Table 2.3-2. (continued)

Species		Rainbow Trout		Smallmouth Bass	
Year		2012	2013	2012	2013
Fork length (51 mm size groups)	min	103-152	153-203	0-50	0-50
	max	306-356	153-203	204-254	153-203
	mean	153-203	153-203	51-102	103-152
Condition factor[1]	condition factor range	n/a	n/a	0.92-1.22	0.79-1.60
Age class frequency in fish/mile (% of total)	0	0	0	957 (67.9%)	563 (44.8%)
	1	15 (13.6%)	0	324 (23.0%)	645 (51.3%)
	2 and older	93 (86.4%)	16 (100.0%)	128 (9.1%)	49 (3.9%)

[1] Condition factor for snorkeled sites was calculated from fish captured by qualitative electrofishing at the site. In some instances, a species was observed by snorkeling, but not captured during electrofishing and therefore a condition factor was not calculated.

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4 mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 0.0 (El. 1,125 ft). The reach has a gradient of 1 percent to 3 percent, expect for a short 0.2 mi section with a gradient of 3 percent to 8 percent.

In 2012 and 2013, YCWA sampled fish by quantitative snorkeling (due to deep water) at one site in the reach - RM 0.2, which was is 2.2 mi downstream of New Bullards Bar Dam. Three fish species were found: rainbow trout; smallmouth bass; and Sacramento sucker. Table 2.4-1 summarizes sampling results.

Table 2.4-1. Summary of 2012 and 2013 fish population information from quantitative snorkeling observations for the North Yuba River Upstream of Middle Yuba River Site (RM 0.2).

Species		Rainbow Trout		Sacramento Sucker		Sacramento Pikeminnow	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. counted by pass	37-40-43	46-39-39	208-224-246	7-15-20	1-0-0	0-0-0
	% of total fish counted	15.0%	74.6%	84.6%	25.4%	0.4%	0.0%
	estimated section abundance	40	41	226	14	1	0
	95% confidence interval	37-43	39-45[1]	208-245[1]	7-21	1	--
	Relative Stock Density	2	3	n/a	n/a	100	--
	fish/100m	35	33	199	11	1	0
	fish/mi	567	534	3,203	181	14	0
Fork length (51 mm size groups)	min	0-50	0-50	0-50	0-50	153-203	--
	max	153-203	153-203	51-102	103-152	153-203	--
	mean	0-50	51-102	0-50	51-102	153-203	--
Condition factor[2]	condition factor range	0.76-1.14	0.41-1.95	0.63-1.33	0.54-1.73	n/a	--
Age class frequency in fish/mile (% of total)	0	543 (95.8%)	460 (86.3%)	3,203 (100.0%)	172 (95.2%)	0 (0.0%)	--
	1	14 (2.5%)	56 (10.5%)	0 (0.0%)	9 (4.8%)	0 (0.0%)	--
	2 and older	9 (1.7%)	17 (3.2%)	0 (0.0%)	0 (0.0%)	14 (100.0%)	--

[1] The lower range of the 95% confidence interval was less than the lowest pass and as a result, the lowest pass was used.
[2] Condition factor for snorkeled sites was calculated from fish captured by qualitative electrofishing at the site. In some instances, a species was observed by snorkeling, but not captured during electrofishing and therefore a condition factor was not calculated.

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3 mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. The 3.6 miles of this reach has a gradient of 1 percent to 3 percent while the remained section has a gradient of 3 percent to 8 percent.

In 2012 and 2013, YCWA sampled fish by quantitative electrofishing at RM 0.3, which is 4.0 mi downstream of Log Cabin Diversion Dam. No other sites were sampled in the reach. Three fish species were found: rainbow trout; smallmouth bass; and Sacramento sucker. Table 2.5-1 summarize sampling results.

Table 2.5-1. Summary results of 2012 and 2013 fish population information collected by quantitative electrofishing for the Oregon Creek downstream of Log Cabin Diversion Dam Site (RM 0.3).

Species		Rainbow Trout		Sacramento Sucker		Smallmouth Bass	
Year		2012	2013	2012	2013	2012	2013
Abundance	no. collected by pass (total)	68-17-7 (92)	33-13-10-5 (61)	5-1-1 (7)	8-2-2-1 (13)	0-1-0 (1)	1-0-0-1 (2)
	% of fish collected	92.0%	80.3%	7.0%	17.1%	1.0%	2.6%
	estimated section abundance	94	65	7	13	1	2
	95% confidence interval	92-98	61-72	7-8	13-15	1-1	2-15
	Relative Stock Density	3	7	n/a	8	100	n/a
	fish/100m	141	89	18	15	1	3
	fish/mi	2,266	1,430	169	286	24	44
Fork length (mm)	mean (range)	93 (56-171)	96 (49-168)	115 (79-132)	109 (78-158)	169	85 (75-95)
Biomass	weight of fish collected (g)	1,089.7	757.7	143.7	248.6	69.2	19.8
	mean weight (g) (range)	11.8 (2.0-56.5)	12.4 (1.2-47.8)	20.5 (10.8-30.2)	19.1 (6.5-35.3)	69.2 (69.2)	9.9 (6.9-12.9)
	estimated section biomass (g)	1,109.2	807.4	143.7	248.6	69.2	19.8
	g/100m	1,661.3	1,103.4	215.2	339.8	103.6	27.1
	lbs/ac	23.9	10.8	3.1	3.3	1.5	0.3
	kg/ha	26.8	12.1	3.5	3.7	1.7	0.3
Condition factor	relative condition range	0.66-1.33	0.84-1.17	0.92-1.08	0.81-1.26	NA[1]	NA
Age class frequency in fish/mile (% of total)	0	1,355 (59.8%)	820 (57.4%)	0 (0.0%)	75 (30.8%)	0 (0.0%)	22 (50.0%)
	1	714 (31.5%)	446 (31.1%)	169 (100.0%)	150 (61.5%)	24 (100.0%)	22 (50.0%)
	2 and older	197 (8.7%)	164 (11.5%)	0 (0.0%)	19 (7.7%)	0 (0%)	0 (0.0%)

[1] Not applicable because of small sample size

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Upper Yuba River Aquatic Monitoring Plan

Attachment B

Electrofishing and Snorkeling Data Sheets

Yuba River Development Project

FERC Project No. 2246

April 2014

Yuba County Water Agency **STREAM FISH POPULATIONS**

Electrofishing Data

Page:______ of ______

Date__________ Time Start:______________ Time End:____________ Weather:______________

Site:________________________________ Prepared by:________________________________

________________________________ Crew: ________________________________

UTM: **Environmental:**

Upstream: Easting:______________________ Northing:____________________ Air Temp:______________

Downstream: Easting:______________________ Northing:____________________ H_2O Temp:______________

Conductivity:______________

Site Length:______________ Ave. Width:______________ Ave. Depth:______________ D.O.:______________

Electrofisher Information:

	Unit 1		Unit 2		Unit 3	
Type						
Voltage						
Frequency						
Pulse Width						

Effort:

	Pass 1	Pass 2	Pass 3	Pass 4
Unit 1				
Unit 2				
Unit 3				

Species Information

Pass	Species	Length	Weight	Condition	Notes		Pass	Species	Length	Weight	Condition	Notes

Species Notes

Photos and comments on back.

Yuba County Water Agency

STREAM FISH POPULATIONS
Electrofishing Data

Page______ of _______

Species Information

Pass	Species	Length	Weight	Condition	Notes		Pass	Species	Length	Weight	Condition	Notes

Species Notes

Photos and Comments:

Depletion: $(1-[(N_2*E_1)/(N_1*E_2)]*100=$ ______________ $(1-[(N_3*E_2)/(N_2*E_3)]*100=$ ______________

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook Trout=BKT; Brown Bullhead=BRB; Brown Trout=BRT; California Roach=CAR; Channel catfish=CCF; Common Carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Inknown=UNK; Unknown centrarchid=UCD; Unkown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle sculpin=RFS; Prickly sculpin=PSC; Unknown sculpin=SCL

IF FOUND: Please contact Joel Passovoy @ 916-679-8753.

HDR Engineering
2379 Gateway Oaks Dr.
Sacramento, CA 95833

Yuba County Water Agency **STREAM FISH POPULATIONS** Page:______ of ______

Snorkel Data

Date__________ Time Start:__________ Time End:__________ Weather:______________

Site:__________________________________ Prepared by:______________________________

__________________________________ Crew:__________________________________

UTM: **Environmental:**

Upstream: Easting:____________________ Northing:____________________ Air Temp:____________

Downstrea Easting:____________________ Northing:____________________ H2O Temp:____________

Conductivity:__________

Site Length:________ Ave. Width:________ Ave. Depth:____________ D.O.:________________

Observer 1:________ **Observer 2:**________ **Observer 3:**________ **Observer 4:**________ **Observer 5:**________

Visibility: ______________

Species Information

			Length Class (inches)							
Pass	Observ.	Species	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14+

Species Codes: Black Bullhead=BKB; Black Crappie=BLC; Bluegill=BLG; Brook Trout=BKT; Brown Bullhead=BRB; Brown Trout=BRT; California Roach=CAR; Channel catfish=CCF; Common Carp=CAP; Goldfish=GOS; Green sunfish=GSF; Hardhead=HDH; Lahontan cutthroat trout=LCT; Lahontan redside=LRS; Largemouth bass=LMB; Mosquitofish=MOF; Rainbow trout=RBT; Sacramento pikeminnow=SPW; Sacramento sucker=SSK; Speckled dace=SPD; Smallmouth bass=SMB; Inknown=UNK; Unknown centrarchid=UCD; Unkown minnow=UMW; Unknown salmonid=USD; White crappie=WHC; Riffle sculpin=RFS; Prickly sculpin=PSC; Unknown sculpin=SCL

Photos and comments on back.

Yuba County Water Agency **STREAM FISH POPULATIONS** Page:______ of ______

Snorkel Data

Species Information										
			Length Class (inches)							
Pass	Observ.	Species	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14+

Supplemental Backpack Electrofishing

Model:____________ Voltage:____________ Frequency:__________ Pulse Width:____________

Species Information										
Species	**Length**	**Weight**	**Condition**	**Notes**		**Species**	**Length**	**Weight**	**Condition**	**Notes**

Species Notes:	

IF FOUND: Please contact Joel Passovoy @ 916-679-8753.

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Sacramento, CA 95833

Upper Yuba River Aquatic Monitoring Plan

Attachment C

Foothill Yellow Legged Frog

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

Foothill yellow-legged frog (FYLF) monitoring will be conducted in stream reaches where known breeding populations of FYLF exist and where data are needed to assess response to flow-related changes in conditions during the new license. Where possible, sampling sites will be at the same locations as relicensing Study 3.4, Special Status Amphibians – Foothill Yellow-legged Frog Surveys to allow for comparison to conditions prior to new license measure implementation.

In 2011 and 2012, YCWA conducted visual encounter surveys (VES) at 10 sites within the watershed. No FYLF of any life stage were found at five sites. Detections of one or more life stages of FYLF were recorded at all other sites. Incidental observations of FYLF recorded during performance of YCWA's other relicensing studies and historical records of FYLF largely conformed to the patterns documented by FYLF surveys. A summary of data collected during the relicensing study in the proposed future monitoring areas are below.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

The Our House Diversion Dam Reach is a 7.9 mile (mi)-long section of the Middle Yuba River from the base of Our House Diversion Dam (elevation, or El., 2,032 ft) at RM 12.6 to the upstream confluence of the Middle Yuba River and Oregon Creek (El. 1,430 ft) at RM 4.7. The reach has a gradient of 1.2 percent.

Two FYLF survey sites representing a total distance of 1.2 mi were located between Our House Diversion Dam and the confluence of Oregon Creek, MYR-4 just below Our House Diversion Dam (RM 12.5) and MYR-3B extending nearly 1 mile upstream from Oregon Creek (RM 5.0).

The survey results at the sites in Our House Diversion Dam Reach included no FYLF egg masses; however, there were detections of all other FYLF life stages during surveys, indicating that breeding had occurred (Table 2.1-1).

Table 2.1-1. Summary of FYLF surveys and other information regarding the distribution of FYLF in the Middle Yuba River downstream of Our House Diversion Dam.

Survey Summary and Incidental Observations	Potential FYLF Breeding and Rearing Habitat at Survey Sites
MIDDLE YUBA RIVER, OUR HOUSE DIVERSION DAM REACH: SITES MYR-3B AND MYR-4	
FYLF, including tadpoles, found at both survey sites and observed incidentally elsewhere on the reach. A total of 23 metamorphosed young-of-year FYLF were documented at Site MYR-3B, but only one was found at Site MYR-4. Large numbers of Sierra newts were observed during surveys and incidentally, especially at Site MYR-3B, along with moderate numbers of American bullfrogs at Site MYR-3B and one observation at Site MYR-4.	Potential habitat was abundant in Site MYR-3B, associated with slow moving water in pool tail-outs, and shallow edgewater throughout the reach. In Site MYR-4, potential habitat occurred in areas of low-velocity edgewater along run and glide sections.

Other amphibians detected during surveys were Sierra newt, Sierran treefrog (*Pseudacris sierra*), and American bullfrog. Adult Sierra newts were particularly abundant at Site MYR-3B. American bullfrog tadpoles were found in pool habitat at Site MYR-3B. Sierran treefrog tadpoles were found at each of the Middle Yuba River below Our House Diversion Dam.

Based on the developmental stages of FYLF tadpoles found during surveys in 2012, water temperature data, and observations from other streams, FYLF breeding in the Middle Yuba River downstream of Our House Diversion Dam may have begun on about May 1 and concluded by mid-May. An earlier brief warm period, which peaked on April 21 with a water temperature of about 15°C before dropping again, could also have triggered limited breeding, although this was not confirmed by the survey results.

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the Middle Yuba River with the North Yuba River at RM 0.0 (El. 1,120 ft). The reach has a gradient of 1.2 percent.

Three sites representing a total distance of 1.15 mi were located between Oregon Creek and the confluence of the North Yuba River. MYR-3A extended about 0.3 mi downstream from the confluence of Oregon Creek, MYR-2 was situated at the confluence of Yellowjacket Creek, and MYR-1 extended 0.25 mi upstream of the North Yuba River.

Downstream of the confluence of Oregon Creek, FYLF breeding was documented only at the confluence site. There were no FYLF survey detections at the other two sites and only one incidental observation from another YCWA study of FYLF at one of the sites (MYR-2). In response to this detection, YCWA surveyed the adjacent tributary, Yellowjacket Creek, in 2013; however, no FYLF were found. Yellowjacket Creek is a small stream lacking suitable FYLF breeding habitat (Table 2.2-1).

Table 2.2-1. Summary of FYLF surveys and other information regarding the distribution of FYLF in the Middle Yuba River downstream of Oregon Creek Confleunce.

Survey Summary and Incidental Observations	Potential FYLF Breeding and Rearing Habitat at Survey Sites
MIDDLE YUBA RIVER, OREGON CREEK REACH: SITES MYR-1, MYR-2, AND MYR-3A; AND YELLOWJACKET CREEK	
FYLF found during surveys only at Site MYR-3A, where there were two detections, a juvenile and egg mass. At Site MYR-2, one adult FYLF was observed incidentally. No young-of-year FYLF were documented at survey sites, but six juveniles, likely including metamorphosed young-of-year, were observed in another part of the reach near Moonshine Creek in August 2012. Detections of Sierra newts were numerous during surveys at Site MYR-2 and there were large numbers of American bullfrogs at each site. Crayfish were found at Site MYR-3A. Juvenile American bullfrogs were found in Yellowjacket Creek during Study 3.13.	Potential habitat was most common in Sites MYR-2 and MYR-3A, which both had slow-moving water in pool tail-outs, and areas of shallow edgewater throughout. In Site MYR-1 potential habitat is limited to parts of the right bank and included low gradient riffles, runs and glides, backwater pools, with edgewater mostly concentrated at the downstream end of the site.

Other amphibians detected during surveys were Sierra newt, Sierran treefrog (*Pseudacris sierra*), and American bullfrog. Adult Sierra newts were particularly abundant at Site MYR-2.

American bullfrog tadpoles were the most commonly detected amphibians at sites downstream of Oregon Creek and particularly abundant at Site MYR-2 and MYR-3A. Sierran treefrog tadpoles were found at each of the Middle Yuba River sites except MYR-1.

Based on the developmental stages of FYLF tadpoles found during surveys in 2012, water temperature data, and observations from other streams, FYLF breeding in the Middle Yuba River downstream of Our House Diversion Dam may have begun on about May 1 and concluded by mid-May. An earlier brief warm period, which peaked on April 21 with a water temperature of about 15°C before dropping again, could also have triggered limited breeding, although this was not confirmed by the survey results.

2.3 Middle/North Yuba River Reach

The Middle/North Yuba River Reach is a 5.8 mi long section of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,120 ft) to the New Colgate Powerhouse at RM 34.2 (El. 540 ft). The overall gradient is less than 2 percent, though there are steeper sections with a map-gradient of near 5 percent.

Two FYLF survey sites, representing a total distance of 0.7 mi were located in the Middle/North Yuba River Reach of the Yuba River under Study 3.4, Site YR-1 situated about 0.37 mi upstream of New Colgate Powerhouse and YR-2 just downstream of the confluence of the North Yuba River. American bullfrog tadpoles were numerous at the survey sites and bass occurred throughout YR-2 (Table 2.3-1). There were no survey detections of FYLF at the survey sites and no reported incidental observations from other studies of FYLF in the reach. Surveys for FYLF were performed again in 2013 under Study 3.13 at Site YR-2A, which included Site YR-2, but expanded to about 0.12 mi in length. The surveys were performed in summer when flows were low to allow for increased survey accessibility. Once again, there were no detections of FYLF. Established FYLF populations likely do not occur in this reach. Because there are no apparent barriers to dispersal at lower flows, individual FYLF may nonetheless occur infrequently.

Table 2.3-1. Summary of FYLF surveys and other information regarding the distribution of FYLF in the Yuba River downstream of Middle Yuba/North Yuba Confluence at Sites YR-1, YR-2, and YR-2A.

Survey Summary and Incidental Observations	Potential FYLF Breeding and Rearing Habitat at Survey Sites
No FYLF found during surveys or observed incidentally. American bullfrog detections were numerous at the survey sites, with larvae more abundant at Site YR-1. The only observations of Sierra newt were two adults observed incidentally on the stream bank in January 2012 at Site YR-1. One Sierran treefrog tadpole was found at YR-1. Crayfish were also found at the sites.	Potential habitat is limited in extent in the reach. In Site YR-2 potential habitat was associated with a single main-channel pool and tail-out. Within the expanded Site YR-2A, the only additional potential habitat for FYLF was associated with edgewater in the higher gradient section downstream of the pool. Potential habitat in Site YR-1 was associated with a low-gradient riffle and mid-channel pool at the downstream end of the site.

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4 mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba

River with the Middle Yuba River at RM 0.0 (El. 1,125 ft). The reach has a gradient of 1 percent to 3 percent, expect for a short 0.2 mile section with a gradient of 3 percent to 8 percent.

One FYLF survey site, 0.55 mi long, was situated in the North Yuba River extending up from the confluence with the Middle Yuba River. The only amphibians found during surveys at the site or reported from the reach as incidental observations from other studies were Sierra newt, American bullfrog, and Sierran treefrog (Table 2.4-1). Potential habitat for FYLF is scarce.

Table 2.4-1. Summary of FYLF surveys and other information regarding the distribution of FYLF in the North Yuba River downstream of New Bullards Bar Dam at Site NYR-1.

Survey Summary and Incidental Observations	Potential FYLF Breeding and Rearing Habitat at Survey Sites
No FYLF found during surveys or observed incidentally. Moderate numbers of detections of American bullfrog and Sierra newt occurred during surveys. Sierran treefrog tadpoles and juveniles also found.	Potential habitat is scarce in the reach and within the site was limited to pool tail-outs and some shallow edgewater associated with mid-channel pools. Substrate is mostly bedrock and massive boulders.

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3 mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. The 3.6 miles of this reach has a gradient of 1 percent to 3 percent while the remained section has a gradient of 3 percent to 8 percent.

Two FYLF survey sites were located in Oregon Creek downstream of Log Cabin Diversion Dam, Site OC-1 situated at the confluence of the Middle Yuba River (0.6 mi long) and OC-2 in Celestial Valley (0.65 mi long). The survey results did not include egg mass detections; however, a small number of tadpoles were found at Site OC-2, indicating that breeding had occurred (Table 2.5-1). There were FYLF detections at both survey sites and incidental observations were reported from other studies throughout the reach. Breeding locations may be scattered, particularly in low gradient sections, such as in Celestial Valley. Incidental observations suggest that more young-of-year (YOY) FYLF occurred in 2009 and 2012 than in 2011.

Table 2.5-1. Summary of FYLF surveys and other information regarding the distribution of FYLF in Oregon Creek downstream of Log Cabin Diversion Dam at Sites OC-1 and OC-2.

Survey Summary and Incidental Observations	Potential FYLF Breeding and Rearing Habitat at Survey Sites
FYLF found at both survey sites and observed incidentally elsewhere on the reach. Small numbers of tadpoles were found at Site OC-2. No metamorphosed young-of-year were observed during the surveys; however, young-of-year were noted incidentally at scattered locations during other studies in 2009 and 2012. There were numerous detections of Sierra newts during the surveys at both sites. Two post-metamorphic Sierran treefrogs were detected at OC-2. Crayfish were found at Site OC-1.	Potential habitat present throughout both sites associated with low-velocity edgewater areas along mid-channel pools and low-gradient riffles.

FYLF breeding in Oregon Creek downstream of Log Cabin Diversion Dam in 2011 probably occurred in June. Water temperatures in the Log Cabin Diversion Dam Reach held favorable for breeding by the first week of June. Upstream of the diversion dam, FYLF egg masses, some less than one week old, were found during the June 15 survey.

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Upper Yuba River Aquatic Monitoring Plan

Attachment D

Foothill Yellow Legged Frog
Data Sheets

Yuba River Development Project

FERC Project No. 2246

April 2014

Egg Masses

Date: mm____ dd____ yy____ **Start UTMs:** _________________ **End UTMs:** _________________ **Reach/Trib:** ____________ **Observers:** ___________

Survey Method: Tandem Separate # Snorkel_____LB RB # Wade_____LB RB **Start Time:** ________ **End Time:** ________ **Actual VES Time:** ________

Start Air Temp: _______ **End** Air Temp: _______ **Start:** Water Temp: (edgewater) _______ (main channel) _______ (pool) _______ **Discharge:** _______ cfs

Mid-Survey: Water Temp: (edgewater) _______ (main channel) ___Time: ____ **End-survey:** Water temp: (edgewater) ______ (main channel) ________

Search Area Length: _______________ **Search Area Width:** _______________ **Total Area Searched: (m^2):** _______________ **Site Visit:** 1 2 3 4

Past 24 hrs: *Sky*: Overcast Drizzle Showers Clear *Wind:* Calm Light Moderate Strong **Today:** *Sky*: Overcast Drizzle Showers Clear *Wind:* Calm Light Moderate Strong

EM Group Letter	# EMs	H2O Temp (°C)	UTM E	UTM N	Distance from Shore (m)	Max Water Depth (cm)	Mid Column Water Velocity (cm/sec)	[1] EM Attach Substrate	[4] Gosner Stage	[6] Macro Habitat	Notes

Fish Present: Yes No **Type**: Salmonid Centrarchid Cyprinid Catastomids **Other**:____

Incidental Herps (sp. and lifestage):____

Comments:____
____
____
____

QA/QC (initials): __________ Date: ___________

Egg Masses

Date: mm____ dd____ yy____ **Start UTM:** _______________ **Reach/Trib:** _____________ **Observers:** _____________________

EM Group Letter	# EMs	H2O Temp (°C)	UTM E	UTM N	Distance from Shore (M)	Max Water Depth (cm)	Mid Column Water Velocity (cm/sec)	[1] EM Attach Substrate	[4] Gosner Stage	[6] Macro Habitat	Notes

Comments:____
____
____
____
____

QA/QC (INITIALS): _______DATE:_________

Tadpoles

Date: mm____ dd____ yy____ **Start UTMs:** _________________ **End UTMs:** _________________ **Reach/Trib:** ____________ **Observers:** ___________

Survey Method: Tandem Separate # Snorkel_____LB RB # Wade_____LB RB **Start Time:** ________ **End Time:** ________ **Actual VES Time:** ________

Start Air Temp: _______ **End** Air Temp: _______ **Start:** Water Temp: (edgewater) _______ (main channel) _______ (pool) _______ **Discharge:** _______ cfs

Mid-Survey: Water Temp: (edgewater) _______ (main channel) ___Time: ____ **End-survey:** Water temp: (edgewater) ______ (main channel) ________

Search Area Length: _______________ **Search Area Width:** _______________ **Total Area Searched: (m^2):** _______________ **Site Visit:** 1 2 3 4

<u>Past 24 hrs</u>: *<u>Sky</u>*: Overcast Drizzle Showers Clear *<u>Wind</u>:* Calm Light Moderate Strong **<u>Today</u>:** *<u>Sky</u>*: Overcast Drizzle Showers Clear *<u>Wind</u>:* Calm Light Moderate Strong

Group Letter	Appox # Tads	H2O Temp (°C)	UTM E	UTM N	Distance from Shore (m)	Max Water Depth (cm)	Mid Column Water Velocity (cm/sec)	[1] Tadpole Stage (1-4)	[2] Gosner Stage	[3] Individual or Average Total Length (mm)	[8] Macro Habitat	Notes

Fish Present: Yes No **Type**: Salmonid Centrarchid Cyprinid Catastomids **Other**:____

Incidental Herps (spp and lifestage):____

Comments:____

____ QA/QC (initials): _________ Date: _________

Tadpoles

Date: mm____ dd____ yy____ **Start UTM:** ________________________ **Reach/Trib:** ______________ **Observers:** ___________

Group Letter	Appox # Tads	H2O Temp (°C)	UTM E	UTM N	Distance from Shore (m)	Max Water Depth (cm)	Mid Column Water Velocity (cm/sec)	[1] Tadpole Stage (1-4)	[2] Gosner Stage	[3] Individual or Average Total Length (mm)	[8] Macro Habitat	Notes

Comments:____
____
____
____
____

QA/QC (INITIALS): ________ DATE: _________

Post-Metamorphic Lifestages

Date: mm____ dd____ yy____ **Start UTMs:** _________________ **End UTMs:** _________________ **Reach/Trib:** ____________ **Observers:** ___________

Survey Method: Tandem Separate # Snorkel_____LB RB # Wade_____LB RB **Start Time:** ________ **End Time:** ________ **Actual VES Time:** ________

Start Air Temp: _______ **End** Air Temp: _______ **Start:** Water Temp: (edgewater) _______ (main channel) _______ (pool) _______ **Discharge:** _______ cfs

Mid-Survey: Water Temp: (edgewater) _______ (main channel) ___Time: ____ **End-survey:** Water temp: (edgewater) ______ (main channel) ________

Search Area Length: _______________ **Search Area Width:** _______________ **Total Area Searched: (m^2):** _______________ **Site Visit:** 1 2 3 4

<u>Past 24 hrs</u>: *<u>Sky</u>*: Overcast Drizzle Showers Clear *<u>Wind</u>:* Calm Light Moderate Strong **<u>Today</u>:** *<u>Sky</u>*: Overcast Drizzle Showers Clear *<u>Wind</u>:* Calm Light Moderate Strong

# Frogs	UTM E	UTM N	[1] Sex (M,F,U)	[2] Stage (Y,J,A,U)	[3] SVL (mm)	[4] Macro Habitat	Notes

Fish Present: Yes No **Type**: Salmonid Centrarchid Cyprinid Catastomids **Other**:____

Incidental Herps (spp and lifestage):____

Comments:____

____

____ QA/QC (initials): ________Date: _________

Post-Metamorphic Lifestages

Date: mm____ dd____ yy____ **Start UTM:** ________________________ **Reach/Trib:** ______________ **Observers:** ___________

# Frogs	UTM E	UTM N	[1] Sex (M,F,U)	[2] Stage (Y,J,A,U)	[3] SVL (mm)	[4] Macro Habitat	Notes

Comments:____
____
____
____
____

Upper Yuba River Aquatic Monitoring Plan

Attachment E

Water Temperature and Stage

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

Water temperature monitoring will occur at locations previously monitored as well as *in situ* measurements taken during fish population, FYLF and BMI monitoring. From 2009 to 2012, YCWA monitoring water temperature at 38 locations throughout the watershed (Study 2.5). Average daily temperatures exceeded 20°C at eight locations, mostly from June through September. A summary of data collected during the relicensing study in the proposed future monitoring areas is below.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

The Our House Diversion Dam Reach is a 7.9 mile (mi)-long section of the Middle Yuba River from the base of Our House Diversion Dam (elevation, or El., 2,032 ft) at RM 12.6 to the upstream confluence of the Middle Yuba River and Oregon Creek (El. 1,430 ft) at RM 4.7. The reach has a gradient of 1.2 percent.

During the monitoring period, summertime (June through September) daily maximum temperatures were between 13.5°C and 24.6°C. Table 2.1-1 shows the monthly minimum and maximum temperature by year.

Table 2.1-1. Summertime monthly minimum and maximum water temperatures by water year.

Location	Water Year	June		July		August		September	
		Min	Max	Min	Max	Min	Max	Min	Max
MYR downstream of Our House (RM 12.6)	2009	14.0	21.9	20.2	24.6	20.1	24.3	15.8	21.2
	2010	9.5	18.8	17.5	23.3	17.6	21.9	16.0	19.8
	2011	7.6	13.5	13.7	21.5	19.4	21.6	16.8	19.8
	2012	13.5	20.7	20.6	23.2	20.3	24.2	17.6	20.8

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the Middle Yuba River with the North Yuba River at RM 0.0 (El. 1,120 ft). The reach has a gradient of 1.2 percent.

During the monitoring period, summertime (June through September) daily maximum temperatures were between 17.7°C and 26.0°C. Table 2.2-1 shows the monthly minimum and maximum temperature by year.

Table 2.2-1. Summertime monthly minimum and maximum water temperatures by water year.

Location	Water Year	June		July		August		September	
		Min	Max	Min	Max	Min	Max	Min	Max
MYR upstream of NYR confluence (RM 0.0)	2009	17.6	24.4	21.5	25.9	20.5	25.5	15.2	21.5
	2010	13.8	23.9	21.7	26.0	18.7	23.3	16.3	20.7
	2011	10.0	17.7	17.3	24.1	20.9	24.0	17.6	20.9
	2012	16.7	23.2	21.7	24.4	20.0	25.1	17.3	21.1

2.3 Middle/North Yuba River Reach

The Middle/North Yuba River Reach is a 5.8 mi long section of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,120 ft) to the New Colgate Powerhouse at RM 34.2 (El. 540 ft). The overall gradient is less than 2 percent, though there are steeper sections with a map-gradient of near 5 percent.

During the monitoring period, summertime (June through September) daily maximum temperatures were between 21.0°C and 25.4°C below the NYR/MYR confluence and between 14.8°C and 26.4°C upstream of the New Colgate Powerhouse. Table 2.3-1 shows the monthly minimum and maximum temperature by year.

Table 2.3-1. Summertime monthly minimum and maximum water temperatures by water year.

Location	Water Year	June		July		August		September	
		Min	Max	Min	Max	Min	Max	Min	Max
Yuba River downstream of Confluence of NYR/MYR (RM 40.0)	2009	17.5	23.9	21.2	25.4	11.5	25.0	15.5	21.0
	2010	13.9	23.5	21.5	25.4	18.6	22.8	16.3	20.4
	2011	No Data	No Data	20.1	23.7	20.7	23.6	17.6	20.8
	2012	16.7	23.0	21.8	24.1	20.1	24.4	17.5	20.9
Yuba River upstream of New Colgate Powerhouse (RM 34.4	2009	18.9	24.5	21.6	25.9	9.6	25.7	17.0	21.8
	2010	14.8	24.6	22.5	26.4	19.8	23.9	17.6	21.5
	2011	11.3	14.8	14.3	24.9	20.8	24.9	18.9	22.0
	2012	17.5	22.6	21.3	23.5	19.6	24.2	17.5	20.8

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4 mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 0.0 (El. 1,125 ft). The reach has a gradient of 1 percent to 3 percent, expect for a short 0.2 mile section with a gradient of 3 percent to 8 percent.

During the monitoring period, summertime (June through September) daily maximum temperatures were between 9.1°C and 23.8°C below the New Bullards Bar Dam and between 10.0°C and 23.9°C upstream of the MYR confluence. Table 2.4-1 shows the monthly minimum and maximum temperature by year.

Table 2.4-1. Summertime monthly minimum and maximum water temperatures by water year.

Location	Water Year	June		July		August		September	
		Min	Max	Min	Max	Min	Max	Min	Max
NYR at Low Flow Releases from New Bullards Bar Dam (RM 2.3)	2009	9.4	10.6	10.3	10.9	10.0	10.7	9.5	10.3
	2010	7.6	9.1	8.9	9.8	9.4	9.7	8.7	9.5
	2011	9.0	10.4	9.9	10.5	9.7	10.5	9.2	9.9
	2012	17.2	22.5	20.2	23.8	8.3	23.5	15.1	19.8
NYR upstream of Middle Yuba River (RM 0.0)	2009	13.8	22.3	20.7	23.9	18.0	22.5	15.9	19.5
	2010	No Data	No Data	19.7	22.5	20.2	22.5	17.1	20.0
	2011	16.2	21.3	20.2	22.0	18.6	22.4	16.4	19.3
	2012	9.4	10.6	10.3	10.9	10.0	10.7	9.5	10.3

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3 mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. The 3.6 miles of this reach has a gradient of 1 percent to 3 percent while the remained section has a gradient of 3 percent to 8 percent.

During the monitoring period, summertime (June through September) daily maximum temperatures were between 13.9°C and 23.0°C below Log Cabin Diversion Dam and between 17.0°C and 20.9°C upstream of the MYR confluence. Table 2.5-1 shows the monthly minimum and maximum temperature by year.

Table 2.5-1. Summertime monthly minimum and maximum water temperatures by water year.

Location	Water Year	June		July		August		September	
		Min	Max	Min	Max	Min	Max	Min	Max
Oregon Creek downstream of Log Cabin Diversion Dam	2009	14.4	21.5	19.7	22.5	18.5	21.8	14.7	18.7
	2010	10.1	19.0	17.7	23.0	17.4	20.8	14.8	18.4
	2011	7.8	13.9	14.0	21.3	19.2	21.4	16.4	19.2
	2012	14.4	19.8	17.8	20.6	17.5	21.2	15.6	17.9
Oregon Creek upstream of confluence with Middle Yuba River	2009	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	2010	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	2011	9.4	17.0	15.6	20.2	17.5	20.1	15.7	18.4
	2012	13.7	19.8	17.8	20.6	16.1	20.9	14.8	17.6

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Upper Yuba River Aquatic Monitoring Plan

Attachment F

Water Quality

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

During the 2012 spring and summer seasons, surface water samples were collected from 28 locations upstream, within, and downstream of the Project. During the 2012 fall season, a single surface water sample was collected downstream of the Project. During the 30 days surrounding and including the 2012 Independence Day and Labor Day holidays, five rounds of surface water samples were collected adjacent to six reservoir and impoundment sites and analyzed for bacteria and hydrocarbons. During a high-turbidity event and when the powerhouses were in operation, one surface water quality sample was collected each from the New Colgate Powerhouse tailrace and the Narrows No. 2 Powerhouse tailrace and analyzed for turbidity, total suspended sediment, total dissolved sediment, total mercury and methylmercury. (Study 2.3). Yuba County Water Agency (YCWA) found that most analytes reported at non-detect to just above reporting limit concentrations. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives. A summary of data collected at sites during the relicensing study in the proposed future monitoring areas are below.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

Water quality sampling occurred at one location in this reach, immediately downstream of Our House Diversion Dam.

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives.

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the Middle Yuba River with the North Yuba River at RM 0.0 (El. 1,120 ft). The reach has a gradient of 1.2 percent.

Water quality sampling occurred at one location in this reach, 1.0 mi upstream of the confluence with the North Yuba River near Yellowjacket Creek.

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives.

2.3 Middle/North Yuba River Reach

Water quality sampling occurred at one location in this reach, above New Colgate Powerhouse (RM 34.4).

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives.

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4 mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 0.0 (El. 1,125 ft). The reach has a gradient of 1 percent to 3 percent, expect for a short 0.2 mile section with a gradient of 3 percent to 8 percent.

Water quality was sampled at one location in this reach, immediately downstream of New Bullards Bar Dam.

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives.

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3 mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. The 3.6 miles of this reach has a gradient of 1 percent to 3 percent while the remained section has a gradient of 3 percent to 8 percent.

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. YCWA found no inconsistencies with the Basin Plan Water Quality Objectives.

Upper Yuba River Aquatic Monitoring Plan

Attachment G

Quality Assurance Protection Plan

Yuba River Development Project

FERC Project No. 2246

April 2014

Quality Assurance Project Plan
Yuba County Water Agency
Yuba River Development Project

Draft
Version 1.0

FERC Project No. 2246

Prepared for
Yuba County Water Agency
1220 F Street
Marysville, CA 95901

Prepared by
HDR Engineering, Hydropower Services
2379 Gateway Oaks, Suite 200
Sacramento, CA 95833

August 2012

REVISION LOG

Number	Description of Change	Section Number	QAPP Version

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LIST OF ACRONYMS

DO	dissolved oxygen
DQO	data quality objective
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
ID	identification number
mg/L	milligrams per liter
NTU	nephelometric turbidity unit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
TRL	Target Reporting Limit
YCWA	Yuba County Water Agency

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SECTION 1.0

GROUP A ELEMENTS: PROJECT MANAGEMENT

1.1 Title and Approval Sheet

This Quality Assurance Program Plan (QAPP) is to be used by HDR, Inc. when implementing Study 2.3 Water Quality, the Federal Energy Regulatory Commission (FERC) approved water quality study developed to support the relicensing of Yuba County Water Agency's (YCWA's) Yuba River Development Project (Project), FERC Project No. 2246.

Prepared by: ______________________________ ______________

(Name) (Date)

Approved by: ______________________________ ______________

(Name) (Date)

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1.2 Distribution List

This document will be distributed to the key personnel listed in Table 1.2-1 and will be provided as an attachment to relevant reports and upon request.

Table 1.2-1. Personnel Responsibilities.

Name	Affiliation	Title	Contact Information
James Lynch	HDR	Project Manager	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Carin Loy	HDR	Study Lead	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Fred Holzmer	HDR	QA Officer	379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Chuck Vertucci	HDR	Field Coordinator	379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Don Burley	CalScience	Laboratory Project Manager	7440 Lincoln Way Garden Grove, CA 92841-1427 (714) 895-5494
Kate Haney	Frontier Global Sciences Inc	Laboratory Project Manager	11720 North Creek Parkway N. Suite 400 Bothell, WA 98011 425-686-1996, ext. 1526
Antonia Powers	Cranmer Engineering, Inc.	Laboratory Director	1188 East Main Street Grass Valley, CA 95945 530-273-7284

1.3 Project/Task Organization

1.3.1 Involved Parties and Roles

This QAPP has been prepared for the water quality investigation component(s) of the Project's relicensing. Within this QAPP are descriptions of methods, procedures, and practices that will be used to assure and control the quality of chemical data.

Key personnel who will be involved in the project are listed above in Table 1.2-1. Under contract to YCWA, HDR will be responsible for all aspects of the water quality study(ies) including the organization of field staff, scheduling of sampling days, field quality assurance/quality control (QA/QC), coordination with the off-site laboratory, and reporting. Laboratory analytical services will be provided by a California certified laboratory.

The Study Lead is responsible for monitoring and verifying implementation of the QA/QC procedures found in this QAPP. Key personnel assigned to the project will have reviewed the QAPP and will be instructed by Study Lead regarding the requirements of the QA/QC program.

The Study Lead will work directly with the Field Coordinator or other designee and Laboratory Project Managers to ensure that QAPP objectives are being met. All members of the team will continually assess the effectiveness of the QA/QC program and recommend modifications, as needed.

1.3.2 Quality Assurance Officer Role

The QA Officer is familiar with the study, but not involved in day-to-day implementation. The QA officer is versed in HDR policies, water quality field sampling, and laboratory procedures. The QA officer will review the study's intermediate and final products, and work with the Study Lead to ensure they are of high quality when complete.

1.3.3 Persons Responsible for QAPP Update and Maintenance

The Study Lead is responsible for keeping the QAPP up-to-date. Modifications may be instigated by any member of the study team—the Study Lead, the Field Coordinator, the QA Officer, the laboratory project manager, or others. Exceptions to the content of this document will be formalized in the table following the title page. New versions of the QAPP will be available to project personnel and attached to subsequent reports. Variances and non-conformances with the QAPP will be documented in applicable project reports.

1.3.4 Organizational Chart and Responsibilities

The organizational chart for implementation of the water quality investigation component of the Project relicensing is presented in Figure 1.3-1.

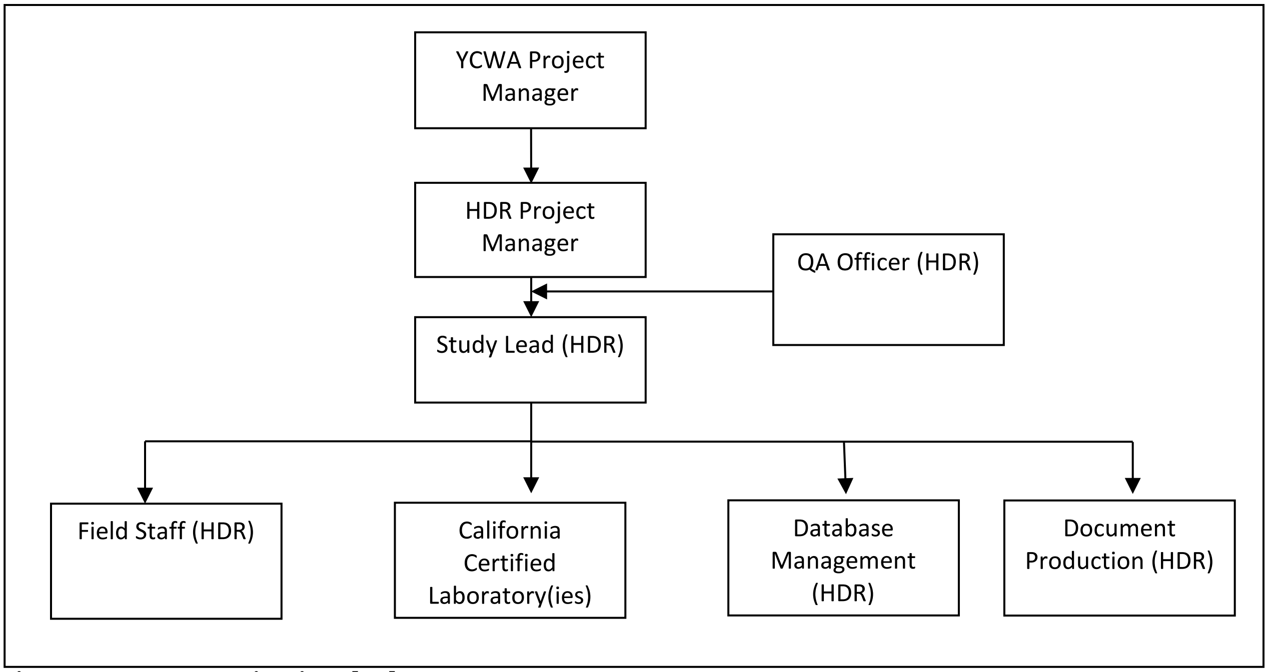

Figure 1.3-1. Organizational Chart

1.4 Problem Definition/Background

1.4.1 Problem Statement

This QAPP has been developed to provide guidance and quality assurance for water quality sampling and analyses conducted to implement the FERC-approved water quality study plan(s) developed to support the Project's FERC relicensing.

1.4.2 Decisions or Outcomes

The collected data will provide one or more "snap-shots" of the physical and/or chemical state of surface water in the study area, defined in the study plan. The data will be filed with FERC in the Initial Study Report and in other relicensing documents, as needed, and will be suitable to compare to applicable regulatory standards and criteria. The data may be integrated with other information or data and used for trend analyses or for modeling. Additional information and detail can be found in the FERC-approved study plan(s).

1.4.3 Water Quality Regulatory Criteria

Water quality objectives for Project reservoirs and Project affected stream reaches are established in Central Valley Regional Water Quality Control Board's (CVRWQCB) Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin Rivers, the fourth edition of which was initially adopted in 1998 and most recently revised in 2011 (CVRWQCB 1998).

The standards are composed of designated existing and potential beneficial uses and water quality objectives to protect the beneficial uses. Additional information and detail can be found in the FERC-approved study plan(s).

1.5 Project/Task Description

1.5.1 General Work Statement

Each FERC-approved study plan details the scope of the water quality investigation. Chemical constituents and characteristics of surface water will be measured both in the field and through collection of water quality samples for off-site analyses by a California certified laboratory. Examples of in situ water field measurements that may be performed include pH, specific conductivity, instantaneous water temperature, dissolved oxygen (DO), DO percent saturation, turbidity, and Secchi disk. Examples of analyses that may be performed on samples sent to an off-site California certified laboratory are trace metals, hardness, bacteria, sediment, nutrients, minerals, chlorophyll, pesticides, total petroleum hydrocarbons or other organics.

Refer to the "Group B Element: Data Generation and Acquisition" section of this QAPP for quality assurance practices associated with sample collection, instrument calibration, and so forth.

1.5.2 Project Schedule

The study schedule is specified in the FERC-approved study plan.

1.5.3 Geographical Setting

Located in California's Sierra Nevada, the study area includes 1) the Middle Yuba River from and including Our House Diversion Dam Impoundment to the confluence with the North Yuba River, 2) Oregon Creek from and including the Log Cabin Diversion Dam Impoundment to the confluence with the Middle Yuba River, 3) the North Yuba River from and including New Bullards Bar Dam Reservoir to the confluence with the Middle Yuba River, and 4) and the portion of the Yuba River from the confluence of the North and Middle Yuba rivers to the Feather River, including USACE's Englebright Reservoir.

1.5.4 Constraints

Water quality sample collection will occur at elevations ranging from 44.4 to 2238.5 feet above sea level and may occur over a wide range of weather conditions (rain, snow, sun, wind, high heat, and cold weather). Stream flows may be high or low. Lake and reservoir sampling may require the use of a boat and occur at different stages of lake or reservoir surface elevation. Remote sites may require 4-wheel driving or long hikes carrying heavy bottles and equipment.

Permission may need to be received from landowners prior to any work on private lands. Due to the distances covered, only five to nine locations may be visited in a single day and still meet the laboratory's hours of operation or shipping deadlines.

Many of the watersheds where HDR works have extremely low naturally occurring levels of trace metals and waters are free or nearly free of contaminants. Hence, samples are highly susceptible to contamination during sampling and handling activities by both the field personnel and the analytical laboratory and the lowest possible method detection limits and reporting limits are required.

1.6 Quality Objectives and Criteria for Measurement Data

Data quality objectives (DQOs) are a set of performance or acceptance criteria that the collected data should achieve in order to minimize the possibility of either making a decision error or failing to keep uncertainty in estimates to within acceptable levels. DQOs are defined in terms of five parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC) and differ with different measurement techniques.

DQOs for relicensing water quality studies are presented in Table 1.6-1.

Table 1.6-1. Data Quality Objectives, by Measurement Type and Sampling Event

Precision	Accuracy	Representativeness	Completeness	Comparability
FIELD MEASUREMENTS (e.g. pH, specific conductivity, temperature, dissolved oxygen)				
--	Instrument calibration meets manufacturers' requirements	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Meets Target Reporting Limits provided in the study plan.
ANALYTICAL LABORATORY ANALYSES (e.g. metals, nutrients)				
Field duplicates within10%; Laboratory QA/QC meet method requirements.	Laboratory QA/QC meets method requirements.	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Meets Target Reporting Limits provided in the study plan.
BACTERIA ANALYSES (e.g. fecal coliform, total coliform, e. coli)				
Field duplicates within 10%; Laboratory QA/QC meet method requirements.	Laboratory QA/QC meets method requirements.	Sample locations, sampling frequency and analytical methods follow study plan.	100%	Meets Target Reporting Limits provided in the study plan.

-- not applicable

Precision is a measure of the reproducibility of analyses under a given set of conditions. In other words, precision describes how well repeated measurements agree. Precision is typically evaluated by comparing analytical results from duplicate samples and calculating the relative percent difference (RPD), where RPD is defined as:

$RPD = \left(\frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2} \right)} \right) \times 100$, where C_1 and C_2 are the analyte's concentrations in each duplicate

Precision will be determined through the use of field duplicates, laboratory matrix spike/matrix spike duplicates and laboratory duplicate quality control samples.

Accuracy is a measure of the bias that exists in a measurement system. In other words, accuracy describes how close an analytical measurement is to its "true" value. For analytical samples, accuracy is typically measured by analyzing a sample of known concentration (prepared using analytical-grade standards) and comparing the analytical result with the known concentration. For bacteria samples, accuracy is evaluated by comparing results to a laboratory reference sample.

Representativeness is the degree sampling data accurately and precisely depict selected characteristics. The representativeness of the data is mainly dependent on the sample design, such as locations (spatial), sampling frequency (temporal), and sample collection procedures, as well as analytical constituents and methods. The FERC-approved study plan presents the study design.

Completeness, which is expressed as a percentage, is calculated by subtracting the number of rejected and unreported results from the total planned results and dividing by the total number of planned results. Estimated results do not count against completeness because they are considered usable as long as any limitations are identified. Results rejected because of out-of-control analytical conditions, severe matrix effects, broken or spilled samples, or samples that could not be analyzed for any other reason are subtracted from the total planned number of results to calculate completeness. Though regulations currently do not require a specific percentage of data completeness, it is expected that the measurement techniques selected for use in this project are capable of generating data that is of 90% of more completeness for field and laboratory analyses.

Comparability is the degree of confidence with which one data set can be compared to another. A broad spectrum of analytical constituents has been selected to characterize water quality and the use of approved/documented analytical methods will ensure that analytical results adequately represent the true concentrations of constituents within these samples. In addition, Target Reporting Limits (TRLs) have been selected for each analyte, where appropriate, to ensure that the analytical methods used are of adequate sensitivity to generate useful data for the purposes of this project. Presented in the FERC-approved study plan, selection of appropriate TRLs was based on a review the CVWRCB's numeric and narrative water quality objectives and other regulatory standards, criteria and benchmarks, as well as the capabilities of commercial laboratories.

1.7 Special Training Needs/Certification

Proper training of field and laboratory personnel represents a critical aspect of quality control.

All field personnel that participate in water quality monitoring will have reviewed this QAPP. Field personnel will have also been trained in water quality sample collection (including QA/QC, grab sampling techniques, flow measurement techniques, completing laboratory chain-of-custody forms, ordering correct laboratory analyses, and proper handling of water samples), field analysis (including instrument calibration, data recording procedures, and interpretation of collected data), and GPS use. All samplers will be provided hands-on training in the "clean hands-dirty hands" technique by the QA Officer or his designee when trace metals are constituents of interest (See Section 11). The QA Officer or his designee will provide training to field personnel. Documentation of training will be will be maintained in the project file.

All laboratories utilized to perform analytical services will be certified by the State of California, The certification includes requirements that laboratory personnel will be certified and trained. Certification and training is documented in the laboratory's quality assurance manual and verified during the State audit[1].

1.8 Documents and Records

1.8.1 Project Documents, Records, and Electronic Files

The documents and records that will be used or generated during this project include the following:

Study Plan. The FERC-approved study plan contains information regarding sampling locations, frequencies, sample collection methods, analytical methods, target reporting limits, and water quality objectives.

Quality Assurance Project Plan. The QAPP (this document) contains details on the quality assurance and quality control procedures that will be implemented throughout the water quality study(ies).

Field records. The Study Lead or designee will maintain all field records, including field data sheets documenting results of field analyses and QC samples, equipment maintenance and calibration documentation, and sample collection and handling documentation (copies of chain-of-custody forms, shipping receipts, etc.).

[1] http://www.cdph.ca.gov/certlic/labs/Pages/default.aspx

Laboratory records. The analytical laboratory will generate records for sample receipt and storage, instrument calibration, analytical QC, and reporting. Lab reports summarizing analytical results and QC results will be provided to HDR both in hard-copy and electronic formats. The information contained within and the format of the data report package will include at a minimum the sample identification number (ID), sampling date/time, test method, extraction date/time, analysis date/time, analytical result, QA sample results, instrument and equipment calibration information, and a description of any corrective action taken to resolve data quality issues.

Data verification records. Field data sheets, field QC results, chain-of-custody forms, and lab reports from each sampling event will be reviewed by the Study Lead and documented for the project file.

Project database. Microsoft Excel spreadsheets will be used to store all water quality data gathered during this project.

1.8.2 Retention of Project Documentation

Throughout the relicensing, the original field notebooks and forms, equipment maintenance and calibration documentation, chain-of-custody forms, laboratory reports, and data verification records will be stored at the HDR office at 2379 Gateway Oaks Drive, Suite 200, Sacramento, CA 95833. Records will be transferred to YCWA upon license receipt or earlier, at YCWA's discretion.

1.8.3 Electronic File Back-up

All electronic files will be stored on HDR network servers and will be backed-up on a regular basis by the HDR information technology staff

1.8.4 Distribution of QAPP Revisions

Revisions that occur after the original QAPP is approved will be indicated on the QAPP title page and will be distributed in subsequent deliverables and upon request.

SECTION 2.0

GROUP B ELEMENTS: DATA GENERATION AND ACQUISITION

2.1 Sampling Process Design

The FERC-approved study plan presents the study design, including sample locations, frequency of sample collection, analytical parameters, and laboratory methods.

2.2 Sampling Methods

Data will be obtained in the field and in the laboratory.

The field sampler will maintain a field notebook and will note relevant conditions during each sampling event on the field data sheet. At a minimum, the following information pertaining to each sample will be recorded: date, time, weather conditions, name(s) of people collecting samples, units of measurements, depth, GPS coordinates for sample site, and river flow or reservoir water level.

Gloves and other appropriate personal protective equipment will be worn during sample and data collection activities. Observations of any field conditions that could affect sample results will be recorded in the field notebook, such as the concentrated presence of domestic animals or wildlife. Digital photo documentation of sampling conditions may also be performed. All field notes will be clearly written in a format that can be reproduced (i.e. scanned (pdf)) and entered into electronic format (Word or Excel).

2.2.1 Field Data Collection

The field measurement equipment that may be used during this project includes the following:

- Handheld multi-parameter meter (Hydrolab™ DataSonde 5) or equivalent. A sonde will be used to measure water temperature (±0.1°C), dissolved oxygen (±0.2 mg/L), pH (±0.2 standard unit, or su), specific conductance (±0.001 µmhos/cm), and turbidity (±1 NTU) and depth.

- Field turbidimeter (Hach Model 2100P Portable Turbidimeter). This meter will be used to measure turbidity in the field. The meter employs a tungsten-filament light source and two light detectors to measure scattered (at 90°) and transmitted light. The unit has a reported range of 0.01 to 1000 NTU.

Prior to each use, the instrument will be calibrated using manufacturer's recommended calibration methods (See Section 16). Any variances will be noted on the field data sheet and final report. If necessary to obtain a complete dataset, re-sampling within the FERC-approved study window will be performed. Non-disposable sampling equipment will be thoroughly cleaned between sampling sites.

Any field collected data that are not already in electronic format (Excel) will be hand entered into an electronic format and checked by a second-party.

2.2.2 Analytical Sample Collection

Surface samples will be collected using a grab sampling technique. Hypolimnetic samples will be collected using a Kemmerer bottle or equivalent. Each laboratory sample will be collected using laboratory-supplied clean containers, certified to meet the reporting limits specified in the study plan. Water samples to be analyzed for metals will be collected using "clean hands-dirty hands" method[2] consistent with the EPA Method 1669 sampling protocol as described in *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (EPA 1996; Attachment A).

Samples requiring filtration before metals analysis will be filtered in accordance with standard protocols. Whether filtering is done in the field or the laboratory, samples will be filtered with a 0.45 micro millimeter (µm) diameter pore-membrane filter, prior to preservation. Filters used in the field will be disposable and certified clean at the desired reporting limits, specified in the study plan.

As part of the field quality assurance program, field blanks and equipment rinsates will also be collected and submitted to the laboratory for analysis (See Section 14). While still in the field, full sample containers will be labeled, placed in re-sealable plastic bags (e.g. Ziploc®), and stored in a cooler on ice to maintain a temperature of approximately 4º C.

2.3 Sample Handling and Custody

A chain-of-custody record will be maintained with the laboratory samples at all times.

A chain-of-custody form that identifies the sample bottles, date and time of sample collection, and analyses requested will be initiated at the time of sample collection and prior to sample shipment or release. Identification information for each sample will be consistent with the information entered in the field notebook. The samples will be transported or shipped to the analytical lab in insulated containers within the appropriate holding time and will be accompanied by the chain-of-custody form. If shipment is needed, the samples will be packaged

[2] One member of a two-person sampling team is designated as "dirty hands"; the second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is all other activities that do not involve direct contact with the sample.

and shipped in accordance with U.S. Department of Transportation standards. The original chain-of-custody will be given to the lab with the samples and HDR will retain a copy for their records.

Once received by the laboratory, a sample receipt and storage record will be generated. The laboratory will perform all analyses within the constituent- or method- specific holding times.

After analyses, all samples will be disposed of in accordance with federal, state, and local requirements.

2.4 Analytical Methods

The FERC-approved study plan presents the laboratory methods that will be employed. Containers, preservatives, holding times, and QA/QC requirements are specified in the analytical methods and/or in the laboratory's own standard operating procedures. Analytical methods are preferentially U.S. Environmental Protection Agency (EPA) or American Society for Testing and Materials (ASTM) methods and are detailed in the laboratory's own quality assurance manual.

For each analyte, the laboratory must be able to achieve target reporting limits and method detection limits that will allow consistency with the Basin Plan's Water Quality Objectives to be assessed. Because many of the watersheds where HDR works are free or nearly free of contaminants, low method detection limits and reporting limits are often required. Though not preferred, it may be necessary for the commercial laboratory to report estimated or "J-flagged" data to meet target reporting limits for some analytes.

2.5 Quality Control

2.5.1 In Situ Data Collection

Projects that require pH and DO sampling also require a method of back-up or corrective action for inconsistent or questionable measurements collected in the field. For example, if pH is measured at less than 6 or greater than 8.5 in the field, a second measurement must be taken to verify the value. The second measurement could consist of ensuring that pH is included in the analyses of grab samples submitted to the California-certified laboratory, recalibrating the probe and re-measuring in the field, or returning to the site with a calibrated probe within the study window specified within the FERC-approved study plan. This information must be recorded in the field notes as well with explanations for the activity.

Projects that require DO sampling also require methods for back-up or corrective action measurements. For example, if a DO reading of less than 7 mg/L, for waters designated as COLD in the Basin Plan, is measured; then the instrument should be recalibrated and the sample collected again. If the reading is still questionable, then a sample must be collected for Winkler titration to verify the DO content of the water. Accurate field notes must be kept for any additional or back-up monitoring required in the field.

2.5.2 Sample Collection

QA/QC activities for sampling processes include the collection of field duplicates for bacterial and chemical testing, and the preparation of field blanks and/or equipment blanks as necessary. The number of duplicates should be one per every ten stations sampled or one per field visit.

Blanks will be prepared by pouring water known to be free of the substance of interest into a sample collection container then subsampling into the appropriate number of replicate sample containers. Ultrapure certified metals-free water will be used for hardness and metals.

2.5.3 Analytical Laboratory

All laboratories providing analytical support for this project will have the appropriate facilities to store, prepare, and process samples and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the project. The California certified laboratory will have a quality assurance plan in place and will adhere to standard protocols for accuracy, precision, instrument bias, and analytical bias.

The laboratory's deliverable (i.e. data package) will include information documenting their ability to conduct the analyses with the required level of data quality. Such information may include results from inter-laboratory calibration studies, control charts, and summary data from internal QA/QC checks, and results from analyses of certified reference materials. Additionally, the laboratory will report any inconsistencies or problems associated with any sample run(s) to HDR, who will document the situation as a variance or non-conformance, as appropriate (e.g., contaminated reagents, equipment malfunction, lost or broken sample bottles upon receipt, etc.).

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

2.6.1 Field Equipment

The field measurement equipment that may be used during this project includes the following:

- Handheld multi-parameter meter (Hydrolab DataSonde 5). This sonde will be used to measure dissolved oxygen, temperature, pH, and conductivity in the field.
- Field turbidimeter (Hach Model 2100P Portable Turbidimeter). This meter will be used to measure turbidity in the field. The meter employs a tungsten-filament light source and

two light detectors to measure scattered (at 90°) and transmitted light. The unit has a reported range of 0.01 to 1000 NTU.

Prior to each field visit, the sonde will be rented from and calibrated by the manufacturer. Upon receipt of the Hydrolab and prior to leaving for the field, the Field Lead or his designee will confirm the probe is working. Written documentation of calibration will be maintained in the project file, attached to relevant reports, and provided upon request.

In the event that the sonde shows signs of malfunction or drift in readings during fieldwork, basic diagnostics will be performed. At a minimum, the following will be checked: batteries, computer connection, and software. The probes will be examined for obstructions, such as algae, or physical damage. The Hydrolab user manual will be taken into the field that includes some basic trouble shooting. If basic trouble shooting is not successful, the sampling team will order a replacement rental unit and return to sample the site in a few days and within the sample period specified in the FERC-approved Study Plan.

2.6.2 Laboratory Equipment

All laboratories utilized to perform analytical services will be certified by the State of California. The certification includes requirements that the laboratory maintain their analytical equipment in accordance with manufactures instructions and analytical method requirements. Instrument testing, inspection and maintenance procedures are documented in the laboratory's quality assurance manual and verified during the State's audit.[3] Records will be kept at the laboratory and available upon request.

2.7 Instrument/Equipment Calibration and Frequency

Field instruments will be calibrated according to manufacturer's instructions immediately before use in the field. Sondes will be rented from and calibrated by the manufacturer immediately before use in the field. Documentation of calibration prior to each field visit will be maintained in the project file.

2.8 Inspection/Acceptance of Supplies and Consumables

Project supplies and consumables that may directly or indirectly affect the quality of results include filters, samplers, gloves, bottles and more. To avoid contaminating samples through supplies, supply selection will be made the meet the needs of the study plan. Supplies will be examined for damage as they are received and consumables will be replaced no later than the date recommended in the manufacturer's instructions.

[3] http://www.cdph.ca.gov/certlic/labs/Pages/default.aspx

The California-certified laboratory will provide all bottles used for sample collection and cleanliness certification will be provided. Specifically, all equipment used for trace metals sample collection will be certified clean and double-bagged, allowing for the measurement at the concentrations required for the study plan using the clean-hands-dirty-hands technique described in EPA Method 1669 (Attachment A).

A small inventory of critical spare parts for field equipment (DO membranes, o-rings, and temperature and conductivity probes) will be kept by HDR and brought in the field if needed; however, perishable supplies or expensive parts may not be kept on hand, and will need to be ordered when needed. All spare parts and supplies will be obtained through the equipment manufacturer or other reputable sources.

2.9 Non-Direct Measurements (Existing Data)

Water quality data has been previously collected in the study area. Though it is unknown at this time what existing data may be incorporated into relicensing documents, if any, the level of review of all incorporated existing data will be disclosed.

2.10 Data Management

Field and laboratory data will be entered and maintained in Excel spreadsheets. The contract laboratory will provide an electronic data deliverable and an electronic narrative that includes, at a minimum, Level II documentation.

Throughout the relicensing, the original field notebooks and forms, equipment maintenance and calibration documentation, chain-of-custody forms, laboratory reports, and data verification records will be stored at the HDR office at 2379 Gateway Oaks Drive, Suite 200, Sacramento, CA 95833. Records will be transferred to YCWA upon license receipt or earlier, at YCWA's discretion.

SECTION 3.0

GROUP C ELEMENTS: ASSESSMENT AND OVERSIGHT

3.1 Assessments and Response Actions

Periodic assessments will be conducted to ensure that data collection is conducted according to requirements presented in this QAPP. The Study Lead will have the primary responsibility for assessing compliance with the QAPP requirements pertaining to sample collection and handling procedures, field analytical procedures, laboratory analytical procedures, and communicating project status to the QA Officer and Project Manager. The QA Officer or his designee will conduct reviews of field sampling and analysis procedures at the beginning of each field season. The reviews may be performed at a demonstration site or involve accompanying sampling personnel to determine whether sampling activities are being conducted in accordance with the QAPP and Study Plan. Laboratory analyses will be assessed through evaluating results of QC samples and compliance with DQOs.

If a non-conformance is identified, the QA Officer and/or Study Lead, will notify the Project Manager immediately. The Project Manager, QA Office, and Study Lead will discuss the observed discrepancy with the appropriate person responsible for the activity to determine whether the information collected can still be considered accurate, what the cause(s) were leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The QA Officer and Study Lead will then follow up to ensure that corrective actions have been implemented.

3.2 Reports to Management

The study schedule is specified in the FERC-approved study plan. As described in the study plan, the primary deliverable will be a technical memorandum, transmitting the data collected.

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SECTION 4.0

GROUP D ELEMENTS: DATA VALIDATION AND USABILITY

4.1 Data Review, Verification, and Validation Requirements

Data review, verification and validation are steps in the transition between data collection via sampling and analysis and data use and interpretation. Although data review, verification and data validation are commonly used terms, they are defined and applied differently in various organizations and quality systems. For the purposes of relicensing, the terms will be generally defined as follows:

- Data review ensures the data have been recorded, transmitted, and processed correctly. That includes, ensuring the data are sensible and checking for data entry, transcription, calculation, reduction, and transformation errors.
- Data verification is the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications (USEPA 2002).
- Data validation is an analyte and sample specific process that extends the evaluation of data beyond method, procedure, or contractual compliance to determine the quality of a specific data set relative to the end use (USEPA 2002). Data validation begins with the output from data verification.

4.2 Verification and Validation Methods

Documentation of review, verification, and/or validation will be maintained in the project file.

For the relicensing, all data will be reviewed and verified. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analyses, HDR will subject all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of results to field blank and rinsate results; and, identification of any data that seem inconsistent. If any inconsistencies are found, HDR will consult with the laboratory to identify any potential sources of error before concluding that the data is correct.

All verified chemical detections, including data whose results are "J" qualified, will be used for this assessment. Should the laboratory need to re-extract samples and re-run the sample under different calibration conditions, the data identified by the laboratory, as the most certain, will be used. If field-sampling conditions, as measured by the field blank and the rinsate sample results, indicate that samples have been corrupted, HDR will identify the data accordingly.

4.3 Reconciliation with User Requirements

To fulfill YCWA's data needs, it is important that the data collected during this project are accurate, precise, representative, and complete, and can therefore be used to characterize water quality within the YCWA Project area. These data requirements will be assessed by ensuring that DQOs are met throughout the project.

After each discrete sampling event, the Study Lead will evaluate if the data quality objectives (DQOs) of Table 7.0-1 have been met. Results of the evaluation will be documented on the Data Review and Verification Form provided in Attachment B. If the impact of the QC failure on data quality is minimal, the data will be flagged and included with in the database. If a greater impact is found, the Study Lead will work with the QA Officer to determine the next steps. Data that does not meet the DQOs listed in Section 7 will be evaluated to 1) determine the cause of the problem; 2) determine whether corrective actions can be implemented so that DQOs are met in the future; and/or 3) determine if re-sampling is necessary to meet completeness or other PARCC objectives.

At the end of the monitoring program, the data generated under this project will be given to the YCWA.

4.4 References

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APPENDIX A.

SAMPLING AMBIENT WATERS FOR TRACE METALS AT EPA WATER QUALITY LEVELS

Method 1669

Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels

July 1996

U.S. Environmental Protection Agency
Office of Water
Engineering and Analysis Division (4303)
401 M Street S.W.
Washington, D.C. 20460

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This version of the method was prepared after observations of sampling teams from the University of California at Santa Cruz, the Wisconsin Department of Natural Resources, the U.S. Geological Survey, and Battelle Ocean Sciences. The assistance of personnel demonstrating the sampling techniques used by these institutions is gratefully acknowledged.

Disclaimer

This sampling method has been reviewed and approved for publication by the Analytical Methods Staff within the Engineering and Analysis Division of the U.S. Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Further Information

For further information, contact:

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Introduction

This sampling method was designed to support water quality monitoring programs authorized under the Clean Water Act. Section 304(a) of the Clean Water Act requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate (e.g., concentration and dispersal) of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability.

Section 303 of the Clean Water Act requires states to set a water quality standard for each body of water within its boundaries. A state water quality standard consists of a designated use or uses of a waterbody or a segment of a waterbody, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific waterbody, and (2) they are the basis for establishing water quality-based treatment controls and strategies beyond the technology-based controls required by Sections 301(b) and 306 of the Clean Water Act.

In defining water quality standards, the state may use narrative criteria, numeric criteria, or both. However, the 1987 amendments to the Clean Water Act required states to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses.

In some cases, these water quality criteria are as much as 280 times lower than those achievable using existing EPA methods and required to support technology-based permits. Therefore, this sampling method, and the analytical methods referenced in Table 1 of this document, were developed by EPA to specifically address state needs for measuring toxic metals at water quality criteria levels, when such measurements are necessary to protect designated uses in state water quality standards. The latest criteria published by EPA are those listed in the National Toxics Rule (57 *FR* 60848) and the Stay of Federal Water Quality Criteria for Metals (60 *FR* 22228). These rules include water quality criteria for 13 metals, and it is these criteria on which this sampling method and the referenced analytical methods are based.

In developing these methods, EPA found that one of the greatest difficulties in measuring pollutants at these levels was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site-specific conditions. This method, therefore, is designed to provide the level of protection necessary to preclude contamination in nearly all situations. It is also designed to provide the procedures necessary to produce reliable results at the lowest possible water quality criteria published by EPA. In recognition of the variety of situations to which this method may be applied, and in recognition of continuing technological advances, the method is performance-based. Alternative procedures may be used, so long as those procedures are demonstrated to yield reliable results.

Requests for additional copies of this method should be directed to:

U.S. EPA NCEPI
11029 Kenwood Road
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Note: This document is intended as guidance only. Use of the terms "must," "may," and "should" are included to mean that EPA believes that these procedures must, may, or should be followed in order to produce the desired results when using this guidance. In addition, the guidance is intended to be performance-based, in that the use of less stringent procedures may be used so long as neither samples nor blanks are contaminated when following those modified procedures. Because the only way to measure the performance of the modified procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the referenced methods, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected.

Method 1669

Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels

1.0 Scope and Application

1.1 This method is for the collection and filtration of ambient water samples for subsequent determination of total and dissolved metals at the levels listed in Table 1. It is designed to support the implementation of water quality monitoring and permitting programs administered under the Clean Water Act.

1.2 This method is applicable to the metals listed below and other metals, metals species, and elements amenable to determination at trace levels.

Analyte	Symbol	Chemical Abstract Services Registry Number (CASRN)
Antimony	(Sb)	7440-36-0
Arsenic	(As)	7440-38-2
Cadmium	(Cd)	7440-43-9
Chromium (III)	Cr^{+3}	16065-83-1
Chromium (VI)	Cr^{+6}	18540-29-9
Copper	(Cu)	7440-50-8
Lead	(Pb)	7439-92-1
Mercury	(Hg)	7439-97-6
Nickel	(Ni)	7440-02-0
Selenium	(Se)	7782-49-2
Silver	(Ag)	7440-22-4
Thallium	(Tl)	7440-28-0
Zinc	(Zn)	7440-66-6

1.3 This method is accompanied by the 1600 series methods listed in Table 1. These methods include the sample handling, analysis, and quality control procedures necessary for reliable determination of trace metals in aqueous samples.

1.4 This method is not intended for determination of metals at concentrations normally found in treated and untreated discharges from industrial facilities. Existing regulations (40 *CFR* Parts 400-500) typically limit concentrations in industrial discharges to the mid to high part-per-billion (ppb) range, whereas ambient metals concentrations are normally in the low part-per-trillion (ppt) to low ppb range. This guidance is therefore directed at the collection of samples to be measured at or near the levels listed in Table 1. Actual concentration ranges to which this guidance is applicable will be dependent on the sample matrix, dilution levels, and other laboratory operating conditions.

1.5 The ease of contaminating ambient water samples with the metal(s) of interest and interfering substances cannot be overemphasized. This method includes sampling techniques that should maximize the ability of the sampling team to collect samples reliably and eliminate sample contamination. These techniques are given in Section 8.0 and are based on findings of researchers performing trace metals analyses (References 1-9).

1.6 Clean and Ultraclean—The terms "clean" and "ultraclean" have been used in other Agency guidance to describe the techniques needed to reduce or eliminate contamination in trace metals determinations. These terms are not used in this sampling method due to a lack of exact definitions. However, the information provided in this method is consistent with summary guidance on clean and ultraclean techniques (Reference 10).

1.7 This sampling method follows the EPA Environmental Methods Management Council's "Format for Method Documentation" (Reference 11).

1.8 Method 1669 is "performance-based"; i.e., an alternate sampling procedure or technique may be used, so long as neither samples nor blanks are contaminated when following the alternate procedures. Because the only way to measure the performance of the alternate procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the methods referenced in Table 1, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected. Section 9.2 provides additional details on the tests and documentation required to support equivalent performance.

1.9 For dissolved metal determinations, samples must be filtered through a 0.45 µm capsule filter at the field site. The filtering procedures are described in this method. The filtered samples may be preserved in the field or transported to the laboratory for preservation. Procedures for field preservation are detailed in this sampling method; procedures for laboratory preservation are provided in the methods referenced in Table 1. Preservation requirements are summarized in Table 2.

1.10 The procedures in this method are for use only by personnel thoroughly trained in the collection of samples for determination of metals at ambient water quality control levels.

2.0 Summary of Method

2.1 Before samples are collected, all sampling equipment and sample containers are cleaned in a laboratory or cleaning facility using detergent, mineral acids, and reagent water as described in the methods referenced in Table 1. The laboratory or cleaning facility is responsible for generating an acceptable equipment blank to demonstrate that the sampling equipment and containers are free from trace metals contamination before they are shipped to the field sampling team. An acceptable blank is one that is free from contamination below the minimum level (ML) specified in the referenced analytical method (Section 9.3).

2.2 After cleaning, sample containers are filled with weak acid solution, individually double-bagged, and shipped to the sampling site. All sampling equipment is also bagged for storage or shipment.

NOTE: *EPA has found that, in some cases, it may be possible to empty the weak acid solution from the bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).*

2.3 The laboratory or cleaning facility must prepare a large carboy or other appropriate clean container filled with reagent water (Section 7.1) for use with collection of field blanks during sampling activities. The reagent-water-filled container should be shipped to the field site and handled as all other sample containers and sampling equipment. At least one field blank should be processed per site, or one per every ten samples, whichever is more frequent (Section 9.4). If samples are to be collected for determination of trivalent chromium, the sampling team processes additional QC aliquots are processed as described in Section 9.6.

2.4 Upon arrival at the sampling site, one member of the two-person sampling team is designated as "dirty hands"; the second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.

2.5 All sampling equipment and sample containers used for metals determinations at or near the levels listed in Table 1 must be nonmetallic and free from any material that may contain metals.

2.6 Sampling personnel are required to wear clean, nontalc gloves at all times when handling sampling equipment and sample containers.

2.7 In addition to processing field blanks at each site, a field duplicate must be collected at each sampling site, or one field duplicate per every 10 samples, whichever is more frequent (Section 9.5). Section 9.0 gives a complete description of quality control requirements.

2.8 Sampling

2.8.1 Whenever possible, samples are collected facing upstream and upwind to minimize introduction of contamination.

2.8.2 Samples may be collected while working from a boat or while on land.

2.8.3 Surface samples are collected using a grab sampling technique. The principle of the grab technique is to fill a sample bottle by rapid immersion in water and capping to minimize exposure to airborne particulate matter.

2.8.4 Subsurface samples are collected by suction of the sample into an immersed sample bottle or by pumping the sample to the surface.

2.9 Samples for dissolved metals are filtered through a 0.45 µm capsule filter at the field site. After filtering, the samples are double-bagged and iced immediately. Sample containers are shipped to the analytical laboratory. The sampling equipment is shipped to the laboratory or cleaning facility for recleaning.

2.10 Acid preservation of samples is performed in the field or in the laboratory. Field preservation is necessary for determinations of trivalent chromium. It has also been shown that field preservation can increase sample holding times for hexavalent chromium to 30 days; therefore it is recommended that preservation of samples for hexavalent chromium be performed in the field. For other metals, however, the sampling team may prefer to utilize laboratory preservation of samples to expedite field operations and to minimize the potential for sample contamination.

2.11 Sampling activities must be documented through paper or computerized sample tracking systems.

3.0 Definitions

3.1 Apparatus—Throughout this method, the sample containers, sampling devices, instrumentation, and all other materials and devices used in sample collection, sample processing, and sample analysis activities will be referred to collectively as the Apparatus.

3.2 Definitions of other terms are given in the Glossary (Section 15.0) at the end of this method.

4.0 Contamination and Interferences

4.1 Contamination Problems in Trace Metals Analysis

4.1.1 Preventing ambient water samples from becoming contaminated during the sampling and analytical process is the greatest challenge faced in trace metals determinations. In recent years, it has been shown that much of the historical trace metals data collected in ambient water are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels (Reference 12). Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing ambient water samples for trace metals.

4.1.2 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination during sampling include metallic or metal-containing sampling equipment, containers, labware (e.g. talc gloves that contain high levels of zinc), reagents, and deionized water; improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust from automobile exhaust, cigarette smoke, nearby roads, bridges, wires, and poles. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation (Reference 3).

4.2 Contamination Control

4.2.1 Philosophy—The philosophy behind contamination control is to ensure that any object or substance that contacts the sample is nonmetallic and free from any material that may contain metals of concern.

4.2.1.1 The integrity of the results produced cannot be compromised by contamination of samples. Requirements and suggestions for controlling sample contamination are given in this sampling method and in the analytical methods referenced in Table 1.

4.2.1.2 Substances in a sample or in the surrounding environment cannot be allowed to contaminate the Apparatus used to collect samples for trace metals measurements. Requirements and suggestions for protecting the Apparatus are given in this sampling method and in the methods referenced in Table 1.

4.2.1.3 While contamination control is essential, personnel health and safety remain the highest priority. Requirements and suggestions for personnel safety are given in Section 5 of this sampling method and in the methods referenced in Table 1.

4.2.2 Avoiding contamination—The best way to control contamination is to completely avoid exposure of the sample and Apparatus to contamination in the first place. Avoiding exposure means performing operations in an area known to be free from contamination. Two of the most important factors in avoiding/reducing sample contamination are (1) an awareness of potential sources of contamination and (2) strict attention to work being performed. Therefore, it is imperative that the procedures described in this method be carried out by well trained, experienced personnel. Documentation of training should be kept on file and readily available for review.

4.2.2.1 Minimize exposure—The Apparatus that will contact samples or blanks should only be opened or exposed in a clean room, clean bench, glove box, or clean plastic bag, so that exposure to atmospheric inputs is minimized. When not being used, the Apparatus should be covered with clean plastic wrap, stored in the clean bench or in a plastic box or glove box, or bagged in clean, colorless zip-type bags. Minimizing the time between cleaning and use will also reduce contamination.

4.2.2.2 Wear gloves—Sampling personnel must wear clean, nontalc gloves (Section 6.7) during all operations involving handling of the Apparatus, samples, and blanks. Only clean gloves may touch the Apparatus. If another object or substance is touched, the glove(s) must be changed before again handling the Apparatus. If it is even suspected that gloves have become contaminated, work must be halted, the contaminated gloves removed, and a new pair of clean gloves put on. Wearing multiple layers of clean gloves will allow the old pair to be quickly stripped with minimal disruption to the work activity.

4.2.2.3 Use metal-free Apparatus—All Apparatus used for metals determinations at the levels listed in Table 1 must be nonmetallic and free of material that may contain metals. When it is not possible to obtain equipment that is completely free of the metal(s) of interest, the sample should not come into direct contact with the equipment.

4.2.2.3.1 Construction materials—Only the following materials should come in contact with samples: fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, polysulfone, polypropylene, or ultrapure quartz. PTFE is less desirable than FEP because the sintered material in PTFE may contain contaminants and is susceptible to serious memory effects (Reference 6). Fluoropolymer or glass containers should be used for samples that will be analyzed for mercury because mercury vapors can diffuse in or out of other materials, resulting either in contamination or low-biased results (Reference 3). Metal must not be used under any circumstance. Regardless of construction, all materials that will directly or indirectly contact the sample must be cleaned using the procedures described in the referenced analytical methods (see Table 1) and must be known to be clean and metal-free before proceeding.

4.2.2.3.2 The following materials have been found to contain trace metals and must not be used to hold liquids that come in contact with the sample or must not contact the sample, unless these materials have been shown to be free of the metals of interest at the desired level: Pyrex, Kimax, methacrylate, polyvinylchloride, nylon, and Vycor (Reference 6). In addition, highly colored plastics, paper cap liners, pigments used to mark increments on plastics, and rubber all contain trace levels of metals and must be avoided (Reference 13).

4.2.2.3.3 Serialization—Serial numbers should be indelibly marked or etched on each piece of Apparatus so that contamination can be traced, and logbooks should be maintained to track the sample from the container through the sampling process to shipment to the laboratory. Chain-of-custody procedures may also be used if warranted so that contamination can be traced to particular handling procedures or lab personnel.

4.2.2.3.4 The Apparatus should be clean when the sampling team receives it. If there are any indications that the Apparatus is not clean (e.g., a ripped storage bag), an assessment of the likelihood of contamination must be made. Sampling must not proceed if it is possible that the Apparatus is contaminated. If the Apparatus is contaminated, it must be returned to the laboratory or cleaning facility for proper cleaning before any sampling activity resumes.

4.2.2.3.5 Details for recleaning the Apparatus between collection of individual samples are provided in Section 10.0.

4.2.2.4 Avoid sources of contamination—Avoid contamination by being aware of potential sources and routes of contamination.

4.2.2.4.1 Contamination by carryover—Contamination may occur when a sample containing low concentrations of metals is processed immediately after a sample containing relatively high concentrations of these metals. At sites where more than one sample will be collected, the sample known or expected to contain the lowest concentration of metals should be collected first with the sample containing the highest levels collected last (Section 8.1.4). This will help minimize carryover of metals from high- concentration samples to low- concentration samples. If the sampling team does not have prior knowledge of the waterbody, or when necessary, the sample collection system should be rinsed with dilute acid and reagent water between samples and followed by collection of a field blank (Section 10.3).

4.2.2.4.2 Contamination by samples—Significant contamination of the Apparatus may result when untreated effluents, in-process waters, landfill leachates, and other samples containing mid- to high-level concentrations of inorganic substances are processed. As stated in Section 1.0, this sampling method is not intended for application to these samples, and samples containing high concentrations of metals must not be collected, processed, or shipped at the same time as samples being collected for trace metals determinations.

4.2.2.4.3 Contamination by indirect contact—Apparatus that may not directly contact samples may still be a source of contamination. For example, clean tubing placed in a dirty plastic bag may pick up contamination from the bag and subsequently transfer the contamination to the sample. Therefore, it is imperative that every piece of the Apparatus that is directly or indirectly used in the collection of ambient water samples be cleaned as specified in the analytical method(s) referenced in Table 1.

4.2.2.4.4 Contamination by airborne particulate matter—Less obvious substances capable of contaminating samples include airborne particles. Samples may be contaminated by airborne dust, dirt, particulate matter, or vapors from automobile exhaust; cigarette smoke; nearby corroded or rusted bridges, pipes, poles, or wires; nearby roads; and even human breath (Section 4.1.2). Whenever possible, the sampling activity should occur as far as possible from sources of airborne contamination (Section 8.1.3). Areas where nearby soil is bare and subject to wind erosion should be avoided.

4.3 Interferences—Interferences resulting from samples will vary considerably from source to source, depending on the diversity of the site being sampled. If a sample is suspected of containing substances that may interfere in the determination of trace metals, sufficient sample should be collected to allow the laboratory to identify and overcome interference problems.

5.0 Safety

5.1 The toxicity or carcinogenicity of the chemicals used in this method has not been precisely determined; however, these chemicals should be treated as a potential health hazard. Exposure should be reduced to the lowest possible level. Sampling teams are responsible for maintaining a current awareness file of OSHA regulations for the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets should also be made available to all personnel involved in sampling. It is also suggested that the organization responsible perform personal hygiene monitoring of each sampling team member who uses this method and that the results of this monitoring be made available to the member.

5.2 Operating in and around waterbodies carries the inherent risk of drowning. Life jackets must be worn when operating from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.

5.3 Collecting samples in cold weather, especially around cold water bodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.

6.0 Apparatus and Materials

NOTE: *Brand names, suppliers, and part numbers are for illustration only and no endorsement is implied. Equivalent performance may be achieved using apparatus and materials other than those specified here. Meeting the performance requirements of this method is the responsibility of the sampling team and laboratory.*

6.1 All sampling equipment and sample containers must be precleaned in a laboratory or cleaning facility, as described in the methods referenced in Table 1, before they are shipped to the field site. Performance criteria for equipment cleaning is described in the referenced methods. To minimize difficulties in sampling, the equipment should be packaged and arranged to minimize field preparation.

6.2 Materials such as gloves (Section 6.7), storage bags (Section 6.8), and plastic wrap (Section 6.9), may be used new without additional cleaning unless the results of the equipment blank pinpoint any of these materials as a source of contamination. In this case, either a different supplier must be obtained or the materials must be cleaned.

6.3 Sample Bottles—Fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, or polypropylene; 500 mL or 1 L with lids. If mercury is a target analyte, fluoropolymer or glass bottles should be used. Refer to the methods referenced in Table 1 for bottle cleaning procedures.

6.3.1 Cleaned sample bottles should be filled with 0.1% HCl (v/v). In some cases, it may be possible to empty the weak acid solution from the sample bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).

6.3.2 Whenever possible, sampling devices should be cleaned and prepared for field use in a class 100 clean room. Preparation of the devices in the field should be done within the glove bag (Section 6.6). Regardless of design, sampling devices must be constructed of nonmetallic material (Section 4.2.2.3.1) and free from material that contains metals. Fluoropolymer or other material shown not to adsorb or contribute mercury must be used if mercury is a target analyte; otherwise, polyethylene, polycarbonate, or polypropylene are acceptable. Commercially available sampling devices may be used provided that any metallic or metal-containing parts are replaced with parts constructed of nonmetallic material.

6.4 Surface Sampling Devices—Surface samples are collected using a grab sampling technique. Samples may be collected manually by direct submersion of the bottle into the water or by using a grab sampling device. Examples of grab samplers are shown in Figures 1 and 2 and may be used at sites where depth profiling is neither practical nor necessary.

6.4.1 The grab sampler in Figure 1 consists of a heavy fluoropolymer collar fastened to the end of a 2-m-long polyethylene pole, which serves to remove the sampling personnel from the immediate vicinity of the sampling point. The collar holds the sample bottle. A fluoropolymer closing mechanism, threaded onto the bottle, enables the sampler to open and close the bottle under water, thereby avoiding surface microlayer contamination (Reference 14). Polyethylene, polycarbonate, and polypropylene are also acceptable construction materials unless mercury is a target analyte. Assembly of the cleaned sampling device is as follows (refer to Figure 1):

6.4.1.1 Thread the pull cord (with the closing mechanism attached) through the guides and secure the pull ring with a simple knot. Screw a sample bottle onto the closing device and insert the bottle into the collar. Cock the closing plate so that the plate is pushed away from the operator.

6.4.1.2 The cleaned and assembled sampling device should be stored in a double layer of large, clean zip-type polyethylene bags or wrapped in two layers of clean polyethylene wrap if it will not be used immediately.

6.4.2 An alternate grab sampler design is shown in Figure 2. This grab sampler is used for discrete water samples and is constructed so that a capped clean bottle can be submerged, the cap removed, sample collected, and bottle recapped at a selected depth. This device eliminates sample contact with conventional samplers (e.g., Niskin bottles), thereby reducing the risk of extraneous contamination. Because a fresh bottle is used for each sample, carryover from previous samples is eliminated (Reference 15).

6.5 Subsurface Sampling Devices—Subsurface sample collection may be appropriate in lakes and sluggish deep river environments or where depth profiling is determined to be necessary. Subsurface samples are collected by pumping the sample into a sample bottle. Examples of subsurface collection systems include the jar system device shown in Figure 3 and described in Section 6.5.1 or the continuous-flow apparatus shown in Figure 4 and described in Section 6.5.2.

6.5.1 Jar sampler (Reference 14)—The jar sampler (Figure 3) is comprised of a heavy fluoropolymer 1-L jar with a fluoropolymer lid equipped with two 1/4 in. fluoropolymer fittings. Sample enters the jar through a short length of fluoropolymer tubing inserted into one fitting. Sample is pulled into the jar by pumping on fluoropolymer tubing attached to the other fitting. A thick fluoropolymer plate supports the jar and provides attachment points for a fluoropolymer safety line and fluoropolymer torpedo counterweight.

6.5.1.1 Advantages of the jar sampler for depth sampling are (1) all wetted surfaces are fluoropolymer and can be rigorously cleaned; (2) the sample is collected into a sample jar from which the sample is readily recovered, and the jar can be easily recleaned; (3) the suction device (a peristaltic or rotary vacuum pump, Section 6.15) is located in the boat, isolated from the sampling jar; (4) the sampling jar can be continuously flushed with sample, at sampling depth, to equilibrate the system; and (5) the sample does not travel through long lengths of tubing that are more difficult to clean and keep clean (Reference 14). In addition, the device is designed to eliminate atmospheric contact with the sample during collection.

6.5.1.2 To assemble the cleaned jar sampler, screw the torpedo weight onto the machined bolt attached to the support plate of the jar sampler. Attach a section of the 1/4 in. o.d. tubing to the jar by inserting the tubing into the fitting on the lid and pushing down into the jar until approximately 8 cm from the bottom. Tighten the fitting nut securely. Attach the solid safety line to the jar sampler using a bowline knot to the loop affixed to the support plate.

6.5.1.3 For the tubing connecting the pump to the sampler, tubing lengths of up to 12 m have been used successfully (Reference 14).

6.5.2 Continuous-flow sampler (References 16-17)—This sampling system, shown in Figure 4, consists of a peristaltic or submersible pump and one or more lengths of precleaned fluoropolymer or styrene/ethylene/butylene/ silicone (SEBS) tubing. A filter is added to the sampling train when sampling for dissolved metals.

6.5.2.1 Advantages of this sampling system include (1) all wetted surfaces are fluoropolymer or SEBS and can be readily cleaned; (2) the suction device is located in the boat, isolated from the sample bottle; (3) the sample does not travel through long lengths of tubing that are difficult to clean and keep clean; and (4) in-line filtration is possible, minimizing field handling requirements for dissolved metals samples.

6.5.2.2 The sampling team assembles the system in the field as described in Section 8.2.8. System components include an optional polyethylene pole to remove sampling personnel from the immediate vicinity of the sampling point and the pump, tubing, filter, and filter holder listed in Sections 6.14 and 6.15.

6.6 Field-Portable Glove Bag—I2R, Model R-37-37H (nontalc), or equivalent. Alternately, a portable glove box may be constructed with a nonmetallic (PVC pipe or other suitable material) frame and a frame cover made of an inexpensive, disposable, nonmetallic material (e.g., a thin-walled polyethylene bag) (Reference 7).

6.7 Gloves—Clean, nontalc polyethylene, latex, vinyl, or PVC; various lengths. Shoulder-length gloves are needed if samples are to be collected by direct submersion of the sample bottle into the water or when sampling for mercury.

6.7.1 Gloves, shoulder-length polyethylene—Associated Bag Co., Milwaukee, WI, 66-3-301, or equivalent.

6.7.2 Gloves, PVC—Fisher Scientific Part No. 11-394-100B, or equivalent.

6.8 Storage Bags—Clean, zip-type, nonvented, colorless polyethylene (various sizes).

6.9 Plastic Wrap—Clean, colorless polyethylene.

6.10 Cooler—Clean, nonmetallic, with white interior for shipping samples.

6.11 Ice or Chemical Refrigerant Packs—To keep samples chilled in the cooler during shipment.

6.12 Wind Suit—Pamida, or equivalent.

NOTE: *This equipment is necessary only for collection of metals, such as mercury, that are known to have elevated atmospheric concentrations.*

6.12.1 An unlined, long-sleeved wind suit consisting of pants and jacket and constructed of nylon or other synthetic fiber is worn when sampling for mercury to prevent mercury adsorbed onto cotton or other clothing materials from contaminating samples.

6.12.2 Washing and drying—The wind suit is washed by itself or with other wind suits only in a home or commercial washing machine and dried in a clothes dryer. The clothes dryer must be thoroughly vacuumed, including the lint filter, to remove all traces of lint before drying. After drying, the wind suit is folded and stored in a clean polyethylene bag for shipment to the sample site.

6.13 Boat

6.13.1 For most situations (e.g., most metals under most conditions), the use of an existing, available boat is acceptable. A flat-bottom, Boston Whaler-type boat is preferred because sampling materials can be stored with reduced chance of tipping.

6.13.1.1 Immediately before use, the boat should be washed with water from the sampling site away from any sampling points to remove any dust or dirt accumulation.

6.13.1.2 Samples should be collected upstream of boat movement.

6.13.2 For mercury, and for situations in which the presence of contaminants cannot otherwise be controlled below detectable levels, the following equipment and precautions may be necessary:

6.13.2.1 A metal-free (e.g., fiberglass) boat, along with wooden or fiberglass oars. Gasoline- or diesel-fueled boat motors should be avoided when possible because the exhaust can be a source of contamination. If the body of water is large enough to require use of a boat motor, the engine should be shut off at a distance far enough from the sampling point to avoid contamination, and the sampling team should manually propel the boat to the sampling point. Samples should be collected upstream of boat movement.

6.13.2.2 Before first use, the boat should be cleaned and stored in an area that minimizes exposure to dust and atmospheric particles. For example, cleaned boats should not be stored in an area that would allow exposure to automobile exhaust or industrial pollution.

6.13.2.3 The boat should be frequently visually inspected for possible contamination.

6.13.2.4 After sampling, the boat should be returned to the laboratory or cleaning facility, cleaned as necessary, and stored away from any sources of contamination until next use.

6.14 Filtration Apparatus—Required when collecting samples for dissolved metals determinations.

6.14.1 Filter—0.45 µm, 15 mm diameter or larger, tortuous-path capsule filters (Reference 18), Gelman Supor 12175, or equivalent.

6.14.2 Filter holder—For mounting filter to the gunwale of the boat. Rod or pipe made from plastic material and mounted with plastic clamps.

NOTE: *A filter holder may not be required if one or a few samples are to be collected. For these cases, it may only be necessary to attach the filter to the outlet of the tubing connected to the pump.*

6.15 Pump and Pump Apparatus—Required for use with the jar sampling system (Section 6.5.1) or the continuous-flow system (Section 6.5.2). Peristaltic pump; 115 V a.c., 12 V d.c., internal battery, variable-speed, single-head, Cole-Parmer, portable, "Masterflex L/S," Catalog No. H-07570-10 drive with Quick Load pump head, Catalog No. H-07021-24, or equivalent.

NOTE: *Equivalent pumps may include rotary vacuum, submersible, or other pumps free from metals and suitable to meet the site-specific depth sampling needs.*

6.15.1 Cleaning—Peristaltic pump modules do not require cleaning. However, nearly all peristaltic pumps contain a metal head and metal controls. Touching the head or controls necessitates changing of gloves before touching the Apparatus. If a submersible pump is used, a large volume of sample should be pumped to clean the stainless steel shaft (hidden behind the impeller) that comes in contact with the sample. Pumps with metal impellers should not be used.

6.15.2 Tubing—For use with peristaltic pump. SEBS resin, approximately 3/8 in. i.d. by approximately 3 ft, Cole-Parmer size 18, Cat. No. G-06464-18, or approximately 1/4 in. i.d., Cole-Parmer size 17, Catalog No. G-06464-17, or equivalent. Tubing is cleaned by soaking in 5-10% HCl solution for 8-24 hours, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with mercury-free air or nitrogen. After drying, the tubing is double-bagged in clear polyethylene bags, serialized with a unique number, and stored until use.

6.15.3 Tubing—For connection to peristaltic pump tubing. Fluoropolymer, 3/8 or 1/4 in. o.d., in lengths as required to reach the point of sampling. If sampling will be at some depth from the end of a boom extended from a boat, sufficient tubing to extend to the end of the boom and to the depth will be required. Cleaning of the fluoropolymer can be the same as cleaning the tubing for the rotary vacuum pump (Section 6.15.1.2). If necessary, more aggressive cleaning (e.g., concentrated nitric acid) may be used.

6.15.4 Batteries to operate submersible pump—12 V, 2.6 amp, gel cell, YUASA NP2.6-12, or equivalent. A 2 amp fuse connected at the positive battery terminal is strongly recommended to prevent short circuits from overheating the battery. A 12 V, lead-acid automobile or marine battery may be more suitable for extensive pumping.

6.15.5 Tubing connectors—Appropriately sized PVC, clear polyethylene, or fluoropolymer "barbed" straight connectors cleaned as the tubing above. Used to connect multiple lengths of tubing.

6.16 Carboy—For collection and storage of dilute waste acids used to store bottles.

6.17 Apparatus—For field preservation of aliquots for trivalent chromium determinations.

6.17.1 Fluoropolymer forceps—1 L fluoropolymer jar, and 30 mL fluoropolymer vials with screw-caps (one vial per sample and blank). It is recommended that 1 mL of ultrapure nitric acid (Section 7.3) be added to each vial prior to transport to the field to simplify field handling activities (See Section 8.4.4.6).

6.17.2 Filters—0.4 µm, 47 mm polycarbonate Nuclepore (or equivalent). Filters are cleaned as follows. Fill a 1 L fluoropolymer jar approximately two-thirds full with 1 N nitric acid. Using fluoropolymer forceps, place individual filters in the fluoropolymer jar. Allow the filters to soak for 48 hours. Discard the acid, and rinse five times with reagent water. Fill the jar with reagent water, and soak the filters for 24 hours. Remove the filters when ready for use, and using fluoropolymer forceps, place them on the filter apparatus (Section 6.17.3).

6.17.3 Vacuum filtration apparatus—Millipore 47 mm size, or equivalent, vacuum pump and power source (and extension cords, if necessary) to operate the pump.

6.17.4 Eppendorf auto pipet and colorless pipet tips (100-1000 µL)

6.17.5 Wrist-action shaker—Burrel or equivalent.

6.17.6 Fluoropolymer wash bottles—One filled with reagent water (Section 7.1) and one filled with high- purity 10% HCl (Section 7.4.4), for use in rinsing forceps and pipet tips.

7.0 Reagents and Standards

7.1 Reagent Water—Water in which the analytes of interest and potentially interfering substances are not detected at the Method Detection Limit (MDL) of the analytical method used for analysis of samples. Prepared by distillation, deionization, reverse osmosis, anodic/cathodic stripping voltammetry, or other techniques that remove the metal(s) and potential interferent(s). A large carboy or other appropriate container filled with reagent water must be available for the collection of field blanks.

7.2 Nitric Acid—Dilute, trace-metal grade, shipped with sampling kit for cleaning equipment between samples.

7.3 Sodium Hydroxide—Concentrated, 50% solution for use when field-preserving samples for hexavalent chromium determinations (Section 8.4.5).

7.4 Reagents—For field-processing aliquots for trivalent chromium determinations

7.4.1 Nitric Acid, Ultrapure—For use when field-preserving samples for trivalent chromium determinations (Sections 6.17 and 8.4.4).

7.4.2 Ammonium Iron (II) Sulfate Solution (0.01M)—Used to prepare the chromium (III) extraction solution (Section 7.4.3) necessary for field preservation of samples for trivalent chromium (Section 8.4.4). Prepare the ammonium iron (II) sulfate solution by adding 3.92 g ammonium iron (II) sulfate (ultrapure grade) to a 1 L volumetric flask. Bring to volume with reagent water. Store in a clean polyethylene bottle.

7.4.3 Chromium (III) extraction solution—For use when field-preserving samples for trivalent chromium determinations (Section 8.4.4). Prepare this solution by adding 100 mL of ammonium iron (II) sulfate solution (Section 7.4.2) to a 125 mL polyethylene bottle. Adjust pH to 8 with approximately 2 mL of ammonium hydroxide solution. Cap and shake on a wrist-action shaker for 24 hours. This iron (III) hydroxide solution is stable for 30 days.

7.4.4 Hydrochloric acid—High-purity, 10% solution, shipped with sampling kit in fluoropolymer wash bottles for cleaning trivalent chromium sample preservation equipment between samples.

7.4.5 Chromium stock standard solution (1000 µg/mL)—Prepared by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid. Store in polyethylene bottle. A commercially available standard solution may be substituted.

7.4.6 Standard chromium spike solution (1000 µg/L)—Used to spike sample aliquots for matrix spike/matrix spike duplicate (MS/MSD) analysis and to prepare ongoing precision and recovery standards. Prepared by spiking 1 mL of the chromium stock standard solution (Section 7.4.5) into a 1 L flask. Dilute to volume with 1% HCl. Store in a polyethylene bottle.

7.4.7 Ongoing precision and recovery (OPR) standard (25 µg/L)—Prepared by spiking 2.5 mL of the standard chromium spike solution (Section 7.4.6) into a 100 mL flask. Dilute to volume with 1% HCl. One OPR is required for every 10 samples.

8.0 Sample Collection, Filtration, and Handling

8.1 Site Selection

8.1.1 Selection of a representative site for surface water sampling is based on many factors including: study objectives, water use, point source discharges, non-point source discharges, tributaries, changes in stream characteristics, types of stream bed, stream depth, turbulence, and the presence of structures (bridges, dams, etc.). When collecting samples to determine ambient levels of trace metals, the presence of potential sources of metal contamination are of extreme importance in site selection.

8.1.2 Ideally, the selected sampling site will exhibit a high degree of cross-sectional homogeneity. It may be possible to use previously collected data to identify locations for samples that are well mixed or are vertically or horizontally stratified. Since mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will ensure good vertical mixing. Horizontal mixing occurs in constrictions in the channel. In the absence of turbulent areas, the selection of a site that is clear of immediate point sources, such as industrial effluents, is preferred for the collection of ambient water samples (Reference 19).

8.1.3 To minimize contamination from trace metals in the atmosphere, ambient water samples should be collected from sites that are as far as possible (e.g., at least several hundred feet) from any metal supports, bridges, wires or poles. Similarly, samples should be collected as far as possible from regularly or heavily traveled roads. If it is not possible to avoid collection near roadways, it is advisable to study traffic patterns and plan sampling events during lowest traffic flow (Reference 7).

8.1.4 The sampling activity should be planned to collect samples known or suspected to contain the lowest concentrations of trace metals first, finishing with the samples known or suspected to contain the highest concentrations. For example, if samples are collected from a flowing river or stream near an industrial or municipal discharge, the upstream sample should be collected first, the downstream sample collected second, and the sample nearest the discharge collected last. If the concentrations of pollutants is not known and cannot be estimated, it is necessary to use precleaned sampling equipment at each sampling location.

8.2 Sample Collection Procedure—Before collecting ambient water samples, consideration should be given to the type of sample to be collected, the amount of sample needed, and the devices to be used (grab, surface, or subsurface samplers). Sufficient sample volume should be collected to allow for necessary quality control analyses, such as matrix spike/matrix spike duplicate analyses.

8.2.1 Four sampling procedures are described:

8.2.1.1 Section 8.2.5 describes a procedure for collecting samples directly into the sample container. This procedure is the simplest and provides the least potential for contamination because it requires the least amount of equipment and handling.

8.2.1.2 Section 8.2.6 describes a procedure for using a grab sampling device to collect samples.

8.2.1.3 Section 8.2.7 describes a procedure for depth sampling with a jar sampler. The size of sample container used is dependent on the amount of sample needed by the analytical laboratory.

8.2.1.4 Section 8.2.8 describes a procedure for continuous-flow sampling using a submersible or peristaltic pump.

8.2.2 The sampling team should ideally approach the site from down current and downwind to prevent contamination of the sample by particles sloughing off the boat or equipment. If it is not possible to approach from both, the site should be approached from down current if sampling from a boat or approached from downwind if sampling on foot. When sampling from a boat, the bow of the boat should be oriented into the current (the boat will be pointed upstream). All sampling activity should occur from the bow.

If the samples are being collected from a boat, it is recommended that the sampling team create a stable workstation by arranging the cooler or shipping container as a work table on the upwind side of the boat, covering this worktable and the upwind gunnel with plastic wrap or a plastic tablecloth, and draping the wrap or cloth over the gunnel. If necessary, duct tape is used to hold the wrap or cloth in place.

8.2.3 All operations involving contact with the sample bottle and with transfer of the sample from the sample collection device to the sample bottle (if the sample is not directly collected in the bottle) are handled by the individual designated as "clean hands." "Dirty hands" is responsible for all activities that do not involve direct contact with the sample.

Although the duties of "clean hands" and "dirty hands" would appear to be a logical separation of responsibilities, in fact, the completion of the entire protocol may require a good deal of coordination and practice. For example, "dirty hands" must open the box or cooler containing the sample bottle and unzip the outer bag; clean hands must reach into the outer bag, open the inner bag, remove the bottle, collect the sample, replace the bottle lid, put the bottle back into the inner bag, and zip the inner bag. "Dirty hands" must close the outer bag and place it in a cooler.

To minimize unnecessary confusion, it is recommended that a third team member be available to complete the necessary sample documentation (e.g., to document sampling location, time, sample number, etc). Otherwise, "dirty hands" must perform the sample documentation activity (Reference 7).

8.2.4 Extreme care must be taken during all sampling operations to minimize exposure of the sample to human, atmospheric, and other sources of contamination. Care must be taken to avoid breathing directly on the sample, and whenever possible, the sample bottle should be opened, filled, and closed while submerged.

8.2.5 Manual collection of surface samples directly into the sample bottle.

8.2.5.1 At the site, all sampling personnel must put on clean gloves (Section 6.7) before commencing sample collection activity, with "clean hands" donning shoulder-length gloves. If samples are to be analyzed for mercury, the sampling team must also put their precleaned wind suits on at this time. Note that "clean hands" should put on the shoulder-length polyethylene gloves (Section 6.7.1) and both "clean hands" and "dirty hands" should put on the PVC gloves (Section 6.7.2).

8.2.5.2 "Dirty hands" must open the cooler or storage container, remove the double-bagged sample bottle from storage, and unzip the outer bag.

8.2.5.3 Next, "clean hands" opens the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. "Dirty hands" then reseals the outer bag.

8.2.5.4 "Clean hands" unscrews the cap and, while holding the cap upside down, discards the dilute acid solution from the bottle into a carboy for wastes (Section 6.16) or discards the reagent water directly into the water body.

8.2.5.5 "Clean hands" then submerges the sample bottle, and allows the bottle to partially fill with sample. "Clean hands" screws the cap on the bottle, shakes the bottle several times, and empties the rinsate away from the site. After two more rinsings, "clean hands" holds the bottle under water and allows bottle to fill with sample. After the bottle has filled (i.e., when no more bubbles appear), and while the bottle is still inverted so that the mouth of the bottle is underwater, "clean hands" replaces the cap of the bottle. In this way, the sample has never contacted the air.

8.2.5.6 Once the bottle lid has been replaced, "dirty hands" reopens the outer plastic bag, and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag.

8.2.5.7 "Dirty hands" zips the outer bag.

8.2.5.8 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.5.9 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedure described in Section 8.3.

8.2.6 Sample collection with grab sampling device—The following steps detail sample collection using the grab sampling device shown in Figure 1 and described in Section 6.4.1. The procedure is indicative of the "clean hands/dirty hands" technique that must be used with alternative grab sampling devices such as that shown in Figure 2 and described in Section 6.4.2.

8.2.6.1 The sampling team puts on gloves (and wind suits, if applicable). Ideally, a sample bottle will have been preattached to the sampling device in the class 100 clean room at the laboratory. If it is necessary to attach a bottle to the device in the field, "clean hands" performs this operation, described in Section 6.4.2, inside the field-portable glove bag (Section 6.6).

8.2.6.2 "Dirty hands" removes the sampling device from its storage container and opens the outer polyethylene bag.

8.2.6.3 "Clean hands" opens the inside polyethylene bag and removes the sampling device.

8.2.6.4 "Clean hands" changes gloves.

8.2.6.5 "Dirty hands" submerges the sampling device to the desired depth and pulls the fluoropolymer pull cord to bring the seal plate into the middle position so that water can enter the bottle.

8.2.6.6 When the bottle is full (i.e., when no more bubbles appear), "dirty hands" pulls the fluoropolymer cord to the final stop position to seal off the sample and removes the sampling device from the water.

8.2.6.7 "Dirty hands" returns the sampling device to its large inner plastic bag, "clean hands" pulls the bottle out of the collar, unscrews the bottle from the sealing device, and caps the bottle. "Clean hands" and "dirty hands" then return the bottle to its double-bagged storage as described in Sections 8.2.5.6 through 8.2.5.7.

8.2.6.8 Closing mechanism—"Clean hands" removes the closing mechanism from the body of the grab sampler, rinses the device with reagent water (Section 7.1), places it inside a new clean plastic bag, zips the bag, and places the bag inside an outer bag held by "dirty hands." "Dirty hands" zips the outer bag and places the double-bagged closing mechanism in the equipment storage box.

8.2.6.9 Sampling device—"Clean hands" seals the large inside bag containing the collar, pole, and cord and places the bag into a large outer bag held by "dirty hands." "Dirty hands" seals the outside bag and places the double-bagged sampling device into the equipment storage box.

8.2.6.10 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.6.11 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedures described in Section 8.3.

8.2.7 Depth sampling using a jar sampling device (Figure 3 and Section 6.5.1)

8.2.7.1 The sampling team puts on gloves (and wind suits, if applicable) and handles bottles as with manual collection (Sections 8.2.5.1 through 8.2.5.4 and 8.2.5.6 through 8.2.5.7).

8.2.7.2 "Dirty hands" removes the jar sampling device from its storage container and opens the outer polyethylene bag.

8.2.7.3 "Clean hands" opens the inside polyethylene bag and removes the jar sampling apparatus. Ideally, the sampling device will have been preassembled in a class 100 clean room at the laboratory. If, however, it is necessary to assemble the device in the field, "clean hands" must perform this operation, described in Section 6.5.2, inside a field-portable glove bag (Section 6.6).

8.2.7.4 While "dirty hands" is holding the jar sampling apparatus, "clean hands" connects the pump to the to the 1/4 in. o.d. flush line.

8.2.7.5 "Dirty hands" lowers the weighted sampler to the desired depth.

8.2.7.6 "Dirty hands" turns on the pump allowing a large volume (>2 L) of water to pass through the system.

8.2.7.7 After stopping the pump, "dirty hands" pulls up the line, tubing, and device and places them into either a field-portable glove bag or a large, clean plastic bag as they emerge.

8.2.7.8 Both "clean hands" and "dirty hands" change gloves.

8.2.7.9 Using the technique described in Sections 8.2.5.2 through 8.2.5.4, the sampling team removes a sample bottle from storage, and "clean hands" places the bottle into the glove bag.

8.2.7.10 "Clean hands" tips the sampling jar and dispenses the sample through the short length of fluoropolymer tubing into the sample bottle.

8.2.7.11 Once the bottle is filled, "clean hands" replaces the cap of the bottle, returns the bottle to the inside polyethylene bag, and zips the bag. "Clean hands" returns the zipped bag to the outside polyethylene bag held by "dirty hands."

8.2.7.12 "Dirty hands" zips the outside bag. If the sample is to be analyzed for dissolved metals, it is filtered as described in Section 8.3.

8.2.7.13 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.8 Continuous-flow sampling (Figure 4 and Section 6.5.2)—The continuous-flow sampling system uses peristaltic pump (Section 6.15) to pump sample to the boat or to shore through the SEBS-resin or PTFE tubing.

8.2.8.1 Before putting on wind suits or gloves, the sampling team removes the bags containing the pump (Section 6.15), SEBS-resin tubing (Section 6.15.2), batteries (Section 6.15.4), gloves (Section 6.7), plastic wrap (Section 6.9), wind suits (Section 6.12), and, if samples are to be filtered, the filtration apparatus (Section 6.14) from the coolers or storage containers in which they are packed.

8.2.8.2 "Clean hands" and "dirty hands" put on the wind suits and PVC gloves (Section 6.7.2).

8.2.8.3 "Dirty hands" removes the pump from its storage bag, and opens the bag containing the SEBS-resin tubing.

8.2.8.4 "Clean hands" installs the tubing while "dirty hands" holds the pump. "Clean hands" immerses the inlet end of the tubing in the sample stream.

8.2.8.5 Both "clean hands" and "dirty hands" change gloves. "Clean hands" also puts on shoulder length polyethylene gloves (Section 6.7.1).

8.2.8.6 "Dirty hands" turns the pump on and allows the pump to run for 5-10 minutes or longer to purge the pump and tubing.

8.2.8.7 If the sample is to be filtered, "clean hands" installs the filter at the end of the tubing, and "dirty hands" sets up the filter holder on the gunwale as shown in Figure 4.

***NOTE:** The filtration apparatus is not attached until immediately before sampling to prevent buildup of particulates from clogging the filter.*

8.2.8.8 The sample is collected by rinsing the sample bottle and cap three times and collecting the sample from the flowing stream.

8.2.8.9 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.3 Sample Filtration—The filtration procedure described below is used for samples collected using the manual (Section 8.2.5), grab (Section 8.2.6), or jar (Section 8.2.7) collection systems (Reference 7). In-line filtration using the continuous-flow approach is described in Section 8.2.8.7. Because of the risk of contamination, it is recommended that samples for mercury be shipped unfiltered by overnight courier and filtered when received at the laboratory.

8.3.1 Set up the filtration system inside the glove bag, using the shortest piece of pump tubing as is practicable. Place the peristaltic pump immediately outside of the glove bag and poke a small hole in the glove bag for passage of the tubing. Also, attach a short length of tubing to the outlet of the capsule filter.

8.3.2 "Clean hands" removes the water sample from the inner storage bag using the technique described in Sections 8.2.5.2 through 8.2.5.4 and places the sample inside the glove bag. "Clean hands" also places two clean empty sample bottles, a bottle containing reagent water, and a bottle for waste in the glove bag.

8.3.3 "Clean hands" removes the lid of the reagent water bottle and places the end of the pump tubing in the bottle.

8.3.4 "Dirty hands" starts the pump and passes approximately 200 mL of reagent water through the tubing and filter into the waste bottle. "Clean hands" then moves the outlet tubing to a clean bottle and collects the remaining reagent water as a blank. "Dirty hands" stops the pump.

8.3.5 "Clean hands" removes the lid of the sample bottle and places the intake end of the tubing in the bottle.

8.3.6 "Dirty hands" starts the pump and passes approximately 50 mL through the tubing and filter into the remaining clean sample bottle and then stops the pump. "Clean hands" uses the filtrate to rinse the bottle, discards the waste sample, and returns the outlet tube to the sample bottle.

8.3.7 "Dirty hands" starts the pump and the remaining sample is processed through the filter and collected in the sample bottle. If preservation is required, the sample is acidified at this point (Section 8.4).

8.3.8 "Clean hands" replaces the lid on the bottle, returns the bottle to the inside bag, and zips the bag. "Clean hands" then places the zipped bag into the outer bag held by "dirty hands."

8.3.9 "Dirty hands" zips the outer bag, and places the double-bagged sample bottle into a clean, ice-filled cooler for immediate shipment to the laboratory.

NOTE: *It is not advisable to reclean and reuse filters. The difficulty and risk associated with failing to properly clean these devices far outweighs the cost of purchasing a new filter.*

8.4 Preservation

8.4.1 Field preservation is not necessary for dissolved metals, except for trivalent and hexavalent chromium, provided that the sample is preserved in the laboratory and allowed to stand for at least two days to allow the metals adsorbed to the container walls to redissolve. Field preservation is advised for hexavalent chromium in order to provide sample stability for up to 30 days. Mercury samples should be shipped by overnight courier and preserved when received at the laboratory.

8.4.2 If field preservation is required, preservation must be performed in the glove bag or in a designated clean area, with gloved hands, as rapidly as possible to preclude particulates from contaminating the sample. For preservation of trivalent chromium, the glove bag or designated clean area must be large enough to accommodate the vacuum filtration apparatus (Section 6.17.3), and an area should be available for setting up the wrist-action shaker (Section 6.17.5). It is also advisable to set up a work area that contains a "clean" cooler for storage of clean equipment, a "dirty" cooler for storage of "dirty" equipment, and a third cooler to store samples for shipment to the laboratory.

8.4.3 Preservation of aliquots for metals other than trivalent and hexavalent chromium—Using a disposable, precleaned, plastic pipet, add 5 mL of a 10% solution of ultrapure nitric acid in reagent water per liter of sample. This will be sufficient to preserve a neutral sample to pH <2.

8.4.4 Preservation of aliquots for trivalent chromium (References 8-9).

8.4.4.1 Decant 100 mL of the sample into a clean polyethylene bottle.

8.4.4.2 Clean an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section (7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL of chromium (III) extraction solution (Section 7.4.3) to each sample and blank.

8.4.4.3 Cap each bottle tightly, place in a clean polyethylene bag, and shake on a wrist action shaker (Section 6.17.5) for one hour.

8.4.4.4 Vacuum-filter the precipitate through a 0.4 µm pretreated filter membrane (Section 6.17.2), using fluoropolymer forceps (Section 6.17.1) to handle the membrane, and a 47 mm vacuum filtration apparatus with a precleaned filter holder (Section 6.17.3). After all sample has filtered, rinse the inside of the filter holder with approximately 15 mL of reagent water.

8.4.4.5 Using the fluoropolymer forceps, fold the membrane in half and then in quarters, taking care to avoid touching the side containing the filtrate to any surface. (Folding is done while the membrane is sitting on the filter holder and allows easy placement of the membrane into the sample vial). Transfer the filter to a 30 mL fluoropolymer vial. If the fluoropolymer vial was not pre-equipped with the ultrapure nitric acid (Section 7.4.1), rinse the pipet by drawing and discharging 1 mL of 10% HCl followed by 1 mL of reagent water into a waste container, and add 1 mL of ultrapure nitric acid to the sample vial.

8.4.4.6 Cap the vial and double-bag it for shipment to the laboratory.

8.4.4.7 Repeat Steps 8.4.4.4-8.4.4.6 for each sample, rinsing the fluoropolymer forceps and the pipet with 10% high-purity HCl followed by reagent water between samples.

8.4.5 Preservation of aliquots for hexavalent chromium (Reference 20).

8.4.5.1 Decant 125 mL of sample into a clean polyethylene bottle.

8.4.5.2 Prepare an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section 7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL NaOH to each 125 mL sample and blank aliquot.

8.4.5.3 Cap the vial(s) and double-bag for shipment to the laboratory.

9.0 Quality Assurance / Quality Control

9.1 The sampling team shall employ a strict quality assurance/ quality control (QA/QC) program. The minimum requirements of this program include the collection of equipment blanks, field blanks, and field replicates. It is also desirable to include blind QC samples as part of the program. If samples will be processed for trivalent chromium determinations, the sampling team shall also prepare method blank, OPR, and MS/MSD samples as described in Section 9.6.

9.2 The sampling team is permitted to modify the sampling techniques described in this method to improve performance or reduce sampling costs, provided that reliable analyses of samples are obtained and that samples and blanks are not contaminated. Each time a modification is made to the procedures, the sampling team is required to demonstrate that the modification does not result in contamination of field and equipment blanks. The requirements for modification are given in Sections 9.3 and 9.4. Because the acceptability of a modification is based on the results obtained with the modification, the sampling team must work with an analytical laboratory capable of making trace metals determinations to demonstrate equivalence.

9.3 Equipment Blanks

9.3.1 Before using any sampling equipment at a given site, the laboratory or equipment cleaning contractor is required to generate equipment blanks to demonstrate that the equipment is free from contamination. Two types of equipment blanks are required: bottle blanks and sampling equipment blanks.

9.3.2 Equipment blanks must be run on all equipment that will be used in the field. If, for example, samples are to be collected using both a grab sampling device and the jar sampling device, then an equipment blank must be run on both pieces of equipment.

9.3.3 Equipment blanks are generated in the laboratory or at the equipment cleaning contractor's facility by processing reagent water through the equipment using the same procedures that are used in the field (Section 8.0). Therefore, the "clean hands/dirty hands" technique used during field sampling should be followed when preparing equipment blanks at the laboratory or cleaning facility. In addition, training programs must require must require sampling personnel to collect a clean equipment blank before performing on-site field activities.

9.3.4 Detailed procedures for collecting equipment blanks are given in the analytical methods referenced in Table 1.

9.3.5 The equipment blank must be analyzed using the procedures detailed in the referenced analytical method (see Table 1). If any metal(s) of interest or any potentially interfering substance is detected in the equipment blank at the minimum level specified in the referenced method, the source of contamination/interference must be identified and removed. The equipment must be demonstrated to be free from the metal(s) of interest before the equipment may be used in the field.

9.4 Field Blank

9.4.1 To demonstrate that sample contamination has not occurred during field sampling and sample processing, at least one field blank must be generated for every 10 samples that are collected at a given site. Field blanks are collected before sample collection.

9.4.2 Field blanks are generated by filling a large carboy or other appropriate container with reagent water (Section 7.1) in the laboratory, transporting the filled container to the sampling site, processing the water through each of the sample processing steps and equipment (e.g., tubing, sampling devices, filters, etc.) that will be used in the field, collecting the field blank in one of the sample bottles, and shipping the bottle to the laboratory for analysis in accordance with the method(s) referenced in Table 1. For example, manual grab sampler field blanks are collected by directly submerging a sample bottle into the water, filling the bottle, and capping. Subsurface sampler field blanks are collected by immersing the tubing into the water and pumping water into a sample container.

9.4.3 Filter the field blanks using the procedures described in Section 8.3.

9.4.4 If it is necessary to acid clean the sampling equipment between samples (Section 10.0), a field blank should be collected after the cleaning procedures but before the next sample is collected.

9.4.5 If trivalent chromium aliquots are processed, a separate field blank must be collected and processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.

9.5 Field Duplicate

9.5.1 To assess the precision of the field sampling and analytical processes, at least one field duplicate sample must be collected for every 10 samples that are collected at a given site.

9.5.2 The field duplicate is collected either by splitting a larger volume into two aliquots in the glove box, by using a sampler with dual inlets that allows simultaneous collection of two samples, or by collecting two samples in rapid succession.

9.5.3 Field duplicates for dissolved metals determinations must be processed using the procedures in Section 8.3. Field duplicates for trivalent chromium must be processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.

9.6 Additional QC for Collection of Trivalent Chromium Aliquots

9.6.1 Method blank—The sampling team must prepare one method blank for every ten or fewer field samples. Each method blank is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on a 100 mL aliquot of reagent water (Section 7.1). Do not use the procedures in Section 8.3 to process the method blank through the 0.45 µm filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.

9.6.2 Ongoing precision and recovery (OPR)—The sampling team must prepare one OPR for every ten or fewer field samples. The OPR is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on the OPR standard (Section 7.4.7). Do not use the procedures in Section 8.3 to process the OPR through the 0.45 µm filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.

9.6.3 MS/MSD—The sampling team must prepare one MS and one MSD for every ten or fewer field samples.

9.6.3.1 If, through historical data, the background concentration of the sample can be estimated, the MS and MSD samples should be spiked at a level of one to five times the background concentration.

9.6.3.2 For samples in which the background concentration is unknown, the MS and MSD samples should be spiked at a concentration of 25 µg/L.

9.6.3.3 Prepare the matrix spike sample by spiking a 100-mL aliquot of sample with 2.5 mL of the standard chromium spike solution (Section 7.4.6), and processing the MS through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.4 Prepare the matrix spike duplicate sample by spiking a second 100-mL aliquot of the same sample with 2.5 mL of the standard chromium spike solution, and processing the MSD through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.5 If field samples are collected for dissolved metals determinations, it is necessary to process an MS and an MSD through the 0.45 µm filter as described in Section 8.3.

10.0 Recleaning the Apparatus Between Samples

10.1 Sampling activity should be planned so that samples known or suspected to contain the lowest concentrations of trace metals are collected first with the samples known or suspected to contain the highest concentrations of trace metals collected last. In this manner, cleaning of the sampling equipment between samples in unnecessary. If it is not possible to plan sampling activity in this manner, dedicated sampling equipment should be provided for each sampling event.

10.2 If samples are collected from adjacent sites (e.g., immediately upstream or downstream), rinsing of the sampling Apparatus with water that is to be sampled should be sufficient.

10.3 If it is necessary to cross a gradient (i.e., going from a high-concentration sample to a low-concentration sample), such as might occur when collecting at a second site, the following procedure may be used to clean the sampling equipment between samples:

10.3.1 In the glove bag, and using the "clean hands/dirty hands" procedure in Section 8.2.5, process the dilute nitric acid solution (Section 7.2) through the Apparatus.

10.3.2 Dump the spent dilute acid in the waste carboy or in the waterbody away from the sampling point.

10.3.3 Process 1 L of reagent water through the Apparatus to rinse the equipment and discard the spent water.

10.3.4 Collect a field blank as described in Section 9.4.

10.3.5 Rinse the Apparatus with copious amounts of the ambient water sample and proceed with sample collection.

10.4 Procedures for recleaning trivalent chromium preservation equipment between samples are described in Section 8.4.4.

11.0 Method Performance

Samples were collected in the Great Lakes during September–October 1994 using the procedures in this sampling method.

12.0 Pollution Prevention

12.1 The only materials used in this method that could be considered pollutants are the acids used in the cleaning of the Apparatus, the boat, and related materials. These acids are used in dilute solutions in small amounts and pose little threat to the environment when managed properly.

12.2 Cleaning solutions containing acids should be prepared in volumes consistent with use to minimize the disposal of excessive volumes of acid.

12.3 To the extent possible, the Apparatus used to collect samples should be cleaned and reused to minimize the generation of solid waste.

13.0 Waste Management

13.1 It is the sampling team's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the discharge regulations, hazardous waste identification rules, and land disposal restrictions; and to protect the air, water, and land by minimizing and controlling all releases from field operations.

13.2 For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* and *Less is Better—Laboratory Chemical Management for Waste Reduction,* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

14.0 References

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15.0 Glossary of Definitions and Purposes

These definitions and purposes are specific to this sampling method but have been conformed to common usage as much as possible.

15.1 Ambient Water—Waters in the natural environment (e.g., rivers, lakes, streams, and other receiving waters), as opposed to effluent discharges.

15.2 Apparatus—The sample container and other containers, filters, filter holders, labware, tubing, pipets, and other materials and devices used for sample collection or sample preparation, and that will contact samples, blanks, or analytical standards.

15.3 Equipment Blank—An aliquot of reagent water that is subjected in the laboratory to all aspects of sample collection and analysis, including contact with all sampling devices and apparatus. The purpose of the equipment blank is to determine if the sampling devices and apparatus for sample collection have been adequately cleaned before they are shipped to the field site. An acceptable equipment blank must be achieved before the sampling devices and Apparatus are used for sample collection.

15.4 Field Blank—An aliquot of reagent water that is placed in a sample container in the laboratory, shipped to the field, and treated as a sample in all respects, including contact with the sampling devices and exposure to sampling site conditions, filtration, storage, preservation, and all analytical procedures. The purpose of the field blank is to determine whether the field or sample transporting procedures and environments have contaminated the sample.

15.5 Field Duplicates (FD1 and FD2)—Two identical aliquots of a sample collected in separate sample bottles at the same time and place under identical circumstances using a duel inlet sampler or by splitting a larger aliquot and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as with laboratory procedures.

15.6 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)—Aliquots of an environmental sample to which known quantities of the analytes are added in the laboratory. The MS and MSD are analyzed exactly like a sample. Their purpose is to quantify the bias and precision caused by the sample matrix. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for background concentrations.

15.7 May—This action, activity, or procedural step is optional.

15.8 May Not—This action, activity, or procedural step is prohibited.

15.9 Minimum Level (ML)—The lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point (Reference 21).

15.10 Must—This action, activity, or procedural step is required.

15.11 Reagent Water—Water demonstrated to be free from the metal(s) of interest and potentially interfering substances at the MDL for that metal in the referenced method or additional method.

15.12 Should—This action, activity, or procedural step is suggested but not required.

15.13 Trace-Metal Grade—Reagents that have been demonstrated to be free from the metal(s) of interest at the method detection limit (MDL) of the analytical method to be used for determination of this metal(s).

The term "trace-metal grade" has been used in place of "reagent grade" or "reagent" because acids and other materials labeled "reagent grade" have been shown to contain concentrations of metals that will interfere in the determination of trace metals at levels listed in Table 1.

TABLE 1. ANALYTICAL METHODS, METALS, AND CONCENTRATION LEVELS APPLICABLE TO METHOD 1669

Method	Technique	Metal	MDL (µg/L) [1]	ML (µg/L) [2]
1631	Oxidation/Purge & Trap/CVAFS	Mercury	0.0002	0.0005
1632	Hydride AA	Arsenic	0.003	0.01
1636	Ion Chromatography	Hexavalent Chromium	0.23	0.5
1637	CC/STGFAA	Cadmium	0.0075	0.02
		Lead	0.036	0.1
1638	ICP/MS	Antimony	0.0097	0.02
		Cadmium	0.013	0.1
		Copper	0.087	0.2
		Lead	0.015	0.05
		Nickel	0.33	1
		Selenium	0.45	1
		Silver	0.029	0.1
		Thallium	0.0079	0.02
		Zinc	0.14	0.5
1639	STGFAA	Antimony	1.9	5
		Cadmium	0.023	0.05
		Trivalent Chromium	0.10	0.2
		Nickel	0.65	2
		Selenium	0.83	2
		Zinc	0.14	0.5
1640	CC/ICP/MS	Cadmium	0.0024	0.01
		Copper	0.024	0.1
		Lead	0.0081	0.02
		Nickel	0.029	0.1

[1] Method Detection Limit as determined by 40 *CFR* Part 136, Appendix B.
[2] Minimum Level (ML) calculated by multiplying laboratory-determined MDL by 3.18 and rounding result to nearest multiple of 1, 2, 5, 10, 20, 50, etc., in accordance with procedures used by EAD and described in the EPA *Draft National Guidance for the Permitting, Monitoring, and Enforcement of Water Quality-Based Effluent Limitations Set Below Analytical Detection/Quantitation Levels*, March 22, 1994.

TABLE 2. ANALYTES, PRESERVATION REQUIREMENTS, AND CONTAINERS

Metal	Preservation Requirements	Acceptable Containers
Antimony Arsenic Cadmium Copper Lead Nickel Selenium Silver Thallium Zinc	Add 5 mL of 10% $HN0_3$ to 1-L sample; preserve on-site or immediately upon laboratory receipt.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (III)	Add 1 mL chromium (III) extraction solution to 100 mL aliquot, vacuum filter through 0.4 µm membrane, add 1 mL 10% $HN0_3$; preserve on-site immediately after collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (IV)	Add 50% NaOH; preserve immediately after sample collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Mercury	Total: Add 0.5% high-purity HCl or 0.5% BrCl to pH < 2; Total & Methyl: Add 0.5% high-purity HCL; preserve on-site or immediately upon laboratory receipt	Fluoropolymer or borosilicate glass bottles with fluoropolymer or fluoropolymer-lined caps

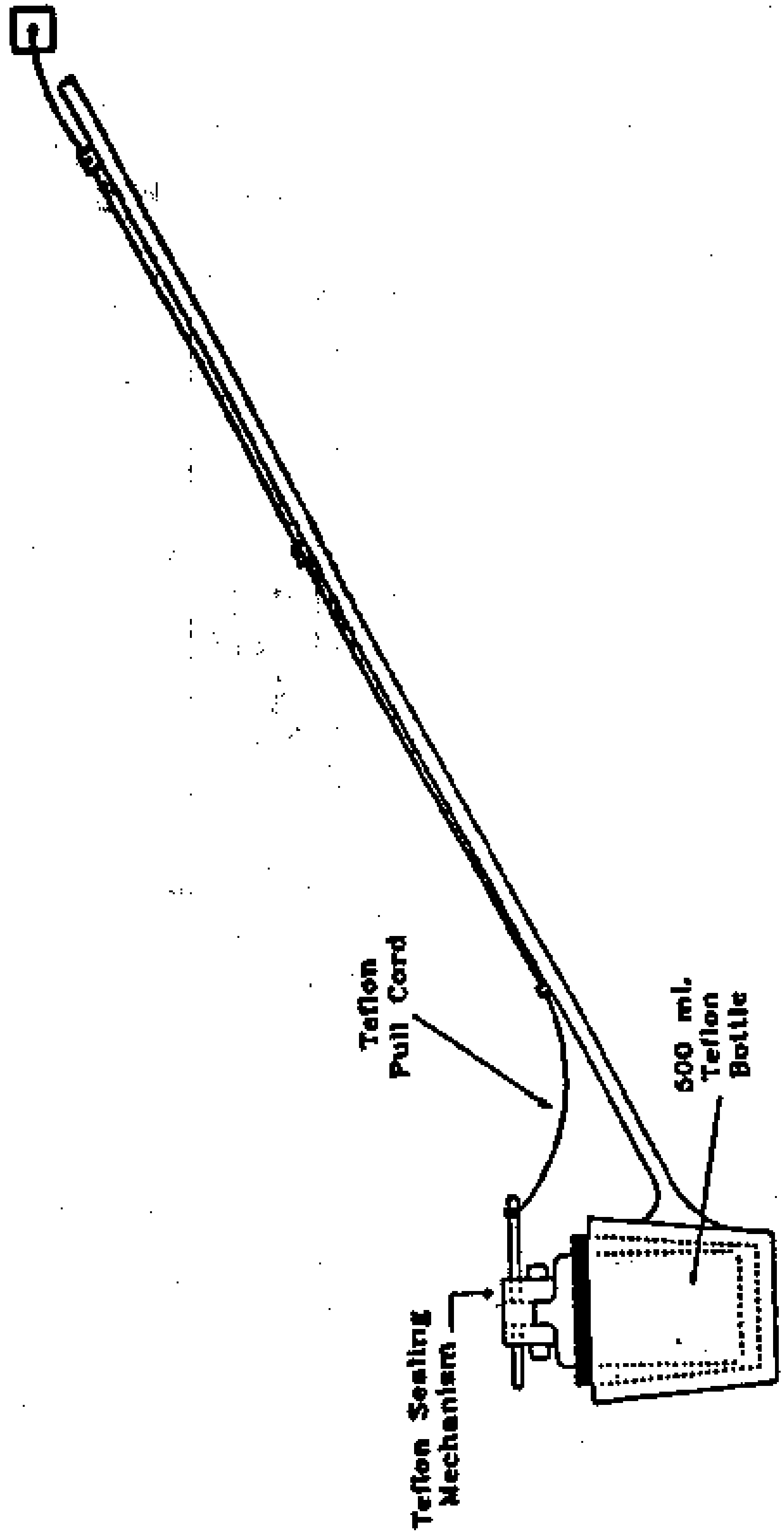


Figure 1 - Grab Sampling Device

Figure 2 - Grab Sampling Device

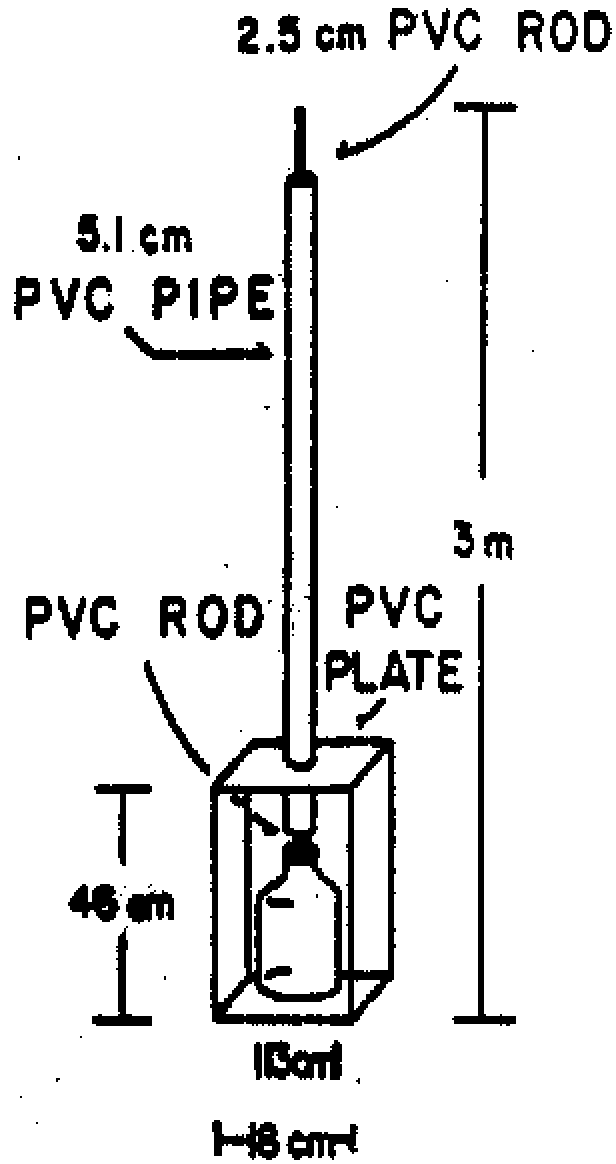


Figure 3 - Jar Sampling Device

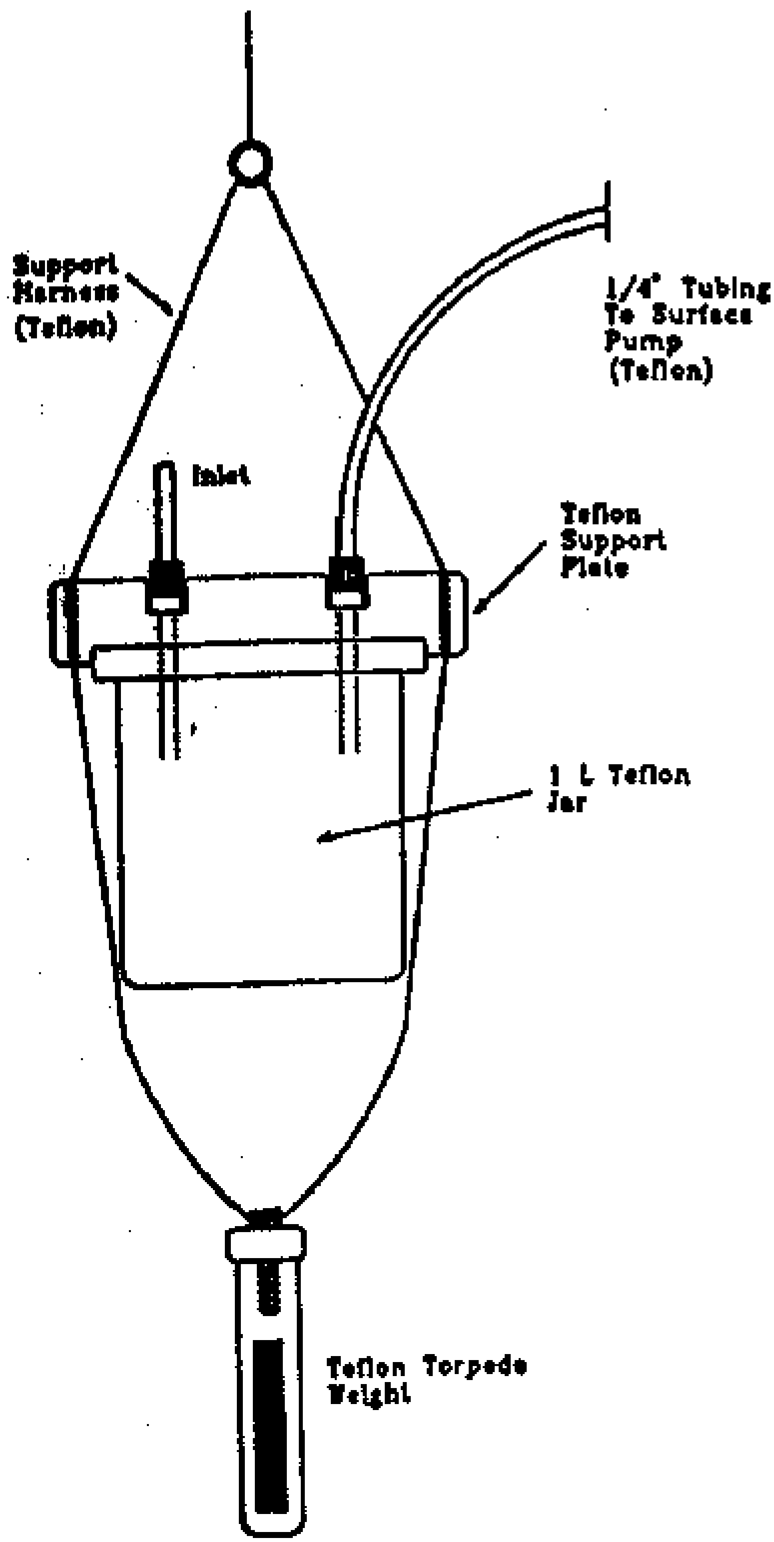
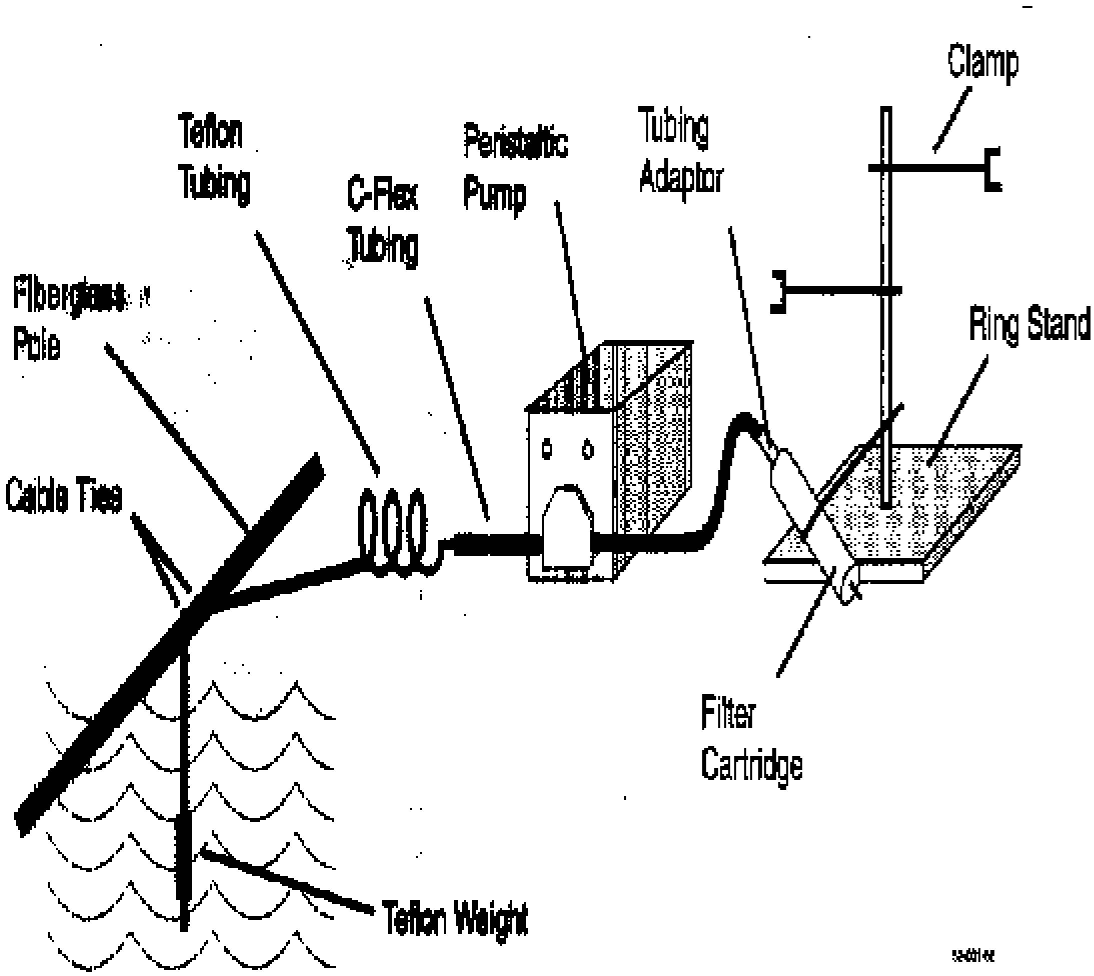


Figure 4 - Sample Pumping System



APPENDIX B.

DATA REVIEW AND VERIFICATION CHECKLIST

APPENDIX B.

DATA REVIEW AND VERIFICATION CHECKLIST

This checklist should be used to document data review verification of data generated through implementation of the FERC-approved study plan.

GENERAL

- ☐ For each sample event, samples have been collected and analyzed at all locations and for all analyses specified in the study plan.
- ☐ For each sample and analyses, the project file contains records field notes, chain-of-custody, and analytical results, including quality assurance documenation (hardcopy and electronic)

FIELD DATA

- ☐ Field notes and/or data sheets include date, time of sample collection, field sampling staff, time arrived at site, time left site, site identification, description of site conditions (weather), field parameters, reservoir level or flow information (measured or estimated), sample collection procedures, and call-out quality assurance samples collected. If mistakes are found on the field data sheet, changes can be made by crossing out the mistake and marking the change with a date of change, initials, and reason for change.
- ☐ Documentation of field equipment calibration is in the fieldnotes and/or project records.
- ☐ Field data entered into Excel, have been checked by a second-party.

LABORATORY REPORT

- ☐ Field duplicates, blanks, and rinsates were submitted to the laboratory at the frequency specified in the study plan.
- ☐ Any constituents found in blanks or rinsates are discussed in the final report.
- ☐ Any duplicate concentrations that differ by more than 10% are discussed in the final report.
- ☐ Samples were received by the laboratory intact and analyzed within method and/or study specified holding times.
- ☐ On laboratory reports, sample IDs, analyses, reporting/detection limits, units, column labels, footnotes, and titles are accurate. Have lab re-issue report with corrections if there are inconsistencies.
- ☐ Check that non-detects are always reported in the same manner using consistent notation. For example, either "ND" or "<." Have lab re-issue report with corrections if there are inconsistencies.
- ☐ If observed, "J" qualified data and/or elevated detection limits are discussed in the final report.

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Upper Yuba River Aquatic Monitoring Plan

Attachment H

Channel Morphology

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

In 2011, the Yuba County Water Agency (YCWA) conducted a channel morphology (Study 1.1) study at seven intensive study sites and three other sites assessed only for bedload deposition. A summary of data collected the relicensing study in the proposed future monitoring areas are below.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

The Our House Diversion Dam Reach is a 7.9 mile (mi)-long section of the Middle Yuba River from the base of Our House Diversion Dam (elevation, or El., 2,032 ft) at RM 12.6 to the upstream confluence of the Middle Yuba River and Oregon Creek (El. 1,430 ft) at RM 4.7. 100 percent of this 7.9 mile reach is classified as Rosgen "B" type channel with an average gradient of 1 percent to 3 percent.

Geomorphology sampling occurred at two locations in this reach and are described in Table 2.1-1. Results of the study are provided in Tables 2.1-2 and 2.1-3.

Table 2.1-1. Location of reaches where channel morphology study sites were located, and transects selected for channel morphology evaluation from among Study 3.10, *Instream Flow Upstream of Englebright Reservoir*, transects.

Stream	Reach Name	Location	Study Site Name	Study Site No.	Cross Section Numbers
Middle Yuba River	Our House Diversion Dam Reach	Upstream of Oregon Creek	Middle Yuba River upstream of Oregon Creek	2	2, 9, 12
	Our House Diversion Dam Reach	Downstream of Our House Diversion Dam	Middle Yuba River downstream of Our House Diversion Dam	3	2, 4, 7

[1] Sites were located to evaluate the effects of base-level control of the Project on bedload deposition. The level of analysis is limited to physical extent of bedload deposition and a "snapshot" of the channel just upstream of the influence that includes one cross section, a pebble count and a gradient. Sites were not associated with Study 3.10, *Instream Flow Study Upstream of Englebright Reservoir*.

Table 2.1-2. Description of inundation frequency under With- and Without-Project conditions.

Site	Bankfull Discharge Estimate (cfs)	Inundation Frequency Bankfull (years)		Floodprone Discharge Estimate (cfs)	Inundation Frequency Floodprone (years)	
		With-Project	Without Project		With-Project	Without Project
Middle Yuba River upstream of Oregon Creek (Site 2)	298[1]	1.1	<1	6,994	5.2	4.6
Middle Yuba River downstream of Our House Diversion Dam (Site 3)	283[2]	1.2	<1	3,014	2.9	2.0

[1] Bankfull discharge was estimated using MANSQ conveyance/discharge relationship for Transect 2; Transects 9 and 12 were estimated using the log-log relationship from PHABSIM.
[2] Average of values for each transect using log/log stage/discharge relationship from PHABSIM.

Table 2.1-3. Estimates of critical discharge using WinXSPro.

Study Site Name/ Study Site No.	Transect No.	D_{50} (mm)	Critical Discharge* (cfs)
Middle Yuba River upstream of Oregon Creek (Site 2)	2	128	861
	9	128	1,043
	12	90	401
Middle Yuba River downstream of Our House Diversion Dam (Site 3)	2	64	285
	4	128	303
	7	128	502

*discharge at incipient motion of D_{50}.

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the Middle Yuba River with the North Yuba River at RM 40.0. 100 percent of this 4.7 mile reach is classified as Rosgen "B" type channel with an average gradient of 1 percent to 3 percent.

Geomorphology sampling occurred at one location in this reach, near the confluence of Moonshine Creek (Table 2.2-1). Results are described in Tables 2.2-2 and 2.2-3.

Table 2.2-1. Location of reaches where channel morphology study sites were located, and transects selected for channel morphology evaluation from among Study 3.10, *Instream Flow Upstream of Englebright Reservoir*, transects.

Stream	Reach Name	Location	Study Site Name	Study Site No.	Cross Section Numbers
Middle Yuba River	Oregon Creek Reach	Downstream of Oregon Creek: upstream and downstream of Moonshine Creek	Middle Yuba River downstream of Oregon Creek	1	9, 12, 13

[1] Sites were located to evaluate the effects of base-level control of the Project on bedload deposition. The level of analysis is limited to physical extent of bedload deposition and a "snapshot" of the channel just upstream of the influence that includes one cross section, a pebble count and a gradient. Sites were not associated with Study 3.10, *Instream Flow Study Upstream of Englebright Reservoir*.

Table 2.2-2. Description of inundation frequency under With- and Without-Project conditions.

Site	Bankfull Discharge Estimate (cfs)	Inundation Frequency Bankfull (years)		Floodprone Discharge Estimate (cfs)	Inundation Frequency Floodprone (years)	
		With-Project	Without Project		With-Project	Without Project
Middle Yuba River downstream of Oregon Creek (Site 1)	404[1]	1.0	1.0	8,408	2.5	1.2

[1] Average of values for each transect using MANSQ/discharge relationship from PHABSIM.

Table 2.2-3. Estimates of critical discharge using WinXSPro.

Study Site Name/ Study Site No.	Transect No.	D_{50} (mm)	Critical Discharge* (cfs)
Middle Yuba River downstream of Oregon Creek (Site 1)	9	90	643
	12	128	1,120
	13	90	519

*discharge at incipient motion of D_{50}.

2.3 Middle/North Yuba River Reach

The Middle/North Yuba River Reach is a 5.8 mi long section of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,120 ft) to the New Colgate Powerhouse at RM 34.2 (El. 540 ft). One hundred percent of this 5.8 mile reach is classified as "confined, Rosgen "B" type channel with a gradient of 1 to 3 percent. Geomorphology sampling occurred at one location in this reach, upstream of New Colgate Powerhouse (Table 2.3-1). Sampling results are provided in Table 2.3-2 and 2.3-3.

Table 2.3-1. Location of reaches where channel morphology study sites were located, and transects selected for channel morphology evaluation from among Study 3.10, *Instream Flow Upstream of Englebright Reservoir*, transects.

Stream	Reach Name	Location	Study Site Name	Study Site No.	Cross Section Numbers
Yuba River	Middle Yuba/North Yuba River Confluence Reach	Upstream of New Colgate Powerhouse	Yuba River upstream of New Colgate Powerhouse	10	8, 11, 15

[1] Sites were located to evaluate the effects of base-level control of the Project on bedload deposition. The level of analysis is limited to physical extent of bedload deposition and a "snapshot" of the channel just upstream of the influence that includes one cross section, a pebble count and a gradient. Sites were not associated with Study 3.10, *Instream Flow Study Upstream of Englebright Reservoir*.

Table 2.3-2. Description of inundation frequency under With- and Without-Project conditions.

Site	Bankfull Discharge Estimate (cfs)	Inundation Frequency Bankfull (years)		Floodprone Discharge Estimate (cfs)	Inundation Frequency Floodprone (years)	
		With-Project	Without Project		With-Project	Without Project
Yuba River upstream of New Colgate Powerhouse (Site 10)	379[1]	1.0	<1	3,539	1.6	1.0

[1] Bankfull discharge was estimated using MANSQ conveyance/discharge relationship for Transects 8 and 11; Transect 15 was estimated using the log-log relationship.

Table 2.3-3. Estimates of critical discharge using WinXSPro.

Study Site Name/ Study Site No.	Transect No.	D_{50} (mm)	Critical Discharge* (cfs)
Yuba River upstream of New Colgate Powerhouse (Site 10)	8	128	880
	11	128	1,939
	15	90	1,424

*discharge at incipient motion of $D_{50.}$

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4 mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 40.0. Approximately 93 percent of this 2.4 mile reach is classified as “confined, Rosgen “B” type channel with a gradient of 1 to 3 percent. A short 0.2 mile section is classified as a Rosgen “A” type channel with a gradient of 3 percent to 8 percent.

Geomorphology sampling occurred at one location in this reach, upstream of the confluence with the Middle Yuba River (Table 2.4-1). Sampling results are summarized in Table 2.4-2 and 2.4-3.

Table 2.4-1. Location of reaches where channel morphology study sites were located, and transects selected for channel morphology evaluation from among Study 3.10, *Instream Flow Upstream of Englebright Reservoir*, transects.

Stream	Reach Name	Location	Study Site Name	Study Site No.	Cross Section Numbers
North Yuba River	North Yuba River Reach	Upstream of Middle Yuba River/North Yuba River Confluence	North Yuba River	7	7, 8, 10

[1] Sites were located to evaluate the effects of base-level control of the Project on bedload deposition. The level of analysis is limited to physical extent of bedload deposition and a “snapshot” of the channel just upstream of the influence that includes one cross section, a pebble count and a gradient. Sites were not associated with Study 3.10, *Instream Flow Study Upstream of Englebright Reservoir*.

Table 2.4-2. Description of inundation frequency under With- and Without-Project conditions.

Site	Bankfull Discharge Estimate (cfs)	Inundation Frequency Bankfull (years)		Floodprone Discharge Estimate (cfs)	Inundation Frequency Floodprone (years)	
		With-Project	Without Project		With-Project	Without Project
North Yuba River (Site 7)	326[1]	2.0	<1	2,640	3.0	1.0

[1] Average of values for each transect using MANSQ/discharge relationship from PHABSIM.

Table 2.4-3. Estimates of critical discharge using WinXSPro.

Study Site Name/ Study Site No.	Transect No.	D_{50} (mm)	Critical Discharge* (cfs)
North Yuba River (Site 7)	7	256	1,819
	8	256	746
	10	180	694

*discharge at incipient motion of D_{50}.

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3-mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. Approximately 68 percent (3.6 mi) of this 4.3 mile reach is in the vicinity of Celestial Valley and is classified as Rosgen B, confined with a gradient or 1 percent to 3 percent while the remaining 32 percent is classified as Rosgen A, confined with a gradient of 3 percent to 8 percent.

Geomorphology sampling occurred at one location in this reach, downstream of Log Cabin Diversion Dam (Table 2.5-1). Sampling results are summarized in Table 2.5-2 and 2.5-3.

Table 2.5-1. Location of reaches where channel morphology study sites were located, and transects selected for channel morphology evaluation from among Study 3.10, *Instream Flow Upstream of Englebright Reservoir*, transects.

Stream	Reach Name	Location	Study Site Name	Study Site No.	Cross Section Numbers
Oregon Creek	Log Cabin Diversion Dam Reach	Celestial Valley upstream of Ridge Road	Oregon Creek Celestial Valley Sub-Reach	5	8, 10, 12

Table 2.5-2. Description of inundation frequency under With- and Without-Project conditions.

Site	Bankfull Discharge Estimate (cfs)	Inundation Frequency Bankfull (years)		Floodprone Discharge Estimate (cfs)	Inundation Frequency Floodprone (years)	
		With-Project	Without Project		With-Project	Without Project
Oregon Creek Celestial Valley Sub-Reach (Site 5)	136[1]	1.2	1.0	1,916	4.8	4.7

[1] Bankfull discharge was estimated using MANSQ conveyance/discharge relationship for Transects 8 and 10; Transect 12 was estimated using the log-log relationship.

Table 2.5-3. Estimates of critical discharge using WinXSPro.

Study Site Name/ Study Site No.	Transect No.	D_{50} (mm)	Critical Discharge* (cfs)
Oregon Creek Celestial Valley Sub-Reach (Site 5)	8	45	304
	10	64	517
	12	45	215

*discharge at incipient motion of D_{50}.

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Upper Yuba River Aquatic Monitoring Plan

Attachment I

Riparian

Yuba River Development Project

FERC Project No. 2246

April 2014

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1.0 Introduction

In 2012, Yuba County Water Agency (YCWA) conducted a riparian habitat study upstream of Englebright Reservoir (Study 6.1). Field efforts included surveys for riparian vegetation and large woody material (LWM). The study was performed by establishing seven riparian assessment sites, one cursory assessment site, and 12 LWM assessment sites. All riparian assessment sites supported woody species in various life stages including mature trees, recruits (i.e., saplings), and seedlings although the abundance of each often depended on the dominant substrates of the site.

YCWA performed a comprehensive search for existing and available data regarding riparian habitat in the study area. Searches for information included geographic information system data, historical information, reports, maps, and aerial photography relevant to riparian vegetation. Information regarding riparian vegetation and physical processes on western slope Sierra Nevada streams, or other pertinent riparian literature from other geographic regions, was also reviewed and incorporated in the analysis, as applicable. Table 1.0-1 is a list of sources used in support of this study and the application of each.

Table 1.0-1. Sources for data and information used in this study, and application.

Author(s)/ Publication Date	Source	Application
Bazzaz (1996)	Plants in Changing Environments: Linking Physiological, Population, and Community Ecology. Cambridge University Press, Cambridge, United Kingdom.	Vegetation, specifically germination
CBEC (2010)	Rehabilitation Concepts for Parks Bar to Hammond Bar Reach for the Lower Yuba River. Funded by USFWS Anadromous Fish Restoration Program. November 2010.	LWM Budget
Hagwood (1981)	The California Debris Commission: a History. U.S. Army Corps of Engineers, Sacramento District, Sacramento. 102 pp.	History related to mining in the Sierra Nevada
Harris (1988)	Associations between stream valley geomorphology and riparian vegetation as a basis for landscape analysis in the eastern Sierra Nevada, California, USA. Environmental Management, 12: 219-228.	Vegetation
NMFS (2012)	Biological Opinion, Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam and Recreational Facilities on and Around Englebright Reservoir.	LWM Budget
Ruediger and Ward (1991)	Abundance and Function of Large Woody Debris in Central Sierra Nevada Streams.	LWM Budget
Senter et al. (2012)	Streamwood Surveys in New Bullards Bar Reservoir, 2010 and 2012. Unpublished data.	LWM Quantity
USDA (2010)	Aerial Photographs - USDA National Agriculture Imagery Program	Reconnaissance efforts, vegetation, and channel morphology
YCWA (2012)	A compilation of historical aerial photographs for 1937, 1939, 1952, 1969, 1993, 1998, and 2009.	Historical aerial analysis
NRCS (2012)	United States Department of Agriculture, Natural Resources Conservation Service. 2012. Plants Database.	Vegetation, specifically rooting depths
USGS (2009)	National Wetlands Inventory (NWI) maps showing the distribution, extent, and types of palustrine wetlands and lacustrine littoral zones.	Hydrology and vegetation
Forest Service (2004)	The Project spans two CalVeg zones: the Northern Sierra Zone and the Central Valley Zone. Using CalVeg, Licensee identified the riparian habitats in the Project Area as White Alder Alliance, Valley Oak Alliance, and Willow Alliance (UDSA-FS 2004). A discussion of each riparian habitat is provided below.	Vegetation
YCWA (2009)	Low-altitude aerial video of the Yuba River downstream of Englebright Dam.	Reconnaissance efforts
YCWA (2012a)	An analysis of historic aerial photographs and maps of the Yuba River dating from 1906 through 1998 were undertaken as a joint project between YCWA and the RMT.	Calculated changes in vegetation cover over time were incorporated in the historical aerial analysis.

2.0 Summary of Results by Reach

2.1 Our House Diversion Dam Reach

The Our House Diversion Dam Reach is a 7.9 mile (mi)-long section of the Middle Yuba River from the base of Our House Diversion Dam (elevation, or El., 2,032 ft) at RM 12.6 to the upstream confluence of the Middle Yuba River and Oregon Creek (El. 1,430 ft) at RM 4.7. The reach has a gradient of 1.2 percent.

Three riparian sites were monitored in this reach and are described in Table 2.1-1. Results of the riparian studies in this reach are included below as well as LWM in Table 2.1-2.

Table 2.1-1. Location and size of assessment sites and type of assessments.

Stream	Site Location	Field Survey Date	Length (ft)	RM Start	RM End	Riparian Assessment[1]		Riparian Cursory Assessment		LWM Assessment	Historical Photograph Analysis
						Transect ID	# of Transects	Transect ID	# of Transects		
Middle Yuba River	Upstream (~0.1 mi) of Oregon Creek	9/25/11	416	4.8	5.0	2, 9, 12	3	--	--	X	X
	Upstream of Oregon Creek ~ 2 miles	3/29/12	460	6.1	6.4	--	--	--	--	X	--
	Downstream (~0.1 mi) of Our House Diversion Dam	8/17/12	323	12.3	12.5	2, 4, 7	3	--	--	X	X

[1] The riparian habitat assessment transects were co-located with channel morphology transects established in Study 1.1, *Morphology Upstream of Englebright Reservoir*. Transect #s are unique per site based on the location of the transect in the stream (i.e., transects are numbered in a downstream to upstream direction beginning at #1).

Table 2.1-2. Summary of LWM located at LWM assessment sites.

Stream Reach	Length (ft)	Diameter (in) and Volume of LWM (m^3)(in parenthesis)				Total
		4 to <12	12 to <24	24 to <36	≥36	
Our House Diversion Dam Reach	DOWNSTREAM OF OUR HOUSE DIVERSION DAM					
	3 to <25	4 (0.6)	--	--	--	5 (0.9)
	25 to <50	1 (0.4)	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	UPSTREAM OF OREGON CREEK (~0.1 mi)					
	3 to <25	--	8 (5.6)	3 (5.8)	--	11 (11.4)
	25 to <50	--	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	UPSTREAM OF OREGON CREEK (~2 miles)					
	3 to <25	1 (0.1)	--	--	--	1 (0.1)
	25 to <50	--	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	

Both seedling and recruits were present at all transects in the Middle Yuba River downstream of Our House Diversion Dam assessment site. Table 2.1-3 summarizes the number of plots where woody species are present as mature trees, recruits, and seedlings.

Table 2.1-3. Number of plots with woody species present at three life stages in the Middle Yuba River downstream of Our House Diversion Dam assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 02		Transect 04		Transect 07	
black locust	*Robinia pseudoacacia*	0|0|1	0|0|0	2|2|0	0|0|1*	0|0|0	0|0|0
Fremont cottonwood	*Populus fremontii*	0|0|0	0|0|0	0|0|0	0|0|0	2|0|0	0|0|0
red willow	*Salix laevigata*	2|2|1	1|0|1	2|2|0	1|1|2*	0|0|2	0|0|0
white alder	*Alnus rhombifolia*	1|0|0	1|0|0	1|1|1	2*|1*|1	4|4|1	1|0|0

* Mid-channel plot data.

In addition to recording vegetation and channel data along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation were not present in the site. A variety of age classes for all observed species was present in the riparian corridor.
- Vegetation in the site was healthy and appeared hydrologically connected within the floodplain.
- Woody species were present in areas with substrate capable of supporting woody vegetation. The dominant substrate at transects included boulders, cobbles, and gravel and woody species were present and supported in the area. Areas with bedrock substrate supported little to no vegetation.

Both seedling and recruits were present at all vegetative transects in the Middle Yuba River downstream of Oregon Creek assessment site. Table 2.1-4 summarizes the number of plots where woody species were present as mature trees, recruits, and seedlings.

Table 2.1-4. Number of plots with woody species present at three life stages in the Middle Yuba downstream of Oregon Creek assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 02		Transect 09		Transect 12	
American dogwood	*Cornus sericea*	1|0|1	0|0|0	0|0|0	0|0|0	0|0|0	1|1|1
black locust	*Robinia pseudoacacia*	0|0|1	0|0|0	0|0|0	0|0|0	0|0|0	1|1|0
red willow	*Salix laevigata*	1|0|1	1|1|1	1|1|1	1|1|1	3|3|2	1|0|0
white alder	*Alnus rhombifolia*	3|0|2	1|1|2	0|0|0	2|2|2	2|0|1	2|1|1

In addition to recording vegetation and channel data in plots along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation were not present in the site. A variety of age classes for all observed species were present in the riparian corridor.
- Vegetation in the site was healthy and appeared hydrologically connected within the floodplain.
- Woody species were present in areas with substrate capable of supporting woody vegetation. The dominant substrate at transects included both cobble and boulder with

some bedrock. Woody species were present and supported on cobble boulder substrates in the site. Transect 12 on the river right did not support riparian vegetation on the extended floodplain dominated by boulder substrates.

2.2 Oregon Creek Reach

The Oregon Creek Reach is a 4.7 mi long section of the Middle Yuba River from the confluence of the Middle Yuba River and Oregon Creek at RM 4.7 (El. 1,430 ft) to the confluence of the Middle Yuba River with the North Yuba River at RM 0.0 (El. 1,120 ft). The reach has a gradient of 1.2 percent.

Riparian sampling occurred at three locations in this reach (Table 2.2-1). LWM results are summarized in Table 2.2-2.

Table 2.2-1. Location and size of assessment sites and type of assessments.

Stream	Site Location	Field Survey Date	Length (ft)	RM Start	RM End	Riparian Assessment[1]		Riparian Cursory Assessment		LWM Assessment	Historical Photograph Analysis
						Transect ID	# of Transects	Transect ID	# of Transects		
Middle Yuba River	Downstream of Oregon Creek near Freemans Crossing	9/27/11	356	3.4	3.6	9, 12, 13	3	--	--	X	X
	Near Confluence with Yellowjacket Creek	5/30/12	658	1.1	1.6	--	--	--	--	X	--
	Upstream of North Yuba River	8/23/12	561	0.0	0.3	--	--	--	--	X	--

[1] The riparian habitat assessment transects were co-located with channel morphology transects established in Study 1.1, *Morphology Upstream of Englebright Reservoir*. Transect #s are unique per site based on the location of the transect in the stream (i.e., transects are numbered in a downstream to upstream direction beginning at #1).

Table 2.2-2. Summary of LWM pieces located at LWM assessment sites and the volume of LWM within each site (in parenthesis).

Stream Reach	Length (ft)	Diameter (in) and Volume of LWM (m^3)(in parenthesis)				
		4 to <12	12 to <24	24 to <36	≥36	Total
Oregon Creek Reach	DOWNSTREAM OF OREGON CREEK					
	3 to <25	22 (3.0)	1 (0.7)	--	--	23 (3.7)
	25 to <50	--	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	NEAR CONFLUENCE WITH YELLOWJACKET CREEK					
	3 to <25	40 (5.5)	4 (2.8)	--	--	45 (10.2)
	25 to <50	--	1 (1.9)	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	UPSTREAM OF THE CONFLUENCE WITH THE NORTH YUBA RIVER					
	3 to <25	22 (3.0)	8 (5.6)	--	--	34 (11.6)
	25 to <50	3 (1.1)	1 (1.9)	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	

Both seedling and recruits were present at all vegetative transects in the Middle Yuba River downstream of Oregon Creek assessment site. Table 2.2-3 summarizes the number of plots where woody species were present as mature trees, recruits, and seedlings.

Table 2.2-3. Number of plots with woody species present at three life stages in the Middle Yuba River downstream of Oregon Creek assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 09		Transect 12		Transect 13	
red willow	*Salix laevigata*	1|1|1	1|1|1	3|3|2	0|0|0	1|1|3	0|0|0
white alder	*Alnus rhombifolia*	0|0|0	2|2|2	2|0|1	1|1|1	2|0|2	1|0|0

In addition to recording vegetation and channel data along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation were not present in the assessment site. A variety of age classes for all observed species were present in the riparian corridor.
- Vegetation in the assessment site was healthy (vigorous) and appears hydrologically connected within the floodplain.[1]
- Woody species were present on substrate that was capable of supporting woody species. The dominant substrate at transects included both cobble and gravel/sand and there was one area of bedrock that supported little vegetation. With the exception of the higher areas on the transect 9 cobble bar, woody species were present and supported on cobble and gravel/sand substrates. Vegetation was not supported on the tuffaceous scarp on transect 12 or within floodprone on river right where a gravel roadway was maintained.

2.3 Middle/North Yuba River Reach

The Middle/North Yuba River Reach is a 5.8 mi long section of the Yuba River from the confluence of the North Yuba River with the Middle Yuba River at RM 40.0 (El. 1,120 ft) to the New Colgate Powerhouse at RM 34.2 (El. 540 ft). The overall gradient is less than 2 percent, though there are steeper sections with a map-gradient of near 5 percent.

Riparian sampling occurred at one location in this reach, upstream of the New Colgate Powerhouse (Table 2.3-1). Table 2.3-2 provides a summary of LWM recorded at the site.

Table 2.3-1. Location and size of assessment sites and type of assessments.

Stream	Site Location	Field Survey Date	Length (ft)	RM Start	RM End	Riparian Assessment[1]		Riparian Cursory Assessment		LWM Assessment	Historical Photograph Analysis
						Transect ID	# of Transects	Transect ID	# of Transects		
Yuba River	Upstream of New Colgate Powerhouse	8/22/12	679	34.8	35.2	8, 11, 15	3	--	--	X	X

[1] The riparian habitat assessment transects were co-located with channel morphology transects established in Study 1.1, *Morphology Upstream of Englebright Reservoir*. Transect #s are unique per site based on the location of the transect in the stream (i.e., transects are numbered in a downstream to upstream direction beginning at #1).

[1] The appearance of hydrologic connectivity includes the presence riparian plant species that appear to be supported by the stream channel with no evidence of other hydrology, such as a seep or small tributary, providing water to the vegetation.

Table 2.3-2. Summary of LWM pieces located at LWM assessment sites and the volume of LWM within each site (in parenthesis).

Stream Reach	Length (ft)	Diameter (in) and Volume of LWM (m^3)(in parenthesis)				Total
		4 to <12	12 to <24	24 to <36	≥36	
	UPSTREAM OF THE NEW COLGATE POWERHOUSE					
Yuba River	3 to <25	--	8 (5.6)	1 (1.9)	--	10 (9.4)
	25 to <50	--	1 (1.9)	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	

Both seedlings and recruits were present in the Yuba River upstream of New Colgate Powerhouse assessment site. Table 2.3-3 summarizes the number of plots where woody species were present as mature trees, recruits, and seedlings.

Table 2.3-3. Number of plots with woody species present at three life stages in the Yuba River upstream of New Colgate Powerhouse assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 08		Transect 11		Transect 15	
button willow	*Cephalanthus occidentalis*	0|0|0	0|0|0	0|0|0	0|0|1	1|0|1	1|0|1
Fremont cottonwood	*Populus fremontii*	0|0|0	0|0|0	0|0|0	1|0|0	0|0|0	0|0|0
Goodding's willow	*Salix gooddingii*	1*|1*|0	1|1|1	3|3|0	1|1|1	1|1|0	0|0|1
red willow	*Salix laevigata*	1*|1*|1*	1|1|1	0|0|0	0|0|0	1|1|1	2|2|0
sandbar willow	*Salix exigua*	1|0|0	0|0|0	0|0|0	0|0|0	0|0|0	0|0|0
shining willow	*Salix lasiandra*	0|0|0	0|0|0	0|0|0	0|0|0	2|2|0	0|0|0
white alder	*Alnus rhombifolia*	1*|0|0	1|0|0	0|0|0	0|0|0	0|0|0	0|0|0

*Mid-channel plot data.

In addition to recording vegetation and channel data along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation was not present in the site. A variety of age classes for all observed species was present in the riparian corridor.
- Vegetation in the site was healthy and appeared hydrologically connected within the floodplain.
- Woody species were present in areas with substrate capable of supporting woody vegetation. The dominant substrate at transects was bedrock and boulder; substrates with limited capability to support woody vegetation; however, woody vegetation was present throughout the site.

2.4 New Bullards Bar Dam Reach

The New Bullards Bar Dam Reach is a 2.4-mi long section of the North Yuba River from the base of New Bullards Bar Dam at RM 2.4 (El. 1,360 ft) to the confluence of the North Yuba River with the Middle Yuba River at RM 0.0 (El. 1,125 ft). The reach has a gradient of 1 percent to 3 percent, expect for a short 0.2 mile section with a gradient of 3 percent to 8 percent.

Riparian sampling occurred at one location in this reach, upstream of Middle Yuba River Powerhouse (Table 2.4-1). Table 2.4-2 provides a summary of LWM recorded at the site.

Table 2.4-1. Location and size of assessment sites and type of assessments.

Stream	Site Location	Field Survey Date	Length (ft)	RM Start	RM End	Riparian Assessment[1]		Riparian Cursory Assessment		LWM Assessment	Historical Photograph Analysis
						Transect ID	# of Transects	Transect ID	# of Transects		
North Yuba River	Upstream of Middle Yuba River	8/15/12	327	0.2	0.4	2, 9, 12	3	--	--	X	X

[1] The riparian habitat assessment transects were co-located with channel morphology transects established in Study 1.1, *Morphology Upstream of Englebright Reservoir*. Transect #s are unique per site based on the location of the transect in the stream (i.e., transects are numbered in a downstream to upstream direction beginning at #1).

Table 2.4-2. Summary of LWM pieces located at LWM assessment sites and the volume of LWM within each site (in parenthesis).

Stream Reach	Length (ft)	Diameter (in) and Volume of LWM (m^3)(in parenthesis)				
		4 to <12	12 to <24	24 to <36	≥36	Total
	UPSTREAM OF THE CONFLUENCE WITH THE MIDDLE YUBA RIVER					
North Yuba River (6.7)	3 to <25	1 (0.1)	9 (6.3)	3 (5.8)	--	13 (12.2)
	25 to <50	--	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	

Both seedling and recruits were present in the North Yuba River assessment site. Table 2.4-3 summarizes the number of plots where woody species were present as mature trees, recruits, and seedlings.

Table 2.4-3. Number of plots with woody species present at three life stages in the North Yuba River assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 07		Transect 08		Transect 10	
arroyo willow	*Salix lasiolepis*	1|0|0	0|0|0	0|0|0	0|0|0	0|0|0	0|0|0
sandbar willow	*Salix exigua*	0|0|1	0|0|0	1|1|0	0|0|0	1|1|0	1|1|0
white alder	*Alnus rhombifolia*	0|0|0	0|0|0	0|0|0	1|0|0	0|0|0	0|0|0

In addition to recording vegetation and channel data along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation were not present in the site. Vegetation was limited, but a variety of age classes for all observed species was present in the riparian corridor.
- Vegetation in the site was healthy and appeared hydrologically connected within the floodplain.
- Woody species were present in areas with substrate capable of supporting woody vegetation.

- The dominant substrate at transects was bedrock and boulder; substrates with limited capability to support woody vegetation (Figure 6.0-1 in Attachment 6-1D).

2.5 Log Cabin Diversion Dam Reach

The Log Cabin Diversion Dam Reach is a 4.3-mi long section of Oregon Creek from the Log Cabin Diversion Dam at RM 4.3 to the confluence of Oregon Creek with the Middle Yuba River at RM 4.7. The 3.6 miles of this reach has a gradient of 1 percent to 3 percent while the remained section has a gradient of 3 percent to 8 percent.

Riparian sampling occurred at three locations in this reach, upstream of Middle Yuba River Powerhouse (Table 2.5-1). Table 2.5-2 provides a summary of LWM recorded at the site.

Table 2.5-1. Summary of LWM pieces located at LWM assessment sites and the volume of LWM within each site (in parenthesis).

Stream	Site Location	Field Survey Date	Length (ft)	RM Start	RM End	Riparian Assessment[1]		Riparian Cursory Assessment		LWM Assessment	Historical Photograph Analysis
						Transect ID	# of Transects	Transect ID	# of Transects		
Oregon Creek	Downstream of Log Cabin Diversion Dam, Upper Section	5/29/12	762	3.8	4.2	--	--	--	--	X	--
	Downstream of Log Cabin Diversion Dam, Celestial Valley Sub-reach	8/16/12	257	2.1	2.3	8, 10, 12	3	--	--	X	X
	Downstream of Log Cabin Diversion Dam, Lower Section	8/14/12	461	0.2	0.4	--	--	--	--	X	--

[1] The riparian habitat assessment transects were co-located with channel morphology transects established in Study 1.1, *Morphology Upstream of Englebright Reservoir*. Transect #s are unique per site based on the location of the transect in the stream (i.e., transects are numbered in a downstream to upstream direction beginning at #1).

Table 2.5-2. Summary of LWM pieces located at LWM assessment sites and the volume of LWM within each site (in parenthesis).

Stream Reach	Length (ft)	Diameter (in) and Volume of LWM (m^3)(in parenthesis)				
		4 to <12	12 to <24	24 to <36	≥36	Total
Oregon Creek (41.7)	**DOWNSTREAM OF LOG CABIN DIVERSION DAM, UPPER SECTION**					
	3 to <25	19 (2.6)	4 (2.8)	--	--	25 (6.2)
	25 to <50	2 (0.7)	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	DOWNSTREAM OF LOG CABIN DIVERSION DAM, CELESTIAL VALLEY SUB-REACH					
	3 to <25	22 (3.0)	3 (2.1)	4 (7.8)	--	35 (15.2)
	25 to <50	6 (2.2)	--	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	
	DOWNSTREAM OF LOG CABIN DAM, LOWER SECTION					
	3 to <25	20 (2.8)	6 (4.2)	4 (7.8)	--	41 (20.3)
	25 to <50	10 (3.7)	1 (1.9)	--	--	
	50 to <75	--	--	--	--	
	≥75	--	--	--	--	

Both seedling and recruits were present in the Oregon Creek Celestial Valley Sub-reach assessment site. Table 2.5-3 summarizes the number of plots where woody species are present as mature trees, recruits, and seedlings.

Table 2.5-3. Number of plots with woody species present at three life stages in the Oregon Creek Celestial Valley Sub-reach assessment site.

Species		Mature|Recruit|Seedling		Mature|Recruit|Seedling		Mature|Recruit|Seedling	
		River Right	River Left	River Right	River Left	River Right	River Left
Common Name	Scientific Name	Transect 08		Transect 10		Transect 12	
black locust	*Robinia pseudoacacia*	0|0|0	0|0|0	0|0|0	0|0|0	1|1|0	0|0|0
Oregon ash	*Fraxinus latifolia*	0|0|0	0|0|0	0|0|0	0|0|0	1|0|0	0|0|0
Pacific madrone	*Arbutus menziesii*	0|0|0	0|0|0	0|0|0	1|1|0	0|0|0	0|0|0
red willow	*Salix laevigata*	0|0|0	0|0|0	1|1|1	0|0|0	2|2|1	2|0|0
white alder	*Alnus rhombifolia*	1|0|0	2|0|0	2|2|0	0|0|0	0|0|0	2|0|0

In addition to recording vegetation and channel data along the vegetative transects, YCWA recorded the following information:

- Monotypic age stands of woody vegetation were not present in the site. A variety of age classes for all observed species was present in the riparian corridor.
- Vegetation in the site was healthy and appeared hydrologically connected within the floodplain.
- Woody species were present in areas with substrate capable of supporting woody vegetation. The dominant substrate in the site included cobbles and sand, with some boulders, and woody species were present and supported along the whole length of the site.

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