4.1.16 Water Quality and Temperature Study

4.1.16.1 Project Nexus

Continued Project O&M activities have the potential to affect water quality and water temperature in Project reservoirs and stream reaches downstream of Project facilities.

4.1.16.2 Existing Information and Need for Additional Information

Existing, relevant, and reasonably available information regarding water quality and water temperature in Pyramid Lake and the Pyramid reach was presented in the Licensees' PAD in Section 4.4. As a summary, Project water quality monitoring has been conducted by the Licensees since 1968. The water quality program monitors eutrophication, salinity and other parameters of concern for drinking water, recreation, and fish and wildlife purposes. Additional data are collected by MWD. Extensive water quality sampling and analysis is ongoing by both DWR and MWD. Additionally, the USGS studies surface-water quality in cooperation with local and State governments, and with other federal agencies. The monitoring program consists of collection, analysis, data archiving, and dissemination of data and information describing the quality of surface water resources. These data are summarized in Section 4.4 of the PAD.

In addition, defined Beneficial Uses and Water Quality Objectives of Project waters are presented in Tables 4.4-6 and G-1, respectively, in the PAD.

Additional water quality and temperature data from this Study will be added to the existing data.

4.1.16.3 Study Goals and Objectives

The goal of this *Water Quality and Temperature Study* is to supplement existing information regarding water quality and temperature. The objective of the Study is to gather sufficient data necessary to fill recognized information gaps concerning water quality and temperature.

4.1.16.4 Study Methods

Study Area

The study area for the *Water Quality and Temperature Study* consists of Quail Lake, Pyramid Lake, Pyramid reach, and Piru Creek immediately upstream of Pyramid Lake (Figure 4.1-24).

General Concepts and Procedures

- Personal safety is the most important consideration of each fieldwork team. Fieldwork will only occur in safely accessible areas and under conditions deemed safe by the field crews. Locations within the study area that cannot be accessed

in a safe manner (e.g., locations containing dense vegetation or unsafe slopes) and areas inundated when the surveys are performed, will not be surveyed; these areas will be identified in the data summary and an explanation for survey exclusion will be provided.

- The *Water Quality and Temperature Study* will begin after FERC issues its Study Plan Determination.

- The *Water Quality and Temperature Study* does not include the development of requirements for the new license, which will be addressed outside the *Water Quality and Temperature Study*.

- The *Water Quality and Temperature Study* focus specifically on Quail Lake, Pyramid Lake, Pyramid reach, and Piru Creek immediately upstream of Pyramid Lake, and the study area for the *Water Quality and Temperature Study* is specific and limited to the locality of these resources.

- If required for the performance of the *Water Quality and Temperature Study*, the Licensees will make a good faith effort to obtain permission to access private property well in advance of initiating the *Water Quality and Temperature Study*. The Licensees will only enter private property if permission has been provided by the landowner.

- The Licensees will acquire all necessary agency permits and approvals prior to beginning fieldwork for the *Water Quality and Temperature Study*.

- Field crews may make variances to the *Water Quality and Temperature Study* in the field to accommodate actual field conditions and unforeseen problems. Any variances in the *Water Quality and Temperature Study* will be noted in the data resulting from the *Water Quality and Temperature Study*.

- Field crews will record incidental observations of aquatic and terrestrial wildlife species observed during the performance of this study. The purpose of this effort is to opportunistically gather data during the performance of the study.

- To prevent the introduction and transmittal of amphibian chytrid fungus and invasive aquatic species (e.g., quagga mussels, zebra mussel, and Asian clams), field crews will be trained on, provided with, and use materials (e.g., Quat) for decontaminating their boots, waders, and other equipment when leaving or traveling between water-based study sites. Field crews will follow DWR's Quagga and Zebra Mussel Rapid Response Plan and CDFW's Aquatic Invasive Species Decontamination Protocol which can be found at the following link: (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333). All boats used during the study will follow cleaning protocols, including inspections before and after use. All decontamination requirements in place at Project reservoirs including those of DWR's *Quagga and Zebra Mussel Rapid Response Plan* for the SWP will be strictly followed (DWR 2010).

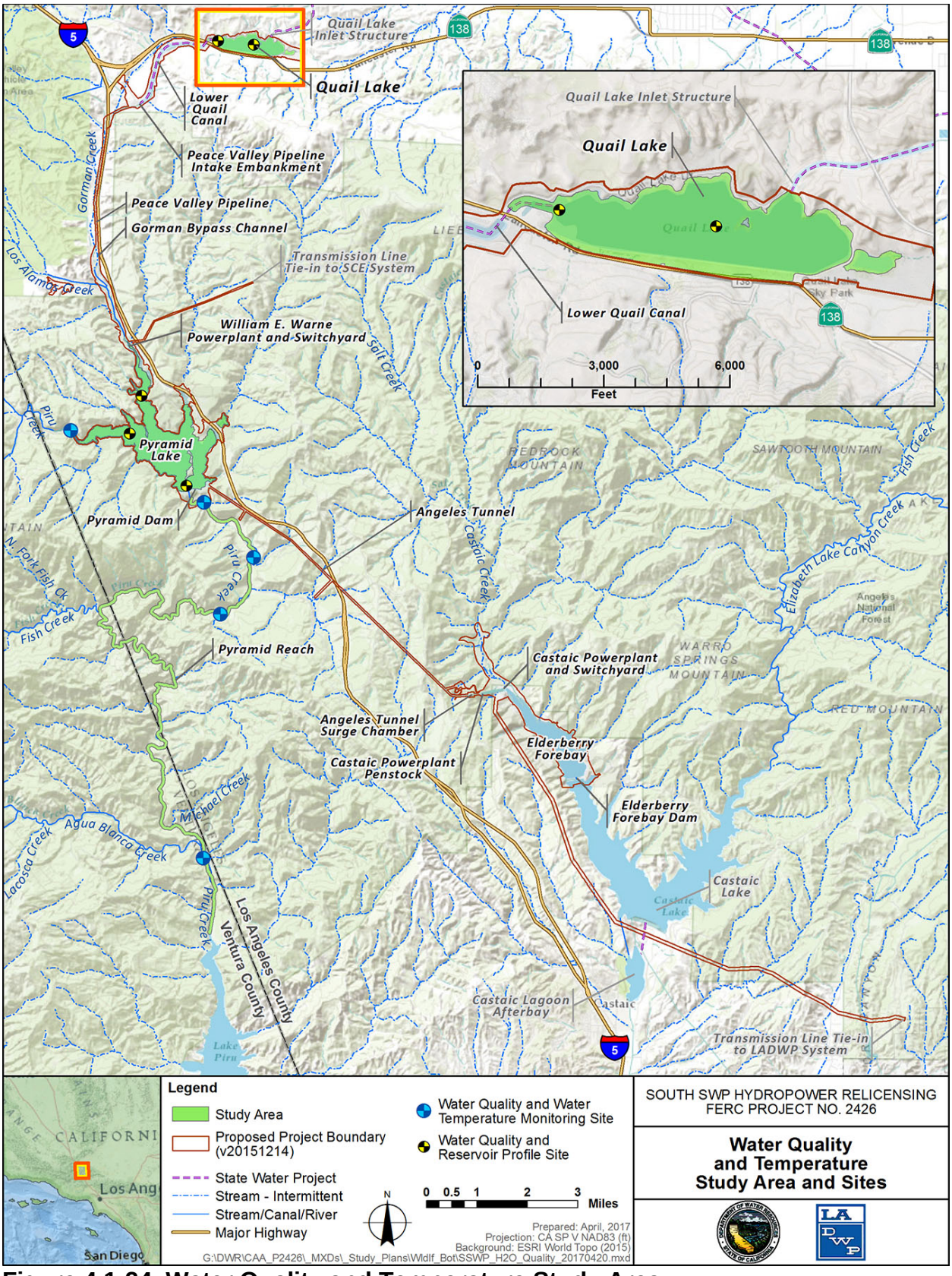

Figure 4.1-24. Water Quality and Temperature Study Area

Methods

This *Water Quality and Temperature Study* will consist of five steps: (1) select water quality parameters; (2) select sampling locations; (3) collect water quality samples; (4) collect reservoir profiles; and (5) install and maintain stream temperature loggers. These steps are described below.

Step 1 – Select Water Quality Parameters. For the purpose of this *Water Quality and Temperature Study*, the water quality parameters and constituents to be measured are divided into two categories: (1) basic water quality – in situ; and (2) basic water quality – laboratory, which includes inorganic ions, nutrients, and metals. The parameters included in each category and associated information is listed in Table 4.1-12. The basic water quality parameters described in Table 4.1-12 data will be collected through quarterly reservoir profiles. Water temperature will be collected in Pyramid reach and immediately upstream of Pyramid Lake by continuous monitoring.

Table 4.1-12. Water Quality Parameters, Analytes, Methods, Reporting Limits and Laboratory Holding Times

Parameter	Method	Target Reporting Limit[1] µg/L (or other)	Hold Time
BASIC WATER QUALITY – *IN SITU*			
Temperature	SM 2550 B	0.1 °C	Field (*in situ*)
Dissolved oxygen (DO)	SM 4500-O	0.1 mg/L	Field (*in situ*)
Specific conductance	SM 2510A	0.01 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	0.5	28 d
Dissolved organic carbon (DOC)	EPA 415.1 D	0.5	28 d
Total dissolved solids (TDS)	EPA 2540 C SM 2340 C	1.0 mg/L	7d
Total suspended solids (TSS)	EPA 2520 D SM 2340 D	1.0 mg/L	7d

Table 4.1-12. Water Quality Parameters, Analytes, Methods, Reporting Limits and Laboratory Holding Times (continued)

Parameter	Method	Target Reporting Limit[1] µg/L (or other)	Hold Time
INORGANIC IONS			
Total alkalinity	SM 2340 B	2000	14 d
Calcium (Ca)	EPA 200.7	1.0 mg/L	180 d
Chloride (Cl)	EPA 300.0	1.0 mg/L	28 d
Hardness (measured value)	EPA 2340 B SM 2340 C	1.0 mg/L as $CaCO_3$	14 d
Magnesium (Mg)	EPA 200.7	1.0 mg/L	180 d
Potassium (K)	EPA 200.7	500	180 d
Sodium (Na)	EPA 200.7	1.0 mg/L	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 4500-NO3	2	28 d at 4 °C
Total ammonia as N	EPA 4500-NH3 SM 4500-NH3	10	28 d at 4 °C
Total Kjeldahl nitrogen as N (TKN)	SM 4500 N	100	28 d at 4 °C
Total phosphorus (TP)	SM 4500 P	100	28 d at 4 °C
Dissolved orthophosphate (PO_4)	EPA 365.1 EPA 300.0	10	48 h at 4 °C
METALS			
Aluminum (total and dissolved) (Al)	EPA 1638	0.1	180 d
Arsenic (total and dissolved) (As)	EPA 1638	0.1	180 d
Cadmium (total and dissolved) (Cd)	EPA 1638	0.1	180 d
Chromium, total (total and dissolved) (Cr)	EPA 1638	0.1	180 d
Copper (total and dissolved) (Cu)	EPA 1638	.05	180 d
Iron (total and dissolved) (Fe)	EPA 1638	0.2	180 d
Lead (total and dissolved) (Pb)	EPA 1638	.04	180 d
Mercury (total) (Hg)	EPA 1631	.0002	28 d
Methylmercury (total and dissolved) (CH_3Hg)	EPA 1630	.005	90 d
Nickel (total and dissolved) (Ni)	EPA 1638	0.1	180 d
Selenium (total) (Se)	EPA 1638	0.2	180 d

Table 4.1-12. Water Quality Parameters, Analytes, Methods, Reporting Limits and Laboratory Holding Times (continued)

Parameter	Method	Target Reporting Limit[1] µg/L (or other)	Hold Time
Silver (total and dissolved) (Ag)	EPA 1638	.04	180 d
Zinc (total and dissolved) (Zn)	EPA 1638	0.1	180 d
PESTICIDES			
Chlorpyrifos	EPA 8081A	0.005mg/L	7 d
Diazinon	EPA 8141A	0.005mg/L	7 d

[1]The Target Reporting Limit is the minimum accuracy at which the parameter will be reported in the Licensees' ISR, USR, DLA, and FLA based on the limit of detection identified by the laboratory.
Key:
EPA = United States Environmental Protection Agency
$CaCO_3$ = calcium carbonate
d = days
h = hours
µmhos = micro-mhos
µg/L = micrograms per liter (equals parts per billion)
mg/L = milligrams per liter (equals parts per million)
NTU = Nephelometric Turbidity Units
SM = Standard Method
su = standard unit

Step 2 – Select Sampling Locations. General water quality data will be collected in Quail Lake, Pyramid Lake, Pyramid reach and Piru Creek immediately upstream of Pyramid Lake. General water quality samples collected in Quail Lake and Pyramid Lake will correspond to reservoir profile locations. To the extent possible, the sampling locations will correspond with the sampling locations of recent or ongoing water quality monitoring by the Licensees. General water quality samples collected in Pyramid reach and upstream of Pyramid Lake will correspond to water temperature monitoring locations. To the extent possible, the sampling locations will correspond with the sampling locations described in the *Pyramid Reach Fish Populations Study*.

Water quality sampling and reservoir profiles in Quail Lake will occur at two locations: (1) near the center of the reservoir; and (2) near the Quail Lake outlet. Water quality sampling and reservoir profiles in Pyramid Lake will occur at three locations: (1) near the dam; (2) in the Piru Creek arm; and (3) in the William E. Warne Powerplant arm. Sampling in Quail Lake and Pyramid Lake will occur at two depths at each sampling location: 1) within the hypolimnion and 2) just below the surface of the epilimnion.

Water quality sampling and water temperature monitoring in Pyramid reach will occur at four locations: 1) near the base of Pyramid Dam, 2) approximately 1.5 miles downstream from Pyramid Dam, 3) approximately 3 miles downstream of the Pyramid Dam, and 4) upstream of Lake Piru near the Blue Point Campground. Water quality sampling and water temperature monitoring in Piru Creek will occur at one location: immediately upstream of Pyramid Lake.

The timing and methods of water quality sampling, reservoir profiles and water temperature monitoring are described in Steps three through five, respectively.

Step 3 – Collect Water Quality Samples. The *in situ* and grab samples listed in Table 4.1-12 will be collected once in Quail Lake and Pyramid Lake at the locations described in Step 2 when Pyramid Lake's elevation is anticipated to be at the lowest elevation for the year. The *in situ* water quality parameters listed in Table 4.1-12 will also be collected during quarterly reservoir profiles. The *in situ* and grab samples listed in table 4.1-12 will be collected once at the locations in Pyramid reach and Piru Creek, as listed in Step 2, in the fall.

This description provides a broad overview of the sample collection procedures that will be followed. Specific quality assurance and quality control protocols will be followed to prevent sample contamination and ensure the sample accuracy. These protocols will be included in the QAPP to be developed in collaboration with the laboratory. The QAPP will include instrument calibration, equipment decontamination, sample cross contamination prevention, labels and documentation, laboratory certification, chain of custody procedures, and sample collection, preservation, storage, transport, and analyses protocols.

In situ water quality measurements will be made with a Hydrolab DataSonde 5 (Hydrolab), or other instrument with similar precision and accuracy. Water temperature (±0.1°C), DO (±0.2 milligrams per liter [mg/L]), pH (±0.2 standard unit, or su), specific conductance (±0.001 micro-mhos per centimeter [µmhos/cm]), and turbidity (± 1 Nephelometric Turbidity Unit [NTU]) will be measured at each location. *In situ* samples in Pyramid reach and upstream of Pyramid Lake will be collected in an area of free flowing water, near the thalweg, to the extent flows allow for safe access. In the event of high flows, samples will be taken along the bank but still in an area of moving water. The datasonde will be suspended at approximately half the total depth as measured at each sampling location. Care will be taken to not submerge the datasonde in any sediments near the bottom in order to achieve accurate readings. The instrument will be calibrated daily using the manufacturer's recommended calibration methods. Any calibration variances will be noted on the field data sheet and in the Licensees' ISR and/or Updated Study Report (USR), and recalibration or repair done as necessary. Field crews 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 the 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).

The Licensees will follow USGS sampling protocol for water quality (Wilde, 2011). In summary, each sample will be collected in laboratory-supplied clean containers. Containers used during stream sampling and reservoir surface sampling will be filled directly from the water, submerged approximately six inches below the surface and facing downstream in order to prevent material from flowing into the container. Sampling from near the bottom of the reservoir will be done using a Kemmerer sampler (or equivalent) designed for trace metals sampling. Containers for the deep water samples

will be filled directly from the sampler. The sampler will be thoroughly cleaned with Alconox and distilled water between sample locations. While in the field, samples requiring refrigeration will be stored on ice, in an ice chest, until transferred to an appropriate laboratory refrigerator. Water samples to be analyzed for metals will be collected using "clean hands" methods consistent with the 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, and a sampling site or unique sample identification number. A field sample log sheet will be maintained that includes a table of sample label information. The sampling site location will be recorded using a GPS unit. All containers will be handled in a manner consistent with appropriate chain-of-custody protocols. The sample containers will be preserved as appropriate, stored and delivered to a State of California-certified water quality laboratory for analyses of the parameters listed in Step 1, and in accordance with maximum holding periods for each parameter. A chain-of-custody record will be maintained with the samples at all times.

As part of the field QA/QC program, one field blank and one equipment rinsate will be collected and submitted to the laboratory, with a target of one for every 10 samples. 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 sample 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/QC process.

Step 4 – Collect Reservoir Profiles. Reservoir profiles will be taken once quarterly during the study at the locations in Quail Lake and Pyramid Lake described in Step 2. Sampling will occur in the third and fourth quarters of 2017 and the first and second quarters of 2018. Sampling will occur no sooner than two months after the previous event to capture maximum variation between events.

A GPS receiver will be used during each successive sampling occasion to locate the geographical coordinates of each sample site. Care will be taken to identify the same site for successive profiles where water conditions and GPS accuracy allow.

Field crews will use a Hydrolab® DataSonde 5® multi-parameter water quality monitoring system (or equivalent) to measure water temperature (±0.2°C) at each of the reservoir sampling sites. Generally, measurements will be taken at 10-foot vertical increments where the change in temperature with respect to depth is low. Where the temperature gradient is higher or where measuring water temperatures near the intake elevations, 5-foot or smaller vertical increments will be used. At each sample depth, the

parameter readings will be allowed to stabilize before water temperature will be recorded. Data will be collected throughout the entire water column.

Field crews will collect a Secchi disc depth reading as an indicator of water clarity and photic zone during each reservoir water temperature profile collection. Secchi depth readings will be taken by lowering a Secchi disc over the shaded side of the boat until the disc is no longer visible from the boat. The disc will then be raised until visible, at which location the depth of the disc will be recorded in tenths of a foot, and the average of the two readings will be used as the water clarity reading for that location.

Step 5 – Install and Maintain Stream Temperature Loggers. Stream temperature loggers will be installed at the stream locations described in Step 2 for at least one year (i.e., 365 days) from the date they are installed. Installation is planned to occur in August 2017.

The stream water temperature recorders in the active flow channel will have 12-bit resolution, with a minimum accuracy of plus or minus 0.2^{o}C (i.e., onset or equivalent). Each stream recorder will be contained in a durable protective housing that permits the active flow of water in and around the unit, and will be placed at an appropriate depth to allow continuous recording during the entire 365 days. Each stream recorder 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 recorder will be secured in the channel during high flow periods without presenting a safety hazard to people or wildlife. The stream recorders will be installed in the channel thalweg, 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 recorder site, including installation configuration, will be taken. Each recorder will be set to record water temperature at 15-minute intervals.

Prior to installation, each recorder will be numbered and calibrated to the manufacturer's recommended specifications. Field crews will install a redundant water temperature recorder at each site. 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., "PC1") 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.

Loggers will be downloaded at least quarterly. During each visit, field crews 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 [Universal Serial Bus] "thumb drive"). Only after the raw water temperature data are safely backed-up will the optic shuttle be cleared or the data processed. In addition, during each site visit, crews will be prepared to replace or fix a recorder installation. Any recorder or optic shuttle that fails to download will be returned to the manufacturer for possible data recovery. Field crews will also check equipment

operation/calibration and remaining battery life, and will calibrate the instrument to manufacturer's specifications. After the recorder is removed from the water, it will be cleaned and visually inspected.

To prevent introduction and transmittal of amphibian chytrid fungus and invasive invertebrates (e.g., quagga mussels, zebra mussels and Asian clams) field crews will be trained on, provided with, and use materials (e.g., Quat) for decontaminating their boots, waders, and other equipment between water-based study sites. All boats used during the study will follow clean protocols, including inspections before and after use. All decontamination requirements in place at Project reservoirs will be strictly followed, including DWR's *SWP Rapid Response Plan for Zebra and Quagga Mussels* which includes a decontamination protocol using heat treatment and chemical solutions.

Quality Assurance and Quality Control

Field data will be collected in a manner that promotes high quality results, and will be subject to appropriate QA/QC procedures. The QAPP, developed in collaboration with the laboratory, will be followed during all field sampling. All water quality data will be verified and/or validated according to the laboratory's QA/QC procedures. The Licensees will subject all data to additional QA/QC procedures including, but not limited to: (1) spot-checks of transcription; (2) review of electronic data submissions for completeness; (3) graphical review of data to check for errors; (4) comparison of results to field blank and equipment rinsate results; and (5) identification of any data that seem inconsistent.

If any datum seems inconsistent during the QA/QC procedure, the Licensees will consult with the laboratory to identify any potential sources of error before concluding that the data is correct. Values that are determined to be anomalous will be removed from the analysis 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 in their unaltered state for future QA/QC reference and data modified in the final record will be so indicated in the record.

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 contaminated, the Licensees will identify the data accordingly.

Analysis

The Licensees will analyze the raw data relative to Los Angeles or Lahontan Basin Plan water quality objectives, as appropriate (California Regional Water Quality Control Board [RWQCB] Lahontan Region 1995 and California RWQCB Los Angeles Region

1994). Data will also be compared to historical data collected by the Licensees in similar locations.

Data collected during the stream temperature monitoring study will be summarized to show mean, minimum, and maximum daily temperatures for each water temperature monitoring location. Reservoir profiles will be plotted as water temperature versus water surface elevation. Additional data will be summarized in tabular formats.

Reporting

Water Quality and Temperature Study methods and results will be prepared and included, to the extent they have been completed for inclusion in the Licensees' ISR, USR, DLA, and FLA.

4.1.16.5 Consistency of Methodology with Generally Accepted Scientific Practices

The *Water Quality and Temperature Study* methods are generally consistent with the methods used for collecting water quality and temperature data in recent relicensing efforts in California, including for the Don Pedro Project (FERC No. 2299), Yuba River Development Project (FERC No. 2246) and Merced River Hydroelectric Project (FERC No. 2179).

4.1.16.6 Schedule

The *Water Quality and Temperature Study* will begin after FERC issues its Study Plan Determination. The Licensees anticipate the schedule below will be followed to complete the *Water Quality and Temperature Study*.

Fieldwork Preparation	July 2017 – August 2017
General Water Quality Sampling	August 2017 – October 2017
Reservoir Profiles	August 2017 – June 2018
Stream Temperature Loggers	August 2017 – August 2018
Data QA/QC	August 2017 – September 2018
Data Analysis and Reporting	June 2018 – December 2018

4.1.16.7 Level of Effort and Cost

Based on the work effort described above, the Licensees estimate the current cost to complete this *Water Quality and Temperature Study* will range between $80,000 and $120,000.

4.1.16.8 References

California RWQCB Lahontan Region. 1995. Water quality control plan for the Lahontan Region, North and South Basins. Plan effective March 31, 1995, amended through August 16, 2011. Available:

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