Study 2.3

# WATER QUALITY STUDY

October 2016

## 1.0 Project Nexus

South Sutter Water District's (SSWD) continued operation and maintenance (O&M) of the Camp Far West Hydroelectric Project (Project) and associated recreation use have the potential to affect water quality.

This Water Quality Study (Study) addresses all pertinent water quality parameters except for water temperature, which is addressed in two separate relicensing studies: Study 2.1, *Water Temperature Monitoring*, and Study 2.2, *Water Temperature Modeling*.

## 2.0 Study Goals and Objectives

The goal of this Study is to supplement existing information regarding water quality.

The objective of the study is to collect information to meet the Study goal.

The Study does not include the development of potential requirements in the new license.

## 3.0 Existing Information and Need for Additional Information

The primary comprehensive plan that addresses water quality in the Project Vicinity is the State Water Resources Control Board's (SWRCB) *Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin Rivers* (CVRWQCB 1998). The Basin Plan, including designated Beneficial Uses in the Project Area,[1] is described in Section 1.3.8 of SSWD's Pre-Application Document (PAD). The Basin Plan designated Water Quality Objectives in the Project Area are provided in Table 3.2.2-5 of the PAD. In addition, Section 1.3.8 of the PAD describes Clean Water Act (CWA) Section 303(d) List of Water Quality Limited Segments in the Project Area and associated Total Daily Maximum Load (TMDL) plans.

Existing, relevant and reasonably available information regarding water quality in the Project Vicinity[2] is provided in Section 3.2.2.9.2 of the PAD. This existing and available information indicates that upstream of the Project, all Water Quality Objectives were met for the parameters available. In Camp Far West Reservoir, Water Quality Objectives were not met during one sampling event for dissolved oxygen (DO), pH and specific conductivity. In most instances, these values occurred near the bottom of the reservoir. No information is available for the Bear

[1] In this Study, "Project Area" refers to the area within and immediately adjacent to the existing FERC Project Boundary, and the Bear River downstream of the Project.

[2] In this Study, "Project Vicinity" refers to the area surrounding the Project on the order of USGS 1:24,000 topographic quadrangle.

River between Camp Far West Dam and the non-Project diversion dam. Downstream of the non-Project diversion dam, existing and available information indicates that Water Quality Objectives are not met for pH; alkalinity; DO; aluminum (total); arsenic (total); copper (total and dissolved); iron (total); manganese (total); and lead (total and dissolved).

Additional information, which will be provided by this Study, is needed to address the Study goal regarding the specific water quality parameters not met by the Basin Plan and the Project O&M activities and associated recreation that affect these parameters.

# 4.0 Study Methods and Analysis

## 4.1 Study Area

For the purpose of this Study, the Study Area includes: 1) the Bear River, approximately 1.5 miles upstream from Camp Far West Reservoir; 2) Camp Far West Reservoir; 3) the 1.3-mile-(mi)-long segment of the Bear River from Camp Far West Dam to the non-Project diversion dam; and 4) the 16.9-mi-long segment of the Bear River from the diversion dam to the Feather River confluence (lower Bear River). Figure 4.1-1 shows the Study Area.

If SSWD proposes an addition to the Project, the Study Area will be expanded if necessary to include areas potentially affected by the addition.

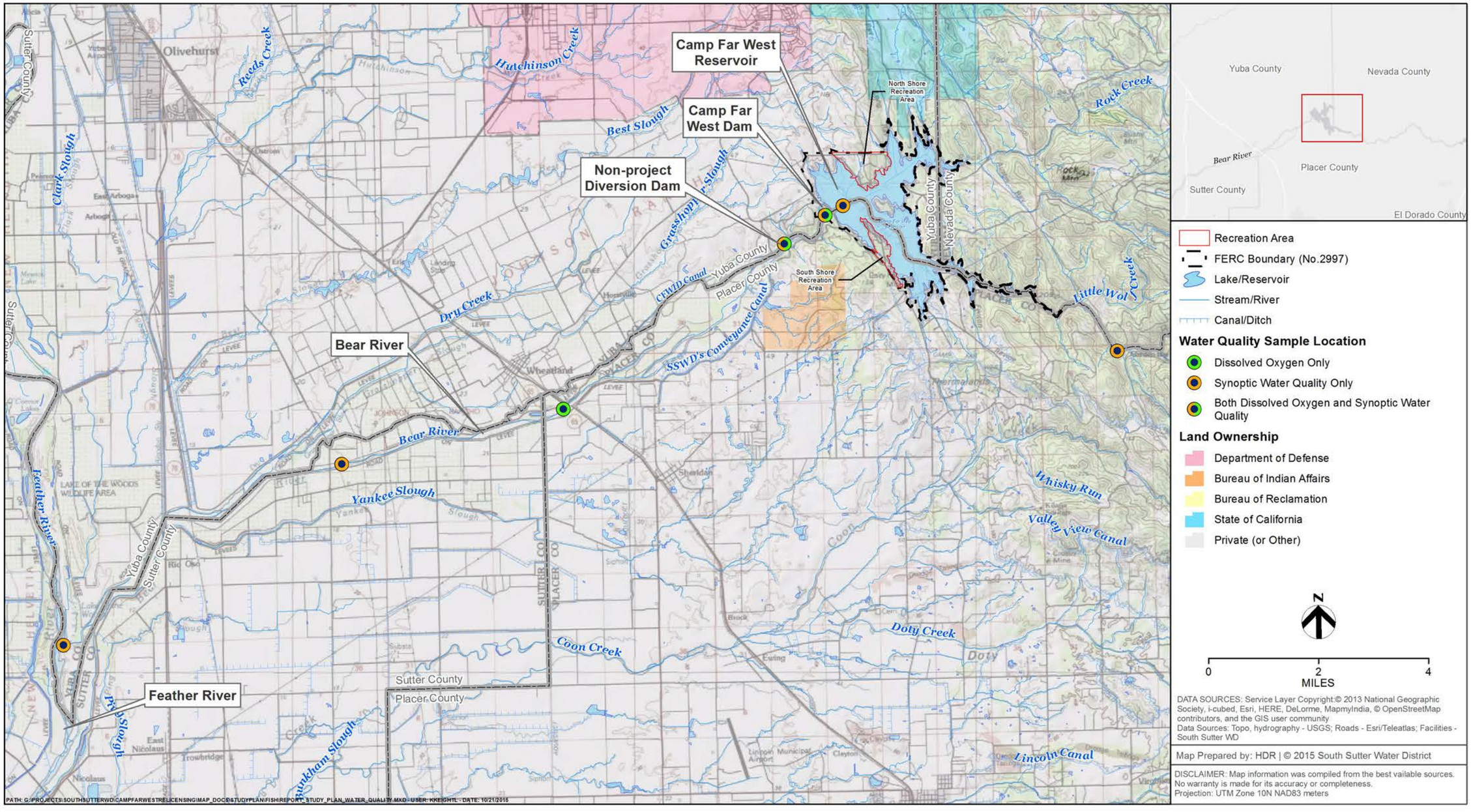


**Figure 4.1-1. Water Quality Study Area and sample locations.**

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## 4.2 General Concepts and Procedures

The following general concepts and practices apply to all SSWD relicensing studies:

- Personal safety is the most important consideration of each fieldwork team.
- If required for the performance of the study, SSWD will make a good faith effort to obtain permission to access private property well in advance of initiating the study. SSWD will only enter private property if such permission has been provided by the landowner.
- SSWD will acquire all necessary agency permits and approvals prior to beginning fieldwork for a study that requires them.
- Field crews may make variances to the study plan in the field to accommodate actual field conditions and unforeseen problems. When a variance is made, the field crew will follow to the extent applicable the protocols in and intent of the study plan.
- SSWD's performance of the study does not presume that SSWD is responsible in whole or in part for measures that may arise from the study.
- If Global Positioning System (GPS) data are required by a study plan, they will be collected using either a Map Grade Trimble GPS (i.e., sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (i.e., 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 SSWD's consultant's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to National Oceanic and Atmospheric Administration, National Marine Fisheries Service; United States Fish and Wildlife Service, Cal Fish and Wildlife or SWRCB in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata. Metadata will be Federal Geographic Data Committee compliant.
- SSWD's field crews conducting relicensing studies will record incidental records of aquatic, botanical and wildlife species observed during the performance of a study. All incidental observations will be reported in the DLA and FLA. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study plan) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of a relicensing study. Species included for incidental observation will include, but are not limited to: bald eagle (*Haliaeetus leucocephalus*); golden eagle (*Aquila chrysaetos*); osprey (*Pandion haliaetus*); any bats or positive sign of bats; Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*), including redds and carcasses; northern western pond turtle (*Actinemys marmorata*); foothill yellow-legged frog (*Rana boylii*); American bullfrog (*Lithobates catesbeianus*), and aquatic invasive species.

- Field crews will be trained on, provided with, and use materials (e.g., Quat disinfectant) for decontaminating their boots, waders, and other equipment between water-based study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*).
- If in the performance of a study, SSWD observes an ESA-listed or special-status species, within 30 days of the observation SSWD will submit to Cal Fish and Wildlife's California Natural Diversity Database a record, on the appropriate form, of the observation.
- If a study plan requires collection and reporting of time series data, the data will be provided at a minimum in Excel (*.xls) or HEC-DSS (*.dss) format. A viewer for *.dss files (HEC-DSSVue) can be obtained from the United States Army Corps of Engineers at the following website as of October 2015: http://www.hec.usace.army.mil/software/hec-dssvue/.
- If a field crew encounters human remains during field work, all work within a 100-foot radius of the discovery will stop immediately. The field crew will not disturb the remains in any way, secure the area to the best of its ability, mark the location with flagging tape in such a way as to not draw attention to the remains, and record the location using a GPS unit or plot the location by hand on a map if no GPS unit is available. As soon as possible thereafter, the field crew will contact SSWD and the relicensing Cultural Resources Lead to report the discovery. SSWD will report the finding and initiate the appropriate steps required under State of California and federal law to address the discovery. Any human remains encountered will be treated with respect, and the field crew members will keep the location confidential and will not disclose the location of the discovery to the public or to any other study crews. The field crew will keep a log of all calls/contacts it makes regarding the discovery and that details the event. Work will not proceed in the secured area of the discovery until provided clearance by SSWD.

## 4.3 Methods

The Study consists of two elements. Element 1 consists of synoptic grab sampling over three events. Element 2 consists of continuous DO monitoring over two events. The Study will be performed in six steps: 1) select water quality parameters; 2) select sampling locations; 3) collect water samples; 4) perform laboratory analyses using standard methods adequately sensitive to determine consistency with state and federal water quality standards; 5) prepare quality assurance/quality control (QA/QC) review; and 6) determine consistency with Basin Plan Objectives and designated Beneficial Use protection needs. Each of these steps is described below.

### 4.3.1 Step 1 – Select Water Quality Parameters

#### 4.3.1.1 Element 1 Parameters

For the purpose of this Study, the water quality parameters and constituents to be measured in Element 1 are divided into six categories: 1) basic water quality – *in situ*; 2) basic water quality

– laboratory; 3) inorganic ions; 4) nutrients; 5) metals; and 6) herbicides and pesticides. The parameters included in each Element 1 category and associated information is listed in Table 4.3-1.

**Table 4.3-1. Water quality parameters and constituents to be measured and methods, reporting limits and laboratory holding times for each.**

| Parameter | | Method | Target Reporting Limit µg/L (or other) | Hold Time |
|---|---|---|---|---|
| **BASIC WATER QUALITY – *IN SITU*** | | | | |
| Dissolved Oxygen | DO | SM 4500-O | 0.1 mg/L | Field (*in situ*) |
| Specific conductance | -- | SM 2510A | 0.001 µmhos | Field (*in situ*) |
| pH | -- | SM 4500-H | 0.1 su | Field (*in situ*) |
| Turbidity | -- | SM 2130 B | 0.1 NTU | Field (*in situ*) |
| Secchi Disc | -- | -- | -- | Field (*in situ*) |
| **BASIC WATER QUALITY – LABORATORY** | | | | |
| Total Organic Carbon | TOC | SM 5310 | 0.2 mg/L | 28 d |
| Dissolved Organic Carbon | DOC | EPA 415.1 D | 0.5/0.1 | 28 d |
| Total Dissolved Solids | TDS | EPA 2540 C SM 2340 C | 1 mg/L | 7d |
| Total Suspended Solids | TSS | EPA 2520 D SM 2340 D | 1 mg/L | 7d |
| **INORGANIC IONS** | | | | |
| Total Alkalinity | -- | SM 2340 B | 2000 | 14 d |
| Calcium | Ca | EPA 6010 B | 30 | 180 d |
| Chloride | Cl | EPA 300.0 | 20 | 28 d |
| Hardness (measured value) | -- | EPA 2340 B SM 2340 C | 1 mg/L as $CaCO_3$ | 14 d |
| Magnesium | Mg | EPA 6010 B | 1 | 180 d |
| Potassium | K | EPA 6010 B | 500 | 180 d |
| Sodium | Na | EPA 6010 B | 29 | 180 d |
| Sulfate | $SO_4^{2-}$ | EPA 300.0 | 1.0 mg/L | 28 d |
| Sulfide | $S^{2-}$ | SM 4500 S2 – D | 0.05 mg/L | 28 d |
| **NUTRIENTS** | | | | |
| Nitrate-Nitrite | -- | EPA 300.0 | 2 | 28 d <pH 2 |
| Total Ammonia as N | -- | EPA 4500-NH3 SM 4500-NH3 | 0.02 | 28 d <pH 2 |
| Total Kjeldahl Nitrogen as N | TKN | SM 4500 N | 100 | 28 d <pH 2 |
| Total phosphorus | TP | SM4500 P | 20 | 28 d <pH 2 |
| Dissolved Orthophosphate | $PO_4$ | EPA 365.1 EPA 300.0 | 0.01 | 48 h at 4 °C |
| **METALS (total and dissolved)** | | | | |
| Aluminum (total and dissolved) | Al | EPA 200.8/EPA 1638 | 4.0/ 0.4 | 180 d |
| Arsenic (total and dissolved) | As | EPA 200.8/1638 | 0.15/0.04 | 180 d |
| Cadmium (total and dissolved) | Cd | EPA 200.8/1638 | 0.020/0.004 | 180 d |
| Chromium, Total (total and dissolved) | Cr | EPA 200.8/1638 | 0.010/0.03 | 180 d |
| Copper (total and dissolved) | Cu | EPA 200.8/1638 | 0.10/0.01 | 180 d |
| Iron (total and dissolved) | Fe | EPA 200.8/1638 | 10.0/3.2 | 180 d |
| Lead (total and dissolved) | Pb | EPA 200.8/EPA 1638 | 0.040/0.003 | 180 d |
| Mercury (total) | Hg | EPA 1631 | 0.0005/0.00008 | 28 d |
| Methylmercury (total and dissolved) | CH3Hg | EPA 1630 | 0.00005/0.000019 | 90 d |
| Nickel (total and dissolved) | Ni | EPA 200.8/1638 | 0.10/0.01 | 180 d |

**Table 4.3-1. (continued)**

| Parameter | | Method | Target Reporting Limit µg/L (or other) | Hold Time |
|---|---|---|---|---|
| **METALS (total and dissolved) (continued)** | | | | |
| Selenium (total) | Se | EPA 200.8/1638 | 0.60/0.19 | 180 d |
| Silver (total and dissolved) | Ag | EPA 200.8/1638 | 0.20/0.006 | 180 d |
| Zinc (total and dissolved) | Zn | EPA 200.8/1638 | 0.2/0.1 | 180 d |
| Chlorpyrifos | -- | EPA 8081A | 0.005/0.0024 mg/L | 7d |
| Diazinon | -- | EPA 8141A | 0.005/0.0029 mg/L | 7d |

Key:
EPA = United States Environmental Protection Agency
$CaCO_3$ = Calcium carbonate
d = days
h = hours
µmhos = micro-ohms
µg/L = micrograms per liter (equals parts per billion)
mg/L = milligrams per liter (equals parts per million)
MPN = Most Probable Number
NTU = Nephelometric Turbidity Units
SM = Standard Method
su = Standard Unit

#### 4.3.1.2 Element 2 Parameters

Element 2 consists of measuring two parameters, DO concentration and water temperature. While DO is the parameter of interest in this Study, water temperature is often tied to DO results and will be incorporated into the analysis, through SSWD will conduct a separate *Water Temperature Monitoring Study* (Study 2.1).

### 4.3.2 Step 2 – Select Sampling Locations

#### 4.3.2.1 Element 1 – Synoptic Water Quality Sample Locations

Synoptic water quality samples will be collected upstream, within and downstream of the Project. Water chemistry samples in the Bear River will be grab samples collected for laboratory analysis from the flowing water. In Camp Far West Reservoir, general water chemistry samples will be collected for laboratory analysis at two depths: within the hypolimnion and just below the surface in the epilimnion. In the event the reservoir is mixed at the time of sampling (as seen from the reservoir profile near the dam), samples will be collected from just below the surface and approximately 5 feet from the bottom. (Table 4.3-2.)

**Table 4.3-2. Synoptic water quality sample locations.**

| Location | River Mile | Sample Depth | Notes |
|---|---|---|---|
| Bear River upstream of Camp Far West Reservoir | 25.1 | Surface | Co-located with Study 2.1, *Water Temperature Monitoring*, sampling location |
| Camp Far West Reservoir; near Dam | 18.4 | Surface | |
| | | Bottom | |
| Bear River below Camp Far West Dam | 18.0 | Surface | |
| Bear River below non-Project Diversion Dam | 16.9 | Surface | |
| Bear River near Pleasant Grove Road Bridge | 7.1 | Surface | |
| Bear River upstream of the Feather River Confluence | 0.1 | Surface | |

#### 4.3.2.2 Element 2 – Continuous DO Monitoring Locations

To better understand DO concentration dynamics, continuous DO monitors will be installed at three locations: 1) in the Bear River downstream of the Camp Far West Powerhouse and low-level outlet (RM 18.0); 2) in the Bear River downstream of the non-Project diversion dam (RM 16.9); and 3) in the lower Bear River near the Highway 65 bridge (RM 11.4). Each monitor will be placed in flowing water near the surface.

### 4.3.3 Step 3 – Collect Samples

All data will be acquired in accordance with standard quality assurance practices.

#### 4.3.3.1 Element 1 – Synoptic Water Quality Reservoir and Stream Sampling

Water chemistry samples will be collected from all locations three times: 1) once in the spring, when the powerhouse is operational and irrigation deliveries are occurring; 2) once in the late summer, when the powerhouse is operational and irrigation deliveries are occurring; and 3) once in the fall, when the powerhouse is off-line and releases from Camp Far West Dam are made exclusively by the low-level outlet.

##### 4.3.3.1.1 *In Situ* Sampling

*In situ* water quality measurements will be made at the sample depths described in Table 4.3-2 with a Hydrolab DataSonde 5 (Hydrolab), or other instrument with similar precision and accuracy. Water temperature (±0.1°C), DO (±0.2 mg/L), pH (±0.2 standard unit, or su), specific conductance (±0.001 micromhos per centimeter [µomhos/cm]), and turbidity (± 1 NTU) will be measured at each location. Prior to and after each use, the instrument will be calibrated using the manufacturer's recommended calibration methods. Any calibration variances will be noted on the field data sheet and in the Study report, and recalibration or repair done as necessary. SSWD will note relevant conditions during each sampling event on the field data sheet (e.g., air temperature; flow, if available at a nearby gage; description of sampling location; floating material; evidence of oil and grease; and activities in the vicinity of the sampling site that could cause short-or long-term alterations to water quality, such as dredging).

##### 4.3.3.1.2 Laboratory Samples

Each sample to be delivered to a laboratory will be 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 (EPA's) Method 1669 sampling protocol *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria* (EPA 1995). Samples requiring filtration before metals analysis will be filtered in accordance with standard protocols in the field. Certification of filter cleanliness will be obtained from the vendor and kept in the Project files.

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 a State of California-certified water quality laboratory for analyses of the parameters listed in Table 4.3-1 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.

As part of the field QA program, one field blank and one equipment rinsate will be collected and submitted to the laboratory, with a target of one for every ten analyses. 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 field blank for filtered samples will be similarly created, but filtered using field techniques before pouring into the container. A field blank assesses the contamination from field conditions during sampling. A rinsate is a sample of analyte-free water poured over or through decontaminated field sampling equipment prior to the collection of samples and assesses the adequacy of the decontamination processes. Two duplicate samples will also be collected to confirm the laboratory's QA process.

#### 4.3.3.1.3 Secchi Depth Readings in Reservoirs

Prior to collecting reservoir samples, a Secchi disk will be slowly lowered into the water on the shady side of the boat until it is no longer visible, and the depth recorded. Then, the Secchi disc will be slowly raised until it just becomes visible once again and this depth will be recorded a second time. The average of the two depths will be considered the Secchi depth and recorded.

### 4.3.3.2 Element 2 – Continuous Dissolved Oxygen Monitoring

Continuous DO monitors will be deployed for a minimum of 14 days during two periods: 1) once in the summer when the Camp Far West Powerhouse is operational and irrigation deliveries from Camp Far West Dam are occurring; and 2) once in the fall when the powerhouse is off-line and releases from Camp Far West Dam are made exclusively by the Camp Far West Dam low-level outlet.

DO monitoring will generally follow the United States Geological Survey (USGS) published method for the operation of continuous water quality stations (Wagner et al. 2006). The DO (±0.3 mg/L or less) will be measured *in situ* at 1-hour intervals using an Onset sonde or similar device with the appropriate precision and accuracy.

Each DO monitor will be contained in a durable protective housing that permits the active flow of water in and around the unit. The protective housing will be secured by a cable to a stable root mass, tree trunk or man-made structure, or secured using embedded rebar where necessary such that the monitor will be secured in flowing water in the channel during high flow periods. The DO monitors will be installed in flowing water, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads. A GPS coordinate will be taken and recorded at each installation point, along with any waypoints that may prove valuable for future retrieval, especially where there is not a defined trail leading to the

access point. Photographs of the sampling site, including installation configuration, will be taken. Prior to installation, each recorder will be numbered and calibrated to manufacturer's recommended specifications.

Redundant recorders will be located as close as possible to the primary recorders. Where a redundant recorder occurs, the primary recorder will be labeled with the recorder number for the site (e.g., "BR1") with the suffix "a" and the redundant recorder with the number for the site with the suffix "b". Data from both recorders will be downloaded during each scheduled visit.

During each visit, SSWD will download data into an optic shuttle or directly to a personal computer. Immediately after the data are safely downloaded, back-ups will be recorded on portable memory devices (i.e., USB "thumb drive"). Only after the raw water temperature data are safely backed-up will the optic shuttle be cleared or the data manipulated. In addition, during each site visit, SSWD will be prepared to replace or fix a recorder installation. Should a recorder need to be replaced because it is missing or has failed, SSWD will be able to do so immediately to reduce the potential for additional data loss. Any recorder or optic shuttle that fails to download will be returned to the manufacturer for possible data recovery.

The data will be downloaded and the loggers inspected/maintained weekly during the deployment periods.

### 4.3.4 Step 4 – Perform Laboratory Analyses

#### 4.3.4.1 Chemical Analyses

All laboratory analyses will be conducted using EPA Standard Methods or the equivalent sufficiently sensitive to detect and report at levels necessary for evaluation against State and federal water quality standards. A State of California-certified laboratory will prepare and analyze water samples for the following surface water analytical parameters:

- Basic Water Chemistry - Laboratory
- Inorganic Ions
- Metals
- Nutrients
- Petroleum Hydrocarbons

The analytes and target reporting limits associated with each parameter are listed in Table 4.3-1.

### 4.3.5 Step 5 – QA/QC Review

All data will be verified and/or validated as appropriate. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analysis, SSWD 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, SSWD 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[3] 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, SSWD will identify the data accordingly.

### 4.3.6 Step 6 – Determine Consistency with Basin Plan Water Quality Objectives

Table 4.3-3 shows the standards, criteria and benchmark values that will be used to assist with in the assessment of sample results and their consistency with the Basin Plan Objectives. The selected values primarily consist of the Title 22 drinking water standards, which are incorporated by reference into the Basin Plan itself, and the California Toxics Rule (CTR) (EPA 2000). However, when a Study analyte does not have a compliance threshold (i.e., benchmark) in one these preferred sources, benchmarks will be applied from *A Compilation of Water Quality Goals* (Marshack 2015, as amended through October 2011 – August 2014); and others as cited.

**Table 4.3-3. Standards, criteria and benchmarks used for determining consistency with Basin Plan Water Quality Objectives and designated Beneficial Uses.[1]**

| Analyte | Symbol or Abbreviation | Standard, Criteria or Benchmark Value | Reference | Notes |
|---|---|---|---|---|
| **BIOSTIMULATORY SUBSTANCES (COLD, SPAWN)** | | | | |
| Total Kjeldahl Nitrogen | TKN | None | -- | -- |
| Total Phosphorous | TP | None | -- | -- |
| **CHEMICAL CONSTITUENTS (MUN)** | | | | |
| Alkalinity | -- | 20 mg/L | Marshack 2015 | EPA AWQC; less than 20 mg/L can affect water treatment |
| Aluminum | Al | 1 mg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Arsenic | As | 0.01 mg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Cadmium | Cd | 5 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Calcium | Ca | None | -- | -- |
| Chromium (total) | Cr (total) | 50 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Chlorphyifos | -- | 2 µg/L | Marshack 2015 | USEPA drinking water source |
| Copper | Cu | 1.3 mg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Diazinon | -- | 1.2 µg/L | Marshack 2015 | California Department of Public Health notification |
| Lead | Pb | 15 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Mercury (inorganic) | Hg | 2 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |

[3] Results with a "J" qualifier are results where the chemical was detected, but there is uncertainty in the quantity. The quantity is above the method detection limit, but below the reporting limit.

**Table 4.3-3. (continued)**

| | | | | |
|---|---|---|---|---|
| Nickel | Ni | 100 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Nitrate | $NO_3$-N | 10 mg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Nitrite | $NO_2$-N | 1 mg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Nitrate + Nitrite | $NO_3$-N+$NO_2$-N | 10 mg/L (combined total) | DDW 2015 | 22 CCR §64431 Primary MCL |
| Selenium | Se | 50 µg/L | DDW 2015 | 22 CCR §64431 Primary MCL |
| Sodium | Na | 20 mg/L | Marshack 2015 | Sodium Restricted Diet[2] |
| **DISSOLVED OXYGEN (COLD, SPAWN)** | | | | |
| Dissolved Oxygen | DO | > 7 mg/L (minimum) | CVRWQCB 1998 | Aquatic life protection |
| **FLOATING MATERIAL (REC-1, REC-2)** | | | | |
| Floating Material | -- | Narrative Criteria | CVRWQCB 1998 | Aesthetics – Absent by visual observation |
| **pH (MUN, COLD, SPAWN, WILD)** | | | | |
| pH | -- | 6.5-8.5 | CVRWQCB 1998 | Aquatic life protection |
| **TASTES & ODOR (MUN)** | | | | |
| Aluminum | Al | 0.2 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Chloride | Cl | 250 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Copper | Cu | 1.0 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Iron | Fe | 0.3 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Silver | Ag | 0.1 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Specific conductance | -- | 900 µS/cm | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Sulfate | $SO_4^{2-}$ | 250 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Total Dissolved Solids | TDS | 500 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| Zinc | Zn | 5 mg/L | DDW 2015 | 22 CCR §64449 Secondary MCL |
| **TEMPERATURE (COLD, SPAWN)** | | | | |
| Temperature | -- | Narrative | CVRWQCB 1998 | See Water Temperature Study |
| **TOXICITY (COLD, SPAWN, MUN)** | | | | |
| Alkalinity | -- | 20 mg/L | Marshack 2015 | EPA AWQC; buffering capacity |
| Aluminum | Al | 87 µg/L | Marshack 2015 | EPA AWQC; aquatic life protective[3] |
| Ammonia as N (pH and Temp dependent) | $NH_3$-N | 24.1 mg/L (CMC); 4.1-5.9 mg/L (CCC) | EPA 2000 | CTR criteria over 0-20ºC assuming pH 7.0 |
| | | 5.6 mg/L (CMC); 1.7-2.4 mg/L (CCC) | EPA 2000 | CTR criteria over 0-20ºC assuming pH 8.0 |
| | | 0.9 mg/L (CMC); 0.3-0.5 mg/L (CCC) | EPA 2000 | CTR criteria over 0-20ºC assuming pH 9.0 |
| Arsenic | As | 0.34 mg/L (CMC); 0.15 mg/L (CCC) | EPA 2000 | CTR criteria |
| Cadmium (hardness dependent) | Cd | 0.16 µg/L (CMC); 0.25 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 0.35 µg/L (CMC); 0.41 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 0.54 µg/L (CMC); 0.56 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 0.95 µg/L (CMC); 0.81 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |

**Table 4.3-3. (continued)**

| Analyte | Symbol or Abbreviation | Standard, Criteria or Benchmark Value | Reference | Notes |
|---|---|---|---|---|
| **TOXICITY (COLD, SPAWN, MUN) (continued)** | | | | |
| Chloride | Cl- | 860 mg/L (CMC); 230 mg/L (CCC) | Marshack 2015 | EPA AWQC; aquatic life protective |
| Chromium (hardness dependent) | Cr | 47.19 µg/L (CMC); 15.31 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 83.25 µg/L (CMC); 27.0 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 116.03 µg/L (CMC); 37.64 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 176.31 µg/L (CMC); 57.19 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |
| Chlorpyrifos | -- | 0.02 µg/L (CMC); 0.014µg/L (CCC) | Marshack 2015 | CDFW water quality criteria |
| Copper (hardness dependent) | Cu | 0.8 µg/L (CMC); 0.69 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 1.54 µg/L (CMC); 1.25 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 2.25 µg/L (CMC); 1.77 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 3.64 µg/L (CMC); 2.74 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |
| Diazinon | -- | 0.16 µg/L (CMC); 0.1 µg/L (CCC) | Marshack 2015 | CDFW water quality criteria |
| Iron | Fe | 1 mg/L (CCC) | Marshack 2015 | EPA AWQC; aquatic life protective |
| Mercury (total) | Hg | 0.050 µg/L | EPA 2000 40 C.F.R. 131.38 | CTR/Federal Register 5/18/00 |
| Nickel (hardness dependent) | Ni | 37.2 µg/L (CMC); 4.1 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 66.9 µg/L (CMC); 7.4 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 94.3 µg/L (CMC); 10.5 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 145.2 µg/L (CMC); 16.1 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |
| Selenium (total) | Se | 20 µg/L (CMC) 5 µg/L (CCC) | Marshack 2015 | EPA AWQC; aquatic life protective |
| Silver (hardness dependent) | Ag | 0.02 µg/L (CMC) Instantaneous | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 0.07 µg/L (CMC) instantaneous | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| Silver (hardness dependent) | Ag | 0.13 µg/L (CMC) instantaneous | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 0.32 µg/L (CMC) instantaneous | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |

**Table 4.3-3. (continued)**

| Analyte | Symbol or Abbreviation | Standard, Criteria or Benchmark Value | Reference | Notes |
|---|---|---|---|---|
| **TOXICITY (COLD, SPAWN, MUN) (continued)** | | | | |
| Lead (hardness dependent) | Pb | 2 µg/L (CMC) 0.086 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 5 µg/L (CMC) 0.191 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 8 µg/L (CMC) 0.303 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 14 µg/L (CMC) 0.54 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |
| Specific conductance | -- | 150 µmhos | CVRWQCB 1998 | Aquatic Life Protection |
| Zinc (hardness dependent) | Zn | 9.26 µg/L (CMC) 9.33 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$ |
| | | 16.66 µg/L (CMC) 16.79 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$ |
| | | 23.48 µg/L (CMC) 23.68 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$ |
| | | 36.20 µg/L (CMC) 36.50 µg/L (CCC) | EPA 2000 | CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$ |
| Turbidity | NTU | increase < 1 NTU for 1-5 NTU background; increase < 20% for 5-50 NTU background; increase < 10 NTU for 50-100 NTU background | CVRWQCB 1998 | Aesthetics, disinfection |

1 Note: a constituent may be listed under more than one beneficial use. When a standard or criterion was not available, benchmarks were excerpted from EPA (2003) and Marshack (2015).
2 Guidance level to protect those individuals restricted to a total sodium intake of 500 mg/day (Marshack 2015).
3 Benchmark is likely overly protective, as EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured (Marshack 2015)

Key:
AWQC = Ambient Water Quality Criteria
EPA = United States Environmental Protection Agency
CaCO3 = Calcium carbonate
CDFW = California Department of Fish and Wildlife
CMC = Criterion Maximum Concentration (1-hour acute exposure) for aquatic toxicity as defined by EPA (2000)
CCC = Criterion Continuous Concentration (4-day chronic exposure) for aquatic toxicity as defined by EPA (2000)
CCR = California Code of Regulations
CTR = California Toxics Rule
MCL = Maximum Contaminant Level
µmhos = micromhos
µg/L = micrograms per liter
mg/L = milligrams per liter
MPN = Most Probable Number
NTU = Nephelometric turbidity units
SM = Standard Method
su = standard unit

The CVRWQCB has adopted, by reference, California Title 22 maximum contaminant levels (MCL) for drinking water as Basin Plan objectives (CVRWQCB 1998), with the exception that more stringent criteria may apply as necessary for protection of specific designated Beneficial Uses. Hence, these values are adopted as the drinking water standard herein. It should be noted,

however, that chemical concentrations that were originally intended to apply to finished tap-water, rather than to untreated sources of drinking water, will be applied to the untreated reservoir or river water.

For Basin Plan Water Quality Objectives related to aquatic toxicity for ammonia and trace metals, the CTR (EPA 2000) is the preferred benchmark source. Part 40 C.F.R. Section 131.38 established Criterion Maximum Concentrations (CMC) as the highest concentrations to which aquatic life can be exposed for a short period[4] (1 hour) without deleterious effects, and Criterion Continuous Concentrations (CCC) as the highest concentration to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. When single grab samples are collected, as will be the case for this Study, it is assumed that constituent concentrations are representative of the continuous ambient condition, and CCC values are therefore used as the appropriate criteria to compare against environmental sample results.

Because of differences in acute and chronic toxicity to aquatic organisms of many elements and compounds, as well as variations with ambient water quality such as pH or hardness, several entries in Table 4.3-3 have multiple benchmarks to illustrate this range. The benchmarks for seven of the metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) addressed in this Study are reported for dissolved metals from the CTR (EPA 2000). In Table 4.3-3, benchmarks for these metals are calculated in 5 mg/L increments of hardness since the aquatic toxicity of these metals reportedly increases as hardness decreases. Similarly, the CMC and CCC levels for ammonia are a function of both pH and temperature and are presented for the temperature range of 0º-20ºC in pH increments of 1.0 su in Table 4.3-3.

# 5.0 Consistency of Methodology with Generally Accepted Scientific Practices

This Study is consistent with the goals, objectives, and methods outlined for most recent FERC hydroelectric relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Hydroelectric Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179) relicensings. The study uses standard water quality monitoring methods. Laboratory analyses are based on the recommended methods by EPA or the State of California.

# 6.0 Schedule

SSWD anticipates the schedule to complete the Study as follows:

Planning ..... March 2017
Collect WQ Data – powerhouse on, diverting ..... April/May 2017
Collect WQ/DO Data – powerhouse on, diverting ..... August 2017
Collect WQ/DO Data – low-level outlet operations only ..... October 2017
QA/QC Review ..... November/December 2017

[4] Based on extended sample collection and 1-hour averaging.

The Study information will be included in SSWD's DLA and FLA. If SSWD completes the Study before preparation of the DLA, SSWD will post the report on SSWD's Relicensing Website and issue an e-mail to Relicensing Participants advising them that the report is available.

# 7.0 Level of Effort and Cost

SSWD estimates the cost to complete this Study in 2016 dollars is between $60,000 and $80,000.

# 8.0 References Cited

Central Valley Regional Water Quality Control Board (CVRWQCB). 1998. Basin Plan. Fourth Edition, The Sacramento River Basin and the San Joaquin River Basin. State of California Regional Water Quality Control Board, Central Valley Region. Revised in October 2011 with the Approved Amendments

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