UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation **PacifiCorp**	**Project Nos. 14803-001; 2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT O

Water Quality Monitoring and Management Plan

(Amended December 15, 2021)

KLAMATH
RIVER RENEWAL
CORPORATION

Lower Klamath Project
FERC Project No. 14803

Water Quality Monitoring and Management Plan

Klamath River Renewal Corporation
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December 2021

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1.0 Introduction

The Lower Klamath Project (FERC No. 14803) consists of four hydroelectric developments on the Klamath River: J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate (Figure 1-1). Specifically, the reach between J.C. Boyle dam and Iron Gate dam is known as the Hydroelectric Reach. In September of 2016, the Klamath River Renewal Corporation (Renewal Corporation) filed an *Application for Surrender of License for Major Project and Removal of Project Works,* FERC Project Nos. 2082-063 & 14803-001 (License Surrender). The Renewal Corporation filed the License Surrender Application as the dam removal entity for the purpose of implementing the Klamath River Hydroelectric Settlement (KHSA). In November of 2020, the Renewal Corporation filed its Definite Decommissioning Plan (DDP) as Exhibits A-1 and A-2 to its Amended License Surrender Application (ALSA). The DDP is the Renewal Corporation's comprehensive plan to physically remove the Lower Klamath Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of adverse downstream impacts (Proposed Action). The Limits of Work is a geographic area that encompasses dam removal and restoration related activities associated with the Proposed Action. The Limits of Work may extend beyond the Federal Energy Regulatory Commission (Commission) boundary associated with the Lower Klamath Project where specifically noted.

The Proposed Action includes the deconstruction of the J.C. Boyle Dam and Powerhouse (Figure 1-2), Copco No. 1 Dam and Powerhouse (Figure 1-3), Copco No. 2 Dam and Powerhouse (Figure 1-4), and Iron Gate Dam and Powerhouse (Figure 1-5), as well as associated features. Associated features vary by development, but generally include powerhouse intake structures, embankments and sidewalls, penstocks and supports, decks, piers, gatehouses, fish ladders and holding facilities, pipes and pipe cradles, spillway gates and structures, diversion control structures, aprons, sills, tailrace channels, footbridges, powerhouse equipment, distribution lines, transmission lines, switchyards, original cofferdams, portions of the Iron Gate Fish Hatchery, residential facilities, and warehouses. Facility removal will be completed within an approximately 20-month period.

This Water Quality Monitoring and Management Plan identifies measures that the Renewal Corporation will implement to assess potential water quality impacts relating to implementation of the Proposed Action from the site of J.C. Boyle Dam to the Pacific Ocean. The Renewal Corporation has prepared 16 Management Plans for the Commission's review and approval as conditions of a License Surrender Order. These Management Plans were developed in consultation with federal, state, and county governments and tribes.

In February 2021, the Renewal Corporation filed the 16 Management Plans with the Commission. Since that time, the Renewal Corporation has undertaken further consultation, resulting in material revisions. Table 2-2 herein shows the material revisions to the February 2021 version of this Water Quality Monitoring and Management Plan. An updated Consultation Record for the Water Quality Monitoring and Management Plan is included as Appendix D.

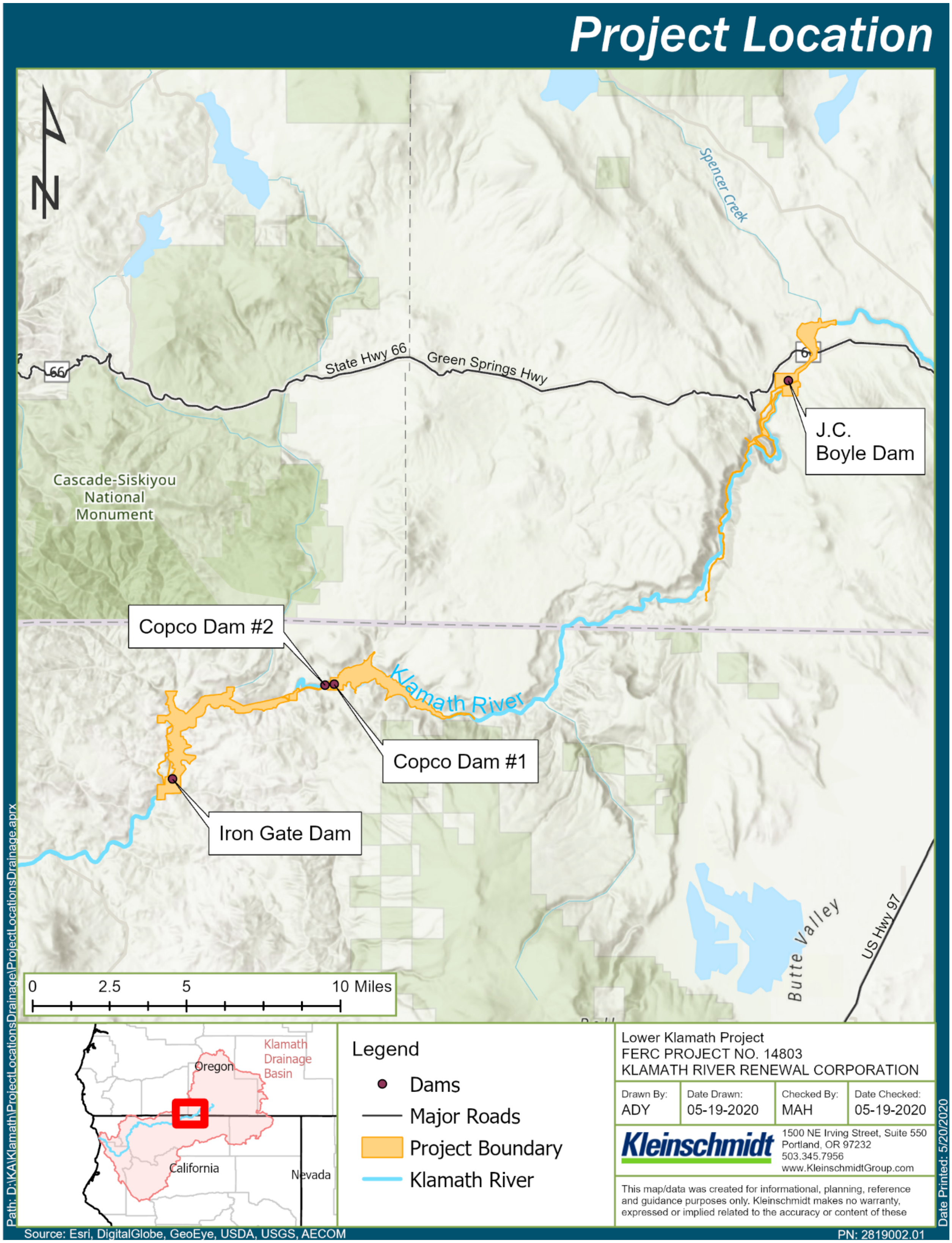
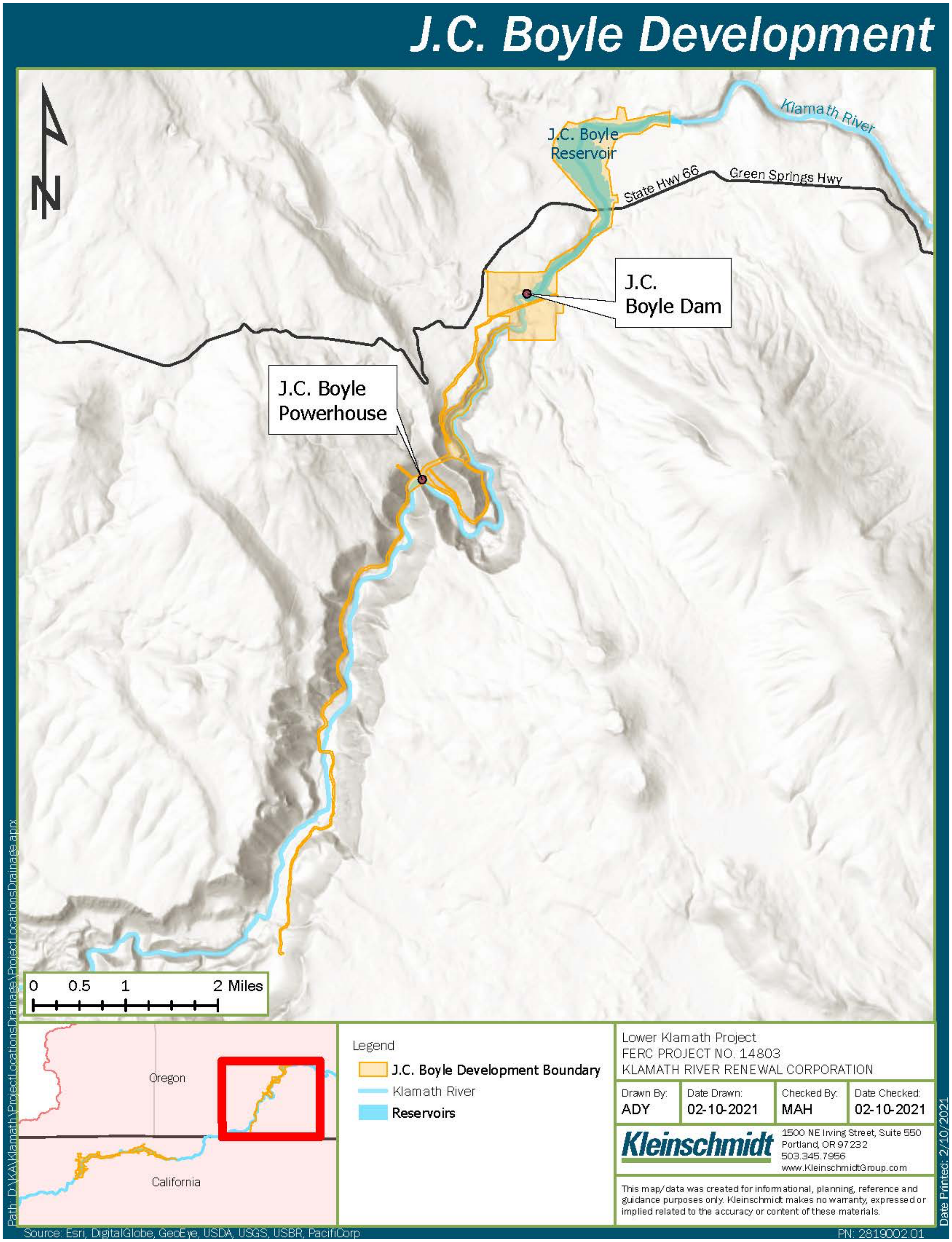


Figure 1-1. Lower Klamath Project Location



Source: Esri, DigitalGlobe, GeoEye, USDA, USGS, USBR, PacifiCorp

Figure 1-2. J.C. Boyle Development Facility Details

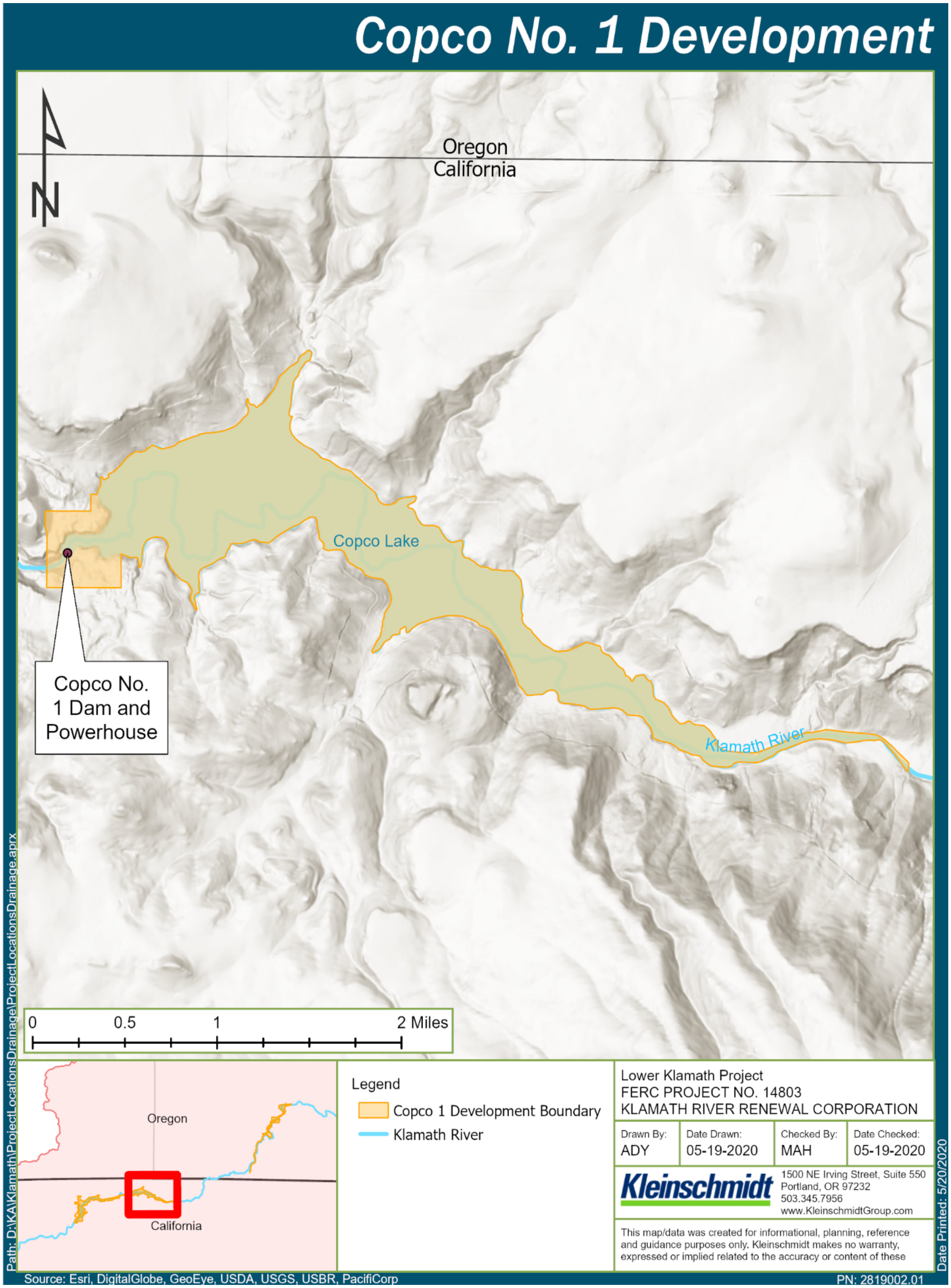


Figure 1-3. Copco No.1 Development Facility Details

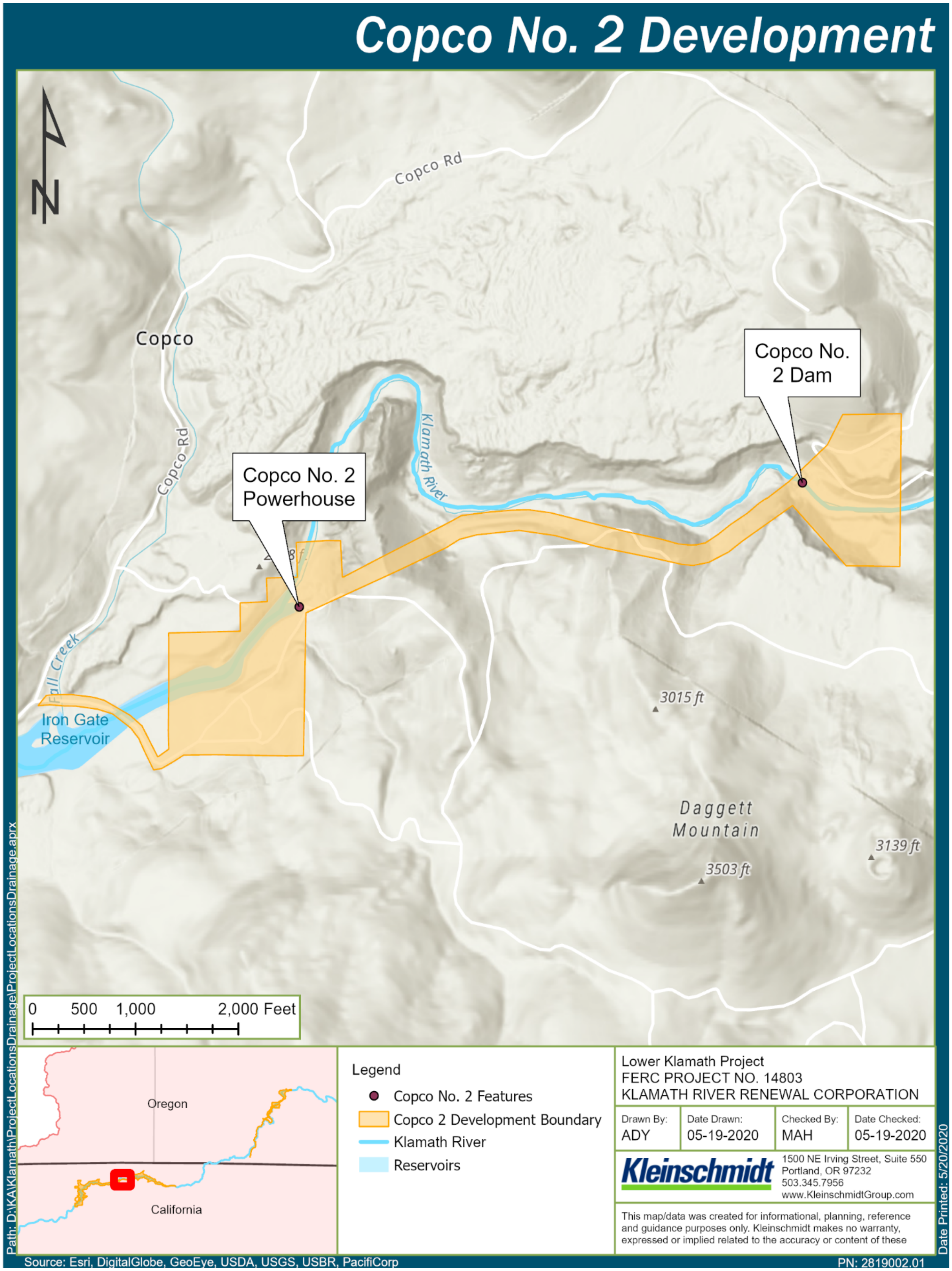


Figure 1-4. Copco No.2 Development Facility Details

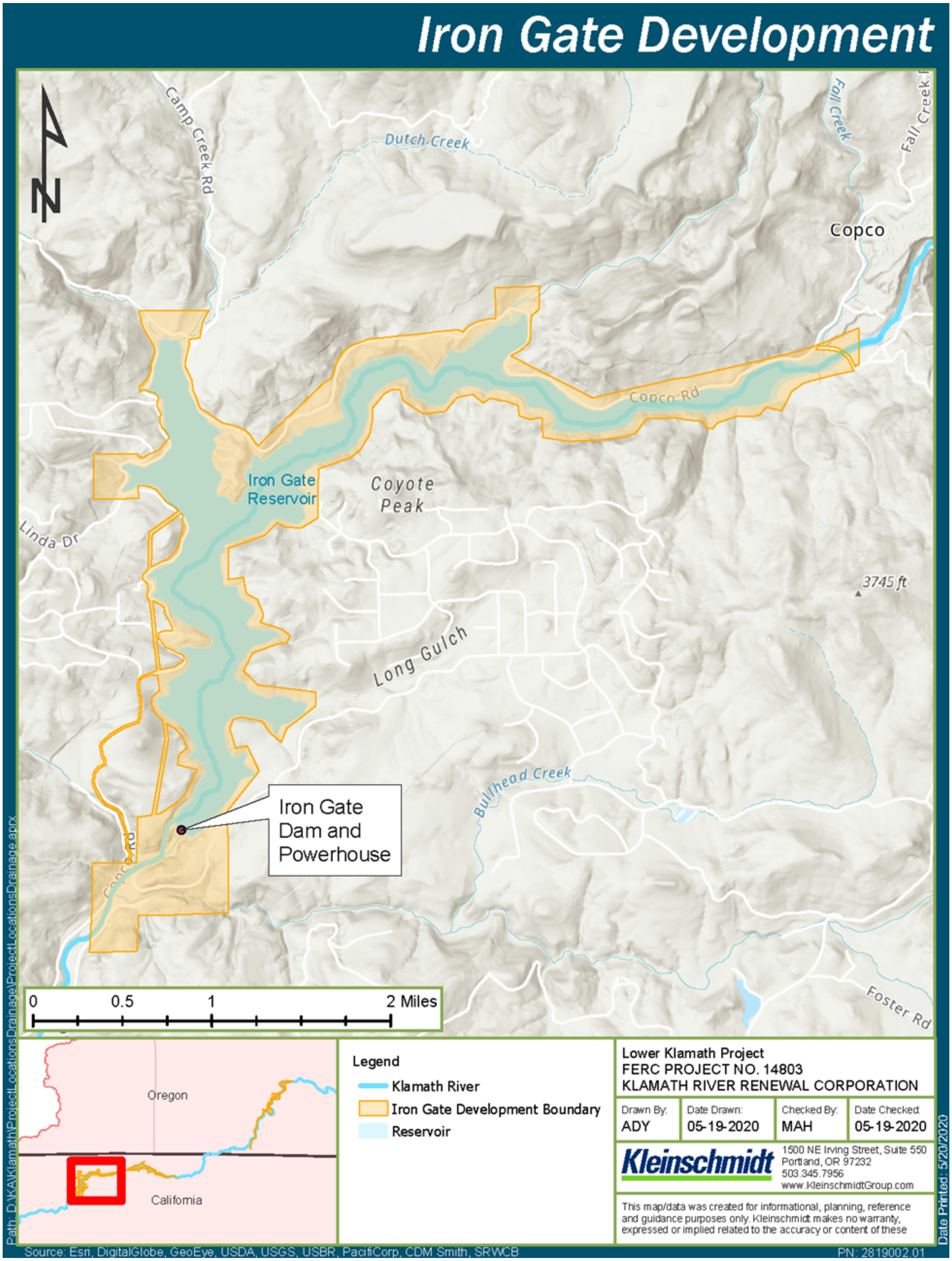


Figure 1-5. Iron Gate Development Facility Details

2.0 Regulatory Context

As described in Table 2-1, the Water Quality Monitoring and Management Plan is one of 16 Management Plans implementing the DDP.

Table 2-1. Lower Klamath River Management Plans

1. Aquatic Resources Management Plan
2. Construction Management Plan
3. Erosion and Sediment Control Plan
4. Hatcheries Management and Operations Plan
5. Health and Safety Plan
6. Historic Properties Management Plan
7. Interim Hydropower Operations Plan
8. Recreation Facilities Plan
9. Remaining Facilities Plan
10. Reservoir Area Management Plan
11. Reservoir Drawdown and Diversion Plan
12. Sediment Deposit Remediation Plan
13. Terrestrial and Wildlife Management Plan
14. Waste Disposal and Hazardous Materials Management Plan
15. Water Quality Monitoring and Management Plan
16. Water Supply Management Plan

2.1 Organizational Structure

The Water Quality Monitoring and Management Plan identifies measures that the Renewal Corporation will implement to assess potential water quality impacts relating to implementation of the Proposed Action. These proposed measures are part of the Proposed Action. Specifically, the Water Quality Monitoring and Management Plan includes two sub-plans, included amongst the Appendices identified below.

- Appendix A: Oregon Water Quality Management Plan
- Appendix B: California Water Quality Monitoring Plan
- Appendix C: Quality Assurance Project Plan
- Appendix D: Consultation Record

2.2 Specific Regulatory Interests

The Renewal Corporation considered the following regulatory interests in the development of the Water Quality Monitoring and Management Plan:

- California Section 401 Water Quality Certification
- Oregon Section 401 Water Quality Certification
- Oregon Memorandum of Understanding
- California Department of Fish and Wildlife Memorandum of Understanding

2.3 Results of Consultation since February 2021

The Renewal Corporation has revised the February 2021 version of this plan, on the basis of further consultation, in the following material respects.

Table 2-2. Results of Consultation

SUB-PLAN	CHANGES TO FEBRUARY 2021 VERSION
Appendix A: Oregon Water Quality Management Plan	• Monitoring objectives in relation to the objectives in the North Coast Basin Plan have been removed and replaced with a stated sampling purpose of confirming when exceedances of water quality standards caused by the Proposed Action have ceased.
Appendix B: California Water Quality Monitoring Plan	• The station upstream of Copco No. 1 Reservoir and downstream of Shovel Creek has been removed from the list of continuous water quality monitoring stations. • Monitoring objectives in relation to the objectives in the North Coast Basin Plan have been removed and replaced with a stated sampling purpose of confirming when exceedances of water quality standards caused by the Proposed Action have ceased.

2.4 Regulatory Approval

The Renewal Corporation will implement the Water Quality Monitoring and Management Plan as approved by the Commission in the License Surrender Order. The Renewal Corporation will obtain and report to the Commission any required approvals from other agencies.

2.5 Force Majeure

The Water Quality Monitoring and Management Plan includes metrics, objectives, and obligations that are dependent upon natural systems, which are inherently variable. Acts of God, natural disasters, flooding, fire, drought, labor shortages, and other events beyond the control of the Renewal Corporation (Force Majeure Event) may affect or delay compliance with a given obligation in the plan. If there is a Force Majeure Event, the Renewal Corporation will report to the Commission and SWRCB and/or ODEQ, as applicable, proposing a variance or other appropriate adjustment of the plan.

3.0 Reporting

By April 15 of each year, the Renewal Corporation will prepare and submit to the Commission an Annual Report which will include information pertaining to implementation of the Water Quality Monitoring and Management Plan.

Appendix A

Oregon Water Quality Management Plan

KLAMATH
RIVER RENEWAL
CORPORATION

Lower Klamath Project
FERC Project No. 14803

Oregon Water Quality Management Plan

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December 2021

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1.0 Introduction

The Oregon Water Quality Management Plan is a subplan of the Water Quality Monitoring and Management Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project. It has been developed in consultation with applicable state and local regulatory agencies. The Oregon Water Quality Management Plan may be modified before the License Surrender Order to reflect further consultation with the Oregon Department of Environmental Quality (ODEQ) and other applicable regulatory agencies.

For purposes of the Oregon Water Quality Management Plan, “Hydroelectric Reach” means the reach between the upstream end of J.C. Boyle Reservoir and Iron Gate Dam.

1.1 Purpose of Water Quality Management Plan

The purpose of the Oregon Water Quality Management Plan is to state the methodology and procedures the Klamath River Renewal Corporation (Renewal Corporation) will implement to evaluate water quality conditions in connection with the Proposed Action. Water quality will be evaluated through monitoring and sampling to determine the impacts of the Proposed Action on water quality in Oregon and to inform adaptive management actions for the protection of aquatic resources and the beneficial uses of the Klamath River in Oregon.

1.2 Relationship to Other Management Plans

The Oregon Water Quality Management Plan is supported by elements of the Reservoir Area Management Plan for effective implementation. So as to not duplicate information, elements from the Reservoir Area Management Plan are not repeated herein but are, where appropriate, referred to in this Oregon Water Quality Management Plan.

2.0 Background

2.1 Clean Water Act Section 303(d)

Several Klamath River reaches in Oregon are listed on the Clean Water Act Section 303(d) list of impaired water bodies. According to ODEQ, the reach between J.C. Boyle Dam and the California/Oregon border is listed for dissolved oxygen, temperature, and inorganic arsenic (ODEQ 2020). Portions of the reach above J.C. Boyle Dam, including J.C. Boyle Reservoir, are listed for ammonia, chlorophyll-a, dissolved oxygen, pH, and inorganic arsenic (ODEQ 2020).

2.2 KHSA Interim Measure 15 Monitoring

As part of the Klamath River Hydroelectric Settlement (KHSA), PacifiCorp is funding long-term baseline water quality monitoring of the Klamath River from Upper Klamath Lake to the Klamath River Estuary (Interim Measure 15 – Water Quality Monitoring (KHSA 2020)). The monitoring includes a combination of continuous water quality monitoring of physical water properties and discrete grab sampling for dissolved and suspended organic and inorganic constituents. Under this measure, twenty-two stations have been monitored from 2009 through the present including stations on the mainstem Klamath River, in the J.C. Boyle Reservoir, and at the mouths of four major tributaries (KHSA 2020). Several of the water quality parameters and stations are similar to those that will be monitored as part of this Oregon Water Quality Management Plan.

2.3 Sediment Transport in the Klamath River Watershed

An average of approximately 6,237,500 tons/year of sediment is delivered annually from the Klamath River to the ocean (SWRCB 2020). Per the California State Water Resources Control Board's Final Environmental Impact Report (EIR) for the Lower Klamath Project License Surrender (SWRCB 2020), the majority of this annual sediment delivery is contributed by three major tributaries downstream of the Hydroelectric Reach. The average delivery from Keno Dam to Iron Gate Dam is estimated to be approximately 150,000 tons/year, while the Scott River supplies approximately 607,000 tons/year, the Salmon River 320,000 tons/year, and the Trinity River 3,300,000 tons/year. These contributions change dramatically from year-to-year, with wet years contributing many times more sediment than dry years. The estimated total amount of sediment impounded behind the dams to be removed in connection with the Proposed Action (including the J.C. Boyle Dam) is approximately 3,600,000 tons (SWRCB 2020).

2.4 Impounded Sediment Analysis

An evaluation of sediment chemistry in J.C. Boyle Reservoir, Copco No. 1 Reservoir, and Iron Gate Reservoir was completed using samples collected in 2004-2005 and 2009-2010 (USDOI 2011).[1] The results of chemical analyses and toxicological bioassay procedures indicate that, if released, the impounded sediments from these three reservoirs will not pose a significant toxicological threat to the downstream environment (SWRCB 2020a). The Renewal Corporation also analyzed high-resolution bathymetric surveys conducted in 2002 and again in 2018 to estimate the total sediment volume in the reservoirs as well as the accumulation rate. Based on this analysis, J.C. Boyle Reservoir contains an estimated 1.19 million cubic yards of impounded sediment. The Renewal Corporation anticipates that 27 to 51 percent (320,000 to 607,000 cubic yards) of this sediment will erode as a result of the Proposed Action (SWRCB 2020). Based on these analyses, the United States Environmental Protection Agency (EPA) determined that the existing data are adequate to proceed with project permitting (EPA 2020).

3.0 Monitoring and Sampling Program

3.1 Continuous Water Quality Monitoring

The Renewal Corporation will deploy continuously recording data sondes at two stations along the mainstem of the Klamath River in Oregon. Each monitoring station will consist of a data sonde equipped with sensors.

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[1] Copco No. 2 Reservoir was not included in this evaluation since it is primarily a run of the river reservoir and, as a consequence, contains an immaterial amount of sediment.

3.1.1 Monitoring Locations

The location of each continuous monitoring station is listed here and is presented in Figure 3-1.

- Klamath River at United State Geological Survey (USGS) gage no. 11509500 (below Keno Dam)
- Klamath River at USGS gage no. 11510700 (below J.C. Boyle Dam)

3.1.2 Monitoring Parameters

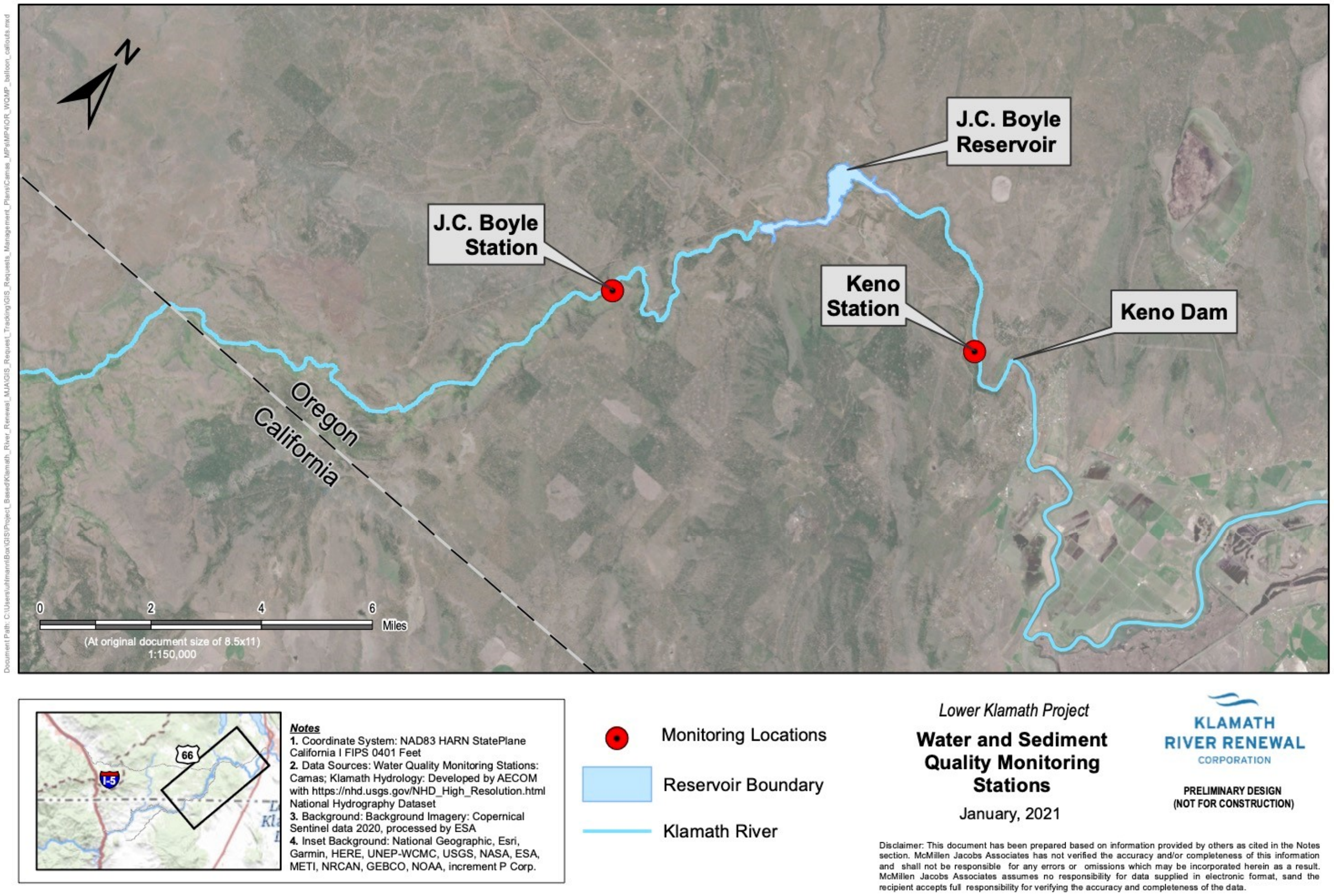
The Renewal Corporation will monitor the following parameters at each location presented in Section 3.1.1.

- Water Temperature
- Conductance
- pH
- Dissolved oxygen (concentration and percent saturation)
- Turbidity
- River flow

Each continuous monitoring station will have telemetry capabilities and the data will be transmitted and stored in an online database automatically. Each sonde will be powered from an external source and will record data at 15-minute intervals. The sensors will undergo the calibration and quality assessment/quality control measures set forth in the Quality Assurance Project Plan (QAPP), a subplan to the Water Quality Monitoring and Management Plan. The QAPP also contains data validation procedures, data interpretation procedures, technical specifications of the sondes, and contingency plans to avoid data gaps due to sensor damage, malfunction, power, or telemetry issues.

3.1.3 Monitoring Schedule and Frequency

The Renewal Corporation will initiate continuous monitoring at least one year prior to drawdown and will continue monitoring until the applicable regulatory agencies approve the Renewal Corporation’s request to discontinue monitoring as outlined in Section 3.3. Continuous water quality parameters will be recorded at 15-minute intervals.



Notes

1. Coordinate System: NAD83 HARN StatePlane California I FIPS 0401 Feet
2. Data Sources: Water Quality Monitoring Stations: Camas; Klamath Hydrology: Developed by AECOM with https://nhd.usgs.gov/NHD_High_Resolution.html National Hydrography Dataset
3. Background: Background Imagery: Copernical Sentinel data 2020, processed by ESA
4. Inset Background: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Lower Klamath Project

Water and Sediment Quality Monitoring Stations

January, 2021

PRELIMINARY DESIGN
(NOT FOR CONSTRUCTION)

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. McMillen Jacobs Associates has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. McMillen Jacobs Associates assumes no responsibility for data supplied in electronic format, sand the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 3-1. Water Quality Monitoring Stations

3.2 Water Quality Grab Sampling

The Renewal Corporation will collect and analyze water quality grab samples. The sampling locations, parameters, collection methods, laboratory analytical methods, and schedule are provided in the following sections.

3.2.1 Grab Sampling Locations

The locations of the water quality grab sampling stations are listed here and are presented in Figure 3-1. Each month, samples will be collected from as close to the same location as possible.

- Klamath River at or near USGS gage no. 11509500 (below Keno)
- Klamath River at or near USGS gage no. 11510700 (below J.C. Boyle)

3.2.2 Sampling Parameters

The Renewal Corporation will analyze water quality grab samples for the following parameters.

- Nitrogen: ammonia, nitrate, nitrite, total nitrogen
- Phosphorus: orthophosphate, organic phosphorus, total phosphorus
- Carbon: dissolved organic carbon, particulate carbon
- Chlorophyll-a
- Suspended sediment concentration

3.2.3 Grab Sample Collection Methods

The Renewal Corporation will use the sample collection methods described in the QAPP, a subplan to the Water Quality Monitoring and Management Plan. These collection methods are consistent with the California Surface Water Ambient Monitoring Program as well as protocols developed and published by the EPA, USGS and California State Water Resources Control Board (SWRCB). The Renewal Corporation will use California sampling protocols in Oregon to maintain consistency with the protocols used to collect samples in California.

3.2.4 Laboratory Analytical Methods

The Renewal Corporation will use the analytical methods described in the QAPP. These methods comply with Code of Federal Regulations, Title 40, Part 136 (40 CFR 136), or applicable methods approved under California's Environmental Laboratory Accreditation Program (ELAP) or Oregon's ELAP. Samples that require laboratory analysis will be analyzed by ELAP-certified laboratories.

3.2.5 Sampling Frequency and Schedule

The Renewal Corporation will initiate collection of water quality grab samples at least one year prior to drawdown and will continue until the applicable regulatory agencies approve the Renewal Corporation's request to discontinue monitoring as outlined in Section 3.3. The Renewal Corporation will collect grab samples monthly, other than suspended sediment concentration samples, which will be collected every two weeks through September of the drawdown year and monthly thereafter. The Renewal Corporation will attempt to collect the samples at approximately the same time of day each month.

3.3 Monitoring and Sampling Objectives and Schedule

The Proposed Action is anticipated to result in temporary exceedances of water quality standards. Pursuant to the Oregon Section 401 Water Quality Certification, ODEQ has established a compliance schedule that requires the temporary exceedances caused by the Proposed Action to end within 24 months of the completion of drawdown (ODEQ 2018).

The objective of the monitoring and sampling described above is to confirm that the anticipated temporary exceedances caused by the Proposed Action have ceased. In furtherance of this objective, the Renewal Corporation will conduct the continuous water quality monitoring described in Section 3.1 and the water quality grab sampling described in Section 3.2 for 48 months following the initiation of drawdown.

At or around the two-year anniversary of the completion of drawdown, the Renewal Corporation will prepare an assessment as to whether temporary exceedances caused by the Proposed Action are anticipated to continue beyond the two-year anniversary of the completion of drawdown. The assessment will be submitted to the Commission and ODEQ. In making its assessment, the Renewal Corporation will use all reasonably available data to evaluate and determine whether any of the monitoring parameters (e.g., water temperature, conductance, pH, dissolved oxygen, turbidity) exceed the levels that would have occurred in the absence of the Proposed Action. To make this determination, the Renewal Corporation will compare water quality data obtained pursuant to Section 3.1 (Continuous Water Quality Monitoring), Section 3.2 (Water Quality Grab Sampling), and Section 6.0 (Other Water Quality Project-Related Monitoring) with (1) pre-drawdown water quality data from the same or a similar location and (2) post-drawdown water quality data from upstream stations.[2] Water quality grab sample results for each station will be compared to the long-term distribution for that parameter at that station and for the month in which it was collected. If an exceedance exists that the Renewal Corporation does not believe is caused by the Proposed Action, the Renewal Corporation will provide data and other information in the assessment to demonstrate that the exceedance was not caused by the Proposed Action. If the assessment identifies a material, unexplained deviation from upstream values and/or baseline (i.e., pre-drawdown) conditions, the Renewal

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[2] The source waters of the Hydroelectric Reach, which flow from Keno Dam and the Upper Klamath Basin, are currently listed on the Clean Water Act Section 303(d) list of impaired water bodies. The water quality of these source waters is beyond the scope of the Water Quality Monitoring and Management Plan. The quality of these source waters as well as the actions of multiple other users outside of the Renewal Corporation's control will have a direct and material impact on downstream water quality. Since it is not the Renewal Corporation's obligation to ensure that the Klamath River comply with all water quality objectives, the application of numeric water quality objectives is inappropriate. The Renewal Corporation's only obligation is to ensure that water quality is no worse than it would have been in the absence of the Proposed Action. The satisfaction of this obligation is best demonstrated by comparing current water quality data with concurrent upstream values and/or baseline (i.e., pre-drawdown) conditions.

Corporation will investigate and consult with ODEQ and other regional water quality experts to determine the most likely cause, source and/or explanation for the deviation.

Independent of whether temporary exceedances caused by the Proposed Action are anticipated to continue beyond the two-year anniversary of the completion of drawdown, the Renewal Corporation will continue monitoring water quality under the Oregon Water Quality Management Plan for 48 months following the initiation of drawdown. The Renewal Corporation may submit a request to ODEQ at any time during the monitoring period to modify or reduce the duration or scope of water quality monitoring under the Oregon Water Quality Management Plan. The request will include supporting information and data. If the request is approved by ODEQ, the Renewal Corporation will file a report with the Federal Energy Regulatory Commission (Commission) within 14 calendar days, which will include a description of the request, the reasons for the request, the supporting information/data, and documentation of consultation with ODEQ.

The Renewal Corporation will prepare and submit a Final Compliance Report to ODEQ 48 months following the initiation of drawdown. The Final Compliance Report will include the following:

- Data and other information demonstrating that the temporary exceedances caused by the Proposed Action have ceased.
- A summary of the post-dam removal Klamath River water quality conditions following attenuation of the impacts associated with drawdown and the establishment of new riverine conditions.
- A summary of changes in water quality following drawdown, including an assessment of trends in water quality parameters.

The Final Compliance Report will also contain a request that the Renewal Corporation be permitted to discontinue all water quality monitoring under the Oregon Water Quality Management Plan. ODEQ is expected to consider the information provided by the Renewal Corporation in the Final Compliance Report when considering the Renewal's Corporation request to discontinue monitoring. If the request is approved by ODEQ, the Renewal Corporation will file a report with the Commission within 14 calendar days, which will include a copy of the Final Compliance Report and documentation of consultation with ODEQ.

3.4 Adaptive Management

If the assessment described in Section 3.3 indicates a high likelihood that an exceedance caused by the Proposed Action will continue beyond the two-year anniversary of the completion of drawdown, the Renewal Corporation will immediately consult with ODEQ to determine whether an adaptive management plan is required to address the anticipated exceedance(s). If so, the Renewal Corporation will promptly develop, in consultation with ODEQ, an adaptive management plan that will be submitted to ODEQ for review and approval. Once approved, the Renewal Corporation will file a report with the Commission within 14 calendar days, which will include a copy of the adaptive management plan and documentation of consultation with ODEQ. The adaptive management plan will include the following information:

- Description and location of each exceedance
- Explanation of why each exceedance continues to occur more than 24 months after the completion of drawdown
- Description of actions taken by the Renewal Corporation to-date to address each exceedance.
- Proposal to address the exceedance as well as a timeline for the cessation of all exceedances caused by the Proposed Action.

If there are outlier exceedances, adaptive management may not be necessary so long as the Renewal Corporation demonstrates that such exceedances are localized, isolated, and/or unrelated to the Proposed Action. In addition, ODEQ may not require the Renewal Corporation to implement adaptive management measures under the Oregon Water Quality Management Plan if the Renewal Corporation demonstrates that it is addressing the exceedances identified in the assessment through adaptive management measures implemented under the Reservoir Area Management Plan.

3.5 Reporting

The Renewal Corporation will submit an Annual Compliance Report to ODEQ by April 1 for the preceding calendar year. The Annual Compliance Report will present, summarize, and interpret the water quality data and will include:

- Monitoring data including graphical representations, as appropriate, that clearly demonstrates trends and relationships.
- Records documenting required consultations and/or approvals.
- Narrative interpretation of results.
- Compliance evaluations.
- Data obtained in connection with the turbidity monitoring described in Section 4.0 (Turbidity Monitoring for Significant Interventions).
- Data regarding sediment movement obtained in connection with the sediment survey mapping described in Section 5.0 (Sediment Load Quantification).

Upon receipt and review of an Annual Compliance Report, ODEQ may, at its discretion, discontinue the requirement to monitor certain water quality parameters as warranted by water quality conditions. The Renewal Corporation will continue to submit Annual Compliance Reports until ODEQ approves its request to discontinue all water quality monitoring under the Oregon Water Quality Management Plan.

In addition, prior to, during, and for a minimum of one year following completion of drawdown, the Renewal Corporation will submit monthly monitoring reports to the Commission, ODEQ, SWRCB, and the North Coast Regional Water Quality Control Board. The Renewal Corporation will submit reports containing all available data collected under the Water Quality Monitoring and Management Plan within the reporting period, but some data may be reported two- and three-months following data collection to allow for laboratory analysis, data post-processing, and reporting by the analytical laboratory. To expedite report preparation and data transmittal, monthly reports will be submitted in two phases. The Initial Monthly Report will be submitted by the 15th day of the following month for continuous water quality monitoring data. When grab sample results become available, the initial report will be updated with those data and renamed the Final Monthly Report. The Renewal Corporation will continue to submit monthly monitoring reports until the applicable regulatory agencies approve its request to discontinue all water quality monitoring under the California Water Quality Monitoring Plan.

4.0 Turbidity Monitoring for Significant Interventions

The Renewal Corporation will conduct fish passage monitoring in Oregon under the Reservoir Area Management Plan and the Fish Passage Permit issued by the Oregon Department of Fish and Wildlife. If a significant intervention (as defined in the Reservoir Area Management Plan) is required following the two-year anniversary of the completion of drawdown, the Renewal Corporation will conduct turbidity monitoring approximately 100 feet upstream and 300 feet downstream of the fish passage barrier during the significant intervention.

5.0 Sediment Load Quantification

5.1 Method to Quantify Sediment within Reservoir Footprints

The Renewal Corporation calculated sediment quantities for J.C. Boyle Reservoir utilizing high-resolution bathymetric surveys conducted in 2002 and 2018 (SWRCB 2020). The volume of sediment that accumulated between these two surveys was used to estimate annual sediment deposition within the reservoir, and this annual load estimate was used to quantify how much sediment has accumulated since the 2018 survey in order to calculate the total sediment volume in J.C. Boyle Reservoir in 2020 (SWRCB 2020).

5.2 Method to Quantify Sediment Exporting Reservoir Footprints

Following drawdown, the Renewal Corporation will conduct sediment survey mapping at J.C. Boyle Reservoir via drones or other high-resolution remote sensing methods. The Renewal Corporation will compare the 2018 bathymetric survey to the post-drawdown drone data to evaluate the reduction in the volume of sediment within the reservoir footprint. Sediment shrinkage will be accounted for using the shrinkage factor of 60% assumed and presented in the Definite Plan Report (KRRC 2018).

6.0 Other Water Quality Project-Related Monitoring

The Renewal Corporation may conduct additional water quality monitoring in connection with the Proposed Action. For informational purposes, this Section 4.0 contains the following list of additional water quality monitoring that may be conducted in Oregon.

- **Construction Site Turbidity Monitoring**: For details regarding turbidity monitoring conducted in connection with certain construction activities (including the rehabilitation of the J.C. Boyle scour hold and powerhouse tailrace), see the Erosion and Sediment Control Plan (1200-C ESCP) developed by the Renewal Corporation in connection with the Oregon NPDES General Permit No. 1200-C issued by ODEQ.

- **Recreation Areas Water Quality Monitoring:** For details regarding water quality monitoring conducted in connection with recreation areas, see the Recreation Facilities Plan and the 1200-C ESCP.

7.0 References

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Appendix B

California Water Quality Monitoring Plan

KLAMATH
RIVER RENEWAL
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Lower Klamath Project
FERC Project No. 14803

California Water Quality Monitoring Plan

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1.0 Introduction

The California Water Quality Monitoring Plan is a subplan of the Water Quality Monitoring and Management Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project. It has been developed in consultation with applicable state and local regulatory agencies. The California Water Quality Monitoring Plan may be modified before the License Surrender Order to reflect further consultation with the State Water Resources Control Board (SWRCB) and other applicable regulatory agencies.

For purposes of the California Water Quality Monitoring Plan, “Hydroelectric Reach” means the reach between the upstream end of J.C. Boyle Reservoir and Iron Gate Dam.

1.1 Purpose of Water Quality Monitoring Plan

The purpose of the California Water Quality Monitoring Plan is to state the methodology and procedures the Klamath River Renewal Corporation (Renewal Corporation) will implement to evaluate water quality conditions in connection with the Proposed Action. Water quality will be evaluated through monitoring and sampling to determine the impacts of the Proposed Action on water quality and to inform adaptive management actions for the protection of aquatic resources and the beneficial uses of the Klamath River.

1.2 Relationship to Other Management Plans

The California Water Quality Monitoring Plan is supported by elements of the Reservoir Area Management Plan for effective implementation. So as to not duplicate information, elements from the Reservoir Area Management Plan are not repeated herein but are, where appropriate, referred to in this California Water Quality Monitoring Plan.

2.0 Background

2.1 Clean Water Act Section 303(d)

The Klamath River downstream of the California-Oregon state line, including the reservoirs within the Hydroelectric Reach, is listed on the Clean Water Act Section 303(d) list of impaired water bodies. According to the California State Water Resources Control Board (SWRCB), the Klamath River from the Oregon border to the Pacific Ocean is listed for nutrients, dissolved oxygen, and temperature. In addition, Iron Gate Reservoir and Copco No. 1 Reservoir are listed for mercury and microcystin, the Klamath River from Copco No. 1 Reservoir to the Trinity River is listed for microcystin, the Klamath River from the Trinity River to the Pacific Ocean is listed for sediment, and the Klamath River from Iron Gate Dam to the Scott River is listed for aluminum (SWRCB 2018).

2.2 KHSA Interim Measure 15 Monitoring

As part of the Klamath River Hydroelectric Settlement (KHSA), PacifiCorp is funding long-term baseline water quality monitoring of the Klamath River from Upper Klamath Lake to the Klamath River Estuary (Interim Measure 15 – Water Quality Monitoring (KHSA 2020)). The monitoring includes a combination of continuous water quality monitoring of physical water properties and discrete grab sampling for dissolved and suspended organic and inorganic constituents. Under this measure, twenty-two stations have been monitored from 2009 through the present including stations on the mainstem Klamath River, in the reservoirs, and at the mouths of four major tributaries (KHSA 2020). Several of the water quality parameters and stations are similar to those that will be monitored as part of this California Water Quality Monitoring Plan.

2.3 Sediment Transport in the Klamath River Watershed

An average of approximately 6,237,500 tons/year of sediment is delivered annually from the Klamath River to the ocean (SWRCB 2020a). Per the Final Environmental Impact Report (EIR) for the Lower Klamath Project License Surrender (SWRCB 2020a), the majority of this annual sediment delivery is contributed by three major tributaries downstream of the Hydroelectric Reach. The average delivery from Keno Dam (Oregon) to Iron Gate Dam is estimated to be approximately 150,000 tons/year, while the Scott River supplies approximately 607,000 tons/year, the Salmon River 320,000 tons/year, and the Trinity River 3,300,000 tons/year. These contributions change dramatically from year-to-year, with wet years contributing many times more sediment than dry years. The estimated total amount of sediment impounded behind the dams to be removed is approximately 3,600,000 tons (SWRCB 2020a).

2.4 Impounded Sediment Analysis

An evaluation of sediment chemistry in J.C. Boyle Reservoir, Copco No. 1 Reservoir, and Iron Gate Reservoir was completed using samples collected in 2004-2005 and 2009-2010 (USDOI 2011).[1] As stated in the EIR, the results of chemical analyses and toxicological bioassay procedures indicate that, if released, the impounded sediments from these three reservoirs will not pose a significant toxicological threat to the downstream environment (SWRCB 2020a). The Renewal Corporation analyzed high-resolution bathymetric surveys conducted in 2002 and again in 2018 to estimate the total sediment volume in the reservoirs as well as the accumulation rate. Based on these analyses, the United States Environmental Protection Agency (EPA) determined that the existing data are adequate to proceed with project permitting (EPA 2020).

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[1] Copco No. 2 Reservoir was not included in this evaluation since it is primarily a run of the river reservoir and, as a consequence, contains an immaterial amount of sediment.

3.0 Monitoring and Sampling Program

3.1 Continuous Water Quality Monitoring

The Renewal Corporation will deploy a series of continuously recording data sondes at stations along the mainstem of the Klamath River. The Renewal Corporation chose the exact location of each of the stations based on a number of factors, including proximity to existing/historical sensor locations, site access, land use, input received during the consultation process, and the potential of a location to determine the source(s) of any water quality impacts during implementation of the Proposed Action. Each monitoring station will consist of a data sonde equipped with sensors.

3.1.1 Monitoring Locations

The locations of the continuous monitoring stations are listed here and are presented in Figure 3-1.

- Klamath River at United State Geological Survey (USGS) gage no. 11509500 (below Keno Dam)
- Klamath River at USGS gage no. 11510700 (below J.C. Boyle Dam)
- Klamath River downstream of Copco No. 2 Powerhouse, no further downstream than the Daggett Road bridge crossing of the Klamath River
- Klamath River at USGS gage no. 11516530 (below Iron Gate Dam)
- Klamath River at or near Walker Bridge
- Klamath River at USGS gage no. 11520500 (below Seiad Valley)
- Klamath River at USGS gage no. 11523000 (Orleans)
- Klamath River at USGS gage no. 11530500 (Klamath)
- Klamath Estuary near the mouth of the Klamath River

3.1.2 Monitoring Parameters

The Renewal Corporation will monitor the following parameters at each location presented in Section 3.1.1.

- Water Temperature
- Conductance
- pH
- Dissolved oxygen (concentration and percent saturation)
- Turbidity

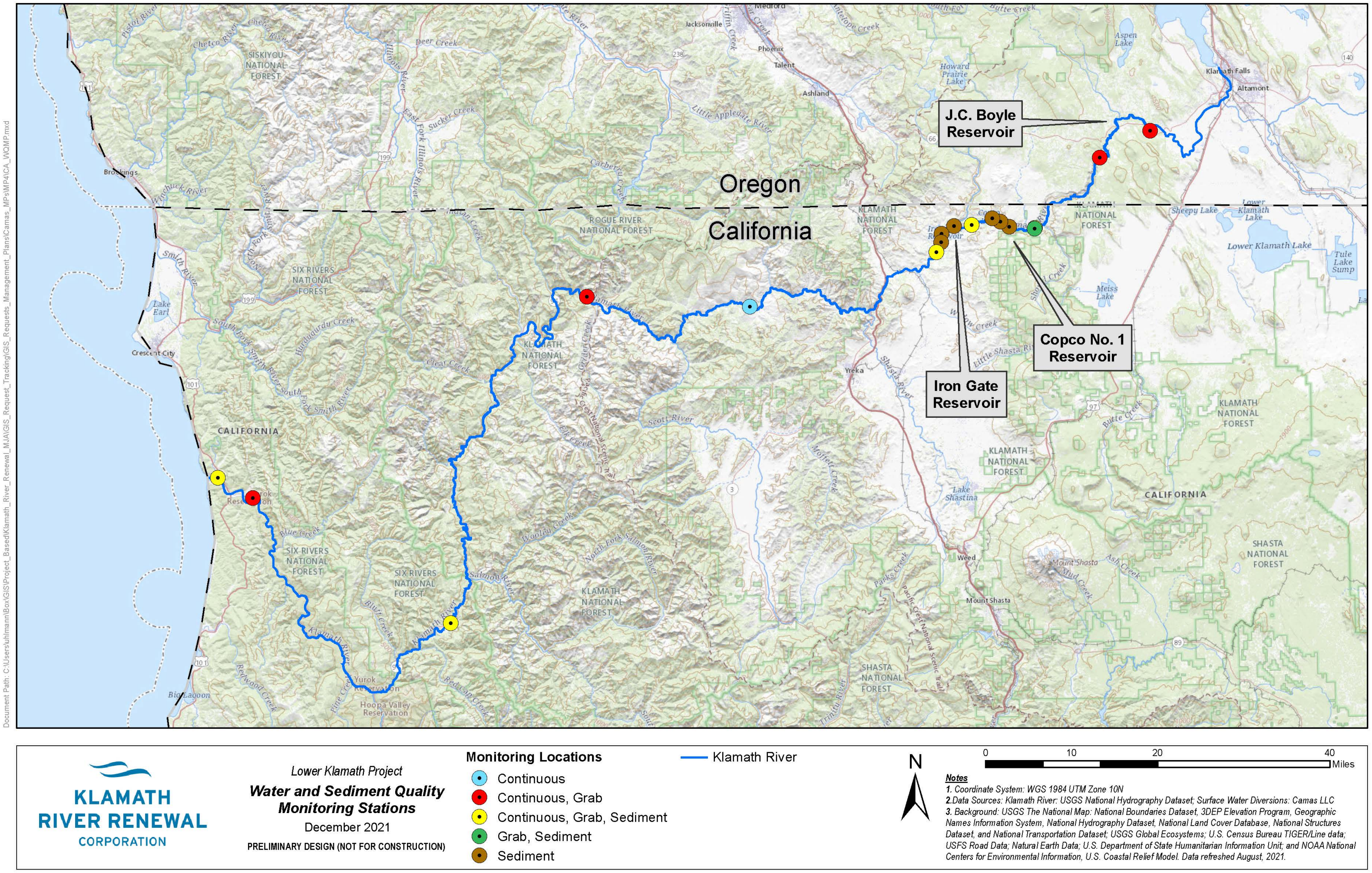
Each sonde will record data at 15-minute intervals and the sensors will undergo the calibration and quality assessment/quality control measures set forth in the Quality Assurance Project Plan (QAPP), a subplan of the Water Quality Monitoring and Management Plan. The QAPP also contains technical specifications of the sondes and contingency plans to avoid data gaps due to sensor damage, malfunction, power, or telemetry issues.

The six continuous monitoring stations associated with USGS gages (see Section 3.1.1) will have telemetry capabilities and the data will be transmitted and stored in an online database automatically. The sondes at these stations will be powered from an external source.

The remaining three continuous monitoring stations not associated with a USGS gage (see Section 3.1.1) will log data internally but will not transmit the data automatically to the online database. Renewal Corporation staff will manually download data from these stations during the monthly collection of water quality grab sample (see Section 3.2). The sondes deployed at these stations will have data logging capabilities and will be equipped with internal batteries. The capacity of the data logger and batteries is sufficient to collect data on 15-minute intervals for up to 90 days, but the data will be retrieved monthly and batteries will be changed every two months. If the battery status on the interim monthly visit indicates lower than expected battery levels, the batteries will be changed at that time.

3.1.3 Monitoring Schedule and Frequency

The Renewal Corporation will initiate continuous monitoring at least one year prior to drawdown and will continue monitoring until the applicable regulatory agencies approve the Renewal Corporation’s request to discontinue monitoring as outlined in Section 3.4. Continuous water quality parameters will be recorded at 15-minute intervals.



Notes

1. Coordinate System: WGS 1984 UTM Zone 10N

2.Data Sources: Klamath River: USGS National Hydrography Dataset; Surface Water Diversions: Camas LLC

3. Background: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. McMillen Jacobs Associates has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. McMillen Jacobs Associates

Figure 3-1. Water Quality Monitoring Stations

3.2 Water Quality Grab Sampling

The Renewal Corporation will collect and analyze water quality grab samples. The sampling locations, parameters, collection methods, laboratory analytical methods, and schedule are provided in the following sections.

3.2.1 Grab Sampling Locations

The locations of the water quality grab sampling stations are listed here and are presented in Figure 3-1. Each month, samples will be collected from as close to the same location as possible.

- Klamath River at or near USGS gage no. 11509500 (below Keno)
- Klamath River at or near USGS gage no. 11510700 (below J.C. Boyle)
- Klamath River upstream of Copco No. 1 Reservoir, and downstream of Shovel Creek
- Klamath River downstream of Copco No. 2 Powerhouse, no further downstream than the Daggett Road bridge crossing of the Klamath River
- Klamath River at or near USGS gage no. 11516530 (below Iron Gate)
- Klamath River at or near USGS gage no. 11520500 (below Seiad Valley)
- Klamath River at or near USGS gage no. 11523000 (Orleans)
- Klamath River at or near USGS gage no. 11530500 (Klamath)
- Klamath Estuary near the mouth of the Klamath River

3.2.2 Sampling Parameters

The Renewal Corporation will analyze water quality grab samples for the following parameters.

- Total Nitrogen
- Nitrate
- Nitrite
- Ammonia
- Total Phosphorus
- Particulate Organic Phosphorus
- Orthophosphate
- Particulate Organic Carbon
- Dissolved Organic Carbon
- Chlorophyll-A (Beginning May 1 following the initiation of drawdown activities and continuing annually from May 1 through October 31)
- Turbidity
- Microcystin (Beginning May 1 following the initiation of drawdown activities and continuing annually from May 1 through October 31)
- Suspended Sediment Concentrations
- Methylmercury (Only at Klamath River Monitoring Locations Below Copco No. 1)
- Settleable Solids

- Particulate and Dissolved Aluminum (only at Klamath River monitoring locations downstream of Iron Gate)

3.2.3 Grab Sample Collection Methods

The Renewal Corporation will use the sample collection methods described in the QAPP, a subplan of the Water Quality Monitoring and Management Plan. These collection methods are consistent with the California Surface Water Ambient Monitoring Program (SWAMP) as well as protocols developed and published by the EPA, USGS and California State Water Resources Control Board (SWRCB).

3.2.4 Laboratory Analytical Methods

The Renewal Corporation will use the analytical methods described in the QAPP. These methods comply with Code of Federal Regulations, Title 40, Part 136, or applicable methods approved under California's Environmental Laboratory Accreditation Program (ELAP) or Oregon's ELAP. Samples that require laboratory analysis will be analyzed by ELAP-certified laboratories.

3.2.5 Sampling Frequency and Schedule

The Renewal Corporation will initiate collection of water quality grab samples at least one year prior to drawdown and will continue until the applicable regulatory agencies approve the Renewal Corporation's request to discontinue monitoring as outlined in Section 3.4. The Renewal Corporation will collect grab samples monthly, other than suspended sediment concentration samples, which will be collected every two weeks following the initiation of drawdown. The Renewal Corporation will attempt to collect the samples at approximately the same time of day each month.

3.3 Sediment Grab Samples

In addition to water quality sampling, the Renewal Corporation will collect and analyze sediment grab samples. The sampling locations, parameters, collection methods, laboratory analytical methods, and schedule are provided in the following sections.

3.3.1 Sampling Locations

The locations of sediment chemistry grab sampling stations are listed here and are presented in Figure 3-1. When sampling, the Renewal Corporation will target slow velocity depositional areas (e.g., eddies and backwaters) where fine sediment accumulation is most likely to occur. Sampling points for locations not associated with USGS stream gages will mirror as closely as possible those used in the 2011 Sediment Chemistry Investigation by the U.S. Department of Interior Bureau of Reclamation (USBR, 2011).

- Klamath River upstream of Copco No. 1 Reservoir and downstream of Shovel Creek.

- Three locations in the Copco No. 1 Reservoir footprint, in areas where sediments will likely be terraced. If terracing does not occur at the previously sampled location, the sample location will be moved to a location with terraced sediments.
- Klamath River downstream of Copco No. 2 Powerhouse, no farther downstream than the Daggett Road bridge crossing of the Klamath River.
- Three locations in the Iron Gate Reservoir footprint, in areas where sediments will likely be terraced. If terracing does not occur at the previously sampled location, the sample location will be moved to a location with terraced sediments.
- Klamath River at or near USGS gage no. 11516530 (below Iron Gate).
- Klamath River at or near USGS gage no. 11523000 (Orleans).
- Klamath Estuary.

3.3.2 Sampling Parameters

The sediment grab samples will be analyzed for the following parameters.

- Arsenic
- Lead
- Copper
- Nickel
- Iron
- Aluminum
- Dioxin
- Cyanide
- Mercury
- Ethyl Benzenes
- Total Xylenes
- Dieldrin
- 4,4’-dichlorodiphenyltrichloroethane (DDT)
- 4,4’-dichlorodiphenyldichloroethane (DDD)
- 2,3,7,8-tetrachlorodibenzodioxin (TCDD)
- 4,4’-dichlorodiphenyldichloroethylene (DDE)
- 2,3,4,7,8-pentachlordibenzofuran (PECDF)

3.3.3 Sample Collection Methods

The Renewal Corporation will use the sample collection methods described in the QAPP, a subplan of the Water Quality Monitoring and Management Plan. These collection methods are consistent with the SWAMP as well as protocols developed and published by the EPA, USGS and SWRCB.

3.3.4 Laboratory Analytical Methods

The Renewal Corporation will use the analytical methods described in the QAPP. These methods comply with Code of Federal Regulations, Title 40, Part 136, or methods approved by California's ELAP, where such methods are available. Samples that require laboratory analysis will be analyzed by ELAP-certified laboratories.

3.3.5 Sampling Frequency and Schedule

The USBR conducted sediment sampling of the reservoirs and Klamath Estuary in 2009 and 2010 (SWRCB 2020a). In lieu of sampling the Klamath Estuary and locations in the Copco No. 1 Reservoir footprint and Iron Gate Reservoir footprint prior to drawdown, the Renewal Corporation will rely on the data collected by USBR in 2009 and 2010, which provides pre-drawdown sediment chemistry data for the reservoirs and estuary. With respect to the four Klamath River stations listed below, the Renewal Corporation will collect sediment grab samples prior to drawdown.

- Klamath River upstream of Copco No. 1 Reservoir and downstream of Shovel Creek.
- Klamath River downstream of Copco No. 2 Powerhouse, no farther downstream than the Daggett Road bridge crossing of the Klamath River.
- Klamath River at or near USGS gage no. 11516530 (below Iron Gate).
- Klamath River at or near USGS gage no. 11523000 (Orleans).

The Renewal Corporation will also collect sediment grab samples once from all locations listed in Section 3.3.1 (Figure 3-1) within the period 12 to 24 months following completion of drawdown activities.

3.4 Monitoring and Sampling Schedule

The Proposed Action is anticipated to result in temporary exceedances of water quality standards related to sediment and other parameters. Pursuant to the California Section 401 Water Quality Certification, such temporary exceedances can occur during and following reservoir drawdown and dam removal in connection with restoration projects like the Proposed Action (SWRCB 2020a). Per the EIR, the main sediment-related water quality impacts from the Proposed Action are anticipated to end within 10 months of the completion of drawdown (SWRCB 2020b).

The purpose of the monitoring and sampling described above is to confirm that the anticipated temporary exceedances caused by the Proposed Action have ceased. In furtherance of this purpose, the Renewal Corporation will conduct the continuous water quality monitoring described in Section 3.1 and the water quality grab sampling described in Section 3.2 for 36 months following the initiation of drawdown. The Renewal Corporation may submit a request to the SWRCB at any time during the monitoring period to modify or reduce the duration or scope of water quality monitoring under the California Water Quality Monitoring Plan. The request will include supporting information and data. If the request is approved by the SWRCB, the Renewal Corporation will file a report with the Federal Energy Regulatory Commission (Commission) within 14 calendar days, which will include a description of the request, the reasons for the request, the supporting information/data, and documentation of consultation with the SWRCB.

At or around 32 months following the initiation of drawdown, the Renewal Corporation will prepare an assessment as to whether temporary exceedances caused by the Proposed Action are anticipated to continue beyond the three-year anniversary of the initiation of drawdown. The assessment will be submitted to the Commission, the SWRCB, the North Coast Regional Water Quality Control Board (RWQCB) and the Hoopa Tribe. In making its assessment, the Renewal Corporation will use all reasonably available data to evaluate and determine whether any of the monitoring parameters (e.g., water temperature, conductance, pH, dissolved oxygen, turbidity) exceed the levels that would have occurred in the absence of the Proposed Action. To make this determination, the Renewal Corporation will compare water quality data obtained pursuant to Sections 3.1 through 3.3 and Section 4.0 (Other Water Quality Project-Related Monitoring) with (1) pre-drawdown water quality data from the same or a similar location and (2) post-drawdown water quality data from upstream stations.[2] For the latter, water quality grab sample results for each station will be compared to the long-term distribution for that parameter at that station and for the month in which it was collected. If an exceedance exists that the Renewal Corporation does not believe is caused by the Proposed Action, the Renewal Corporation will provide data and other information in the assessment to demonstrate that the exceedance was not caused by the Proposed Action.

If there is a material, unexplained deviation from upstream values and/or baseline (i.e., pre-drawdown) conditions, the Renewal Corporation will investigate and consult with the SWRCB, RWQCB, and other regional water quality experts to determine the most likely cause, source and/or explanation.

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[2] The source waters of the Hydroelectric Reach, which flow from Keno Dam and the Upper Klamath Basin, are currently listed on the Clean Water Act Section 303(d) list of impaired water bodies. The water quality of these source waters is beyond the scope of the Water Quality Monitoring and Management Plan. The quality of these source waters as well as the actions of multiple other users outside of the Renewal Corporation's control will have a direct and material impact on downstream water quality. Since it is not the Renewal Corporation's obligation to ensure that the Klamath River comply with all water quality objectives, the application of numeric water quality objectives is inappropriate. The Renewal Corporation's only obligation is to ensure that water quality is no worse than it would have been in the absence of the Proposed Action. The satisfaction of this obligation is best demonstrated by comparing current water quality data with concurrent upstream values and/or baseline (i.e., pre-drawdown) conditions.

If the temporary exceedances caused by the Proposed Action are not anticipated to extend beyond the three-year anniversary of the initiation of drawdown, the Renewal Corporation will prepare and submit a report to the SWRCB that includes the following:

- Data and other information demonstrating that the temporary exceedances caused by the Proposed Action have ceased.
- A summary of the post-dam removal Klamath River water quality conditions following attenuation of the impacts associated with drawdown and the establishment of new riverine conditions.
- A summary of changes in water quality following drawdown, including an assessment of trends in water quality parameters.
- An evaluation of the Proposed Action's impacts on all California portions of the Klamath River (i.e., from the California/Oregon border to the Klamath Estuary).

The report will also contain a request that the Renewal Corporation be permitted to discontinue all water quality monitoring under the California Water Quality Monitoring Plan. The SWRCB is expected to consider the information provided by the Renewal Corporation in both its assessment and report when considering the Renewal's Corporation request to discontinue monitoring. If there are outlier exceedances, the SWRCB may still approve the request to discontinue monitoring so long as the Renewal Corporation demonstrates that such exceedances are localized, isolated, and/or unrelated to the Proposed Action. In addition, the SWRCB may discontinue monitoring under the California Water Quality Monitoring Plan, subject to the Renewal Corporation addressing the localized or isolated exceedances through adaptive management measures implemented under the Reservoir Area Management Plan. If the request is approved by the SWRCB, the Renewal Corporation will file a report with the Commission within 14 calendar days, which will include a copy of the report and documentation of consultation with the SWRCB.

If non-localized or non-isolated exceedances are anticipated beyond the three-year anniversary of the initiation of drawdown, water quality monitoring will continue, and the Renewal Corporation will prepare and submit the compliance proposal described in Section 3.5.

3.5 Adaptive Management

If the assessment described in Section 3.4 indicates a high likelihood that an exceedance caused by the Proposed Action will continue beyond the three-year anniversary of the initiation of drawdown, the Renewal Corporation will immediately begin developing, in consultation with the SWRCB and RWQCB, a compliance proposal for actions to address the anticipated exceedance(s). The compliance proposal will include the following information:

- Description and location of each exceedance
- Explanation of why each exceedance continues to occur more than 32 months after the initiation of drawdown
- Description of actions taken by the Renewal Corporation to-date to address each exceedance

- Proposal to address the exceedance as well as a timeline for the cessation of all exceedances caused by the Proposed Action.

The Renewal Corporation will submit the report and proposal to the SWRCB for review and approval no later than 35 months following the initiation of drawdown activities. Once approved, the Renewal Corporation will file a report with the Commission within 14 calendar days, which will include a copy of the compliance proposal and documentation of consultation with the SWRCB and RWQCB.

If the Renewal Corporation is unable to demonstrate that all temporary exceedances caused by the Proposed Actions have ceased within 36 months of the initiation of drawdown, the Renewal Corporation will notify the Commission and SWRCB and immediately begin implementation of the portions of the compliance proposal that have previously been approved by the SWRCB and filed with the Commission. As soon as it can demonstrate that the adaptive management measures have caused the relevant exceedance(s) to cease, the Renewal Corporation can prepare and submit the report described in Section 3.4 that (among other things) requests that the Renewal Corporation be permitted to discontinue all water quality monitoring under the California Water Quality Monitoring Plan.

3.6 Reporting

Prior to, during, and for a minimum of one year following completion of drawdown, the Renewal Corporation will submit monthly monitoring reports to the Commission, SWRCB, Oregon Department of Water Quality, and the RWQCB. The Renewal Corporation will submit reports containing all available data collected within the reporting period, but some data may be reported two- and three-months following data collection to allow for laboratory analysis, data post-processing, and reporting by the analytical laboratory. To expedite report preparation and data transmittal, monthly reports will be submitted in two phases. The Initial Monthly Report will be submitted by the 15th day of the following month for continuous water quality monitoring data. When water and sediment grab sample results become available, the initial report will be updated with those data and renamed the Final Monthly Report. The Renewal Corporation will continue to submit monthly monitoring reports until the applicable regulatory agencies approve its request to discontinue all water quality monitoring under the California Water Quality Monitoring Plan.

The Renewal Corporation will include the following information in the monthly monitoring reports.

- A summary of the results of the month’s monitoring, including continuous water quality monitoring, water quality grab samples, and any sediment grab sampling that was completed within the reporting period.
- A Microsoft Excel spreadsheet containing all data collected during the reporting period.
- Highlights of any temporary exceedances caused by the Proposed Action.
- Highlights of observed trends.

- Reporting on any adaptive management measures taken and proposals of any additional or substitute adaptive management measures to address exceedances caused by the Proposed Action.

4.0 Other Water Quality Project-Related Monitoring

The Renewal Corporation may conduct additional water quality monitoring in connection with the Proposed Action. For informational purposes, this Section 4.0 contains the following list of additional water quality monitoring that may be conducted.

- **Recreation Areas Water Quality Monitoring:** For details regarding water quality monitoring conducted in connection with recreation areas, see the Recreation Facilities Plan.

- **Crescent City Harbor Water Quality Monitoring**: For details regarding sediment transport monitoring conducted in the Pacific Ocean and Crescent City Harbor, see the Del Norte Sediment Management Plan.

- **Fall Creek Fish Hatchery Water Quality Monitoring**: For details regarding water quality monitoring conducted in connection with the Fall Creek Fish Hatchery, see the Hatcheries Management and Operations Plan.

- **City of Yreka Water Pipeline Water Quality Monitoring**: For details regarding water quality monitoring conducted in connection with the City of Yreka water pipeline, see the California Public Drinking Water Management Plan.

- **Construction Site Turbidity Monitoring**: For details regarding turbidity monitoring conducted in connection with certain construction activities, see the Stormwater Pollution Prevention Plan (SWPPP) developed by the Renewal Corporation in connection with the California NPDES Construction General Permit issued by the RWQCB.

5.0 Sediment Load Quantification

5.1 Method to Quantify Sediment within Reservoir Footprints

The Renewal Corporation calculated sediment quantities for Copco No. 1 Reservoir and Iron Gate Reservoir utilizing high-resolution bathymetric surveys conducted in 2002 and 2018 (SWRCB 2020a). The volume of sediment that accumulated between these two surveys was used to estimate annual sediment deposition within the reservoirs, and this annual load estimate was used to quantify how much sediment has accumulated since the 2018 survey and calculate the total sediment volume in the reservoirs in 2020 (SWRCB 2020a). As described in Section 2.7.3 of the EIR, Copco No. 2 Reservoir does not contain accumulated sediment deposits and was not included in the sediment accumulation quantification (SWRCB 2020a).

5.2 Method to Quantify Sediment Exporting Reservoir Footprints

Following drawdown, the Renewal Corporation will conduct sediment survey mapping at each reservoir via drones or other high-resolution remote sensing methods. The Renewal Corporation will compare the 2018 bathymetric surveys to the post-drawdown drone data to evaluate the reduction in the volume of sediment within the reservoir footprints. Sediment shrinkage will be accounted for using the shrinkage factor of 60% assumed and presented in the Definite Plan Report (KRRC 2018), with the exception of Copco No.2, which was shown to contain no reservoir sediment.

5.3 Method to Quantify Sediment between Iron Gate and Cottonwood Creek

The Renewal Corporation conducted a bathymetric survey for the reach of the Klamath River between Iron Gate Dam and Cottonwood Creek in 2018 and will conduct additional bathymetric surveys in the same reach 12 months and 24 months following drawdown. The Renewal Corporation will compare post-drawdown bathymetric survey results to the 2018 bathymetry to evaluate the amount of sediment that may have settled in this reach as a result of drawdown activities.

5.4 Reporting

The Renewal Corporation will prepare and submit reports to the Commission and SWRCB 15 months and 27 months after completion of drawdown that describe the status of the sediment movement 12 months and 24 months, respectively, following completion of drawdown. The data and information in the reports will be collected for informational purposes only and is unrelated to the water quality monitoring and sampling efforts described in Section 3.0 (Monitoring and Sampling Program). The reports will include the following information:

- Amount of sediment present in each reservoir footprint.
- Total amount of sediment exported from the reservoirs.
- Amount of sediment that has settled in the Klamath River between Iron Gate Dam and Cottonwood Creek (River Mile 185).

The amount of sediment present and exported from the reservoirs will be presented in million cubic yards, tons (dry weight), and percentage of sediment compared to total amount of sediment present prior to drawdown. The amount of sediment settled will be presented as total estimated quantities in million cubic yards, tons (dry weight), average depth change from pre-drawdown conditions, and percent particle size composition.

6.0 References

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Appendix C

Quality Assurance Project Plan

Klamath River Renewal Corporation
Water Quality Monitoring Network for the Klamath River Renewal Project

Water Quality Sampling and Analysis
Quality Assurance Project Plan

December 2021

KLAMATH
RIVER RENEWAL
CORPORATION

USGS
science for a changing world

PROJECT TITLE: Water Quality Monitoring for the Lower Klamath River Project

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EFFECTIVE DATE: January 1 of the year prior to drawdown to Program End

VERSION: 02

PREFACE: SWAMP-compliant QAPP for Klamath River water quality monitoring at nine continuous monitoring stations, water quality grab sampling at nine locations, and sediment grab sampling at 11 locations in connection with the Lower Klamath River Project. This document was produced using the SWAMP-EPA Review Checklist.

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____Date________

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Appendix C	Quality Assurance Plan for the Analysis of Fluvial Sediment by the USGS California Water Center Science Center Sediment Laboratory

Distribution List

The final Quality Assurance Project Plan (QAPP) will be kept on file by the Karuk Tribe Water Program, Yurok Tribe Environmental Program, Resource Environmental Solutions (RES), and the United States Geological Survey (USGS). The following individuals (Table 1) will receive copies of the approved QAPP and any subsequent revisions. Field personnel will have a copy of the QAPP and Health and Safety Plan (HSP) during all field activities.

Table 1. Distribution list.

Title	Contact Information
Darrell Smolko **RES** **Project Manager**	22 Battery Street, Suite 508 San Francisco, CA 94111 Mobile: (510) 910-0916 dsmolko@res.us
Laura Hazlett **KRRC** **Chief Operations Officer and Chief Financial Officer**	2001 Addison Street, Suite 317 Berkeley, CA 94704 Mobile: (510) 679-6928 lhazlett@klamathrenewal.org
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Chauncey Anderson **USGS** **KRRP Monitoring Site & Sediment Monitoring Coordinator**	2130 SW 5th Avenue Portland, OR 97201 Office: (503) 251-3206 chauncey@usgs.gov
Mathieu Marineau **USGS – California** **Program QA/QC Officer & Monitoring Team Leader**	USGS California Water Science Center 6000 J Street, Placer Hall Sacramento 95819 Office: (916) 278-3179
Liam Schenk **USGS – Oregon** **Monitoring Team Leader**	2795 Anderson Avenue, Suite 106 Klamath Falls, Oregon 97603 Office: (541) 273-8689 x208 lschenk@usgs.gov
Alex Etheridge **USGS** **QA/QC and Program Data Manager**	6000 J Street, Placer Hall Sacramento, CA 95819 Office: (916) 995-0784 aetherid@usgs.gov
Dennis O'Halloran **USGS** **QA/QC**	6000 J Street, Placer Hall Sacramento, CA 95819 Office: (916) 278-3168 Mobile: (530) 412-0578 dohall@usgs.gov

Title	Contact Information
Grant Johnson **Karuk Tribe Water Program** **WQ Monitoring Team Coordinator & Monitoring Team Lead**	P.O. Box 282 Orleans, CA 95556 Office: (530) 469-3258 gjohnson@karuk.us
Matt Hanington **Yurok Tribe Environmental Program** **Monitoring Team Leader & QA/QC**	15900 Hwy 101 N P.O. Box 1027 Klamath, CA 95548 Office: (707) 482-1822 ext. 1002 Mobile: (707) 954-7519 mhanington@yuroktribe.nsn.us
Duncan Ocel **Sprague River Water Quality Laboratory** **Klamath Tribes Laboratory Director**	5671 Sprague River Hwy. Chiloquin, OR 97624 Office: (541) 827-5231 Duncan.Ocel@Klamathtribes.com
Stephen Low **USGS Sediment Lab** **Lab Manager**	2885 Mission Street Santa Cruz, CA 95060 Office: (831) 460-7500 stephlow@usgs.gov

A. Project Description

A.1 Project Organization

A.1.1 Key Individual and Responsibilities

Resource Environmental Solutions, LLC (RES) is a prime consultant to the Klamath River Renewal Corporation ("Renewal Corporation") for the Project and is managing the implementation of the California Water Quality Monitoring Plan and the Oregon Water Quality Management Plan (together, the WQMPs). As collaborators and partners with the Renewal Corporation, the Project Water Quality Management Team is comprised of RES, the Karuk Tribe, the Yurok Tribe, the Klamath Tribes, USGS, and certified laboratories. The Project Water Quality Management Team will complete data collection activities, process laboratory samples and continuous data, manage the program and contracts, and develop all regulatory reporting documents. The Sprague River Water Quality Laboratory operated by the Klamath Tribes and located in Chiloquin, Oregon will perform chemical and biological analyses of the water samples. The USGS Sediment Laboratory (USL) located in Santa Cruz, CA will perform suspended sediment concentration (SSC) analysis of the water samples. Grab sediment analyses will be performed by Eurofins Test America Laboratory in West Sacramento, CA. In support of the development of this QAPP, Camas has provided regulatory compliance oversight and reviewed all documents and plans related to the requirements within the California and Oregon 401 Water Quality Certifications for the Project.

The key individuals involved in all major aspects of the Project, including contractors, are set forth in Table 2, which also includes their responsibilities. Figure 1 provides an organizational chart that shows lines of authority and reporting responsibilities.

Table 2. Personnel, contact information, and responsibilities.

Program Team Member	Contact Information	Responsibility
Program Management/Administration		
Laura Hazlett KRRC	(510) 679-6928 lhazlett@klamathrenewal.org	Chief Operations Officer
Darrell Smolko RES	(510) 910-0916 dsmolko@res.us	Project Manager
Water Quality Monitoring Team		
Grant Johnson Karuk Tribe Water Program	(530) 469-3258 gjohnson@karuk.us	WQ Monitoring Team Coordinator & Karuk Tribe Monitoring Team Leader
Chauncey Anderson, USGS	(503) 251-3206 chauncey@usgs.gov	KRRP Monitoring Site & Sediment Monitoring Coordinator
Mathieu Marineau USGS - California	(916) 278-3179 mmarineau@usgs.gov	USGS California Monitoring Team Leader

Program Team Member	Contact Information	Responsibility
Liam Schenk, USGS - Oregon	(541) 273-8689 ext. 208 lschenk@usgs.gov	USGS Oregon Monitoring Team Leader
Matt Hanington, Yurok Tribe Environmental Program	(707) 482-1822 ext. 1002 mhanington@yuroktribe.nsn.us	Yurok Tribe Monitoring Team Leader
Tim Reed USGS California	(530) 246-5282 treed@usgs.gov	USGS California Field Manager
Marc Stewart USGS Oregon	(541) 776-4258 mastewar@usgs.gov	USGS Oregon Field Manager
Kassandra Grim Yurok Tribe Environmental Program	(707) 482-1822 ext. 1003 kgrimm@yuroktribe.nsn.us	Yurok Tribe Field Manager
Quality Assurance/Quality Control		
Mathieu Marineau USGS - California	(916) 278-3179 mmarineau@usgs.gov	Program QA/QC Officer
John R Oberholzer Dent Karuk Tribe Water Program	(530) 469-3258 joberholzerdent@karuk.us	Karuk Tribe QA/QC
Alex Etheridge, USGS	(916) 995-0784 aetherid@usgs.gov	USGS QA/QC – Sondes
Denis O'Halloran, USGS	(916) 278-3168 dohall@usgs.gov	USGS QA/QC - Sediment
Matt Hanington, Yurok Tribe Environmental Program	(707) 482-1822 ext. 1002 mhanington@yuroktribe.nsn.us	Yurok Tribe QA/QC
Laboratory Manager		
Stephen Low, USGS Sediment Laboratory	(831) 460-7500 stephlow@usgs.gov	Oversee USL analysis of SCC samples
Duncan Ocel Sprague River Water Quality Laboratory	Duncan.Ocel@Klamathtribes.com (541) 827-5231	Klamath Tribes Laboratory Director
Nathan Horner Eurofins Test America	(916) 374-4306 Nathaniel.horner@eurofinset.com	Project Manager
Data Manager		
Alex Etheridge USGS	(916) 995-0784 aetherid@usgs.gov	Monitoring Data Management and Validation

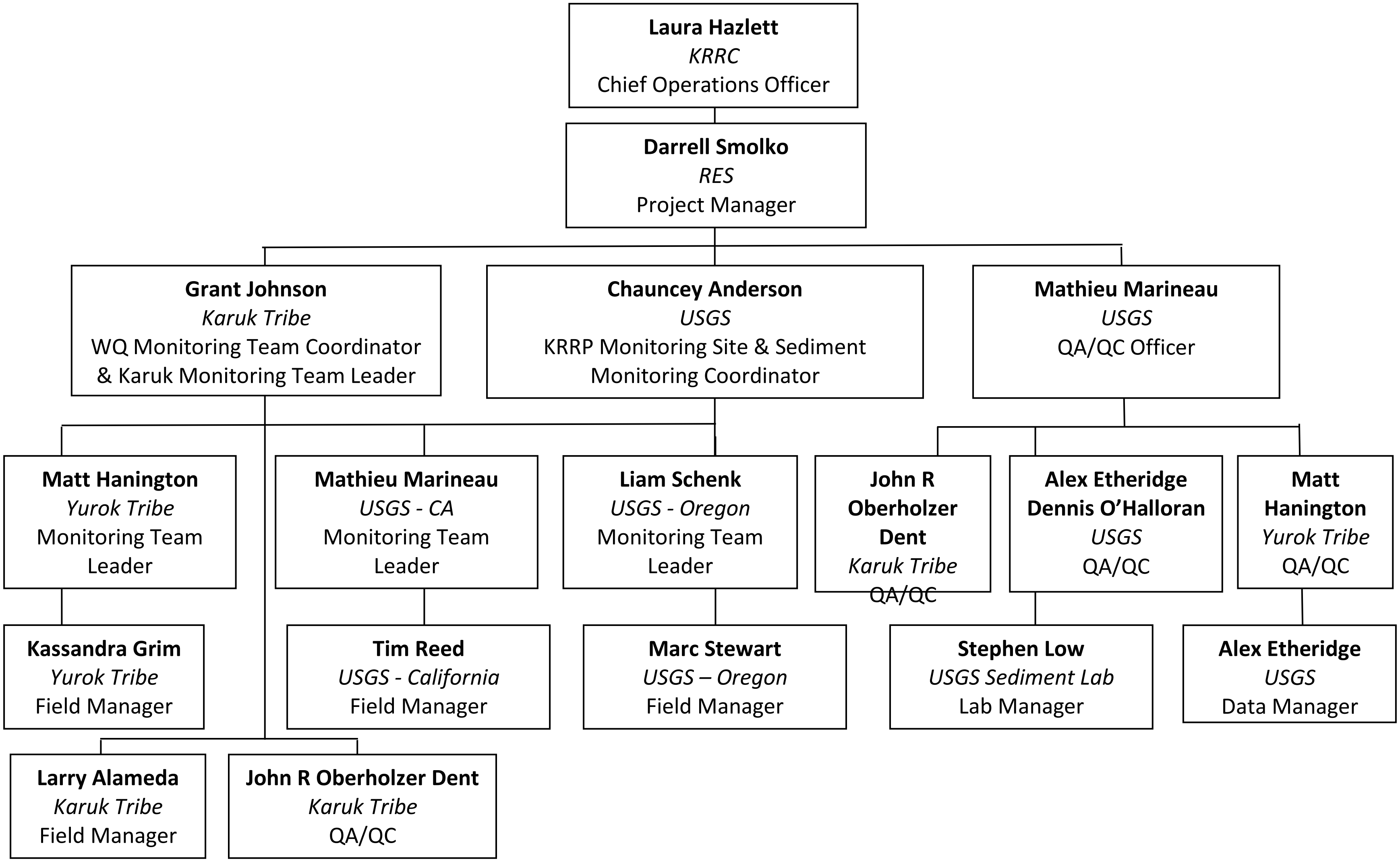

Figure 1. Organizational chart.

A.1.2 Project Quality Assurance Officer

The Quality Assurance/Quality Control (QA/QC) Officer role is independent of data generation. This individual's role is to establish the QA/QC procedures found in this QAPP as part of the sampling, field analysis, and laboratory analysis procedures (Figure 1). The QA/QC Officer will also work with the laboratory managers by communicating all quality assurance and quality control issues contained in this QAPP. The QA/QC Officer will also review and assess all procedures during the life of this project against QAPP requirements. The QA/QC Officer will report all findings to the Water Quality Project Manager including all requests for corrective action. The QA/QC Officer may stop all actions, including those conducted by subcontractors, if there are significant deviations from required practices or if there is evidence of a systematic failure.

A.2 Project Background

The Lower Klamath Project (Project) (FERC No. 14803) consists of four hydroelectric developments on the Klamath River: J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate. Specifically, the reach between J.C. Boyle dam and Iron Gate dam is known as the Hydroelectric Reach. In September of 2016, the Renewal Corporation filed an *Application for Surrender of License for Major Project and Removal of Project Works,* FERC Project Nos. 2082-063 & 14803-001 (License Surrender). The Renewal Corporation filed the License Surrender Application as the dam removal entity for the purpose of implementing the Klamath River Hydroelectric Settlement (KHSA). In November of 2020, the Renewal Corporation filed its Definite Decommissioning Plan (DDP) as Exhibits A-1 and A-2 to its Amended License Surrender Application (ALSA). The DDP is the Renewal Corporation's comprehensive plan to physically remove the Lower Klamath Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of adverse downstream impacts (Proposed Action). The Limits of Work is a geographic area that encompasses dam removal related activities associated with the Proposed Action. The Limits of Work may extend beyond the Federal Energy Regulatory Commission (Commission) boundary associated with the Project where specifically noted.

The Proposed Action includes the deconstruction of the J.C. Boyle Dam and Powerhouse, Copco No. 1 Dam and Powerhouse, Copco No. 2 Dam and Powerhouse, and Iron Gate Dam and Powerhouse, as well as associated features. Associated features vary by development, but generally include powerhouse intake structures, embankments, and sidewalls, penstocks and supports, decks, piers, gatehouses, fish ladders and holding facilities, pipes and pipe cradles, spillway gates and structures, diversion control structures, aprons, sills, tailrace channels, footbridges, powerhouse equipment, distribution lines, transmission lines, switchyards, original cofferdams, portions of the Iron Gate Fish Hatchery, residential facilities, and warehouses. Facility removal will be completed within an approximately 20-month period.

The WQMPs identify the methodology and procedures the Renewal Corporation will implement to evaluate water quality conditions in connection with the Proposed Action. Water quality will be evaluated through monitoring and sampling to determine the impacts of the Proposed Action on water quality and to inform adaptive management actions for the protection of aquatic resources and the beneficial uses of the Klamath River.

The WQMPs are being implemented by the Renewal Corporation in accordance with the Oregon Clean Water Act (CWA) Section 401 Water Quality Certification (OR 401 WQC) issued by the Oregon Department of Environmental Quality (ODEQ 2018) and the California CWA Section 401 Water Quality Certification (CA 401 WQC) issued by the California State Water Resources Control Board (SWRCB 2020b). The purpose of this QAPP is to describe the Project's monitoring goals, data needs and assessment, responsible individuals, quality assurance plan, equipment maintenance, quality control measures, and reporting deadlines. This QAPP reflects conditions stated within the OR 401 WQC and CA 401 WQC.

A.3 Project Summary

A.3.1 Geographic Setting

The Klamath River flows 257 miles through Oregon and California to the Pacific Ocean and is the second largest river in California by discharge. It originates in the high desert of south-central Oregon and moves through the Klamath Mountains. Figure 2 shows the overall geographic location of water quality stations, grab water locations, and grab sediment locations. Nine continuous monitoring stations, nine grab water locations, and 11 grab sediment locations were selected to characterize water and sediment quality conditions from below Keno Dam to the Klamath River estuary.

Monitoring site locations were determined based on a number of facors, including proximity to existing/historical sensor locations, site access, land use, input received during the consultation process, and the potential of a location to determine the source(s) of any water quality impacts during implementation of the Proposed Action. Six existing USGS stream gage sites along the mainstem of the Klamath River within California and Oregon are being utilized to conduct continuous water quality monitoring. Three additional continuous monitoring sites will be established leading up to reservoir drawdown. Grab water and grab sediment locations were selected with respect to the above considerations. The location of the water quality stations, grab water sites, and grab sediment sites are provided in Table 3 and Figure 2.

A.3.2 Summary of Work to be Performed

Under this QAPP, four types of water quality monitoring will be conducted: continuous water quality monitoring, water quality grab sampling, and sediment grab sampling. The types of monitoring to be conducted at each location are outlined in Table 3. Parameters (Table 4) will be analyzed depending on the type of sampling conducted. All information collected under this QAPP is critical for the Project and there are no collections outlined below that are for informational purposes only.

Stations

Figure 2. Map showing water quality sampling locations.

Table 3. Sampling locations and the associated type(s) of water quality monitoring to be conducted.

Sampling Location	Continuous Monitoring	Water Quality Grab Sampling	Sediment Grab Samples
Klamath River at or near USGS gage no. 11509500 (below Keno)	X	X	
Klamath River at or near USGS gage no. 11510700 (below J.C. Boyle)	X	X	
Klamath River upstream of Copco No. 1 Reservoir, and downstream of Shovel Creek		X	X
Three locations in the Copco No. 1 Reservoir footprint, in areas where sediments will likely be terraced.[1]			X
Klamath River downstream of Copco No. 2 Powerhouse, no further downstream than the Daggett Road bridge crossing of the Klamath River	X	X	X
Three locations in the Iron Gate Reservoir footprint, in areas where sediments will likely be terraced.1			X
Klamath River at or near USGS gage no. 11516530 (below Iron Gate)	X	X	X
Klamath River at or near Walker Bridge	X		
Klamath River at or near USGS gage no. 11520500 (below Seiad Valley)	X	X	
Klamath River at or near USGS gage no. 11523000 (Orleans)	X	X	X
Klamath River at or near USGS gage no. 11530500 (Klamath)	X	X	
Klamath Estuary near the mouth of the Klamath River	X	X	X

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[1] If terracing does not occur at the previously sampled location, the sample location will be moved to a location with terraced sediments.

Table 4. Parameters to be monitored under the three different monitoring types under this QAPP.

Continuous Monitoring	Water Quality Grab Sampling	Sediment Grab Sampling
• Temperature • Conductivity • pH • Dissolved oxygen (concentration and percent saturation) • Turbidity	• Total Nitrogen • Nitrate • Nitrite • Ammonia • Total Phosphorus • Particulate Organic Phosphorus • Orthophosphate • Particulate Organic Carbon • Dissolved Organic Carbon • Chlorophyll-A • Turbidity • Microcystin • Suspended Sediment Concentration • Methylmercury • Settleable Solids • Particulate and Dissolved Aluminum	• Arsenic • Lead • Copper • Nickel • Iron • Aluminum • Dioxin • Cyanide • Mercury • Ethyl Benzenes • Total Xylenes • Dieldrin • 4,4’-dichlorodiphenyltrichloroethane (DDT) • 4,4’-dichlorodiphenyldichloroethane (DDD) • 2,3,7,8-tetrachlorodibenzodioxin (TCDD) • 4,4’-dichlorodiphenyldichloroethylene (DDE) • 2,3,4,7,8-pentachlordibenzofuran (PECDF)

A.3.3 Work Schedule

The work schedule, indicating critical Project points, is provided in Table 5.

Table 5. Work schedule.

Task/Deliverables	Anticipated Date of Completion
Task 1: Perform Field Data Collection Activities	
Continuous Water Quality Monitoring	• For sonde locations in California, monitoring shall begin one year prior to drawdown and shall continue for a minimum of 36 months unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies. Monitoring shall continue until the Renewal Corporation's request to discontinue monitoring is approved by the applicable regulatory agencies. • For sonde locations in Oregon monitoring shall begin one year prior to drawdown and shall continue for a minimum of 48 months unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies. Monitoring shall continue until the Renewal Corporation's request to discontinue monitoring is approved by the applicable regulatory agencies.
Water Quality Grab Sampling	• Sampling in California shall occur monthly beginning one year prior to drawdown and shall continue for a minimum of 36 months unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies. The Renewal Corporation will attempt to collect the samples at approximately the same time of day each month. Monitoring shall continue until the Renewal Corporation's request to discontinue monitoring is approved by the applicable regulatory agencies. • Sampling in Oregon shall occur monthly beginning one year prior to drawdown and shall continue for a minimum of 48 months unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies. The Renewal Corporation will attempt to collect the samples at approximately the same time of day each month. Monitoring shall continue until the Renewal Corporation's request to discontinue monitoring is approved by the applicable regulatory agencies. • Suspended sediment concentration samples shall be collected every two weeks in California following the initiation of drawdown and every two weeks in Oregon through September of the drawdown year.

Sediment Grab Samples	One sediment grab sampling event will be conducted prior to drawdown activities at 4 locations. In lieu of sampling the Klamath Estuary and the locations in the Copco No. 1 Reservoir footprint and the Iron Gate Reservoir footprint prior to drawdown, the Renewal Corporation will rely on the data collected by the U.S. Bureau of Reclamation (USBR) in 2009 and 2010, which provides pre-drawdown sediment chemistry data for the reservoirs and estuary. An additional sediment grab sampling event will be conducted at all locations within the period 12 to 24 months following completion of drawdown activities.
Task 2: Data Management and Analysis	
Continuous provisional Karuk and Yurok data published in real-time	Ongoing through contract.
Laboratory Analysis	Results will be reported 2-3 months after sample collection.
Task 3: Annual Progress Reporting	
Monthly monitoring reports will be issued to the following agencies: FERC, SWRCB, and the RWQCB. Monthly reports will also be copied to ODEQ and BLM.	Prior to, during, and for a minimum of one year following completion of drawdown. The Renewal Corporation will continue to submit monthly monitoring reports until the applicable regulatory agencies approve its request to discontinue all water quality monitoring under the California Water Quality Monitoring Plan.
Annual Compliance Report will be submitted to ODEQ.	Annually on April 1st. The Renewal Corporation will continue to submit Annual Compliance Reports until the applicable regulatory agencies approve its request to discontinue all water quality monitoring under the Oregon Water Quality Management Plan.

A.3.4 Resource and Time Constraints

Automated pump samplers (ISCO) are deployed to collect samples when the sites cannot be visited. High flow events will be captured to the best of the Project teams' ability. If weather conditions create unsafe working environment for sampling crews, the samples will be collected by the automated samplers described above.

A.4 Quality Objectives and Criteria

A.4.1 Measurement Quality Objectives

For continuous time-series measurements, precision and accuracy will be assessed quantitatively (Section A.4.2).

These assessments will be different for grab water quality and sediment samples, which involve laboratory analyses. The measurement quality objectives for these sampling types follow SWAMP guidance and are summarized in Table 6.

A.4.2 Precision and Accuracy

Precision is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions.

Precision will be assessed quantitatively with duplicate samples and expressed as relative percent difference (RPD) by the following equation:

$$RPD(\%) = \frac{|x1 - x2|}{\frac{(x1 + x2)}{2}} X\ 100$$

where,

RPD (%) = relative percent difference

x1 = Original sample concentration

x2 = Duplicate sample concentration

|x1 - x2| = Absolute value of x1 - x2

To assess precision associated with all steps of the project (from sample collection through analysis), field duplicates will be collected and analyzed for all water and sediment grab samples. Composite (cross-section) grab samples will always be collected in duplicate and are referred to as A and B sets in USGS terminology. An A set represents one cross-section sample, and a B set is collected directly after, representing a duplicate cross-section sample. To assess laboratory precision alone, the USGS QA Plan for the Analysis of Fluvial Sediment by the USGS California Water Science Center (CAWSC) will be followed (Appendix C).

Precision of field results will be tested using duplicate samples, with a target of less than 20% RPD.

Accuracy is the degree of agreement of a measurement with the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) that result from sampling and analytical operations. Accuracy of water quality measurements contained in this QAPP are a function of the equipment used during sampling and of the sampling methods.

For grab and automatic (pump) samples, single bottle samples collected in conjunction with cross-section samples will be collected at a frequency of 5% (1 duplicate/20 field samples). Collecting a pump sample in conjunction with a cross-section sample allows for accuracy testing of the pump samples, by determining if the pump samples are representative of the cross section. If the pump samples and cross section samples differ in concentrations, then a box coefficient is applied to the pump samples. The box coefficient is simply a multiplier that is applied to the pump sample to adjust the concentration of that sample to the concentration of the cross-section sample. Applying box coefficients to pump samples is a common practice by USGS, and more documentation can be found in Edwards and Glysson (1999).

A.4.3 Bias

Bias describes the tendency for under or over prediction of sampled or measured values relative to the true value. Bias is typically assessed using matrix spikes and reference materials. Samples of known sediment concentrations are routinely tested as described in the QA Plan for the Analysis of Fluvial Sediment by the USGS California Water Science Center Sediment Laboratory (Appendix C, and as described in the USGS Office of Surface Water technical memo 98.05 (USGS, 1998). Bias is also assessed in the lab through negative controls (Blanks). Detectable quantities in the blank would indicate positive bias. The USGS Sediment Lab bi-annually participates in the Sediment Lab QA Plan described in Appendix C.

A.4.4 Representativeness

This is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or a population. Field crews collecting samples will maximize representativeness of samples by selecting sites and employing methodologies to best characterize environmental conditions.

A.4.5 Completeness

Completeness on this project with regards to expected number of collected SSC samples is expected to be approximately 90%. Completeness with regards to continuous water quality data is expected to be as close to a complete record as possible (a complete record is retaining all unit values over a water year), recognizing that data loss can occur for several reasons. These reasons include loss of data during field visits and on-site calibrations, incidental damage, electronic malfunction, vandalism, and other unforeseen circumstances that could result in loss of data.

Table 6. Quality control measures, frequency of analyses, and measurement quality objectives for water and sediment grab samples.

Laboratory Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent.	<RL for target analyte
Matrix Spike and Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent (n/a for chlorophyll a).	Conventional Parameters: 80-120% recovery. Inorganic Analytes: 75-125% recovery. Nutrients: 80-120% recovery RPD<25% for duplicates.
Laboratory Duplicate	Per 20 samples or per analytical batch, whichever is more frequent (chlorophyll a: per method).	RPD<25% (n/a if native concentration of either sample<RL).
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**

Field Duplicate	5% of total project sample count.	RPD<20% (n/a if native concentration of either sample<RL).
Field Blank, Travel Blank, Equipment Blank	Per method	Blanks<RL for target analyte.

A.5 Special Training /Certifications

There are no formal certifications for personnel training for this work. However, in October 2021, the USGS completed an annual evaluation for the Karuk tribal staff on collection of samples for grab samples. Additional sampling training is offered annually through USGS in Castle Rock, WA, which could be attended by new staff within USGS, the Tribes, or other sampling personnel.

For operation of continuous monitoring sondes, the USGS California Water Science Center (CAWSC) offers water quality data collection training , which includes turbidity as well as the other water quality parameters. All personnel collecting or processing water quality samples will receive all relevant annual training.

Monitoring team leaders for Karuk tribal staff, Yurok tribal staff, and USGS will be responsible for ensuring sufficient training and certification for their team members. All relevant training and certification documentation will be stored by the respective organization in accordance with their standard operating procedure.

A.6 Documentation and Records

All USGS data will be maintained and served publicly through the National Water Information System (NWIS) database. Provisional continuous time series data will be published in real time on the USGS NWIS website, with final annual approved records available by April 1 the following year. Laboratory results will be provided by the USGS via the NWIS web database. Laboratory results may also be provided electronically for inclusion in a separate project database.

Continuous water quality data collected by the Karuk and Yurok Tribe will be available on the Karuk website and will be submitted electronically for inclusion in the project database. The Karuk and Yurok continuous data and associated field data will be stored on their individual servers indefinitely in addition to the project database. SSC samples collected by the Karuk and Yurok tribes will be sent to nearest USGS field office under a Chain of Custody (COC, Appendix A) where a Sediment Laboratory Analysis Request (SLAR) electronic form can be filled out by USGS staff and then sent to USGS Sediment Laboratory, and those records will be available through the USGS NWIS database. Monthly grab water samples collected for chemical and biological parameters will be sent to the Sprague River Water Quality Laboratory in Chiloquin, OR under a COC. Grab sediment samples collected in two events; prior to and post drawdown will be sent to Eurofins Test America Laboratory in West Sacramento, CA under a COC (Appendix A). Analytical reports for grab water and sediment samples will be stored electronically by the Karuk.

Monthly reports by all monitoring entities will provide a summary of data collected each month and will be submitted to RES for review and then to the Renewal Corporation Technical Team.

Field records will include a written (Appendix A) or electronic record (Aquarius Software) of site visits documenting field observations, site conditions, calibration and maintenance conducted. A field visit summary will be provided in the monthly reports. Field crews will also collect dated photo documentation of site conditions from each visit showing the condition of equipment and gage and unusual site and river conditions. Additionally, field staff will fill out a Field Inspection Sheet for grab sampling (Appendix A) including all monitoring sites where grab samples are collected with information including date, time, number of samples collected, and notes on site conditions.

The Karuk Tribe, Yurok Tribe, and USGS will prepare and submit an Annual Progress Report that covers work completed including upgrades and development of monitoring locations, samples collected, all other monitoring conducted, photos, and recommendations for program modifications. The Annual Progress Report will include site descriptions with photos, mapping, coordinates, monitoring activities, and links to data and results.

Each sampling entity's QA/QC staff will be tasked with ensuring that all relevant personnel have the most recent version of this QAPP.

Table 7. Document and record retention, archival, and disposition information.

	Identify Type Needed	Retention	Archival	Disposition
Station Log	Station Description files (record of site visits and conditions – road logs, ownership, equipment, etc.).	Onsite and copy retained in CAWSC and ORWSC (Oregon Water Science Center) Data Program Offices.	Archived according to USGS policy SM 502.9 and/or in accordance with this QAPP.	Indefinite
Field Visit and Sample Collection Records	Field notes for (1) monitor calibration, (2) Grab Sample collection.	Retained in CAWSC and ORWSC Data Program Offices, and Karuk and Yurok Tribal offices.	Archived according to USGS policy and/or in accordance with this QAPP.	Indefinite
Analytical Records	Laboratory analyses for SSC, water, and sediment grab samples.	Stored at USL, Santa Cruz, CA and electronically by the Karuk	Archived according to USGS policy and in accordance with this QAPP.	Indefinite
Data Records	Time Series Data	Retained in CAWSC and ORWSC Data Program Offices, and Karuk and Yurok	Archived according to USGS policy and in accordance with this QAPP.	Indefinite

	Identify Type Needed	Retention	Archival	Disposition
		Tribal offices and project database.		
Assessment Records	Surrogate Model Archives, WQ Station Analyses.	Retained in CAWSC and ORWSC Data Program Offices.	Archived according to USGS policy.	Indefinite

B. Data Acquisition

B.1 Sampling Design

Site selection criteria included the use of existing USGS gaging stations, located to enable measurement of changing water quality conditions below project actions.

B.1.1. Continuous Water Quality Monitoring

Continuous water quality monitoring will begin one year prior to drawdown and will continue in California for a minimum of 36 months and in Oregon for a minimum of 48 months, in each case, unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies (Table 5). This monitoring will be conducted at nine locations (Figure 2) on the Klamath River from below Keno Dam to the Klamath estuary (Table 3), and data will be recorded every 15 minutes. The six continuous monitoring stations associated with USGS stations will have telemetry capabilities and the data will be transmitted and stored in online databases held and managed by the Karuk Tribe and USGS. The remaining three continuous monitoring stations will log data internally but will not transmit the data automatically to the online database. The data will be manually downloaded by field crews during water quality grab sample collection efforts (Section B.1.2). The capacity of the data logger and battery is sufficient to collect data on 15-minute intervals for up to 90 days, but the data will be retrieved monthly, and batteries will be changed every two months. If the battery status on the interim monthly visit indicates lower than expected battery levels, the batteries will be changed at that time. Each sonde, regardless of telemetry capability, will be configured to record data at 15-minute intervals.

All continuous monitoring will be conducted uniformly and in accordance with the USGS protocols and EPA-approved Karuk and Yurok protocols (Wagner *et al.*, 2006; Rasmussen *et al.*, 2009; Appendix B).

If a sonde becomes inoperable during the monitoring period, appropriate actions will take place to repair the sonde and resume continuous monitoring as soon as possible. One potential source of error is from sondes that have not been calibrated correctly or frequently enough. This potential will be minimized by regular bi-monthly (every two weeks) calibrations of sondes in accordance with the manufacturer's standard.

B.1.2. Grab Water Quality Samples

Water quality samples will be collected beginning one year prior to drawdown. They will be collected monthly, other than suspended sediment concentration samples, which will be collected every two weeks in California following the initiation of drawdown and every two weeks in Oregon through

September of the drawdown year. The Renewal Corporation will attempt to collect the samples at approximately the same time of day each month. For a complete compliance schedule including determination of cessation of sampling, refer to Table 5.

Water quality grab samples will be collected from the locations outlined in Table 3. Water quality grab samples will be collected at CA sampling locations for a minimum of 36 months and at OR sampling locations for a minimum of 48 months, in each case, unless a reduction in the duration of monitoring is approved by the applicable regulatory agencies (Table 5).

One potential source of bias or misrepresentation may arise from grab samples being collected from different locations within a site or from a location not representative of river conditions (e.g., eddy or backwater). This will be minimized by standardizing grab sample locations that are sufficiently within the river channel.

B.1.3. Sediment Grab Samples

Sediment grab samples will be collected in California only. When sampling, the Renewal Corporation will target slow velocity depositional areas (e.g., eddies and backwaters) where fine sediment accumulation is most likely to occur. One sediment grab sampling event will be conducted at the following four locations prior to drawdown activities.

- Klamath River upstream of Copco No. 1 Reservoir and downstream of Shovel Creek.
- Klamath River downstream of Copco No. 2 Powerhouse, no farther downstream than the Daggett Road bridge crossing of the Klamath River.
- Klamath River at or near USGS gage no. 11516530 (below Iron Gate).
- Klamath River at or near USGS gage no. 11523000 (Orleans).

The USBR conducted sediment sampling of the reservoirs and Klamath Estuary in 2009 and 2010 (SWRCB 2020a). In lieu of sampling the Klamath Estuary and locations in the Copco No. 1 Reservoir footprint and Iron Gate Reservoir footprint prior to drawdown, the Renewal Corporation will rely on the data collected by USBR in 2009 and 2010, which provides pre-drawdown sediment chemistry data for the reservoirs and estuary.

An additional sediment grab sampling event will be conducted at all sediment grab locations listed in Table 3 within the period 12 to 24 months following completion of drawdown activities. Sediment grab samples will be collected at locations detailed in Table 3. Sampling points for locations not associated with USGS stream gages will mirror as closely as possible those used in the 2011 Sediment Chemistry Investigation by the U.S. Department of Interior Bureau of Reclamation (USBR, 2011).

If a sampling site becomes inaccessible, the Renewal Corporation will collect a sediment grab sample when the site becomes accessible again. This should not pose an issue, given the required time frame of 12 to 24 months following reservoir drawdown. One potential source of bias or error may arise from grab samples being collected from different locations within a site. This potential will be minimized by standardizing grab sample locations to occur at the same location between sampling events. However, at sampling locations within reservoir footprints, it is possible that terracing may not occur at the previously sampled location. In this case, the sample location will be moved to a location with terraced sediments.

B.2 Sampling Methods

B.2.1. Procedures

The procedures for calibrating sondes are in the SOPs (Appendix B) summarized in Section B.7. They are also described in Wagner *et al.* (2006) and Rasmussen *et al.* (2009) for USGS sites.

B.2.2. Continuous Water Quality Monitoring

Continuous water quality monitoring will be conducted with YSI EXO2 data sondes, described in detail in Section B.4.1. The USGS, Karuk and Yurok Tribe will perform all data collection and equipment maintenance as outlined by manufacturer specifications, this QAPP, and in accordance with SOPs (Appendix B). The sondes will be housed within a protective PVC perforated pipe, which will secure the sondes in the water column and help avoid damage to equipment. At the six USGS gage stations, communication cables will be attached to the submerged sondes and routed to the gage house where they will be connected to a datalogger. The datalogger will send USGS data to the database through a GOES satellite window. The Karuk and Yurok Tribes sondes are connected to FTS Axiom data loggers with an SDI-12 cable. The data logger will transmit data via the GOES satellite network and will be available on Karuk and USGS servers. In addition, Karuk and Yurok data will be made available on the Karuk water quality web portal in real time. Sondes will record data at a 15-minute interval, and both the data logger and sonde will retain data that can be manually retrieved in the event of data transmission failure.

USGS will deploy and operate high-range continuous turbidity sensors at the J.C. Boyle, Iron Gate, Seiad, Orleans, and Klamath sites. The sensors will be ANALITE NEP-5000 180-degree backscatter sensors and will be calibrated and operated by the published protocols referenced in Section B.7.

B.2.3. Grab Water Samples

Water quality grad sample collection methods will be consistent with the California Surface Water Ambient Monitoring Program (SWAMP) as well as protocols developed and published by the EPA, USGS and California State Water Resources Control Board (SWRCB). Sample equipment and methods are detailed in Section B.4.1 and SOP (Appendix B).

B.2.4. Sediment Grab Samples

Sediment grad sample collection methods will be consistent with SWAMP as well as protocols developed and published by the EPA, USGS and SWRCB. Sample equipment and methods are detailed in Section B.4.1 and SOP (Appendix B).

B.3 Sample Handling and Custody

Water and sediment grab samples will be delivered to the appropriate laboratory dependent upon analysis and media as detailed in Table 9 and Table 10 within designated hold times Table 8 of sample collection for analysis. Samples will be stored, packaged, and shipped on ice. Samples collected by Karuk and Yurok Tribes will be either directly shipped to the lab or physically transferred to USGS personnel, who will then transport the samples to the lab. Analytical service request forms (ASR) will be filled out by USGS personnel using field forms from USGS, Karuk, and Yurok personnel, and all samples will be accompanied by COC forms. The sample bottles will be labeled by Site ID, Date, median sample time (the median time between the start and stop time of the samples), gage height at time of sample, and the sample set (A or B). USGS personnel will fill out necessary information into the electronic forms prior to submitting samples to the lab.

Table 8. Sample handling.

Analyte	Bottle Size/Type (1 bottle per event)	Preservative Requirements (Chemical, Temperature, and Light)	Maximum Hold Time
Total Nitrogen	250ml, polyethylene bottle	4°C	48 hours
Nitrate			
Nitrite			
Ammonia			
Total Phosphorus			
Particulate Organic Phosphorus			
Orthophosphate			
Particulate Organic Carbon	100ml, glass bottle	Filter and preserve to pH<2 within 48 hours of collection; cool to ≤6 °C	28 days
Dissolved Organic Carbon		Cool to ≤6 °C; acidify to pH<2 with HCl, H_3PO_4, or H_2SO_4	
Chlorophyll *a*	1L, polyethylene bottle	Filter as soon as possible after collection; keep samples at ≤6 °C	Samples must be frozen or analyzed within 4 hours of collection; filters can be stored frozen for 28 days
Turbidity	1L, polyethylene bottle	4 °C	48 hours
Microcystin	250ml, clear glass bottle	Freeze and ship at <4 °C	14 days
Suspended Sediment Concentrations	250ml, polyethylene bottle	4 °C	7 days
Methylmercury	250ml, polyethylene bottle	Immediately after collection, cool to ≤6 °C in the dark; acidify to 0.5% with pre-tested HCl within 48 hours; if salinity is >0.5 ppt, acidify with H_2SO_4	6 months at to ≤6 °C in the dark following acidification
Settleable Solids	250ml, polyethylene bottle	4 °C	7 days

Particulate and Dissolved Aluminum	250ml, polyethylene bottle	HNO_3 to pH<2 within 48 hours and at least 24 hours prior to analysis	6 months at room temperature following acidification

B.4 Equipment, Analytical Methods and Field Measurements

B.4.1 Field Equipment

Continuous Monitoring Methods

The EXO2 sondes contain sensors that continuously record observations of water temperature, pH, dissolved oxygen, specific conductance, and turbidity. Water temperature and specific conductance are located on the same probe. The temperature thermistor is calibrated with a NIST-traceable wet calibration and an accuracy specification of 0.01 degrees Celsius and a resolution of 0.001 degrees Celsius. The specific conductance sensor reports water conductance compensated to 25 degrees Celsius and uses four internal pure-nickel electrodes to measure solution conductance. Conductance resolution is 0.0001 to 0.01 ms/cm. The dissolved oxygen sensor is an optical sensor and operates by shining a blue light of a specified wavelength onto a luminescent dye which is immobilized in a matrix and formed to a disk. Accuracy of the dissolved oxygen sensor is increased by irradiating a red light during the measurement cycle to act as a reference in the determination of the luminescence lifetime. Dissolved oxygen resolution is 0.01 mg/L, or 0.1% air saturation. pH is measured using two electrodes combined into the same probe: one for hydrogen ions and one for a reference. The sensor is a glass bulb filled with a solution of stable pH. pH range is 0 to 14 units with a resolution of 0.01 units. The turbidity sensor employs a near-infrared light source and detects scattering at 90 degrees of the incident light beam, also characterized as a nephelometric near-IR turbidimeter, non-radiometric. As such, units are reported as formazin nephelometric units (FNU). The sensor range is 0-4000 FNU with a resolution of 0.01 FNU for 0-999 FNU, and 0.1 FNU for 1000-4000 FNU. The high-range ANALITE NEP-5000 turbidity sensor is a backscatter sensor that detects scattering at 180 degrees of the incident light beam. The units are reported as nephelometric turbidity units (NTUs). The ANALITE NEP-5000 sensor range is 0-30,000 NTU with a resolution of +/- 1.5 NTU for 0-5,000 NTU, +/- 3.0 NTU for 5,000-10,000 NTU, +/- 9.0 NTU for 10,000-30,000 NTU.

For calibration, maintenance, see manufacturer’s instructions and auditing procedures. Raw data from sondes will be collected and stored on dataloggers in the USGS gage houses. This data will also be transmitted via the GOES network and made publicly available.

Automated Samplers

The Teledyne ISCO automated pump samplers function using a peristaltic pump head that is capable of pumping volumes of water up to 26 vertical feet from the point of pumping to the pump head, and at manufacturer-recommended velocities. The sampler can be configured to hold bottles sized from 1-L to 5.5 gallons if needed. No measurement principle is associated with this equipment. Major attributes include the ability to program the sampler to collect samples at specified temporal frequencies and at specified turbidity thresholds. An SDI-12 interface allows connection with the YSI EXO2 sondes via the data logger to trigger the samples at specified turbidity thresholds without disrupting the transmission of continuous water quality data from the sondes.

Grab Water Sampling

Standard water quality grab sample procedures will be used for collection of water quality parameters, nutrients, chlorophyll, and microcystin, using a churn to mix samples and following an appropriate regimen of blanks, duplicates, and other steps to assure quality. Calibration and maintenance of data sondes adheres to protocols established by USGS and the manufacturer. To ensure reliability YSI multi-channel data sondes are calibrated in the field daily before use following YSI instructions and other standard procedures for calibration (EPA, 2001) that are attached as Appendix B.

Grab water samples will be collected at nine discrete locations (Table 3), collected with a churn splitter to ensure that the sample is homogeneously mixed before the sample bottles are filled (Appendix B – SOPs). Depending on location with or without bridge access, two collection methods may be used. For most sites, the churn is fully submerged into the stream and filled to the lid with flowing water, not stagnant water. For sites from a bridge (Daggett Road and Walker), a Van Dorn sampler can be used to collect three samples from across the channel. The samples are poured into the churn and treated the same as all other sites. Prior to filling the churn for nutrient, chlorophyll, or microcystin sampling, the churn will be decontaminated by rinsing three times with distilled water. After rinsing with distilled water, the churn will be rinsed three times with stream water. Samples shall be collected from uniformly mixed water with the churn fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allows for all sample bottles to be filled from one churn; thereby minimizing differences in water properties and quality between samples. The churn should be stirred at a uniform rate by raising and lowering the splitter at approximately 9 inches per second while bottles are being filled (Bel-Art Products, 1993). Care must be taken to avoid breaking the surface of the water as the splitter rises toward the top of the water in the churn.

Sample bottles will be filled directly from the churn and placed on ice in coolers with completed and signed chain of custody forms for transport to an accredited laboratory for analysis. For quality assurance/quality control (QA/QC) purposes, duplicate and blank bottle sets will be prepared and collected according to the schedule outlined in Table 6. These additional bottle sets will be handled, prepared, and filled following the same protocol used for regular bottle sets and samples.

Isokinetic Suspended-Sediment Sampling

Composite and individual analyses suspended-sediment sampling will be conducted from bridges, boats, cableways, and by wading the stream cross section following methods described in Edwards and Glysson (1999). For bridge, cableway, and boat samples, a USGS D-49, D-96, D-74, D-95, DH-95 or DH-59 sediment sampler with appropriate glass or plastic bottles or plastic bags for the D-96 bag sampler will be used to collect the samples. These samplers will be lowered and raised through the water column using cable and reel devices. For wading samples, a hand-held DH-81 sediment sampler enclosing a 1-L Nalgene plastic bottle, or a DH-48 sediment sampler enclosing a glass pint bottle will be used. These samplers will be manually lowered and raised through the water column during sample collection.

Individual sample bottles will be sent to the USGS Sediment Laboratory for analysis. The measurement principle of these samplers follows isokinetic sampling theory, which states that the water approaching and entering the sampler intake does not change velocity while the sampler is being moved through the water column and collecting the sample. Isokinetic samplers are limited to water velocities greater than 1.5 feet per second and depths less than 15-ft for samplers with rigid bottles (D-74, D-95, DH-95, DH-59). The D-96 bag sampler can be used in velocities from 2.0 to 12.5 ft/s and depths up to 110-ft depending on the nozzle diameter.

Two cross-section composite samples will be collected per sampling event generating 10 1-L sample containers. The first sample (A-set) will generate 5 sample bottles that will be analyzed individually for SSC and percent of sample finer than 63 microns (percent fines). The second sample will composite the 5 containers resulting in one SSC and percent fines value and will be analyzed for full particle size distribution.

Grab Sediment Streambed Sampling

Obtaining sediment samples that are representative of the river reach is essential to maintain data and sampling program integrity. The sediment sample collection strategy focuses on obtaining samples of fine-grained surficial sediments from natural depositional zones, in part because specific trace elements that are part of the sampling program, such as methylmercury have a strong affinity to organic carbon content and fine grain sediment (Ravichandran, 2004; Lambertsson and Nilsson, 2006). In wadeable sections, sediment sample locations should include the insides and outsides of meander bends, crossovers, as well as forewater and backwater side habitats (USGS 2008). Sample locations will be chosen in areas outside the hydraulic effects of bridges and other man-made objects.

The surficial 0 to 3 centimeter of bed sediment within each sample location or zone will be subsampled several times in the same reach and combined to create a composite sample for each sample location. Compositing subsamples from different depositional areas within the same reach or zone will smooth the local scale variability and provide samples that are more representative of the average or mean contaminant concentrations. To minimize possible contamination, sediment samples should be collected with non-metallic materials or from the center of the Van Veen grab sampler, avoiding areas that are near or directly contacting metal surfaces. In addition to sediment-sampling activities, stream-water field measurements of pH, specific conductance, dissolved oxygen (DO), temperature, and streamflow also are collected at the time of sampling using a YSI EXO handheld water quality meter (USGS 2008). In addition, location information should be supplemented with Global Positioning System (GPS) coordinates recorded at each sampling area (USGS 2008). Sample equipment decontamination between all collection locations in accordance with USGS and EPA SWAMP shall be completed to minimize cross-contamination.

B.4.2 Analytical Methods and Field Measurements

This QAPP requires laboratory analysis for suspended sediment, grab water, and grab sediment samples collected at locations described in Sections B.1.2 and B.1.3, respectively, for analytes listed in Table 10 and Table 11, respectively. All laboratory analyses will be completed in accordance with 40 CFR 136 methodology by California Environmental Laboratory Accreditation Program (ELAP) or Oregon

Environmental Laboratory Accreditation Program (ORELAP) certified laboratories as necessary. Grab water analyses will be performed at ORELAP accredited Sprague River Water Quality Laboratory in Chiloquin, OR. Grab sediment analysis will be performed by ELAP accredited Eurofins Test America Laboratory in West Sacramento, CA. Suspended Sediment Concentration will be analyzed by the USGS Sediment Laboratory in Santa Cruz, CA. Table 9 provides a detailed list of analytes, laboratories, and reporting limits.

Table 9. Laboratories & reporting limits.

Analyte	Media	Reporting * Limits	Unit	Laboratory
Total Nitrogen	Water	0.060	mg/L	Sprague River
Nitrate	Water	0.016	mg/L	Sprague River
Nitrite	Water	0.002	mg/L	Sprague River
Ammonia	Water	0.012	mg/L	Sprague River
Total Phosphorus	Water	0.018	mg/L	Sprague River
Particulate Organic Phosphorus	Water	0.018	mg/L	Sprague River
Orthophosphate	Water	0.006	mg/L	Sprague River
Particulate Organic Carbon	Water	0.010	mg/L	Sprague River
Dissolved Organic Carbon	Water	0.010	mg/L	Sprague River
Chlorophyll-A	Water	1.0	µg/L	Sprague River
Microcystin	Water	0.30	ppb	Sprague River
Methylmercury	Water	0.5	ng/L	Eurofins Test America
Particulate and Dissolved Aluminum	Water	0.010	mg/L	Sprague River
Settleable Solids	Water	2	mg/L	Sprague River
Suspended Sediment Concentration	Water	1.60	g/L	USGS Sediment Laboratory
Turbidity	Water	0.200	NTU	Sprague River
Arsenic	Sediment	2.00	mg/kg	Eurofins Test America
Lead	Sediment	1.00	mg/kg	Eurofins Test America
Copper	Sediment	1.50	mg/kg	Eurofins Test America
Nickel	Sediment	1.00	mg/kg	Eurofins Test America
Iron	Sediment	10.0	mg/kg	Eurofins Test America
Aluminum	Sediment	20.0	mg/kg	Eurofins Test America
Dioxin	Sediment	1.00	pg/kg	Eurofins Test America
Cyanide	Sediment	0.500	mg/kg	Eurofins Test America
Mercury	Sediment	0.040	mg/kg	Eurofins Test America
Ethyl Benzenes	Sediment	50.0	µg/kg	Eurofins Test America
Total Xylenes	Sediment	50.0	µg/kg	Eurofins Test America

Dieldrin	Sediment	1.70	µg/kg	Eurofins Test America
4,4’-dichlorodiphenyltrichloroethane (DDT)	Sediment	1.70	mg/kg	Eurofins Test America
4,4’-dichlorodiphenyldichloroethane (DDD)	Sediment	1.70	mg/kg	Eurofins Test America
2,3,7,8-tetrachlorodibenzodioxin (TCDD)	Sediment	1.70	mg/kg	Eurofins Test America
4,4’-dichlorodiphenyldichloroethylene (DDE)	Sediment	1.70	mg/kg	Eurofins Test America
2,3,4,7,8-pentachlordibenzofuran (PECDF)	Sediment	1.70	mg/kg	Eurofins Test America

Chemistry

SSC will be analyzed using method, ASTM D 3977-97, Standard Test Method for Determining Sediment Concentration in Water Samples (ASTM, 1999). This is the USGS standard for determining concentrations of suspended material in surface water samples. This method is used by all USGS sediment laboratories, and by cooperating laboratories certified to provide suspended-sediment data to the USGS. The laboratory will report both concentration in mg/L and percent of sample less than 63 microns, operationally defined as the break between silt and sand.

Table 10. Analytical methods for water quality grab samples.

Analyte	Unit	Analytical Method or Standard
Total Nitrogen	mg/L	EPA 365.2
Nitrate	mg/L	EPA 353.2
Nitrite	mg/L	EPA 353.2
Ammonia	mg/L	EPA 350.1
Total Phosphorus	mg/L	EPA 365.2
Particulate Organic Phosphorus	mg/L	EPA 200.7
Orthophosphate	mg/L	EPA 365.1
Particulate Organic Carbon	mg/L	ASTM D4129
Dissolved Organic Carbon	mg/L	ASTM D7573
Chlorophyll-A	CFU	EPA 445
Microcystin	µg/L	EPA 546 [Enzyme-Linked ImmunoSorbent Assay (ELISA) Microcystin-ADDA Method]
Methylmercury	µg/L	EPA 1630
Particulate and Dissolved Aluminum	mg/L	EPA 200.7
Settleable Solids	mg/L	SM 2540F
Suspended Sediment Concentration	mg/L, % < 63 microns	ASTM D 3977-97

Turbidity	NTU	EPA 180.1

Table 11. Analytical methods for sediment grab samples.

Analyte	Unit	Analytical Method or Standard
Arsenic	mg/kg	EPA 6010B
Lead	mg/kg	EPA 6010B
Copper	mg/kg	EPA 6010B
Nickel	mg/kg	EPA 6010B
Iron	mg/kg	EPA 6010B
Aluminum	mg/kg	EPA 6010B
Dioxin	pg/kg	EPA 8290A
Cyanide	mg/kg	EPA 4500
Mercury	mg/kg	EPA 7471A
Ethyl Benzenes	mg/kg	EPA 8260B
Total Xylenes	mg/kg	EPA 8260B
Dieldrin	µg/kg	EPA 8081A
4,4’-dichlorodiphenyltrichloroethane (DDT)	µg/kg	EPA 8081A
4,4’-dichlorodiphenyldichloroethane (DDD)	µg/kg	EPA 8081A
2,3,7,8-tetrachlorodibenzodioxin (TCDD)	µg/kg	EPA 8290A
4,4’-dichlorodiphenyldichloroethylene (DDE)	µg/kg	EPA 8081A
2,3,4,7,8-pentachlordibenzofuran (PECDF)	µg/kg	EPA 8081A

Sample Disposal

Disposal of water and sediment chemistry grab samples will be completed by the analytical laboratory.

B.5 Quality Control

B.5.1 Quality Control Activities

Quality control activities are outlined in Table 6 for conventional parameters, nutrients, and inorganic analytes. This includes laboratory blanks, spikes, duplicates, and field duplicates and blanks.

If control limits are exceeded, corrective actions will be assessed and documented following guidance in SWAMP Quality Control and Sample Handling Tables.

Procedures and formulas for calculating quality control results are outlined in Section A.4.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

B.6.1 Sampling Equipment

Sampling equipment will be inspected regularly prior to use for safety and operational reasons. Cable reels will also be inspected to ensure crew safety during sample collection. The full lists of all sampling equipment are described in the SOPs (Appendix B).

Calibration and maintenance of field equipment/instruments will be performed according to the manufacturer’s instructions and sampling SOPs (Appendix B) and recorded in an instrument/equipment logbook.

The project-specific criteria for calibration (frequency, acceptance criteria, and corrective actions associated with exceeding the acceptance criteria) are provided in Table 12.

The chemistry analytical laboratory maintains its equipment in accordance with its SOPs, which include those specified by the manufacturer and those specified by the method. Problems with the instrumentation during analysis will require repair, recalibration, and re-analysis of the sample. Table 12 outlines analytical equipment, maintenance frequencies, and the responsible person.

Table 12. Field equipment calibration, maintenance, testing, and inspection.

Analytical Parameter	Instrument	Calibration Activity	Maintenance & Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action
Temperature (Sensor)	EXO2 MPS Multi Probe System: YSI Precision ™ Thermistor		According to Wagner *et al.* (2006) Manufacturer's manual and SOPs (Appendix B)	Initial and bi-weekly (every other week) for Karuk and Yurok sites, once every 4-6 weeks for USGS sites	± 0.15°C of true value at both endpoints or as dictated in Wagner *et al.* (2006)	Remove from use and replace with backup sensor if doesn't pass calibration criteria
pH (electrode)	EXO2 MPS Multi Probe System: YSI Glass Combination electrode	Initial: Two-point calibration bracketing expected field sample range (using 7.0 and 10.0 pH buffer)	According to Wagner *et al.* (2006) and Manufacturer's manual and SOPs (Appendix B)	Initial and bi-weekly (every other week) for Karuk and Yurok sites, once every 4-6 weeks for USGS sites	Initial: Two- point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria and replace with backup sensor.
		Post: single-point check with 7.0 pH buffer			Post: ±0.1 pH units of true value or as dictated in Wagner *et al.* (2006)	
Dissolved oxygen (sensor)	EXO2 MPS Multi Probe Optical Sensor	Initial: One-point calibration with saturated air (need temp, barometric pressure).	According to Wagner *et al.* (2006) and Manufacturer's manual and SOPs (Appendix B)	Initial and bi-weekly (every other week) for Karuk and Yurok sites, once every 4-6 weeks for USGS sites	Initial: One-point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria and replace with backup sensor.
		Post: single-point check at full saturation			Post: ±0.5 mg/L of true saturated value or as dictated in Wagner *et al.* (2006)	
Turbidity (sensor)	EXO2 MPS Multi Probe System	Initial: 2 or 3-point calibration using 0, 124, 1010 FNU copolymer beads	According to Wagner *et al.* (2006) and Manufacturer's manual and SOPs (Appendix B)	Initial and bi-weekly (every other week) for Karuk and Yurok sites, once every 4-6 weeks for USGS sites	Initial: One-point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria and replace with backup sensor.
		Post: same calibration as pre-deployment			Post: ±1 NTU of true value or as dictated in Wagner *et al.* (2006) and Rasmussen *et al.* (2009)	

Analytical Parameter	Instrument	Calibration Activity	Maintenance & Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action
Conductivity (sensor)	EXO2 MPS Multi Probe System: YSI 4-electrode cell with auto ranging	Initial: One- point calibration at high end of expected field sample range (1000 mS/cm standard)	According to Wagner *et al.* (2006) and Manufacturer's manual and SOPs (Appendix B)	Initial and bi-weekly (every other week) for Karuk and Yurok sites, once every 4-6 weeks for USGS sites	Initial: one-point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria and replace with backup sensor.
		Post: two-point check with high (1000 mS/cm) and low (0 mS/cm) standards			Post: high standard ±5% of true value and low standard ±10% of true value, or as dictated in Wagner *et al.* (2006)	

Table 13. Testing, inspection, and maintenance of analytical instruments.

Equipment / Instrument	Responsible Person	Frequency	SOP Reference
Sartorius Analytical Balance LA230S	Lab Manager	Daily during periods of operation	Knott *et al.* (1992)
Sartorius Macro Balance AZ4101	Lab Manager	Daily during periods of operation	Knott *et al.* (1992)
Fisher Scientific Isotemp Premium Oven 700 Series 13247750F	Lab Manager	Weekly during periods of operation	Knott *et al.* (1992)
Filtration Equipment	Lab Manager	Weekly during periods of operation	Knott *et al.* (1992)

B.7 Instrument/Equipment Calibration and Frequency

For a description of equipment, tools, and instruments and the frequency of calibration see Appendix B for Karuk protocols, Table 12 and Table 13. Calibration of EXO2 sondes and documentation of the calibrations will follow procedures outlined in Wagner *et al.* (2006) and Rasmussen *et al.* (2009) for the USGS sites at Keno and J.C. Boyle. At Copco No. 2, Walker Bridge, Iron Gate, Seiad Valley, Orleans, Klamath, and Klamath Estuary, calibrations will follow the SOPs (Appendix A) and the manufacturer's manual. Any deficiencies in sampling will be documented in quarterly report and resolved by individual sampling entities.

B.8 Inspection/Acceptance for Supplies and Consumables

USGS hydrographers from the Klamath Falls field office will be responsible for the purchase of consumables necessary for the operation and maintenance of continuous water quality sondes at Keno and J.C. Boyle. Acceptance criteria are addressed by the internal USGS supply store prior to shipping to field offices. Tracking and storing of the materials is conducted by USGS hydrographers at the field office.

The field measurement supplies the Karuk and Yurok Tribes will use, such as calibration solutions, will be acquired from standard traceable sources, such as the instrument manufacturer or reputable suppliers. The Karuk Tribe will obtain calibration standards from Fondriest Environmental, Inc. The lot number and expiration date on standards and reagents will be checked prior to use. Expired solutions will be discarded and replaced. The source, lot number, and expiration dates of all standards and reagents will be recorded in the field log books.

B.9 Non-direct Measurements

For comparison purposes, previous field measurements and laboratory analytical results collected from the Project area may be reviewed through Annual Reports and online databases. These sources could include, but are not limited to, the USGS, the United States Forest Service, the Karuk Tribe, the Hoopa Tribe, and the Yurok Tribe.

Previously collected data that will be used for comparison purposes will have gone through the QAPP review process (Karuk QAPP 2019, Yurok QAPP 2017). However, for data that has not been EPA-SWRCB-approved, it will first be reviewed to verify that they are of sufficient quality to meet the needs of the project by examining:

- sample collection and location information;
- consistency with data collected from other Tribal monitoring programs from the same general vicinity; and
- QA/QC information associated with the data.

If the data are of insufficient or unknown quality, limitations will be placed on its use in supporting project decisions. In general, it is anticipated that decisions for the current project will be based on data collected by the Tribe following this current QAPP.

B.10 Data Management

Management of data collected by USGS will follow established protocols, and will be stored in the NWIS database, which is publicly accessible. USGS databases retain all original raw data, and records processing and management follows guidelines detailed in Wagner *et al.* (2006) and Rasmussen *et al.* (2009).

The Karuk Tribe will ensure that all field-collected audit and calibration data will be recorded on paper and digitally. All raw continuous monitoring data collected by the Karuk and Yurok Tribe will be stored on their individual servers or the Karuk server and made available to the Renewal Corporation. Filling of project related documents will follow the guidelines in the Karuk and Yurok Tribes QAPPs (Karuk 2018, Yurok 2017). Raw continuous time series data will be entered into Aquatic Informatics, Inc. Time Series software to be evaluated and corrected based upon procedures outlined in the Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting (Wagner *et al.*, 2006, and Rasmussen *et al.*, 2009) by the USGS. Both real-time and corrected data will be made available on the Karuk Tribes Water Quality Web Portal and submitted to the project database.

C. Assessment and Oversight

During the course of the Project, it is important to assess the Project’s activities to ensure that the QAPP is being implemented as planned. This helps to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the Project when it may be too late to remedy the situation. For the current Project, the ongoing assessments will include:

- Field oversight;
- Readiness review of the field team prior to starting field efforts;
- Field activity audits;
- Review of field sampling and measurement activities, methodologies, and documentation at the end of each event; and

- Laboratory oversight.

Monitoring team leaders for Karuk tribal staff, Yurok tribal staff, and USGS will be responsible for conducting assessments. These individuals have the authority to issue stop work orders if it is found that quality control measures are insufficient. These individuals will also be responsible for submitting these assessments to the Renewal Corporation Water Quality Monitoring Program Manager. Monitoring team leaders will implement corrective actions, either as they see fit, or upon discussions with the Program Manager.

C.1 Reporting

Prior to, during, and for a minimum of four years following completion of drawdown, monthly monitoring reports will be issued to the following agencies: FERC, SWRCB, RWQCB, and ODEQ until otherwise approved by the SWRCB Deputy Director and ODEQ. These monthly reports will also be made available as a courtesy to BLM.

Annual progress reports will also be prepared and submitted to the above agencies by April 1 containing data from the previous calendar year. The annual progress reports will describe equipment installation and site reinforcement with photos, mapping and site coordinates, all monitoring activities, links to USGS, Karuk, and Yurok data results or an established repository with all the results, and recommended QAPP revisions and site modifications, as necessary.

D. Data Validation and Usability

Prior to utilizing data to make project decisions, the quality of the data needs to be reviewed and evaluated to determine whether the data satisfy the project objectives. This process involves technical evaluation of the off-site laboratory data, as well as review of the data in conjunction with the information collected during the field sampling and field measurement activities. This data, which includes water quality parameters such as turbidity, pH, temperature, dissolved oxygen, conductance, flow conditions, and sample location can help to provide a clearer understanding of the overall usability of the project data and potential limitations on data use. Section A.4 outlines various criteria that will be used to evaluate project data.

D.1 Data Review, Verification, and Validation

Section A.4 discusses the quality objectives for the project and the performance criteria used for accepting, rejecting, or qualifying project data.

D.2 Verification and Validation Methods

The setting of data review, verification, and validation requirements helps to ensure that project data are evaluated in an objective and consistent manner. For the current project, QA/QC officers and personel designated in Figure 1 and Table 2 will be responsible for performing data review in accordance with the requirements set forth in Section A.4, which include standards for precision/accuracy, bias, representativeness, and completeness.

D.3 Reconciliation with User Requirements

The USGS and the Karuk Tribe will flag data that does not meet the acceptance criteria outlined in Section A.4.

Uncertainty for data collected by USGS is reported and quantified as part of the records processing that is required for all USGS datasets. Data limitations are reported by flagging of data and qualitative rating of water quality records. These flags and ratings are retained with the data when retrieved from the USGS database.

Once all the data from the field and laboratory have been evaluated, the QA Officers will make an overall assessment concerning the final usability of the data (and any limitations on its use). The initial steps of this assessment will include, but are not necessarily limited to:

- Discussions with the Field Technicians;
- Review of deviations from the QAPP or associated SOPs to determine whether these deviations may have impacted data quality and whether any impacts are widespread or single incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses;
- Evaluation of the field and laboratory results and QC information;
- Review of any other external information which might influence the results, such as activities upstream, meteorological conditions, wildfires, and data from other sources;
- Evaluation of whether the completeness goals defined in this QAPP have been met;
- Examination of any assumptions made when the study was planned, if those assumptions were met and, if not, how the Project's conclusions are affected.

E. References

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APPENDIX A

Field Checklists, Sampling Forms, and COCs

APPENDIX A-1

WATER QUALITY CHECKLISTS, FIELDSHEETS, and COCs

Appendix A-1: Field Activities Review Checklist

Sampling Location(s): Date(s) of Sampling: __________

Mark each topic "Yes," "No," or "NA" (not applicable), and comment as appropriate.

_______All required information was entered into field logbooks in ink, and logbook pages were signed & dated. Comment:

_______Deviations from SOPs , along with any pertinent verbal approval authorizations and dates, were documented in field logbooks. Comment:

_______Samples that may be affected by deviations from SOPs were flagged appropriately. Comment:

_______ Field measurement calibration standards were not expired and were in the correct concentrations. Comment:

_______ Field calibrations were performed and results were within QAPP-specified limits for all parameters (Temperature, pH, Dissolved Oxygen, Conductivity, and Turbidity). Comment:

_______Field measurement QC samples were within the QAPP-specified limits for all parameters. Comment:

_______Field measurement data were recorded in the appropriate logbooks(s). Comment:

_______Samples were collected at the correct sites. Comment:

_______The correct number of samples for each type of analysis and the correct volume was collected. Comment:

_______Certified clean sample containers, appropriate for the intended analysis, were used. Comment:

_______Requested/required field quality control (QC) samples (Field blanks and field duplicates) were collected, and at the correct frequency. Comment:

_______Samples were preserved with the correct chemicals, if required. Comment:

_______Samples were stored and/or shipped at the proper temperature. Comment:

_______Chain-of-custody documents were completed properly. Comment:

_______Custody seals were applied and intact when relinquishing custody of the samples. Comment:

_______Sample holding times were not exceeded during field operations. Comment:

Reviewer's Name (print):

Reviewer's Signature: ____

Reviewer’s Title: ____

Karuk Tribe Water Quality Program:

Date of Review:____/___/______

Appendix A-2: Lab Data Review Checklist

Sampling Project:____

Date of Sampling:____

Analytical Laboratory:____

Mark each topic “Yes,” “No,” or “NA” (not applicable), and comment as appropriate.

_______Final data package includes chain-of-custody forms. Comment:

_______ Chain-of-custody forms were properly completed and signed by everyone involved in transporting the samples. Comment:

_______Laboratory records indicate sample custody seals were intact upon receipt. Comment:

______Samples arrived at the laboratory at the proper temperature. Comment:

______All requested analyses were performed and were documented in the analytical report. Comment:

______Analyses were performed according to the methods specified in the approved QA Project Plan. Comment:

______Holding times for extraction and analysis were not exceeded. Comment:

______Method detection and/or quantitation limits were included in the report. Comment:

______A Narrative summarizing the analyses and describing any analysis problems was included in the final report. Comment:

______Data qualifiers and flags were explained in the analytical report. Comment:

_____Method (laboratory) blank results were included for all analyses, at the appropriate frequency, and showed no laboratory contamination. Comment:

______ Initial calibration data (if requested from the laboratory) were within QAPP, method, or laboratory SOP defined acceptance criteria for all analyses. Comment:

______Continuing calibration data (if requested from the laboratory) were within QAPP, method, or laboratory SOP defined acceptance criteria for all analyses. Comment:

______Matrix spike data were included for all pertinent analyses for every 20 samples. Comment:

______Laboratory Control Sample data were included for all analyses for every 20 samples. Comment:

______Laboratory Duplicate data were included for all analyses for every 20 samples. Comment:

______ Field blanks do not contain analytes of interest or interfering compounds and included for all pertinent analyses for every 20 samples. Comment:

______ Field Duplicates are within QAPP-defined acceptance criteria and included for all analyses for every 10 samples. Comment:

______Matrix spike results were listed and within QAPP or laboratory defined acceptance criteria. Comment:

______Matrix interferences were definitively identified either through a second analysis or use of Laboratory Control Sample Results. Comment:

______ Laboratory Control Sample results were within QAPP or laboratory defined acceptance criteria. Comment:

_______Laboratory Duplicate results were within QAPP or laboratory defined acceptance criteria. Comment:

_______Reported results were within method detection or quantitation limits. Comment:

Reviewer's Name (print):

Reviewer's Signature: ____

Reviewer's Title: ____

Karuk Tribe Water Quality

Program: Date of Data Review:

/______________________/_____

Field Inspection Sheet - Total Load Sediment

Station Number:				**Date:**		
Station Name:						
Party:			**Weather:**			
Flow:			**H20 Temperature:**			°C
Meas. Type:			**Stage:**			
Location:				**gage.**		
Sampler Type (84164):						
Nozzle Size:						

ISOKINETIC SAMPLE?:	

Discharge Measurement Details:

Width:		**Area:**		**Velocity:**		**Gage Height:**		**Discharge:**	

ONLY FILL OUT SEDIMENT CHANNEL EDGE OF WATER LOCATIONS AND NUMBER OF VERTICALS IF SAMPLING VIA EWI

Sediment Channel REW		**Sediment Channel LEW**		**Sediment Channel Width**		**Number of Verticals**	

SUSPENDED SEDIMENT

Method (82398)	Station	Start Time	Finish Time	Number of Bottles	Set	Number of Verticals	Recorded GH	WW/OSS	Analysis Requested

Observer Contacted:		**USGS Therm:**		°C	**Cases**	
Thermometer Checked:		**Observer Therm:**		°C		

Remarks:

SedLogin Notes:

ISCO Program - Bottle Retrieval - Field Form

Sample Date	Sample Time	PST / PDT?	Bottle Number

General Notes:

Next Sample Programmed (periodic) Date/Time: ______________________

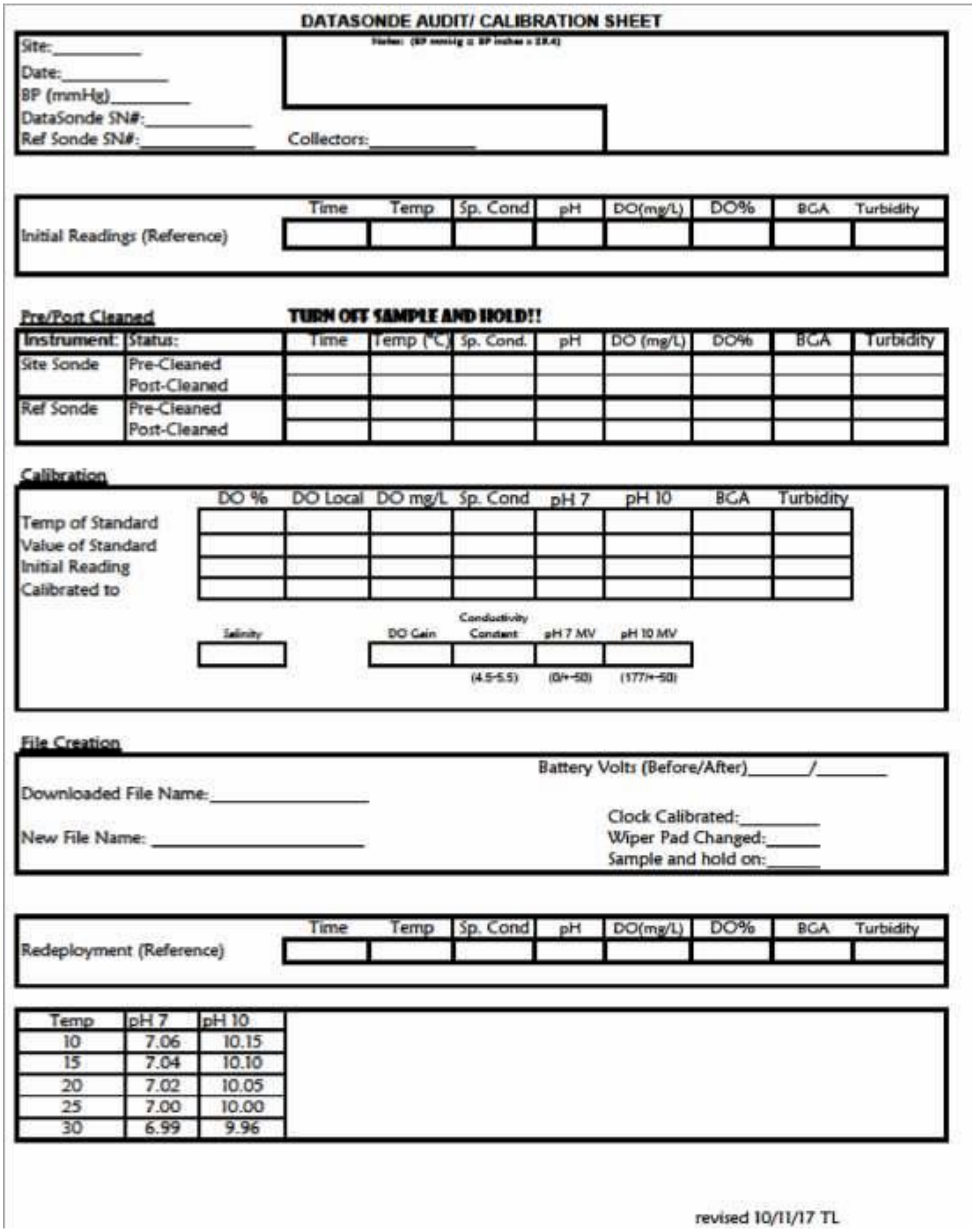
Trigger Parameter (episodic) Date/Time: ______________________

Trigger Level (ft?, FNU? Etc.): ______________________

Intitials: ______________

-

Appendix A 3 Audit/Calibration for YSI Datasonde



DATASONDE AUDIT/ CALIBRATION SHEET

Notes: (BP mmHg = BP inches x 25.4)

Site:__________
Date:____________
BP (mmHg)_________
DataSonde SN#:___________
Ref Sonde SN#:___________
Collectors:___________

	Time	Temp	Sp. Cond	pH	DO(mg/L)	DO%	BGA	Turbidity
Initial Readings (Reference)								

Pre/Post Cleaned **TURN OFF SAMPLE AND HOLD!!**

Instrument:	Status:	Time	Temp (°C)	Sp. Cond.	pH	DO (mg/L)	DO%	BGA	Turbidity
Site Sonde	Pre-Cleaned								
	Post-Cleaned								
Ref Sonde	Pre-Cleaned								
	Post-Cleaned								

Calibration

	DO %	DO Local	DO mg/L	Sp. Cond	pH 7	pH 10	BGA	Turbidity
Temp of Standard								
Value of Standard								
Initial Reading								
Calibrated to								

Salinity	DO Gain	Conductivity Constant	pH 7 MV	pH 10 MV
		(4.5-5.5)	(0/+-50)	(177/+-50)

File Creation

Battery Volts (Before/After)______/_______
Downloaded File Name:________________
New File Name: ______________________
Clock Calibrated:________
Wiper Pad Changed:_____
Sample and hold on:_____

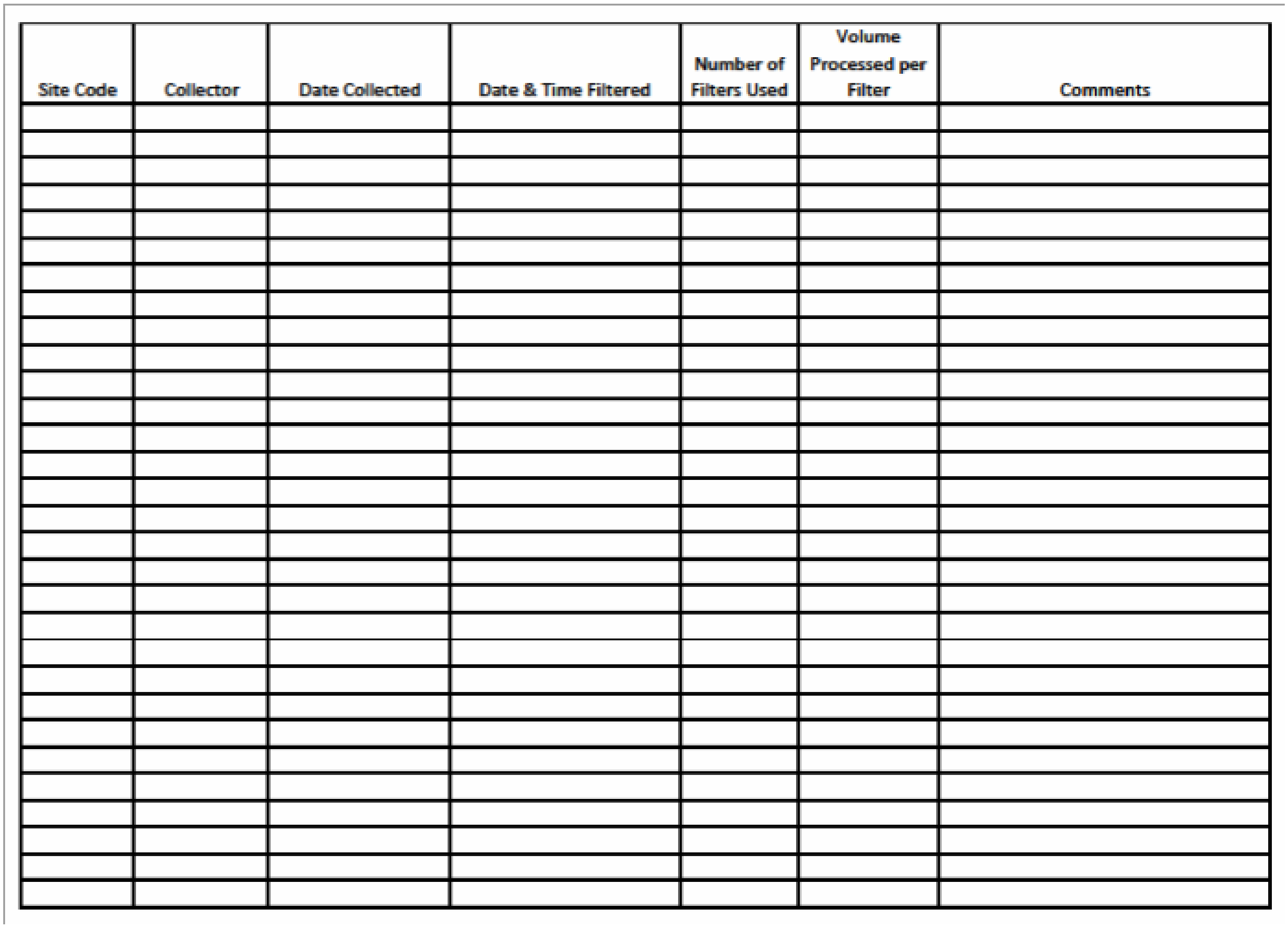
	Time	Temp	Sp. Cond	pH	DO(mg/L)	DO%	BGA	Turbidity
Redeployment (Reference)								

Temp	pH 7	pH 10
10	7.06	10.15
15	7.04	10.10
20	7.02	10.05
25	7.00	10.00
30	6.99	9.96

revised 10/11/17 TL

-

Appendix A 4: C.Shasta Filtering



Site Code	Collector	Date Collected	Date & Time Filtered	Number of Filters Used	Volume Processed per Filter	Comments

ISCO Program - Bottle Retrieval - Field Form

Sample Date	Sample Time	PST / PDT?	Bottle Number

General Notes:

Next Sample Programmed (periodic) Date/Time: ______________________________

Trigger Parameter (episodic) Date/Time: ______________________________

Trigger Level (ft?, FNU? Etc.): ______________________________

Intitials: ____________________

Environmental Analysis Request/Chain of Custody

eurofins
Lancaster Laboratories
Environmental

Acct. # ______________ Group # ____________________ Sample # ____________________________

Client:	
Project Name/#:	Site ID #:
Project Manager:	P.O. #:
Sampler:	PWSID #:
Phone #:	Quote #:
State where samples were collected: ____	For Compliance: Yes ☐ No ☐

Matrix

- ☐ **Soil** ☐ **Sediment** ☐ **Tissue**
- **Water**: ☐ Potable ☐ NPDES ☐ Ground ☐ Surface
- **Other:**

Analyses Requested

Preservation and Filtration Codes

For Lab Use Only

SF #: ___________

SCR #: ___________

Preservation Codes

H = HCl	T = Thiosulfate
N = HNO_3	B = NaOH
S = H_2SO_4	P = H_3PO_4
F = Field Filtered	O = Other

Sample Identification	**Collection**		**Grab**	**Composite**	**Soil ☐ Sediment ☐ Tissue ☐**	**Water**	**Other:**	**Total # of Containers**											**Remarks**
	Date	**Time**																	

Turnaround Time Requested (TAT) (please check): Standard ☐ Rush ☐

(Rush TAT is subject to laboratory approval and surcharges.)

Date results are needed:

Rush results requested by (please check): E-Mail ☐ Phone ☐

E-mail Address:

Phone:

Data Package Options (please check if required)

Type I (Validation/non-CLP)	☐	MA MCP	☐
Type III (Reduced non-CLP)	☐	CT RCP	☐
Type VI (Raw Data Only)	☐	TX TRRP-13	☐
NJ DKQP	☐	NYSDEC Category	☐ A or ☐ B

EDD Required? Yes ☐ No ☐ If yes, format: ______________

Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time

Relinquished by Commercial Carrier:

UPS _______ FedEx _______ Other ____________

Temperature upon receipt ____________ °C

Eurofins Lancaster Laboratories Environmental, LLC • 2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300

7045 0717

APPENDIX A-5. FIELD EQUIPMENT MANUALS AND INSTRUCTIONS

Onset HOBO Water Temp Pro Logger Manual

http://www.onsetcomp.com/files/manual_pdfs/10366-C-MAN-U22-001.pdf

Van Dorn Sampler Manual

http://wildco.com/wp-content/uploads/2017/05/Wildco-Water-Bottle-Guide.pdf

YSI 6600 Datasonde User Manual

https://www.ysi.com/File%20Library/Documents/Manuals/069300-YSI-6-Series-Manual-RevJ.pdf

YSI EXO Datasonde User Manual

https://www.ysi.com/File%20Library/Documents/Manuals/EXO-User-Manual-Web.pdf**Appendix C 5: YSI EXO Handheld Operation Guide**

https://www.ysi.com/File%20Library/Documents/Manuals/E117-EXO-Handheld-Operation- MiniManual.pdf

ISCO Automatic Sampler Manual

https://www.yumpu.com/en/document/view/23528603/6700-portable-sampler-isco

Churn Sample Splitter Instruction Manual

https://www.belart.com/media/catalogstudio/Instructions/937805001.pdf

APPENDIX B

Standard Operation Procedures

APPENDIX B-1

Standard Operation Procedures

Suspended Sediment Samples

Suspended Sediment Sampling – SOP

Klamath River water quality monitoring and SSC sampling

General order of operations at the site

ISCO automated sampler servicing

1. Pause program & collect sample time information
    a. Option 1. Download program / sample log to a computer
    b. Option 2. Fill out ISCO sample history field form as you page through the ISCO or datalogger display
2. Put on gloves as you handle bottles
3. Cap and label bottles with date/time or appropriate information to match sample date/time to bottles back in the office
4. Remove full bottles one by one as you label them with appropriate sample time from log/sheet
5. Replace full bottles with capped empty/clean bottles one by one in tray
6. When done handling all the full / empty bottles, change gloves
7. Uncap empty bottles, store clean caps in ziplock in gagehouse for next visit
8. RESART the program (you may leave it unstarted during EDI sampling so you can get before/after EDI grabs)

Discharge Measurement (if needed)

1. Complete a gage inspection and obtain initial GH readings using SVMAQ
2. Complete a discharge measurement with an ADCP and obtain the EDI stationing information for the EDI sample using QRev
3. Enter the Qm info as you normally would in SVMAQ
4. If an EDI rating has been developed based on rated Q and you are not able to make a Qm, EDI stations can be obtained from the rating.

Equal Discharge Increment (EDI) Sediment Sampling

NOTE: if water temp is <10degC and you are using a bag sampler, see 2013 memo for revised transit rates (policy_memos folder)

“Although a given one-way transit rate must be constant, neither the descending and ascending transit rates in any one vertical need to be equal nor do the transit rates need to be equal among verticals. The number of transits in each vertical can vary if no sample bottle overfills. Although different diameter nozzles for the isokinetic sampler can be used from vertical to vertical, it may complicate the data collection procedure, hence, the practice is discouraged.”

“If an equal amount of sample is collected at each vertical, the samples can be composited and analyzed as a single sample. However, to realize the full benefits of the EDI method, samples should be analyzed separately and the resulting SSC values summed and then divided by the number of subsections to derive a mean water discharge-weighted SSC. One advantage of this method is that data describing the cross-sectional variation in SSC are produced. Additionally, a bottle containing an abnormal amount of sediment – particularly sand – compared to others in the set (because of recirculation or to gouging the nozzle into the bed) can be identified and excluded from the calculated mean cross-sectional SSC to minimize the potential for bias”

1. Collect an ISCO Grab sample prior to the START of sampling
    a. Fill a 3-liter bottle if turbidity is <10 FNU from EXO reading
2. Note the time of the grab on the ISCO bottle
3. Collect the EDI sample (set A & B)
    a. Do an intake efficiency test if you are using a D-96 bag sampler (see tab in this sheet)
    b. Select appropriate transit rate and/or nozzle to fill each bottle for each veritcal with roughly the same volume
        i. See transit rate tables, use rule of thumb = 0.4 x mean velocity = transit rate in sec/ft
        ii. If using transit rate tables in ft/sec, divide 1 by rate to get sec/ft on B reel, e.g., transit rate is 2 ft/sec from table, then 1/2 = 0.5 and transit rate on B reel is 0.5 sec/ft or 1 sec for every two feet as you are reeling/watching on the B-reel dial
        iii. BEGIN SAMPLNG: Lower field-rinsed sampler at the predetermined constant transit rate until slight contact is made with the streambed. **Do not pause** upon contacting the streambed. Raise the sampler immediately until sampler completes the vertical traverse.
            1. Take care not to disturb the streambed by bumping the sampler on it; bed material may enter the nozzle, resulting in erroneous data.
            2. Do not overfill the sampler container.
            3. Inspect each subsample as it is collected, looking for overfilling or underfilling of the sampler container and (or) the presence of anomalously large amounts of particulates that might have been captured because of excessive streambed disturbance during sample collection.
            4. If the sampler is overfilled or the nozzle digs into the streambed, dump sample and re-collect sample starting at the first vertical from the previous sample
            5. Transit rates can vary when lowering and raising through the water column, so long as the transit rate does not exceed the velocity of the water, and that the same volume is collected at each sampling location in the cross section.
        iv. Move sampling equipment to the next vertical. Collect sample.
    c. For A-set samples, retain all containers from each EDI station (minimum 5 locations)
    d. For B-set samples, composite all of the samples from individual EDI stations into 3-L bottles, or whatever size bottle will hold all of the sample
    e. <u>For SedLogin:</u> Analyze the A-set containers individually, Analyze the B-set samples as a composite with particle size distribution
4. Collect an ISCO Grab sample in the ~middle of sampling
5. Note time for each vertical as you are sampling
6. Collect an ISCO Grab sample prior to the END of sampling
    a. Fill a 3-liter bottle if turbidity is <10 FNU from EXO reading

7. Complete sample, and fill out bottle labels and field sheet fully (see “SSC_fieldsheet.pdf”)

Equipment List

1. ISCO form
2. ISCO computer cable
3. Axiom computer cable
4. ISCO labels and pens
5. Ziplocks
6. Gloves
7. Clean ISCO bottles
8. 3L grab sample bottle (<10 FNU EXO Turb)
9. Appropriate sediment sampler for expected conditions
    a. Light samplers: DH-48, DH-59, DH-81, DH-95
    b. Heavy samplers: D-74, D-95, D-96
10. A-reel, B-reel, or E-reel
11. Nozzles (3/16”, ¼”, 5/16”)
12. Appropriate sediment bottles and carrier (3-L, 1-L, glass quart, glass pint)
13. 4-wheel crane and counterweights (if site conditions require)
14. Boom truck and crane (if site conditions require)
15. Boat (if site conditions require)

1. Pre-trip preparation

- ☐ Load equipment listed above
- ☐ Ensure all manuals are available on tablet
    - ISCO
    - AXIOM
    - SatLink3
    - EXO
    - Analite

APPENDIX B-2

Standard Operation Procedures

Grab Water Samples

Standard Operating Procedure for Water Quality Grab Sampling

07/02/02
Version 2.1

Prior to leaving the office

- Gather sampling equipment - see Equipment & Supplies List on page 11
- Inspect all sampling equipment for damage, dirt, etc.
- Pack a cell phone and telephone number directory
- Check equipment batteries, replace if expired and carry extras
- Verify that the multi-probe unit and turbidimeter have been recently calibrated by checking the calibration log.
- Pack field notebook, extra paper, SOP, QAPP, Chain Of Custody (COC) sheets, and shipping addresses (should be in QAPP or SOP)
- Check bottles needed for sampling - see Grab Sample List on page 2
- Affix labels to appropriate bottles or pack appropriate labels
- Prepare Blank samples and reference solution bottles (If applicable)
- Get Ice (Blue Ice or crushed ice)

At the sampling site

- Fill in the labels on the bottles
- Collect all necessary samples - see the appropriate Quality Assurance Project Plan for a constituent/bottle list for the project
- Filter and preserve samples as needed - see Grab Sample List on page 2
- Store samples in a cooler on ice and cover with ice
- Fill out field notebook and field log (field log and field notebook are the same for Reclamation.) and COC sheet(s)

After sampling

- Package coolers for shipping (fill out shipping label, affix cooler seal). Place COC in plastic bag in cooler before sealing.
- Ship the samples at the end of each day of sampling
- Post-calibration of equipment
- Clean and store field equipment
- Copy pages from field notebook and store in a secure location in the office after sampling session.
- Copy field notebook, field log and COC and send to appropriate parties.

1. Grab Sampling

The sample bottle or churn splitter is used to collect a water grab sample. Care is exercised not to disturb sediment while sampling. Avoid surface debris when collecting samples. The sample bottle and/or churn splitter is rinsed with environmental water three times. If bottles are pre-preserved, rinsing with environmental water is not appropriate.

prior to collecting the sample and water is run through the pour spout of the churn splitter during each rinse. Do not disturb the location where sample is to be taken with discarded rinse water. The preferred method of collecting whole (unfiltered) samples is to dip the sample bottle with the mouth pointed up-stream in the current. Filtered and Quality Assurance (QA) samples must be collected in a churn splitter. If used, the churn splitter is cleaned at each site after sample collection by 1) carefully inspecting and removing any foreign material, 2) rinsing the exterior, and 3) rinsing the interior three times with De-Ionized (DI) water. Allow DI water to run through the pour spout during each rinse.

See Table 1 for a list of constituents, appropriate bottles, filtration, and sample preservation information.

Table 1. Grab Sample List

Constituents	Bottle	Filtered	Preservation
Nutrients: NH4, (NO_2+NO_3) as N, TKN, Total P	1,000 ml HDPE	No	4?C 2 ml H_2SO_4
Ortho PO_4	500 ml HDPE	No	4?C
Trace Metals: B, Mo, Se	500 ml HDPE **(level one)**	No	4?C 2 ml $HN0_3$
Trace Metals: Ag, Al, As, Cd, Cr, Cu, Fe, Ni, Pb, Sb, Tl, Zn, Ca+Mg	500 ml HDPE **(level one)**	Yes	4?C 2 ml $HN0_3$
Mercury	250 ml HDPE **(level one)**	Yes	4?C 1 ml $HN0_3$
Hydrogen Sulfide (Sulfide)	250 ml HDPE	No	4?C NaOH
Biological Oxygen Demand (BOD)	1,000 ml HDPE	No	4?C
Chlorophyll a (USBR)	1000 ml Dark HDPE	No	4?C Then Freeze
Chlorophyll a (PacifiCorp)	250 ml Dark HDPE	No	4?C Then Freeze
Total Dissolved Solids (TDS)	250 ml HDPE	Yes	4?C
Algae Speciation	250 ml HDPE	N	4^{o}C, 5ml Lugol

2. Van Dorn Sampler

The Van Dorn sampler is used to collect samples from a site where it is not possible to directly fill the sample bottles or churn splitter, such as reservoir sampling from a bridge. Rinse the Van Dorn sampler with environmental water three times prior to the collection of sample water. The Van Dorn sampler is lowered, the trigger mechanism activated, and then raised to the surface. The water is then poured from the Van Dorn sampler into the churn splitter. The Van Dorn sampler is cleaned at each site after sample collection by 1) carefully inspecting and removing any foreign material, 2) rinsing the exterior, and 3) rinsing the interior three times with DI water.

Samples may also be collected using a battery operated 12v DC submersible pump (Ben Meadows Model DC60, ABS body, stainless steel propellers and chemically inert seals). The pump fitted with 30 m of 3/8" ID Tygon tubing is lowered to the desired sampling depth and run until 5 tube volumes have been pumped. The sample bottles are then filled sequentially as the pump continues to operate. For QA samples (regular, duplicate, and spikes) the pump is used to fill the churn splitter. Sample bottles are filled from the churn splitter as described below. The pump is rinsed with distilled water between sample locations. At the end of the sampling period the pump and tubing are rinsed with distilled water followed by a dilute chlorine bleach solution.

3. Churn Splitter

The churn splitter allows different sub-sample volumes to be obtained from the composite sample while still maintaining the same basic chemical and physical properties of the original sample. The volume of the churn splitter limits the volume of sample that can be divided. Suspended inorganic sediments coarser than 62 micrometers (um) cannot be split. Samples may be taken from a plastic (Nalgene^{TM}) churn splitter for analysis of all other dissolved and suspended inorganic constituents.

Sub-samples totaling 10 liters may be withdrawn from the 14-liter churn. The 4 liters remaining in the 14-liter churn should not be used for unfiltered sub-samples because they will not be representative. However, the sample water remaining in the churn splitter may be used for filtered sub-samples for the determination of dissolved constituents.

The procedure for cleaning and use of the churn splitter is as follows:

A. The Klamath Basin Area Office (KBAO) will clean the churn splitter between sampling events. They will use gloves while doing this. After removing any foreign material from the churn splitter with a nylon brush, soap & water, the churn splitter is rinsed three times with DI water.

B. Pour about 200 ml of dilute (i.e. 6%) nitric acid into the churn splitter (if sampling for low level metals constituents). Wet all inside surfaces of churn splitter with the acid. Acid is run through the pour spout. Dispose of dilute acid down a drain with a good flow of tap water.

C. Rinse the churn splitter with DI water three times. Drain DI water from the spout during each rinse. The churn splitter is now ready for field use.

D. The churn splitter is rinsed with environmental water three times in the field at each sample site prior to sample water collection. Drain environmental water through pour spout during each rinse.

E. Fill out the labels on all sub-sample containers. Set aside the filtered sample bottles (at the QA site there are multiple bottles to be filtered) that will contain filtered environmental water. These samples will be filtered from the remaining environmental water in the churn splitter after the other unfiltered samples have been collected. The remaining bottles (unfiltered sample bottles) are rinsed three times with environmental water after the churn splitter has been rinsed and filled. Only rinse the bottles that will contain water collected at the current site. The churn splitter is rinsed three times with DI water after each site.

F. If QA samples are not collected at a site, then approximately 6 liters of environmental water is required at each site. Fill the churn splitter so as to have enough water for all samples. The last 4 liters of sample in churn cannot be used for non-filtered samples. It is important to sufficiently fill the churn splitter to have adequate water supply for all samples.

G. For QA samples, the churn splitter may have to be filled more than once to collect all the required samples. Duplicate and triplicate (spike or reference) samples are collected at the QA site. Three sample bottles (regular, duplicate, and spike) are filled from the same churn splitter volume for most of the constituents. All three bottles for these constituents must be collected from the same churn splitter volume. Triplicate (spike) samples are collected for mercury, trace metals, Mg & Ca, orthophosphate, and nutrients. The field sampler adds a spike solution to a known volume of environmental water for these constituents. For some of the constituents, only two sample bottles (regular and duplicate samples) of environmental water are filled from the same churn splitter of water and the third is filled with a reference solution. A third bottle of environmental water is not collected for total alkalinity, BOD, or TDS triplicate (spike/reference) samples. A reference solution of known concentration is poured into the spike/reference bottle by the sampler for this constituent. Specific preparation of QA samples is discussed in the “Sample Quality Control and Quality Assurance” section of this SOP.

H. It is sometimes necessary to composite water into the churn splitter from a sampling devise. A Van Dorn sampler can be used for this. Where a Van Dorn sampler cannot be used, a sample bottle is used over and over to fill the churn splitter. Swirl the water in sample bottle prior to pouring into the churn splitter in order to minimize the amount of suspended material lost in transferring from the bottle to the churn splitter. As stated in the Grab Sampling section above, it is preferred to collect unfiltered environmental water directly into a sample bottle. QA samples (regular, duplicate, and triplicate) must be dispensed from a single churn splitter volume.

I. Churn the sample at a uniform rate of about 9 inches per second (in/s). The churning disc should touch the bottom of the tank on every stroke and the stroke length should be as long as possible without breaking the water surface. If the churning rate is significantly greater than 9 in/s or if the churning disc breaks the water surface, excessive air is introduced into the sample and may change the dissolved gases, bicarbonate, pH, and other characteristics of the sample. On the other hand, inadequate stirring may result in non-representative sub-samples.

J. After churning the sample in the splitter for at least 10 strokes to assure uniform dispersion of the suspended material, begin the withdrawal of sub-samples. As sub-samples are withdrawn and the volume of sample in the churn decreases, maintain the churning rate of about 9 in/s. If a break in churning is necessary, the stirring rate must be reestablished (i.e., 10 strokes) before withdrawals are continued.

K. While operating the churn, withdraw an adequate volume of sample water to field rinse bottles for unfiltered sub samples. Rinse each bottle three times with sample water.

L. Withdraw sub-samples for unfiltered samples first. The first sub-sample withdrawn should be the largest sub-sample required (usually 1 liter of sample).

M. After all the required unfiltered sub-samples have been withdrawn, the environmental water remaining in the churn may be filtered for sub-samples required for dissolved constituents. Remember to field rinse bottles three times with **filtered** sample water prior to filling. Procedures for filtering and preserving samples are described later.

N. After all filtered sub-samples have been withdrawn, empty the churn splitter and clean the mixing tank, lid, and churning disc three times with DI water. Allow the DI water to run through the pour spout during each rinse.

4. Filtering Water Samples

Water samples are filtered using a peristaltic pump and 0.45um inline filter. The inlet tube to the pump is rinsed with environmental water then placed in the churn splitter. An inline filter is attached to the exit tube of the pump. About 500-ml of environmental water is pumped through filter before any sample water is collected. This water should not be used to rinse sample bottles. Rinse all filtered sample bottles three times with the filtered environmental water. Continue filtering until all filtered samples have been collected. After using the pump at a sample site, discard the inline filter and pump about a 500-ml of DI water through the tubing. Rinse the outside of the inlet and outlet tubing with DI water.

If the peristaltic pump fails or is unusable for any reason, samples can be filtered with a filter syringe. The filter syringe is used as follows: Disassemble a clean 100-ml filter syringe. Rinse the inside of syringe with environmental water three times. Place a new 0.45um disc style filter on the end of the syringe. Fill the filter syringe with environmental water. Push 10-15 ml of environmental water through the filter before any sample water is collected. Filter approximately half of the water in the syringe into the sample bottle and rinse. Shake sample bottle and discard water. Rinse the sample bottle three times with the filtered environmental water. Fill the sample bottle with filtered water using the syringe-filter procedure. Refill the syringe if more sample water is needed and the filter has not clogged. If filter is clogged, attach a new filter, rinse as stated above and continue.

5. Water Sample Preservation

Physical preservation techniques are used for all samples and include cooling and keeping the samples out of the sunlight. Some of the water samples are also preserved with acid to prevent degradation of constituents before they are analyzed. Specific requirements for the field preservation of the samples are listed in the Grab Sample List (Table 1) on page two of this SOP. All samples will be preserved immediately at the collection site.

Metals

Preserve metals in water for a 6 month hold time with nitric acid. Mercury has a hold time of only 28 days. 1 ml of 70% nitric acid is used for each 250 ml of sample water. The sample is also chilled to 4^oC in the field.

Nutrients

The 1,000 ml nutrient suite bottle requires 2 ml of H_2SO_4 and has a hold time of 28 days. The sample is also chilled to 4^oC in the field.

Other Samples

No acid preservation is used for orthophosphate, BOD, total alkalinity, and TDS. Total alkalinity and TDS samples have a 14-day hold time. Orthophosphate samples have a 48-hour hold time. BOD samples have a 48-hour hold time. Hydrogen Sulfide (Sulfide) samples are preserved with NaOH and have a 7-day hold time. The samples are also chilled to 4^oC in the field.

If in doubt about any sample, it is best to keep it chilled and out of the sunlight.

6. Dispensing Acid from Ampule for preserving samples

Rubber, latex or vinyl gloves and safety glasses are worn to prevent acid from contacting hands or eyes while preserving samples. If acid is present in the neck of the ampule, gently tap until all of the acid is in the body of the ampule. Place the provided ampule "breaker" over the ampule, point away from face, and apply steady pressure until the ampule snaps at the prescored line. Hold the ampule upside down over the sample bottle between the thumb and index finger of one hand. With the other index finger, lightly tap the bottom of the ampule until all of the acid is dispensed. Properly discard the empty acid ampules.

PacifiCorp site samples will be preserved using acid from re-closable plastic vials. Gloves and safety glasses are also worn during the use of the re-closable vials to protect hands and eyes from acid. Vials should also be properly discarded once empty.

7. Sample Handling and Transportation

Sample handling and transportation vary depending upon the analysis requested, sample preservation requirements, and the distance to the laboratory. However, once preserved, some samples will remain stable for long periods of time. All samples for KBAO projects will be shipped overnight delivery on the day they are collected.

All water samples will be shipped in a cooler or ice chest. This provides protection, insulation, and containment in case of breakage or spillage. When shipping samples that require chilling, pack adequate quantities of frozen blue ice or crushed ice with the samples. Seal the ice chests securely with duct or packing tape to ensure they do not accidentally open.

8. Sample Quality Control and Quality Assurance

A. Objective

Quality control of samples during collection, transportation and processing is an integral part of a sampling program. Quality control procedures are implemented to assess potential sampling and analytical bias.

B. Techniques

Production Samples
A production sample is a sample taken at a site where no QA samples are collected. A production sample has the abbreviation of "P".

Regular Samples
A regular sample is the production sample at the QA site and has associated QA samples. A regular sample has the abbreviation of "R".

Duplicate Samples

A split sample is a portion or sub-sample of a total sample. The duplicate sample has an identical water matrix as the regular sample. This sample is used to determine analytical precision within a laboratory. A duplicate sample has the abbreviation of "D".

Triplicate Samples (Field Spikes and Reference Solutions)
These are reference solutions used to fill the sample bottles or chemical solutions (spikes) that are added to specified volumes of environmental water. A graduated cylinder is used to measure the volume of environmental water used for the "spiked" samples. All of the triplicate sulfide nutrient and trace metal samples are "spiked". Rinse the graduated cylinder three times with sample water. Using the graduated cylinder, measure out the appropriate volume of sample water (total triplicate sample volume – volume of spike = volume of environmental water). Pour approximately half of the sample water from the graduated cylinder into the sample bottle. Add the "spike" solution to the sample bottle. DO NOT add the spike to the graduated cylinder. Rinse the inside of the "spike" container with sample water from the graduated cylinder and add to the sample bottle. Pour the remaining half of the sample water from the graduated cylinder into the sample bottle. A reference solution is used for the total alkalinity BOD and TDS triplicate sample. In this case the triplicate (reference solution) is not mixed with environmental water, instead the reference solution is used to fill the entire sample bottle. A triplicate sample has the abbreviation of "S".

Blanks
A blank sample is used to test laboratory analysis and ensure the bottles are not contaminated. Blank sample bottles are rinsed three times with DI water. The sample bottles are then filled with DI water and corresponding preservatives are added. The blank should be prepared in the lab/office to avoid field contamination and carried in the field while sampling. A blank sample has the abbreviation of "B".

Rinsate Blanks
A rinseate blank tests the field crew techniques and sampling equipment for contamination. After the sampling equipment has been cleaned with DI water at the last sampling site , the rinseate blank is collected. Rinseate blanks are prepared by pouring DI water into the sample collection equipment (Van Dorn, etc). Wet all internal surfaces. The rinseate water is then collected into the churn splitter. The sample bottles are rinsed three times with the rinsate water before sample collection. Fill the sample bottles with rinsate water. Filter rinsate water for filtered constituents using a peristaltic pump and filter. Preservation is added to samples requiring it. A rinseate blank has the abbreviation of "RB".

Standards
Standards or reference materials are used for equipment that requires calibration. Use of reference standards is an integral component of quality control. Both field and laboratory equipment must be periodically calibrated to assure the instruments accuracy. Laboratories should calibrate equipment as required by the analysis method. The field equipment, such as the Hydrolab H20 unit and the Hach 2100P turbidity meter require regular calibration. The Hydrolab H20 unit will be calibrated as described in the KBAO

Hydrolab calibration SOP. PacifiCorp will calibrate the YSI 600 in the office and/or field as per manufacturer specifications. The manufacturer's instructions for calibrating the turbidimeter will be followed.

C. Sample Identification

A unique sample identification (ID) number is used for samples collected at different sites. The same number is used for all sample bottles collected at a given site on a given day. A letter prefix associated to the specific sampling project precedes the sample ID number. For example, a letter prefix of KRWQ identifies the sample as part of the Klamath River Water Quality Monitoring Program. These sample identification numbers are pre-selected by the KBAO and/or other sampling agency.

9. Field Notebooks

A bound field notebook is used to document collection of a sample, sample ID number, field observations, and other pertinent information necessary to reconstruct the sample collection processes. All entries are made in permanent waterproof ink. Any corrections made to the field notebooks are lined out, initialed, and dated. The person who collected the sample signs the field notebook. Field personnel will carry the field notebook during sampling. Past physical measurements and observations can be compared to current conditions. The field crew will make copies of the field notebook once they have returned to the office. Making copies will minimize the amount of data lost in the event the field notebook gets lost or damaged.
Field notebooks include:

- Sample Identification Information (including Field ID)
- Field Measurements (Water temp., pH, DO, etc)
- Equipment Information (serial number, model number, manufacturer, etc.)
- Sample Types (P, R, D, S, B, RB)
- Sample Collection (what analysis/constituents requested, etc.)
- Sample Preservation Information
- Date and Time of Collection
- Weather Conditions
- Comments

Field notebooks provide a convenient system for tracking the monitoring and analysis requests for each site in a particular project. Further, the field ID provides the cross-reference to laboratory results and sampling locations. The field crew keeps the field notebooks on file when the program is complete.

10. Chain of Custody

A COC accompanies all samples to record possession and transportation of samples. Field identification number, sample type, requested analysis, date of collection, and time of collection as well as other information is recorded on the COC. COC's are completed with permanent ink. Any corrections made to the COC's are lined out, initialed, and dated. All samples are kept in a secured area accessible only to authorized personnel during sample collection and transport. Upon completion of the field collection of the samples, the COC sheet accompanies the samples to the lab. COC sheets are also legally binding and act as a work order for the laboratory. It is critical that the field identification numbers are properly recorded on the field notebook and COC forms. Sample collectors, individuals transferring samples, and those receiving samples, all sign the COC. The COC forms are in triplicate and field personnel should remove only the field copy (pink sheet).

11. Calibration Log

A bound calibration logbook is used to store calibration information for equipment requiring calibration. Calibration information for the Hydrolab H20 unit and Hach 2100P turbidimeter will be recorded in a bound calibration logbook. When instruments are calibrated in the field, all appropriate calibration information is recorded in the field notebook.

12. Ringed Field Binder

A ringed binder is used to store information pertinent to a sampling project. The binder can be used to store a copy of the SOP, Quality Assurance Project Plan, level one clean-bottle certificates, acid purity certificates, certificates for in-line filters, COC sheets, copy of field notebook, and other pertinent information.

13. Security Shipping Seals

When shipping samples a security seal is attached across the lid and side of the ice chests. The seal is signed and dated by the sampling personnel. The seal is attached so that it must be broken when the container is opened.

Equipment & Supplies List

Equipment and Supplies

- Field notebook
- Field datasheets
- Clipboard
- Chain Of Custody form
- Zip-lock bag for COC form
- “Sharpie” felt tip pens
- Ball point pens
- Van Dorn sampler with rope
- Churn splitter
- Peristaltic pump and in-line filters
- Prepared bottles and labels
- Extra sample bottles
- Extra bottle labels
- Sulfuric acid ampules
- Nitric acid ampules
- Waste container for broken acid ampules
- Rubber, latex, or vinyl gloves
- Safety glasses
- Spikes
- Graduated cylinder
- 10 gallons DI water
- Squeeze bottle for DI water
- Hydrolab$^{?}$ H20 unit, spare battery and cables
- Bucket for Hydrolab$^{?}$
- Turbidity meter
- Ice chests
- Ice packs (Blue ice)
- Packing tape
- UPS overnight shipping forms
- Rope
- Waders (Waders may be knee, hip, or chest)
- Cell phone and telephone numbers
- Knife/scissors
- Maps
- Paper towels
- Camera and film
- GPS unit
- Extra batteries
- Tools
- Syringe filters (back-up filters)

Personal Supplies

-Drinking water / food
-Leather gloves
-Sunglasses
-Hat
-Extra socks
-Sun block
-Anti-bacterial hand gel

Contact Information

Laboratory Addresses (Jason, Richard update as appropriate)

Basic Laboratory
2218 Railroad Ave
Redding, California 96001
530-243-7234
Parameters: BOD, Alk, PO_4, TP, NO_3-NO_2, NH_4, TKN

SEM

Aquatic Analysts
7975 SW Tennis Ct
Wilsonville, OR 97070Parameters: Algae speciation and chlorophyll a
(503) 570-9007
(503) 349-2188
E-Mail: aaalgae@aol.com
Contact: Jim Sweet

Agency Addresses

USBR Addresses

U.S. Bureau of Reclamation
Klamath Basin Area Office
6600 Washburn Way
Klamath Falls, Oregon 97603
Phone: 541-883-6935
Contact:
Jason Cameron

U.S. Bureau of Reclamation
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, Ca. 95825
Contacts:
916-978-5285 (Victor)
916-978-5286 (Bruce)

PacifiCorp
Representative/Contact: Richard Raymond
E&S Environmental Chemistry, Inc.
2161 NW Fillmore St.
PO Box 609
Corvallis, OR 97339
Tel. 541 758-5518
Fax. 541 758-4413
Richard.Raymond@EandS.net

Watercourse Engineering, Inc.
1732 Jefferson Street, Suite 7
Napa, CA 94559
707-265-6560
Contact: Mike Deas

APPENDIX B-3

Standard Operation Procedures

Grab Sediment Samples

Standard Operating Procedure for Bed Sediment Grab Sampling

Klamath River water quality monitoring

1. **Prior to collecting samples**
    a. Gather equipment and supplies needed (see list)
    b. Inspect equipment for any damage, cleaning needs, fouling, battery needs. etc.
    c. Ensure you have the appropriate ice and sample transport supplies
    d. Identify key details of sampling visit
        i. Locations
        ii. Goals
        iii. Number of sites
        iv. Staff needed

2. **Grab sampling**
    a. Ensure water conditions are safe to enter
    b. If water samples or water quality readings are being collected within the same reach:
        i. Collect water quality samples or readings prior to sediment grab sampling
        ii. Ensure the sediment to be sampled has not been walked on or disturbed by field staff
    c. Choose sampling location(s):
        i. A minimum of three subsamples will be collected from each site. More may be required to reach the needed sample volume (see Table 1)
        ii. Sites with recently-deposited, fine sediments will be chosen—sediment grab samples will not be collected from locations that only have larger grain material
        iii. Identify subsample locations of fine sediment deposition before entering water to avoid disturbing the sediments to be collected
        iv. Label sampling containers with site information, analysis type, date, and time before collecting sample
        v. Photo document the overall site reach, subsample locations, and other important features
        vi. Note GPS location of sample collections
    d. Collect sample(s)
        i. Using the Van Veen grab sampler or a polyethylene scoop, collect the top 2 cm of recently deposited fine sediment
            1. Lower the sampler slowly and raise slowly to avoid incomplete closure and/or loss of fine material
            2. Avoid allowing portions of the sample to sit in contact with any metal surfaces
            3. Gently tip grab to pour off any overlying water, but do not remove surficial sediments
            4. When using the Van Veen grab, collect material from the center of the grab to avoid areas that have been in contact with the metal walls
        ii. Move upstream as subsequent subsamples are being collected within a reach—do not advance downstream where disturbed sediment is traveling
    e. Homogenize subsamples
        i. Combine subsamples in the 4 L glass homogenization jar and stir (do not shake) for at least 5 min, ensuring all sediment is homogenized
        ii. Quickly scoop the sediment out of the homogenizing jar and into pre-labeled sampling jars
            1. Stir sediment in homogenizing jar between each aliquot
        iii. Visually inspect each sample container for consistency in grain size
    f. Short-term sample storage
        i. Single-bag each sample jar to avoid contamination
        ii. Immediately place sample on ice according to temperatures outlined in Table 1
    g. Samples will be rejected if:
        i. Mud surface is pressing out of the top of the sampler (grab needs to be lowered more slowly)
        ii. Overlying water is leaking out and removing surficial sediment
        iii. The sediment surface in the sampler is not flat and level (the grab tilted over before closing)

3. **Equipment decontamination and protection from contamination**
    a. Decontamination at ONE site (between subsamples)
        i. Scrub sampler with ambient water to remove adhering sediments
        ii. Visually inspect sampler to ensure no contact surfaces have remaining sediments
    b. Decontamination between EACH site (between locations)
        i. Rinse all sampling surfaces with ambient water
        ii. Scrub all contact surfaces with phosphate-free, disinfecting detergent
        iii. Rinse all sampling surfaces with ambient water
        iv. If equipment has recalcitrant mineral residue, rinse contact surfaces with 5% HCl
        v. If equipment has recalcitrant oily residues, rinse all contact surfaces with methanol
        vi. Rinse with deionized water
    c. If boats are used for sampling, engines will be turned off when possible while collecting samples to avoid contamination from engine exhaust
    d. Samples will not be touched with ungloved hands
    e. All sampling equipment will be made of non-contamination materials and will be appropriately cleaned between uses

4. **Upon return after grab sampling**
    a. Copy and/or save any (hard or digital copy) field notes, data sheets, COCs, etc. as necessary
        i. Share with the appropriate parties as needed
    b. Ensure all samples are appropriately labeled
    c. Ship samples to analysis laboratory
        i. Place COC(s) in plastic bag within cooler(s)
        ii. Ensure volume of ice is equal to (or, preferably, double the volume of the sample containers
        iii. Pack cooler(s) for shipping (affix cooler seal(s) and shipping label(s))
        iv. Ship overnight
    d. Address any equipment issues or cleaning needs
        i. Decontamination should be conducted immediately following sampling, but complete upon return from the field if necessary
        ii. Store equipment in sealed non-reactive bags

Based on:

Collections of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California, MPSL Field SOP v1.1. California State Water Resources Control Board. 2014. https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/collect_bed_sediment_update.pdf

Radtke, Dean B., 2005, Chapter A8, Bottom-Material Samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9; chap. A8, https://doi.org/10.3133/twri09A8.

Table 1. Summary of sample container, volume, preservation, and storage requirements by analysis parameter

Analysis Parameter	Containers	Sample Volume	Field preservation	Max Holding Time
Trace metals	60-mL I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 C	12 months (-20 °C)
Methylmercury	60-mL I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Freeze to ≤-20 °C immediately	12 months (-20 °C)
Selenium	60-mL I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months (-20 °C)
Synthetic organic compounds	250-mL I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	500 mL (two jars)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months (-20 °C)
Sediment TOC	250-mL clear glass jar; Pre-cleaned	125 mL (one jar)	Cool to ≤6 °C or freeze to ≤-20 °C	28 days at ≤6 °C; 1 year at ≤- 20 °C
Sediment grain size	250-mL clear glass jar; Pre-cleaned	125 mL (one jar)	Wet ice to ≤6 °C in the field, then refrigerate at ≤6 °C	1 year (≤6 °C) Do not freeze
Sediment toxicity testing	1-L I-Chem wide-mouth polyethylene jar with Teflon lid-liner; Precleaned	2 L (two jars completely filled)	Cool to 4 °C, dark, up to 14 days	14 days (4 °C) Do not freeze

Equipment and Supplies

Field notebook
Field datasheets (extras)
Clipboard
Chain Of Custody form (extras)
Zip-lock bag for COC form
“Sharpie” felt tip pens
Ball point pens
Van Veen sampler
Polyethylene scoops
4L Glass homogenization bottles
Sample bottles
Bottle labels
Extra sample bottles
Extra bottle labels
Deionized water
Cleaning detergent
Other cleaning chemicals
Rubber, latex, or vinyl gloves
Safety glasses
Ice chests
Ice packs (Blue ice)
Packing tape
UPS overnight shipping forms

Rope
Waders (Waders may be knee, hip, or chest)
Cell phone and telephone numbers
Knife/scissors
Maps
Paper towels
Camera
GPS unit
Extra batteries
Tools

APPENDIX B-4

Standard Operation Procedures

Data Sonde Calibration

Continuous Water Quality Monitors – SOP

Klamath River water quality monitoring and SSC sampling

I. ANALITE high-range turbidity service Protocols

1. Place cal-checked Analite NEP5000 from the office adjacent to deployed sensor
2. Wipe both sensors (field and site)
3. Obtain pre-clean readings, enter in SVMAQ
4. Remove deployed sensor, clean it.
    a. Q-tip on optics face and wiper
    b. Tooth brush or similar on sensor body and cable
    c. Chimney brush to clean deployment tube
    d. Long pool brush or similar to clean outside of deployment tube
    e. Inspect wiper, inspect wiper position ensure it is normal (about 190deg from the optics, or slightly more than 180deg from optics)
    f. Look for scratches on optics face
5. Replace cleaned site sensor in cleaned deployment tube
6. Obtain post-clean readings, enter in SVMAQ
7. Quarterly Cal Checks:
    a. Remove cleaned sensor again from deployment tube
    b. Check in 0 DI water after rinsing 3 times in DI water
        i. Rinse again and check again in DI water if readings are >1.5 FBU above/below zero (FBU = formazin backscatter unit, which is what this sensor measures in, not NTU)
    c. Check in 5000 NTU (really FBU) standard after rinsing 3 times
        i. Use previously used standard to triple rinse, dump out in waste container
        ii. Use new standard to check, and pour out in rinse container for next rinse
    d. Record cal check readings in SVMAQ, cover the range of conditions with polymer (e.g., if conditions <5000 FBU, you do not need to use 10000 or 30000 to check)
    e. DO NOT recalibrate in the field
    f. Swap in the spare sensor if:
        i. >1.5 FBU different from zero DI after several attempts to ensure proper rinsing
        ii. >5% off in 5000 or other polymer standard, will be alerted in SVMAQ by orange data
    g. If spare sensor is swapped in, cal check the old sensor again in the office and recalibrate as necessary.

II. EXO Service Protocols

California sites – Operated by Karuk and Yurok Natural Resources Departments

1. In general, it has been agreed that the Karuk tribal members will perform cal checks on EXOs.
2. Deploy cal-checked field EXO from the office
3. Enter pre-clean readings in SVMAQ for the field and site EXOs
4. Clean the deployed EXO (see below) and re-deploy
5. Enter post-clean readings in SVMAQ

6. Save SVMAQ file and send to Karuk email members
7. Let Karuk know if calibration appears off after cleaning, i.e., there is large disagreement in post-clean readings

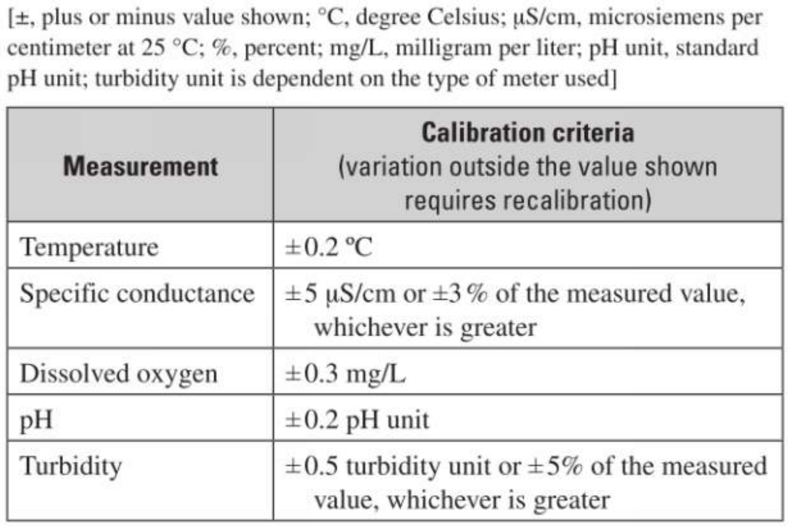
Oregon Sites – Operated by U.S. Geological Survey

Cleaning YSI EXO2 sondes in the field

1. Place cal-checked YSI EXO from the office adjacent to deployed sensor
2. Wipe both sensors (field and site)
3. Obtain pre-clean readings for all water quality parameters, enter in SVMAQ
4. Remove deployed sensor, clean it.
    a. Q-tip on optics face and wiper
    b. Tooth brush or similar on sensor body and cable
    c. Chimney brush to clean deployment tube
    d. Long pool brush or similar to clean outside of deployment tube
    e. Inspect wiper, inspect wiper position ensure it is normal (about 190deg from the optics, or slightly more than 180deg from optics)
    f. Look for scratches on optics face
5. Replace cleaned site sensor in cleaned deployment tube
6. Obtain post-clean readings, enter in SVMAQ

Quarterly Calibration checks

Calibration of deployed EXO2 sondes will occur approximately quarterly at USGS-operated continuous water quality monitoring sites. When calibration checks reveal only a small amount of calibration drift, it may not be necessary to recalibrate the instrument. Calibration criteria will be used to determine if sensor require re-calibration (Table 1). In practice, a calibration check of cleaned sensors using calibration standards is compared to the calibration criteria. If calibration drift is within the calibration criterion, the sensor is considered stable and recalibration is not required (Wagner and others, 2006)



[±, plus or minus value shown; °C, degree Celsius; µS/cm, microsiemens per centimeter at 25 °C; %, percent; mg/L, milligram per liter; pH unit, standard pH unit; turbidity unit is dependent on the type of meter used]

Measurement	Calibration criteria (variation outside the value shown requires recalibration)
Temperature	±0.2 ºC
Specific conductance	±5 µS/cm or ±3 % of the measured value, whichever is greater
Dissolved oxygen	±0.3 mg/L
pH	±0.2 pH unit
Turbidity	±0.5 turbidity unit or ±5% of the measured value, whichever is greater

Table 1: Calibration criterion for continuous water-quality monitors (Wagner and others, 2006)

If calibration checks result in re-calibration of sensors, the following procedures will be followed:

Before Calibrating

1. Clean all probes with the correct brushes (Kimwipe for DO and Phycocyanin probe, SC brush for SC probe, pipe cleaner for pH Probe) before calibrating. Clean the body of the probes and any other surfaces inside of the calibration cup with a toothbrush
2. Check that all the probes are tight. They should be tight, **but not torqued.**

Preparation:

1. Use the lab calibration cup and probe guard for all calibrations and checks.
2. Prepare sonde for dissolved oxygen (DO) calibration. Remove the calibration cup, probe guard and the probe guard end-cap with holes, exposing the sensors. Carefully dry the temperature and DO probe surfaces using a Kimwipe, **do not use condensed air to dry the DO probe.**
3. Replace the black probe guard, minus the holy end-cap, over sensors (removing end-cap now will aid in further rinses later on) without wetting the DO or temperature probe tips. (Note the different threads on each end of the probe guard & match accordingly, the finer threads correspond with the sonde body). Be careful not to cross-thread as the plastics are soft.
4. With the calibration cup still detached and resting on the benchtop, add approximately 1 inch of tap water.
5. Mount the sonde vertically (probes pointed downward) by carefully placing the sonde into the water filled calibration cup, but carefully without wetting the DO or temperature probe tips. The sonde's probes should now be hovering above the water in the calibration cup.
6. Loosen the calibration cup almost completely. This will ensure that the barometric pressure inside the cup is the same as the pressure outside of the cup. **It is important to wait at least 15 minutes** for the temperature reading to stabilize and for the air inside the calibration cup to become 100% water-vapor saturated before calibrating the DO probe.

Connecting to EXO Sondes: (Via PC Notebook)

1. Activate the Bluetooth connectivity of the sonde by holding the associated magnetic wand tool (or any magnet) over the magnet symbol on the sonde.
2. The solid Blue LED light on the sonde should now be on, displaying the sonde's Bluetooth is active (a Red LED should also be blinking letting the user know the sonde is now 'awake').
3. Open the KOR-EXO software on the Desktop.
4. Connect to the EXO sonde via Bluetooth (if PC is Bluetooth capable & allows devices to connect) by selecting the "Connections" menu (Green/Blue Circling arrows) and selecting the "Rescan" button on the left. If the computer you are using before has connected to this EXO before it will pop up here. If not, then, select the "Search Bluetooth" button. This will "Discover Devices" and sometimes multiple attempts are required. Select your sonde and "Connect". **Note: The sonde Bluetooth range is rated at 30 feet, but 10 feet is more realistic to prevent problems initially connecting.**
5. If the Bluetooth does not work for some reason, you can connect to the EXO sonde via the USB Signal Output Adapter to the sonde's upper right 6-pin communications port and to the laptop's associated (COM) USB port.
6. Sonde is now connected and it's corresponding model & S/N will now be displayed in a box in the upper right-hand of KOR (sonde connection is also displayed by the sonde symbol having a green check mark). You will also be automatically take you the "Dashboard" screen (Green Runner) with the various sensor parameters displayed. Proceed to calibrations.

Dissolved Oxygen Calibration:

1. After sonde "Preparation" for DO (as described above) and at least 15 minutes, it is time to calibrate.
2. Check that the temperature and DO readings are stable via the Dashboard (Runner Icon). The temperature may change very slowly (e.g. one-hundredth of a mg/L every 10 seconds or so), but this is stable enough.
3. To determine what value to calibrate to, enter in pressure and temperature in CHIMPS or SVMOBILE, where the value will auto populate.
4. Navigate to the Calibration screen (Crosshair symbol) to begin the calibration sequence. Select "Port-3 ODO" and then select "ODO mg/L". A "Device Calibration" window will now appear in a separate window.
5. Select "1 Point" calibration and enter the value from the DO concentrate on table into the "Standard Value" box.
6. "Sal psu" value should be '0'. DO NOT ENGAGE WIPE SENORS.
7. Select "Start Cal". Real time readings will be displayed. Once the values have stabilized (green "Stable Data") Select "Apply" and then "Complete".
8. A "Calibration Summary" for DO will now be provided.
   Record the calibration DO values and also the ODO Gain value from this summary. DO gain should be somewhere between 0.85 and 1.15. If the gain is drastically out of range, or the QC score has a red 'X' or yellow '!' the DO probe may need to be serviced or replaced. Otherwise, go by the QC score in the calibration summary, a 'green check' should be displayed in the summary indicating proper probe function.

9. Verify the calibrated value is equal to the value you entered for the sensor to calibrate to.
10. Next, remove the calibration cup so it's just the probe guard and place the sonde in the 100% air-saturated water bucket.
11. View real time readings by selecting the Dashboard. At the top right of the screen, select "Wipe Sensors" and wait for the sensors to be cleaned. This will remove air bubbles from the ODO probe.

12. After the DO reading has stabilized, record the temperature reading of the water and check that the barometric pressure has not changed.
13. Use the DO table in the lab folder to find the DO mg/L value the sonde should read in the 100% air-saturated water.
14. Record the DO mg/L value the sonde reads in the water in the comments section in CHIMPS or SVMOBILE. If the sonde reads outside the range of ± 0.06 mg/L of the DO concentration table value, the DO sensor needs to be recalibrated.

Notes about the YSI ROX Optical DO probes:

- The Optical Dissolved Oxygen sensor does not require any special sonde setup or burn-in.
- Calibration data is stored in the probe so it can be calibrated in one sonde and then used in another without recalibrating the probe in the new sonde.
- Calibration data are automatically transferred to the host sonde as soon as the sonde powers up the sensor.
- Field DO calibrations should be avoided!
- The DO sensor must remain hydrated at all times.

If you believe that you have calibrated a probe in error, then you can return the probe back to its original factory calibration by using the “uncal” command. At the “Device Calibration” screen where you would type in the “Standard Value” for a DO calibration, press the “Advance” button in the lower left and select the “uncal” button.

Specific Conductance (SC) (Combined with Temperature on same probe):

1. Reinstall the calibration cup onto the sonde body. **Note: Make sure the threads are nice and tight! As this is a compression fitting and sonde could slip loose from cup and crash.**
2. Rinse the calibration cup (accessed via the calibration cup’s endcap) and sensors vigorously three times with a small amount of 1000 µS/cm standard solution and discard. Use the bottles labeled “flush” for these rinses. Shake the sonde each time to rinse all surfaces in the cup with the standard flush solution.
3. Put *FRESH* 1000 µS/cm standard solution in the cal cup, **just enough to submerge the SC sensor completely when the sonde is laid on its side. Use the least amount of solution as possible, as this stuff is expensive!!!** The vent holes in the side of the probe must be under the solution. It is important not to have trapped bubbles in the cells. Gently shake the sonde to help dislodge any air bubbles that may be trapped in the conductivity sensor.
4. Navigate to the Calibration screen (Crosshair symbol) to begin the calibration sequence. Select “Port-1 Conductivity” and then select “SpCond µS/cm ”. A “Device Calibration” window will now appear in a separate window.
5. Enter the value of 1000 µS/cm as your “Standard Value.” Make sure the probe is fully submerged in standard and clear of bubbles to proceed with “Start Cal”.
6. Select “Start Cal.” Real time readings will be displayed. Once the values have stabilized (green “Stable Data”) Select “Apply” and then “Complete”.
7. A “Calibration Summary” for SC will now be provided.
8. Record the values, and don’t forget the cell constant value which will be listed under “Additional Post Calibration Info.”

1. Check the conductivity cell constant is in a somewhat acceptable range of 4.5 - 6.5. Numbers drastically outside of this range may indicate a problem in the calibration process, with the standard that was used or that the sensor needs to be serviced or replaced. Otherwise, mainly go by the QC score in the calibration summary, a ‘green check’ should be displayed in the summary indicating proper probe function. A red ‘X’ or yellow ‘!’ indicate the probe may need to be serviced or replaced.
9. If the sonde reports “Out of Range” after the calibration, investigate the cause! Never override a calibration error message without knowing the reason. Typical causes for this error message are incorrect entries, low solution level, fouled probe contacts, air bubbles in the probes cell, calibrating conductivity instead of specific conductance (SpCond), and/or bad standard or the sensor needs to be serviced or replaced.
10. Pour the standard solution used for calibration into the 1000 µS/cm bottle marked “flush.”
11. Proceed to the Dashboard menu to check the SC calibration in 180 µS/cm and 50 µS/cm standards. Starting with the 180 µS/cm standard, rinse the probes and calibration cup three times with each standard (flush). Fill the cup to cover the SC probe with *FRESH* solution, and record the measured values.
12. Record the lot numbers of the FRESH standards used.
13. Pour the solution used to check the SC calibration into the appropriate flush bottles. The sonde SC should read within ± 3 µS/cm of the measured value of the check standards. If a check standard is out of range, first try tapping or shaking the sonde to get air bubbles out of the conductivity sensor. If that does not work, try to re-flush with the same standard. If that does not work, clean the SC probe with a conductivity brush and repeat the calibration in the 1000 µS/cm standard solution.
14. Dry the SC probe and record the SC value in air using canned air. This should be between 0 and 1 µS/cm. If a different value is found, try blowing through the probe with compressed air to remove any remaining solution. If the SC reading is 2 µS/cm or less, the probe is acceptable for deployment. If it reads higher than this, try re-calibrating the probe, or try cleaning the SC probe ports with a dilute Liquinox solution and a conductivity brush. If the probe still does not read below 2 µS/cm, replace the probe.

Notes about the SC/Temperature sensors:

- The accuracy of the **reference** temperature probe must be checked by comparison with a traceable thermometer (NIST). Temperature compensation is used in every sonde measurement, so its accuracy should be verified and recorded. These thermistor checks should be done quarterly at 5 temperatures. More verifications may be needed if there is evidence the probe is not working properly.
- Never calibrate with conductivity standards that are less than 1000 µS/cm. You are setting the slope on a linear device, so a good strong conductivity signal will give the best performance.

pH

1. Rinse the calibration cup (accessed via the calibration cup’s endcap) and sensors three times with a small amount of pH 7 buffer flush. After the three rinses, fill the calibration cup with just enough *FRESH* pH 7 standard so that the pH and temperature sensors are completely immersed when sonde is laid on its side**. Use the least amount of solution as possible, as this stuff is expensive!!!**. Check that there are no bubbles in contact with the bulb of the pH sensor.
2. Record the lot number of the FRESH pH 7 standard.
3. Make sure before you start the calibration process that the pH value is stable. Usually, 2-3 minutes is needed for the values to become stable, as the values slowly drift.
4. After confirming the pH values are stable, navigate to the Calibration screen (Crosshair symbol) to begin the calibration sequence. Select “Port-2 pH” and then select “pH”. A “Device Calibration” window will now appear in a separate window.

5. Select a ‘2 Point” calibration
6. Wait for the temperature reading near the left to stabilize, and record the temperature. (This will be the temperature used to correct for both pH 7 and pH 10)
7. Enter the temperature information into SVMOBILE or CHIMPS, the program will auto populate the correct value to calibrate to.
8. Begin the calibration sequence for pH by selecting “Start Cal”. Real time readings will be displayed for pH 7. Once the values have stabilized (green “Stable Data”) Select “Apply” and then “Proceed”. **Note: The “Proceed” button actually finalizes the calibration for pH 7. Do not proceed to pH 10 before selecting “Proceed”.**
9. A “Proceed to Standard: 10 pH” prompt will appear.
10. **BEFORE YOU CONTINUE** – rinse the probes and calibration cup three times with pH 10 flush solution and fill with FRESH pH 10 standard solution to completely cover the pH probe.
11. Press “Ok”
12. Real time readings will be displayed for pH 10. Once the values have stabilized (green “Stable Data”) Select “Apply” and then “Complete”.
13. A “Calibration Summary” for pH will now be provided.
2. Record the values, along with pH millivolts for each calibration point via the summary. The acceptable millivolt output for the pH 7 buffer is around 0 ± 35 mv. The acceptable millivolt output for the pH 10 buffer is around -180 ± 35 mv. Otherwise, mainly go by the QC score in the calibration summary, a ‘green check’ should be displayed in the summary indicating proper probe function. A red ‘X’ or yellow ‘!’ indicate the probe may need to be serviced or replaced.
3. Record the “Delta Slope” of the sensor from the summary (Delta Slope value will be listed under “Additional Post Calibration Info”). This is the calculated difference (in mv) between the two calibration points that were used. For example, if you record +3 mv for the pH 7 buffer and -177 mv for the pH 10 buffer, the slope would be 180. The acceptable range for the slope is 165 to 180. If the difference is out of this range but the QC score checks out OK then the probe is probably OK, but this is usually a sign that the probe tip needs to be replaced soon.

Notes about the pH sensor:

- Do not use a probe that has given the warnings “Calibration Error” or “Out of Range.”

Turbidity

1. Clean the optics of any fouling, fingerprints, etc.
2. Start with the 0 FNU standard (DI Water). Rinse the calibration cup and probes three times with DI water.
3. Fill the calibration cup, very carefully down the side of the cup, with DI water. Be very careful, avoiding aerating the water at all. **THERE SHOULD BE NO BUBBLES!**
4. Replace the ‘end cap’. Carefully invert sonde into the upright position, resting it on its ‘end cap’. Verify that there are no air bubbles on the probe face and engage the wiper (if applicable). If bubbles remain on the probe surface, engage wipers again (via the Dashboard Menu- Wipe Sensors) or replace with fresh DI water.
5. Navigate to the Calibration screen (Crosshair symbol) to begin the calibration sequence. Select “Port-5 Turbidity” then “Turbidity FNU” and select “2-Point” Calibration.
6. Enter 0 FNU for the first calibration point (DI Water). Also, enter your value of the formazin standard you will be using for the second calibration point, replacing the “NaN” value. (This standard value is up to the user and is typically based on the environmental water conditions that will be expected in the field.)

7. Begin the calibration sequence for turbidity by selecting “Start Cal”. Real time readings will be displayed for the DI value. Once the values have stabilized (green “Stable Data”) Select “Apply” and then “Proceed” to calibration point 2 or 2.
8. BEFORE YOU CONTINUE – rinse the probes and calibration cup three times with your formazin flush solution and then fill with FRESH formazin standard solution to completely cover the pH probe when in the upright right position.
9. Return the sonde to its upright vertical position. Press “Ok”
10. Real time readings will be displayed for your formazin standard. Once the values have stabilized (green “Stable Data”) Select “Apply” and then “Complete”.
11. A “Calibration Summary” for Turbidity will now be provided.
12. Record the “Pre” and “Post” FNU values for both points onto your Calibration Form. Circle Y under Cal? on your Calibration Form.

Notes about the turbidity sensor:

- Never override a calibration error message without understanding the cause of the problem. Error messages indicate that a problem exists that could result in incorrect field readings.
- The calibration of YSI turbidity sensors must be done with either YSI distributed standards, Hach StablCal, diluted Hach 4000 NTU Formazin, or standards that have been prepared according to the instructions in Standard Methods (Section 2130B). Standards from other vendors are NOT approved, and their use will likely result in a bad calibration and incorrect field readings.

- When a sonde is deployed in clean water and it reports negative turbidity data, the cause can usually be traced to the zero calibration. Despite the best practices it is sometimes impossible to clean the sonde and the calibration equipment to a point where the zero standard is not contaminated by some small amount. This is especially true when using previously deployed equipment.

III. Equipment List

- ☐ Chimney brush
- ☐ Pool brush
- ☐ Qtips
- ☐ Toothbrush
- ☐ Tablet with synced SVMAQ
- ☐ Cal-checked reference sensor EXO and/or Analite
- ☐ Calibration standards for pH and specific conductance
- ☐ 0 DI water from HIF
- ☐ 5000 polymer standard (Analite only)
- ☐ 10000 polymer standard (Analite only, if needed)
- ☐ 30000 polymer standard (Analite only, if needed)
- ☐ Cal cup (250 mL brown HDPE wide mouth bottles)
- ☐ Waste container (containerize used calibration standards)
- ☐ Rinse container for polymer standards (one per standard)

IV. Pre-trip preparation

- ☐ Calibrate field EXO/Analite
- ☐ Load equipment listed above
- ☐ Ensure all manuals are available on tablet
    - ISCO
    - AXIOM
    - SatLink3
    - EXO
    - Analite

APPENDIX C

Quality Assurance Plan for the Analysis of Fluvial Sediment by the USGS California Water Science Center Sediment Laboratory

QUALITY-ASSURANCE PLAN FOR THE ANALYSIS OF FLUVIAL SEDIMENT BY THE U.S. GEOLOGICAL SURVEY CALIFORNIA WATER SCIENCE CENTER SEDIMENT LABORATORY

Updated February 2018

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Acronyms used in this report:

CAWSC	California Water Science Center
CVO	Cascades Volcano Observatory, Vancouver, Washington
NWIS	National Water Information System
PCMSC	Pacific Coastal and Marine Science Center
SLEDS	Sediment Laboratory Environmental Database System
SLQA	Sediment Laboratory Quality-Assurance Program
USGS	United States Geological Survey
WRD	Water Resources Division of the U.S. Geological Survey

Abbreviated units used in this report:

cm	centimeter
g	grams
gal	gallons
in.	inches
L	liter
L/min	liter per minute
m	meter
mm	millimeter
mg	milligrams
mg/L	milligrams per liter
mL	milliliter
ppm	parts per million
µmhos/cm	micromhos per centimeter at 25 degrees Celsius (µS/cm at 25° C)
µS/cm	microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25° C)

Quality-Assurance Plan for the Analysis of Fluvial Sediment by the U.S. Geological Survey California Water Science Center Sediment Laboratory

Prepared by Stephen S. Low and Allan C. Mlodnosky

Introduction

This report describes the quality-assurance plan for the U.S. Geological Survey (USGS) California Water Science Center (CAWSC) Sediment Laboratory (hereafter referred to as Lab) co-located with the CAWSC Santa Cruz Field Office and the Pacific Coastal and Marine Science Center (PCMSC) in Santa Cruz, California. The Lab is one of several sediment laboratories operated by the USGS Water Mission Area (WMA) to provide analytical services for hydrologic and hydraulic studies. The Lab uses various techniques to help insure the accuracy of the analyses performed and the information released. These techniques are based on quality-assurance and quality-control (QA/QC) guidelines described in Knott et al (1992) and Matthes et al (1992). The laboratory theory and analytical methods used in the Lab are described by Guy (1969).

The Lab performs a variety of analysis on the 4000 to 5000 samples received each year from USGS field and project offices that are located throughout California and Nevada, as well as samples received from other agencies. Of the samples received, approximately 3000 are analyzed for suspended sediment concentration, 1500 are for sand/fine separation, 200 are dry sieve particle size analysis (PSA), 100 are wet sieve PSA, and 100 are PSA via the pipet method.

Quality assurance is an integral part of all laboratory activities. Quality assurance guidelines are established to detect and correct problems with laboratory equipment, detect and document biases in analytical processes, and prevent these issues from causing incorrect data interpretation by Lab customers.

This Quality Assurance Plan has three principal goals:

- Promote effective operations within the Lab
- Assist the laboratory staff in performing their duties
- Ensure that the information and data generated by the Lab is reliable and correct

Quality Assurance of Laboratory Equipment

The following sections describe the specific procedures used by the Lab for assuring the quality of the equipment and supplies used in the analysis of fluvial sediments.

Laboratory Equipment

The analysis of fluvial sediment samples by the Lab requires a wide variety of laboratory equipment. Electronic balances, conductivity meters, ovens, thermometers, Ro-Tap sieve shakers, dishwashers, sediment sample mixers, and vacuum pumps are purchased from commercial laboratory supply companies. Other equipment, such as decanting equipment, crucible holding apparatuses, or filtering equipment are fabricated to fit the needs of the laboratory.

The equipment is periodically inspected to insure that it operates properly and up to specific standards. Maintenance and calibration is done by Lab staff on as-needed bases. When maintenance or calibration for certain equipment requires professional assistance a service representative is contracted to do the work.

Electronic Balances

The Lab uses two types of electronic balances to determine the mass of sediment samples and containers. Both types of balances are set up in areas with minimal vibration and where temperature and humidity are not subject to excessive change. The macro balance is used for tarring sample containers, weighing in samples, and for weighing sediment during coarse particle size analysis. The analytical balance (Fig. 1) is used for weighing filtration crucibles and evaporating dishes. The balances are checked prior to use with ASTM test weights that encompass the high, middle and low points of the expected range of sample weights. The checks are recorded in the balance log book and a separate log book is kept for each balance. The balances are calibrated by Quality Control Services, Inc. annually. After the balances have had their annual calibration, the labs check weights are tested against the calibrated balance to insure the check weights are accurate. If there is more than a one percent difference between the check weights and the calibrated balance reading, then new check weights are purchased.

Figure 1: Computer station with analytical balance used for working in Sediment Lab Environmental Database System (SLEDS) and on other laboratory tasks.

Conductivity Meters

A conductivity meter is used to measure specific conductance of suspended sediment samples prior to analysis. Specific conductance is measured in microsiemens per centimeter (µS/cm) at 25 °C. The specific conductance of the sample determines if it can be run using evaporating dishes and if it needs a dissolved solids correction.

The conductivity meter is also used to determine the purity of the deionized water (DI). The DI water is routinely checked twice a week to insure that the conductivity is below 1.0 µS/cm. The conductivity meter is calibrated on a monthly and an as-needed basis with calibration standards. For checking the conductance of the DI water supply, the calibration of the conductivity meter is bracketed by a 50 µS/cm standard and a 0 µS/cm standard (which is obtained by rinsing the probe and holding it in the air). For checking environmental samples, two standards are used that bracket the expected range of conductivity for the sample. The meter is recalibrated if more than a three percent difference exists between the standard solution and the displayed value of the meter.

Ovens

Three convection ovens (Fig. 2) are used to dry sediment, crucibles, evaporating dishes, and other types of laboratory equipment. The ovens are checked weekly with a separate thermometer to determine if the built in thermometer is reading accurately. If the ovens are found to be out of tolerance, the set temperature is adjusted and checked until the desired temperature is achieved. The oven temperatures and temperature checks are recorded in a log book. Separate log books are kept for each oven.

Two of the ovens are routinely used for drying crucibles and evaporating dishes containing samples. When the ovens are drying evaporating dishes, they are operated at 85°C ± 2°C, which is slightly below boiling temperature and intended to prevent splattering of the samples, loss of sample, and cross contamination. When the ovens are drying filtration crucibles, they are operated at 103°C ± 2°C.

The third oven is used for drying bags or cups of coarse sediment for particle size analysis using the Ro-Tap. This oven is operated at 60°C ± 2°C and typically left on over night when drying coarse sediment.

Figure 2: Three mechanical convection ovens used to dry sediment, crucibles, dishes, sample containers and other laboratory items.

Decanting Equipment

Decanting equipment is used to extract the supernatant or sediment-free portion of the water-sediment mixture from the sample bottle. This is done after the initial sample weight has been obtained and the sample has had sufficient time to settle. Usually two weeks is enough time to ensure that all sediment particles have settled to the bottom of the sample container. The equipment used to decant supernatant water from the samples consists of a vacuum pump that is connected to storage container. On the other end of the storage tank is rubber tubing which connects the tank to a valve operated crucible holding rack and a separate piece of tubing with a J-shaped tube (hereafter referred to as J-tube) attached on the end. While decanting, the valves on the crucible holding rack are closed so as to not lose pressure. The rate of suction from the J-tube should not exceed 1.0 or 1.5 L/min. This ensures that sediment below the opening of the J-tube will not be sucked up from the bottom of the sample container. If necessary, the suction rate can be adjusted by partially opening one of the valves attached to the crucible holding rack. The suction rate is periodically checked by decanting 1.0 L of DI water. The time it takes to completely decant and any adjustments that were made are recorded in a log book.

Dishwashers

Two commercial grade dishwashers (Fig. 3) are used to clean bottles, containers, lids, crucibles, evaporating dishes, and other lab supplies. The dishwashers are both Hobart LXi's with chemical sanitation. At this time no chemical sanitation procedures are in place for washing lab supplies. The dishwashers are operated at temperatures above ~120 ºF. The pressure is regulated by a flow restrictor that was installed on the water line leading into the dishwater. No dishwashing detergent is used. The dishwashers are capable of running 30 racks per hour and use 0.74 gallons of water per rack.

Figure 3: Commercial grade dishwashers and double basin sink for washing lab supplies.

Filtering Carts

Two filtering carts (Fig. 4) are used for analyzing suspended sediment concentration and sand/fine separations of sediment samples. The filtering equipment is used to separate the sediment from the water-sediment mixture through crucibles that have perforated bottoms and glass microfiber filters. The glass microfiber filters allow the passage of water while retaining sediment. The filtering carts are equipped with crucible racks with crucible holders attached to a vacuum system. Rubber tubing and valves are used to connect and operate the filtering apparatus. The outflow is connected to a storage tank near the bottom of the cart and is used to collect the filtrate. After each use the storage tank is emptied into the floor drain located in the lab.

Figure 4: Filtering cart used for sediment analysis. The cart is equipped with a valve operated crucible holding rack, vacuum system and storage tank.

Pipette-Method Equipment

The Lab uses a water bath with a sliding pipette apparatus attached above the bath (here after referred to as Pipet Bath, see Fig. 5) for particle size analysis of sediment finer than 0.0625 mm. The pipette used in the analysis holds 25 mL of water-sediment mixture and has marks drawn on the end for determining withdrawal depths. A vacuum system is attached to one stem of the pipette and a DI water rinsing system is attached to the other stem to allow for evacuating the sample and rinsing the pipette between withdrawals.

Graduated sedimentation cylinders ranging in volume from 500 to 1000 mL are used in the pipet method for particle size analysis. The cylinders are made of glass and have known volume marks etched on them. The volume marks were obtained by pouring DI water into the cylinder until it reached a specified weight. The weight of water is equal to the volume of water at room temperature (1.0 mL = 1.0 g). The water level was marked on the sedimentation cylinder to indicate the specific volumes.

During the pipet method analysis, the sedimentation cylinders containing samples of water-sediment mixture are placed in a constant-temperature water bath. The water bath is kept at 27 ºC ± 1°C. The temperature of the water bath is regulated by a heating element and water circulation pump. The temperature is monitored by a digital thermometer with a submersible probe that is placed in the water bath and is keep there throughout the analysis. The thermometers accuracy is ± 1°C with a resolution of 0.1°C and has memory storage capabilities for recording maximum and minimum temperatures.

A vacuum system attached to the pipette is used to make a series of aliquot withdrawals during the analysis. The system is equipped with a pipette bulb with valve controls that allows for the adjustment of the vacuum pressure and regulation of the pipette withdrawal time. The ideal withdrawal time is 14 seconds when the tip of the pipette is immersed to a depth of 15, 10, 5 or 3 cm, depending on the required particle size depth. The withdrawal rate is periodically checked throughout the analysis by a stopwatch that is mounted next to the pipette.

Figure 5: Pipet Bath used for preforming particle size analysis via the pipet method.

Sediment Sample Mixers

Four sediment sample mixers (Fig. 6) are used for preparing samples for PSA analysis via pipet method. The mixers are stick blender types with the blender cups. The blender cups are each marked with permanent ink to keep track of the different samples. The samples of sediment-water mixture are rinsed into the cups, which are then attached to the blender and mixed for five minutes on the low setting. A programmable timer controls the mixing time.

Figure 6: Sediment sample mixers used for mixing and dispersing sediment-water mixture.

Ro-Tap Sieve Shaker

A W.S. Tyler Ro-Tap Sieve Shaker (model RX-29, see Fig. 7) is used to agitate sieves during dry sieve analysis. Two sets of 8 in. sieves are kept with the Ro-Tap to allow the lab technician to be able work on two samples simultaneously. The Ro-Tap runs for 10 min when a stack of sieves are placed in and the noise and dust are contained by a sound enclosure surrounding the machine. A timer controls the Ro-Tap operation time and shuts the machine off after 10 min.

Figure 7: Ro-Tap sieve shaker with sound enclosure and test stand to contain dust and sound.

Laboratory Supplies

The analysis of fluvial sediment samples by the Lab requires a wide variety of laboratory supplies. Sample containers, crucibles, filters, evaporating dishes, sieves, pipettes, and desiccators are purchased from laboratory supply companies. DI water is provided by an in-house water conditioning system which supplies all labs located in the facility.

The supplies are periodically inspected to insure that they are in good condition. When new supplies are needed, they are purchased and old supplies are either discarded or set aside for use as back-ups. Supplies are dated to track when they were purchased and then put into use.

Sample Containers

The Lab receives samples for suspended sediment analysis in a variety of containers (Fig. 8). Containers A, B, and C are plastic and can hold up to 5 L, 1 L, and 1 quart, respectively. Containers D and E are wedge shaped and used in ISCO auto samplers. Container D holds up to 1 L and container E holds up to 0.5 L. Container F is the most common container used and holds up to 1 pint.

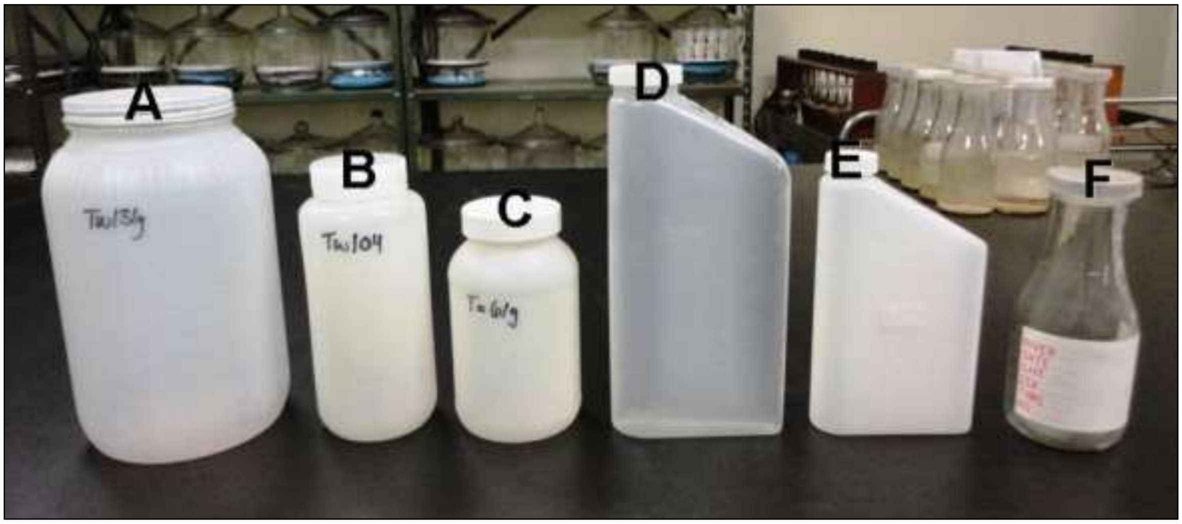

Figure 8: Typical sample bottles received by the Lab for suspended sediment analysis.

Crucibles and Filters

CoorsTek porcelain crucibles are used to analyze suspended sediment concentration and sand/fine seperation samples. Prior to use, the crucibles are cleaned in a commercial grade dishwasher, dried, then seated with filter pads and dried in an oven at 103°C ± 2°C for one hour. The filters used with the crucibles are "Whatman 934-AH". They have a diameter of 2.4 cm to match the diameter of the base of the crucible and are made from glass-microfibers to allow for 1.5 µm retention of suspended solids. After drying in the oven, the crucibles are immediately placed into desiccators to cool. Once cooled down to room temperature they are ready to be tarred to the nearest 0.0001g and assigned to samples during the sample preparation stage. After the crucibles are cleaned they are handled with gloves or tongs to prevent the transfer of moisture, dirt or oils.

Evaporation Dishes

The evaporation dishes used by the Lab are Pyrex glass dishes that have a number etched into the sides to track individual dishes. The evaporation dishes are used for weighing sediment samples requiring the evaporation method for concentration analysis. The evaporating dishes are also used for PSA by wet sieving and pipet method. The dishes are cleaned by hand with a scouring pad and hot water. They are then put through a commercial grade dishwasher. Once they are dried, they are organized by dish number and stored in drawers. Prior to use for sediment analysis, they are dried in an oven for one hour at 103°C ±2°C to remove any moisture. They are removed and promptly put in desiccators to cool. When they have cooled to room temperature they can be tarred to the nearest 0.0001 g and assigned to samples. After the cleaning process, the dishes are handled with gloves or tongs to prevent the transfer of moisture, dirt or oils.

Sieves

The sieves are visually inspected before each use to check for tears, damage, slack or obstructions. If a sieve is estimated by the laboratory staff to have more than 10 percent of the surface area clogged, then the sieve is cleaned in an ultrasonic bath. Generally, the larger sieves used for Ro-Tap analysis are cleaned after each batch of samples is ran. If the sieve is determined to be damaged or cannot be cleaned, it is discarded. New supplies of sieves are kept on hand in the event that one needs to be removed from use. Each sieve is dated with a permanent marker when put into service.

Desiccators

Desiccators are used to store dry sediment, crucibles and evaporating dishes in order to maintain a humidity free environment. After crucibles or dishes are removed from the oven, they are subject to moisture-absorption from the ambient conditions in the lab. Therefore, crucibles and dishes must immediately be placed in desiccators after they are removed from the oven. Desiccant is placed in the bottom of the desiccators to absorb any residual moisture than can collect in the vessel. The desiccant in the desiccators is inspected weekly and recharged every six months by placing the desiccant in a container and drying it in the oven at 105°C ±2°C for 2 hours to restore its original color and moisture absorption capacity. While the desiccant is recharging the desiccators are cleaned and inspected to insure that they are operating properly. The date of last recharge is written on the side of the desiccators.

Deionized Water

De-ionized (DI) water is used for a variety of laboratory tasks, such as rinsing sediment from a sample containers into crucibles, dish, and cylinders; rinsing lab wear after cleaning; prepping analysis equipment; and preparing QC samples (i.e. blanks and knowns). DI water is used to prevent the accidental introduction of dissolved solids into the sample during this process, which could contaminate the weight of the sample. DI water is provided from the in-house water conditioning system. The water condition system supplies the DI water needed by the labs in the facility. The Lab is equipped with two DI water taps, one for each lab sink. They are tested at least weekly by laboratory staff to ensure the specific conductance is below 1.0 µS/cm. The DI water checks are recorded in a logbook.

Quality Assurance of Laboratory Procedures

The following sections describe procedures used by the Lab for assuring the quality of the sample management and methods for the analysis of fluvial sediment.

Sample Management

The following describes quality assurance procedures for sample arrivals, sample storage and sample inventory.

Sample Arrival

Sediment samples are shipped to the Lab from different field and project offices located throughout California and Nevada. When samples arrive at the lab, the shipment is inspected to see if any obvious spillage or breakage has occurred. In the event of spillage, the field user is notified and the sample is held until further instruction is received from the sender. In some cases, DI water can be added to the sample to recover the original water level. In the event of breakage, the sender is notified and the sample and broken container are discarded. The sample container information is cross checked with the Sediment Laboratory Analysis Request (SLARs) form to assure that nothing is missing and the information is from both sources agree. A sample arrival log is filled out to help track sample shipments arriving to the lab. All samples in each shipment must be weighed in (gross weight obtained) within two days of arrival. This procedure is preformed to minimize the loss of sample mass due to evaporation. In the event that this criteria is not met, a note is made on the SLAR indicating the samples affected and a value qualifier is assigned to the samples results.

Sample Storage

Sample containers containing the sediment-water mixture are stored under tarps in the sediment storage room to block sunlight and slow the rate of organic growth. They will remain in the sediment storage room until they are ready to be logged in and set up for analysis. Bed material and bedload samples are also kept in the sediment storage room. If they arrive wet or damp, they are oven dried at 60°C ±2°C to prevent organic growth. They are arranged on a table in chronological order and remain there until ready for processing.

Sample Inventory

At the end of every month a tracking report is completed. This report tallies samples that have arrived, samples that were processed, and samples that remain in storage for that month. The tracking report is posted to the Lab website so customers can track samples that have been shipped to the lab. This report also provides lab productivity data that is made available to supervisors.

Sample Analysis

The Lab receives two types of sediment samples. Suspended sediment samples (i.e. sample bottles containing water-sediment mixture) and coarse sediment samples (i.e. samples that have been collected for sieve size analysis, that are usually contained in bags or cups and are dry). The Lab performs five types of analyses: suspended sediment concentration, sand-fine separation, and particle size analyses via wet sieve, dry sieve, and pipet methods. The following summarizes the standard operating procedures of these analyses and the software used to store data and compute results. These descriptions of procedures are not intended to be comprehensive SOPs, but rather documentation of some of the steps taken to achieve results of a known quality. For more detail on SOPs see Laboratory Theory and Methods (Guy 1969) or laboratory specific SOP documentation.

Laboratory Information Management System

The Lab is currently using the Sediment Lab Environmental Database System (SLEDS) Version 6.2 as its Laboratory Information Management System (LIMS) for all sediment sample analysis. SLEDS was developed by the Cascades Volcano Observatory (CVO) in Vancouver, WA and is maintained and updated by their staff. SLEDS computes and stores all Lab data. Utilizing this software with an electronic data transfer system eliminates keypunch and transcription errors as well as other mathematical errors.

SedLOGIN software is used with SLEDS for entering sample information into the NWIS Web, QWDATA and SLEDS databases. SedLOGIN is a “one-time-data-entry” program which allows field users to enter sample information into an online database that can be accessed by the lab staff. The field users enter the information for a batch of samples into SedLOGIN which generates file records in the database and a Sediment Lab Analysis Request Form (SLAR) for the batch. The SLAR generated by SedLOGIN also assigns an event number to each batch of samples so they can be located in the database by the lab staff. When they have arrived at the lab, the information on the SLAR is checked against the information on the sample bottles to make sure all the samples have arrived intact and there are no errors. When the samples are ready to begin processing, they are located in SedLOGIN and the sample information can be transferred into SLEDS. Once in SLEDS, the sample is assigned a Lab ID number which is used to track the sample throughout the rest of the analysis.

The Lab also uses Excel spreadsheets to track QC metrics. A quality control schedule is used list the types of QC checks and frequency at which they should be performed. These include dish re-weighs, decant tests, dispersing agent tests and blender rinse tests. An in-house known test spreadsheet is used to track the results of single blind in-house knowns used for tracking percent recovery of sediment mass and performance testing of new laboratory staff.

Sample Weight Determination

Upon arrival at the Lab each case of suspended sediment samples are weighed-in. For coarse sediment (i.e. bed material and bed load), this process can be skipped. The suspended sediment in sample bottles need to be weighed in as soon as possible in order to get the initial sample weight before any potential evaporation can occur which would decrease the weight of the sediment-water mixture. Before the bottle is weighed, dirt or foreign material is wiped from the outside of the sample containers. Each bottle is weighed on the macro balance in the sediment storage room, and the net weight is recorded on the bottle with a permanent marker for pint size glass bottles. This is done by tarring the scale using the standard tare bottle located next to the balance. The gross weight is recorded for all other containers, as these have tare weights written on the side of the container. The tare weights of the bottles are periodically checked for accuracy and re-tarred if needed. The sample weight determination process is checked by randomly selecting samples and re-weighing them to ensure the sample weights agree.

Sample Preparation

When a sample is ready for analysis, it is brought on a cart to the analytical balance computer station. All data written on the bottle by the field user is checked for accuracy against the SedLOGIN SLAR. After the bottle has been checked and logged in, it is arranged on the laboratory bench and ready for processing.

Concentration Analysis

Two methods of suspended sediment concentration analysis are used by the Lab. The filtration method is used for light samples (i.e. estimated low concentration) and the evaporation method is used for heavy samples (i.e. estimated high concentration).

Filtration Method

Samples for concentration using the filtration method are decanted and poured into a crucible or set of crucibles with a glass-microfiber filter. DI water is used to rinse the sample out of the bottle. A vacuum pump is used to draw the sample through the filter. After the all the sample has filtered, the filter and crucible are rinsed with DI water to ensure the passage of dissolved solids through the filter membrane before the crucibles are placed in ovens to dry. The ovens are set at 103ºC ±2°C. When they are completely dry, the crucibles are immediately placed into desiccators to cool to prevent them from absorbing moisture. After a minimum of three hours, the crucibles will have cooled to room temperature. They are then weighed again, and the weights are automatically added to SLEDS to the assigned sample.

Evaporation Method

The samples for concentration using the evaporation method are decanted the sample way as filtration method samples. The sample is washed from the bottle using DI water and poured into a dish or set of dishes. The ovens are set at 85ºC ±2°C when dishes are used to prevent splattering from boiling the sediment-water mixture. Once all standing water has evaporated, the ovens are turned up to 103ºC ±2°C for an hour. When they are completely dry, the dishes are immediately placed into desiccators to cool to prevent them from absorbing moisture. After a minimum of three hours, the dishes will have cooled to room temperature. They are then weighed again, and the weights are automatically added to SLEDS to the assigned sample.

Particle-Size Analysis

Four methods of particle-size analysis are used by the Lab. Sand-fine break separates the sand fraction (particles larger than 0.0625 mm) from the silt/clay fraction (particles finer than 0.0625 mm). Sand analysis separates the sand fraction of the sample into one phi interval size breaks. The range of particle sizes analyzed in the sand analysis differs per sample, but typically encompasses gravel size down to 0.0625 mm particles. Full size analysis offers a size distribution in one phi intervals for the sand and the silt-clay fractions. The range of particles analyzed for the full size method encompasses gravels down to 0.002 mm particles. For each of the above methods of particle size analysis, suspended sediment concentration data is also provided.

The last method of particle size analysis is the Ro-Tap analysis. For this analysis, particles ranging from coarse gravels to 0.0625 mm are separated into one phi interval size breaks. No concentration data is provided in this method, as the samples are analyzed by dry sieving.

Sand-Fine Break

For sand-fine separation analysis the sample is first decanted and rinsed through a 0.0625 mm ASTM testing sieve. The sample is assisted through the sieve by use of an electric vibrating hand massager (if needed) and DI water. The silt/clay material that passes through the sieve is captured in a porcelain evaporating dish before being rinsed into either evaporating dishes or filtration crucibles. Crucibles are used if possible; however, if there is a large amount of silt/clay and evaporation dish maybe necessary. The material retained on the sieve is rinsed into another porcelain dish into a dish or crucible. The sand-fine separation samples are then handled the same as the suspended sediment concentration samples.

Sand Analysis

A wet sieve Sand Analysis is preformed on suspended sediment or bed material samples. Typically when sand concentrations of a suspended sediment sample are high, field users will request a wet sieve analysis to determine the particle size distribution of the sand fraction. In addition, when a bed material sample is over 90 percent dominate by fines, a wet sieve analysis is needed. The wet sieve analysis (also referred to as Sand Analysis) is a part of the Full Size analysis (a grain size analysis to determine the particle size distribution of both the sand and silt/clay fractions of a sample). The difference between the two is the Sand Analysis only measures the net weight of the silt/clay fraction and not the individual weights of each grain size.

The Sand Analysis samples are received, weighed in and put in storage like the other suspended sediment samples. After the two week settling period, the samples are decanted and rinsed through a 0.0625 mm ASTM testing sieve. The hand massager and DI water are used to assist the sediment through the sieve. When the sieve no longer lets any visible sediment pass through, the sieve is turned over in the porcelain dish and the sediment retained is rinsed into the dish. If there is a large amount of sand, it may be necessary to repeat this step until the entire sample is passed through or retained by the sieve.

The silt/clay material is poured into a glass cylinder and a few drops of 30% Hydrochloric Acid (HCl) are added to speed up settling. Usually three drops from a disposable pipette will suffice. When the silt/clay has settled (overnight or longer if necessary) it is decanted, rinsed into an evaporating dish and placed in an oven to dry following standard procedures for oven temperatures, drying time and cooling in desiccators.

The sand fraction is poured through a series of ASTM testing sieves, starting with the largest screen that retains particles and one phi intervals after. The material retained by each sieve is rinsed into pre tarred evaporation dishes and dried in an oven following standard procedures for oven temperatures, drying time and cooling in desiccators. The gross weights of the dishes are entered into SLEDS using the auto balance transfer to avoid any transcription errors.

Full Size Analysis

Initially, the full size analysis begins the same way as the wet sieve analysis. After an initial sand break, a particle size analysis is performed on the sand fraction by the wet sieve method. The silt/clay fraction is poured into a cylinder as was done in the wet sieve analysis, but no HCl is added. Instead, a trial aliquot is taken from the silt/clay cylinder using of a 20 mL pipette. The 20 mL aliquot of silt/clay is rinsed into a pre-tarred evaporating dish and placed in an oven to dry following standard procedures for oven temperatures, drying time and cooling in desiccators. The dish with the trial aliquot is weighed back on an analytical balance to the nearest 0.0001 g.

The mass of the entire silt/clay fraction in the cylinder can be determined by the sediment mass by volume extrapolation method. The net weight of a dried aliquot dish is multiplied by the ratio of cylinder volume to aliquot volume. For example, if a 20 mL withdrawal was extracted from a 1000 mL cylinder, the ratio would be 50:1. In this example, the total sediment mass in the cylinder would be equal to the weight of the withdrawal multiplied by 50. If the silt/clay fraction is more than 5.0 g, the sample is split in half by the use of an acrylic vane splitter. This is done until 5.0 g or less is reached. If the silt/clay amount is less than 0.8 g, then the sample is treated as a Sand Analysis because the minimum mass requirement for the pipet method is 0.08 g of silt/clay. If there is enough material for a pipet method, the ideal volume at which to perform the analysis can be determined by looking at the chart on the pipet bath (also summarized below in Figure 9).

Ideal Run Volumes for Pipet Method		
Est. Fines Mass in Cylinder (g)	Ideal Run Volume (mL)	Avg. Est. Mass in Cylinder (g)
0.8 – 2.0	400	1.4
1.4 – 3.5	700	2.4
1.6 – 4.0	800	2.8
1.8 – 4.5	900	3.2
2.0 – 5.0	1000	3.5

Figure 9: Table of ideal run volumes for particle size analysis of fines fraction via pipet method.

The pipette uses a vacuum system attached to a 20 ml pipette. A water bath at 27.0°C ±1°C is used to keep a constant sample temperature. It is essential that this specific temperature is maintained for the entire period of this analysis in order to accurately determine the theoretical fall diameter of the sediment particles. The pipette analysis is run either at 400, 700, 800, 900, or 1000 mL. A dispersing agent of sodium hexametaphosphate is added to the silt/clay mixture. One mL of dispersing agent is used for every 100 mL of silt/clay mixture. The combined silt/clay and dispersing agent are stirred in a mixer for five minutes on the low setting. A timer controls the mixing time. The sample is filled to the desired volume in a cylinder and placed in the water bath until it reaches 27.0°C ±1°C. Up to ten cylinders can be run at a time.

There are seven pre tarred evaporating dishes assigned to each cylinder. The cylinders are labels with the lab numbers for the samples. The first two dishes are for an instantaneous concentration withdrawal. The remaining five dishes are used for the 31, 16, 8, 4, and 2 µm withdrawals. The withdrawal depths and times required to accurately determine a given theoretical fall diameter are as follows; 31 micron is 10 cm at 1 minute 38 seconds, 16 micron is 10 cm at 6 minutes 31 seconds, 8 microns is 10 cm at 26 minutes 6 seconds, 4 micron is 7 cm at 1 hour 12 minutes 56 seconds, 2 micron is 2.5 cm at 1 hour 44 minutes 13 sec. The times are monitored by use of two clocks, an electric clock and a stop watch. Each withdrawal is done in approximately 14 seconds. The withdrawals are begun seven seconds before the start time and ended seven seconds after the start time. Each time a withdrawal is made the pipette is rinsed out twice with DI water into the dish from the withdrawal.

After all withdrawals are completed, the dishes are placed in an oven to dry following standard procedures for oven temperatures, drying time and cooling in desiccators. The pipette dishes are weighed back on the analytical balance to the nearest 0.0001 g and recorded in SLEDS. SLEDS computes the results for the full size analysis and these data are checked by another qualified lab technician before being sent to NWIS.

Ro-Tap Analysis

Dry coarse sediment samples (i.e. bed material and bed load) usually arrive at the lab in fabric sacks or cardboard cups. Upon arrival to the lab they are logged in on a lab form and placed in a lab oven. The oven is set at 80°C ±2°C and allowed to run overnight. When dry, the sample is weighed on a macro balance and the net weight is recorded on the lab form. The sample is hand sieved for particles larger than 8.0 mm. If the remaining portion weighs more than 250 g, it is split until the 250 g limit is reached. All splits are performed with a large metal vane splitter and the weights of each split are recorded on the lab form. The unused splits are put back into the original sample container in case the sample needs to be re-analyzed.

The final split of the sample is then placed in the top sieve screen of a stack of sequentially graded sieve screens. The largest sieve mesh size is at the top, the smallest at the base. The screens are A.S.T.M. testing sieves that have been visually inspected that day, for rips, stretched areas, or clogging in the mesh. Sieve are cleaned or replace if noted to be damaged. The stack of screens is placed in a sieve shaking tapping machine (Ro-Tap) for 10 minutes. The length of shaking time is controlled by a timer. The size fractions retained on each sieve are weighed and recorded on the lab form. When a sample has been completed, the operator adds up the fractions to check for errors. If there is more than a one percent difference in the starting weight to the ending weight, the sample is re-run. After a batch of samples has been run, the hand written results are checked by a qualified lab person and then entered into SLEDS where the results are computed. Results are then checked against the hand written forms for data entry errors.

Sediment Weight Determination

When the containers have cooled in the desiccators for a minimum of 3 hours or to room temperature, they are weighed back on the analytical balance using rubber or cotton gloves. The use of gloves ensure oils, moisture or dirt from the technicians' hands does not contaminate the weight of the container. The gross weights are recorded in SLEDS using an electronic balance transfer system to eliminate keypunch and transcription errors.

Calculation of Results

SLEDS automatically performs the calculations for the results of the sediment analyses. Sediment analysis results and quality assurance data are stored in SLEDS. Field user can access sediment data from SLEDS, QWDATA and NWIS Web. Backups of computer stored information are done by the SLEDS development team.

Analytical Quality Control

Analytical quality control is used to ensure that proper procedures are being performed in the processing of various types of sediment samples and data of known quality is being produced. The Lab is tested internally as well as through external sources. Internal testing includes sample evaporation monitoring, the processing of blank samples and known samples, and field replicates. External testing includes the participation in the Sediment Lab Quality Assurance (SLQA) study and in the triennial sediment laboratory reviews.

Internal Testing

Method Blanks

Method blanks (also referred to as Process Blank) are sample containers filled with DI water that pass through all the sample processing steps of a sediment analysis. The purpose is to assess potential bias attributable to dish handling, filtration, dust, contamination of the blank water and other processing issues. One method blank is processed with every 20 samples, or one per each analytical batch.

Known Samples

Quality control samples of known sediment mass are produced by the Lab using sediment from bed material samples that have already been analyzed. The sediment thoroughly cleaned, separated and process to ensure certain size fractions are being obtained. Detailed descriptions of the processing steps can be found in the Natural Matrix Reference Material for WMA Sediment Labs document. Sediment is weighed on the analytical balance and put into a sample container. A known volume of water is added to the sample container and then the sample is capped. All pertinent information is recorded and the sample is then place in storage. Known samples are processed the same way as environmental samples and usually on a monthly basis or when new lab staff are being trained.

Lab Replicates

Lab replicates are samples that are being re-analyzed to determine if the data matches the original results. For every 20 Ro-Tap analyses, one is re-run as a replicate. The data is checked to determine if there are any significant discrepancies in the results of the analysis (Note: deviations of more than three percent from the original result in any size class are considered significant. All size classes are compared.). If none exist, the Ro-Tap worksheets are copied and placed into the Lab Replicate Check folder. The replicate analysis results are also logged into SLEDS under the state code REP. If large discrepancies do exist, then the sample is analyzed again and compared against the original run. If differences of greater than three percent still exist, the Lab Chief is notified.

If the lab receives enough sample material to run lab replicates on suspended sediment, such as pipet method samples, then replicate analyses are performed and the results are compared to assess whether values differ by more than three percent. Typically, replicate suspended sediment analyses can only be performed once so if discrepancies exist, then value qualifiers are assigned to the result values and the field user is notified.

External Testing

Sediment Laboratory Quality Assurance Project

The Sediment Laboratory Quality Assurance Project (SLQA), sponsored by the Branch of Quality Systems (BQS), is part of an overall quality assurance program for sediment analyses. The SLQA combines and augments several existing quality assurance activities. The SLQA provides quantitative information on sediment data quality to sediment laboratories and their customers. The focus of this project is on all quantitative analyses conducted on water-sediment mixtures including concentrations, sand/fine splits, and particle-size distributions completed by the visual accumulation tube and sieve/pipette, SediGraph, and bottom withdrawal methods. The overall quality assurance program also includes on-site qualitative reviews of sediment laboratory operations, procedures, and equipment (see OSW Memo 98.05, 1998).

Analytical results from all sediment quality control samples are compiled and statistically summarized by the BQS both on a laboratory-by-laboratory basis and on a national basis. The national database is used to develop relative criteria with which to evaluate the performance of each participating sediment laboratory. Results and comparisons may be viewed at the address. http://bqs.usgs.gov/slqa/frontpage_study_results.htm

Upon completion of the statistical analyses, each participating laboratory receives a detailed analysis of their results. The results of each of the tests are used as a tool to assess the performance of each sediment laboratory. The data collected is also used to populate a National Sediment Laboratory Quality Assurance database. The information in the national database is published, with individual laboratories identified by code. Criteria for evaluating the laboratories are also published. Data users of a given sediment laboratory are provided the code of the laboratory they use so that they can assess its performance with respect to all participating laboratories (see OSW Memo 98.05, 1998).

Follow-up evaluations following the semi-annual SLQA Project studies will be required for laboratories providing data that plot outside statistically determined data-quality boundaries. Laboratories may be required to process additional quality control samples. The intent of follow-up evaluations is to eliminate the source of the identified problems, increase the competence of the laboratory, and improve the data it produces (see OSW Memo 98.05, 1998). The decision for follow-up is initiated by the BQS. The laboratory under review, Office of Surface Water, and BQS will discuss the results of follow-up evaluations before the data will be added to the national database. Recommendations and any subsequent quality assurance testing will be based on the outcome of the follow-up evaluation.

Laboratory Reviews

All USGS sediment laboratories undergo a formal review of facilities and operations every three years as part of the triennial Office of Surface Water review. The reviewing team is comprised of sediment specialists designated by the OSW. The purpose of the review is to evaluate laboratory operations, identify deficiencies in procedures, and provide recommendations of correcting problems or improving quality.

Summary

The above report describes the quality-assurance plan for the U.S. Geological Survey California Water Science Center Sediment Laboratory located in Santa Cruz, California. The principle goals of this Quality Assurance Plan were to promote effective operations within the Lab, to assist the laboratory staff in performing their duties, and to ensure that the information and data generated by the Lab is reliable and correct. For further information or inquires about quality assurance or quality control methods of the California Sediment Laboratory please contact the Laboratory Chief at the address below.

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Appendix D

Consultation Record

Consultation Record

Water Quality Monitoring and Management Plan			
Sub-Plan	**Agency**	**Date of Agency Plan Submittal**	**Agency Comments Received Date**
Oregon Water Quality Management Plan	Oregon Department of Environmental Quality	January 25, 2021 August 4, 2021	February 11, 2021 September 3, 2021
	Oregon Department of Fish and Wildlife	January 25, 2021 August 4, 2021	No Comments Received No Comments Received
	Bureau of Land Management – Klamath Falls	February 12, 2021 August 4, 2021	April 15, 2021 No Comments Received
California Water Quality Monitoring Plan	California State Water Resources Control Board	January 25, 2021 August 4, 2021	February 2, 2021 September 1, 2021
	California North Coast Regional Water Quality Control Board	January 25, 2021 August 4, 2021	No Comments Received No Comments Received
	California Department of Fish and Wildlife	January 25, 2021 August 4, 2021	No Comments Received No Comments Received
	Oregon Department of Environmental Quality	January 25, 2021 August 4, 2021	No Comments Received No Comments Received
	California Department of Water Resources	January 25, 2021 August 4, 2021	No Comments Received No Comments Received