AVISTA CORPORATION

REVISED

LONG LAKE HED TAILRACE

DISSOLVED OXYGEN MONITORING PLAN

WASHINGTON 401 CERTIFICATION, SECTION 5.6(B)

Spokane River Hydroelectric Project
FERC Project No. 2545

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Acronyms and Abbreviations

%	percent
°C	degrees Celsius
Avista	Avista Corporation
cfs	cubic feet per second
cm	centimeters
DO	dissolved oxygen
DQO	Data quality objectives
Ecology	Washington Department of Ecology
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
Golder	Golder Associates Inc.
Hach	Hach Company Inc.
HED	hydroelectric development
LLFB	Long Lake HED forebay monitoring station near the Unit 3 and 4 intakes
LLGEN	Long Lake HED Unit 4 generation plume monitoring station
LLTR	Long Lake HED tailrace monitoring station
main dam	concrete gravity dam
mg/L	milligrams per liter
mm Hg	millimeters of mercury, as pressure
MOA	Memorandum of Agreement
MQO	Measurement Quality Objectives
NIST	National Institute of Standards and Technology

RFP	request for proposal
RMSE	root mean squared error
USGS	U.S. Geological Survey
WQC	water quality certification

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1.0 PURPOSE AND ORGANIZATION

This Dissolved Oxygen Monitoring Plan has been prepared to fulfill requirements of:

- Washington State Department of Ecology (Ecology) for a dissolved oxygen (DO) monitoring plan as a component of a Long Lake Dam Phase II Feasibility and Implementation Plan, which is specified in section 5.6(B) of the amended section 401 water quality certification (WQC) issued on May 8, 2009 for the Spokane River Hydroelectric Project (FERC No. 2545) (Ecology 2009a)
- Federal Energy Regulatory Commission (FERC) for a DO monitoring plan in the Long Lake Dam Phase II Feasibility and Implementation Plan as specified in Article 401 of the license issued for the Spokane River Project on June 18, 2009 (FERC 2009a)
- FERC for "information regarding the frequency of monitoring, sampling procedures, and equipment to be used" for monitoring DO and associated total dissolved gas to be filed with the FERC as required by FERC's order approving and modifying the Water Quality Monitoring and Quality Assurance Project Plan, which was issued on September 17, 2009 (FERC 2009b)

Results of previous water quality monitoring indicate that Long Lake Hydroelectric Development (HED) at certain times of the year discharges water that does not meet the applicable dissolved oxygen (DO) water quality standards. To address this issue, Avista proposed to conduct a feasibility study to identify potential mechanisms to improve DO levels at the discharge of Long Lake HED, evaluate which alternatives are reasonable and feasible, and implement selected alternative(s) to improve DO of Long Lake HED discharges. Avista initiated this process with the Long Lake HED Phase I Aeration Study (HDR 2006). Avista issued a request for proposal (RFP) for conducting the Phase II Feasibility and Implementation Plan, and selected HDR as the contractor for this work.

On October 14, 2008, Avista signed a Memorandum of Agreement (MOA) with the Spokane Tribe, which also addresses low DO (and other water quality issues) on their reservation. This MOA commits Avista to *"work collaboratively [with the Spokane Tribe] to develop and carry out feasibility studies and implementation actions pertaining to the goal of meeting the DO, TDG, and Temperature requirements at the Reservation boundary."*

Condition 5.6(B) of the Washington WQC requires that Avista *"submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on the* <u>*Long Lake HED DO Aeration Study*</u> *within one year of license issuance [(by June 17, 2010)], choosing one or several options to implement. The plan shall contain:*

- *Anticipated compliance schedule for conducting preliminary and final implementation plans; and*
- *A monitoring plan to evaluate compliance (including avoidance of super-saturation) and coordinate results with the DO TMDL efforts."*

The required monitoring plan will need to be consistent with the Water Quality Monitoring and Quality Assurance Project Plan, as approved by the FERC on September 17, 2009.[1]

This plan is organized into four sections with two appendices of supporting material. Section 1.0 describes the purpose for the plan. Section 2.0 provides an introduction and describes pertinent project facilities and historical water quality data. Section 3.0 describes planned monitoring and reporting procedures for this plan. Section 4.0 provides the references for cited documents. Appendix A provides a record of consultation for this plan. Appendix B documents comments provided on earlier drafts of the plan and responses to those comments.

[1] FERC order modifying and approving Water Quality Monitoring and Quality Assurance Project Plan pursuant to Article 401(A)(12).

2.0 INTRODUCTION AND BACKGROUND

2.1 Factors Affecting Dissolved Oxygen

Dissolved oxygen (DO), necessary to support aquatic life in rivers and reservoirs, is influenced by temperature, pressure, wind, chemical reactions, photosynthesis, atmospheric diffusion and biologic respiration (HDR 2006; EPRI 2002). DO is consumed through a number of processes including decomposition of organic substances, respiration by aquatic plants and animals, nitrification, and oxidation of iron (EPRI 2002), and is replenished through atmospheric re-aeration and photosynthesis.

Changes in water temperature affect DO levels because temperature determines both the amount of gases, including oxygen, that can be dissolved and the rates of most physical and biochemical processes affecting DO (EPRI 2002). The maximum amount of oxygen that can be dissolved at equilibrium, referred to as the saturation concentration, is largely determined by a nonlinear relationship with temperature. DO saturation concentrations are much greater in cold water than warm water.

This study is focused on DO levels downstream from the Long Lake dam, which are directly influenced by the DO level of the water drafted from Lake Spokane. DO levels in reservoirs can be heavily influenced by algal growth, vertical stratification, and the water flow path. Typically, algae increases DO levels during daylight through photosynthesis and decreases DO levels during non-daylight periods because of respiration. Algae growth generally impacts upper levels of reservoirs, whereas algae decomposition primarily impacts the lower reservoir levels because DO is not replenished by atmospheric processes (EPRI 2002). These processes along with reservoir density currents, which are largely determined by the temperature of inflows and outlet depth and design, highly influence DO levels of water released from the reservoir.

2.2 Water Quality Standards

The purpose of Washington State's DO standard is to maintain conditions that support healthy populations of fish and other aquatic life. The Washington Administrative Code, WAC 173-201A-200(1)(d), sets the water quality standard for DO to protect the designated aquatic life uses. Downstream of Long Lake Dam, the applicable Washington State numeric criterion is a 1-day minimum of 8.0 mg/L downstream of the Long Lake HED. WAC 173-201A-200(1)(d) also includes the following language which applies to the reach downstream of Long Lake Dam:

> (i) When a waterbody's D.O. is lower than the criteria in Table 200 (1)(d) [(i.e., 8.0 mg/L for the Spokane River downstream of Long Lake Dam)] (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the D.O. of that water body to decrease more than 0.2 mg/L.
>
> …

(iii) Concentrations of D.O. are not to fall below the criteria in the table at a probability frequency of more than once every ten years on average.

(iv) D.O. measurements should be taken to represent the dominant aquatic habitat of the monitoring site. This typically means samples should:

(A) Be taken from well mixed portions of rivers and streams.

(B) Not be taken from shallow stagnant backwater areas, within isolated thermal refuges, at the surface, or at the water's edge.

Starting approximately 1.5 mile downstream of Long Lake Dam, the Spokane Tribe of Indians water quality standards, which also limit DO to no less than 8.0 mg/L (Spokane Tribe 2003, § 9(2)(c)(ii)), applies to the Spokane River.

2.3 Project Facilities and Operations

Long Lake Hydroelectric Development (HED) is the lowermost of the five hydroelectric developments of the Spokane River Hydroelectric Project (FERC No. 2545). It is located on the Spokane River at approximately river mile 34, a distance of 25-30 miles northwest of Spokane, Washington. The drainage area upstream of Long Lake Dam is approximately 5,840 square miles, and includes the Hangman Creek, also known as Latah Creek, and Little Spokane River watersheds, along with the watersheds that feed Coeur d'Alene Lake in Idaho. Plate 2-1 shows the primary Long Lake HED facilities.

Long Lake HED includes an L-shaped, concrete gravity dam ("main dam") and adjacent intake structure; a concrete arch cutoff dam ("crescent dam") located along the western shoreline approximately 700 to 800 feet upstream of the main dam; a gated spillway along the top of the main dam; and a powerhouse. The powerhouse contains four double Francis-type, horizontal-shaft turbines and generator units with a total generating capacity of 71.7 megawatts and a combined hydraulic capacity of 6,300 cfs. The HED's reservoir (commonly known as Lake Spokane) extends approximately 23.5 miles upstream of the main dam. Lake Spokane has a surface area of 5,060 acres at normal full pool elevation of 1,536 feet and a usable storage of 66,720 acre-feet at a drawdown of 14 feet. The powerhouse intake structure is located at elevations of 1,491 to 1,507 feet, 29-45 feet below full pool.

Long Lake HED is operated as a storage facility for power generation purposes with a normal full-pool elevation of 1,536 feet. Although Avista was allowed to draw down Lake Spokane by as much as 24 feet under the previous FERC license, it voluntarily limited drawdown to approximately 14 feet (elevation 1,522 feet) beginning in the late 1980s. Article 402 of the new Federal Energy Regulatory Commission

(FERC) license, which was issued on June 18, 2009, officially establishes the 14-foot drawdown limit.[2] Winter drawdown does not occur each year, due to variations in weather and river flows. When a drawdown occurs, its magnitude is dependent on weather conditions and other factors. The lake is normally held within 1 foot of the full-pool elevation throughout the summer recreation season.

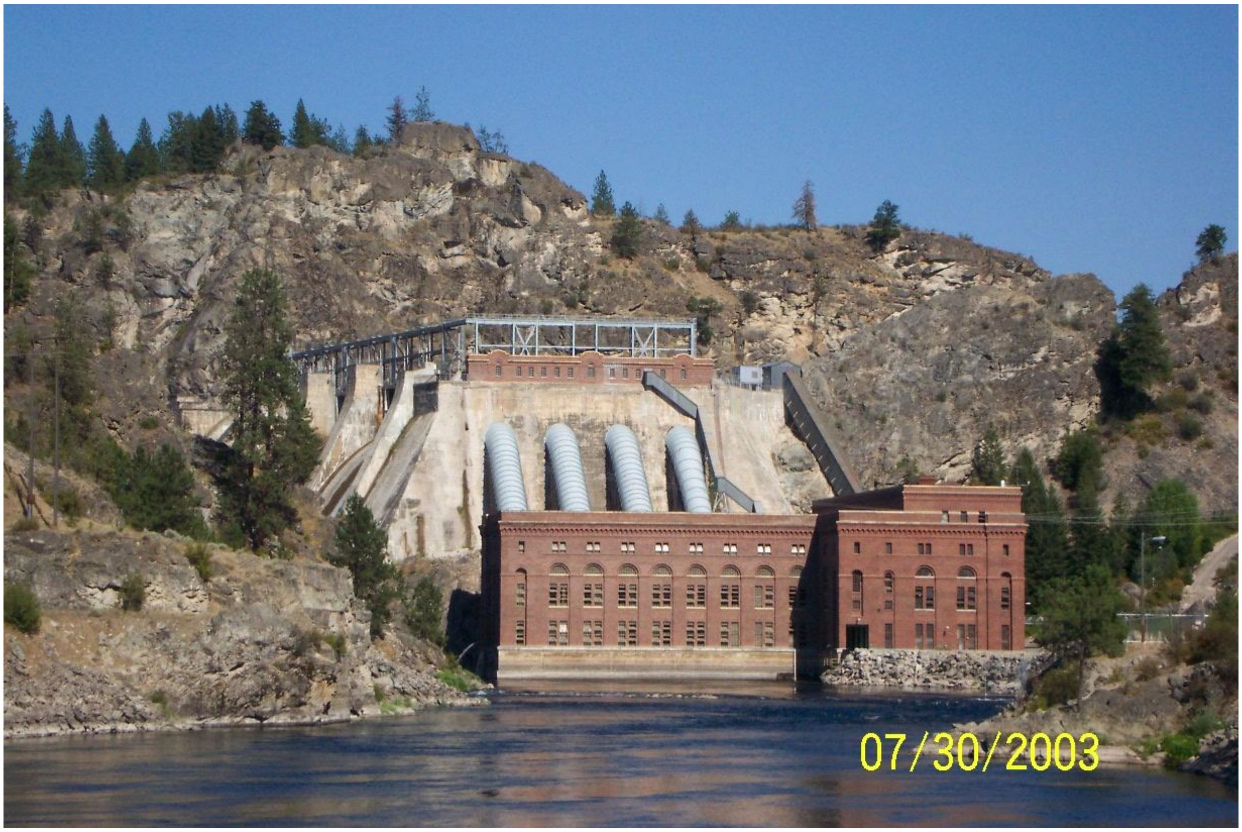

Plate 2-1. Long Lake Dam and Powerhouse

2.4 Historical Conditions

The following discussion of the historical DO conditions in Lake Spokane and in water discharged from Long Lake HED is from Golder and Weitkamp (2008). In Lake Spokane, nutrient loadings and associated consumption of DO combined with natural thermal stratification of the Lake results in low-oxygen water in the deep portions of the Lake because there is no mixing with the aerated surface layer during the summer. Although August DO concentrations are consistently less than 5.0 mg/L in the hypolimnion and near the bottom of the down-lake end of the transition zone, DO concentrations remain greater than 8.0 mg/L throughout the water column in the riverine zone, the upper end of the transition zone, and in the epilimnion (CH2MHILL 2004). Low DO levels in the Spokane River and Lake Spokane are currently being addressed by development of a DO TMDL (Ecology 2009b). Implementation of measures by numerous

[2] License Article 402 states that "The drawdown requirement may be temporarily modified if required by operating emergencies beyond the control of the licensee."

parties to meet the TMDL are expected to increase DO levels in the Spokane River and Lake Spokane and also improve the DO levels of water discharged from the Long Lake HED powerhouse.

Water discharged from Long Lake HED has DO concentrations that vary depending on the degree of thermal stratification and oxygen demand within the Lake. Ecology conducts monthly spot monitoring of Spokane River water quality at a station (54A070) located at the bridge on Spring Creek road (State Highway 231), 0.6 mile downstream of Long Lake powerhouse. This station was monitored in 1959-1966, 1969-1981, and 2007-2009 (Ecology 2010). Review of Ecology's 2007-2009 data shows that monitored DO concentrations for this station ranged from 6.1 mg/L in September 2007 to 13.3 mg/L in April 2009 (Ecology, 2010).[3] Seven of these 26 DO measurements were less than the 8.0-mg/L criterion. These low DO concentrations occurred in the months August, September, and October. Spokane Tribe provisional data (personal communication (e-mail) between Chris Butler, Project Manager/Fisheries Biologist, Spokane Tribe, and Hank Nelson, Environmental Coordinator, Avista, regarding DO 2007-09, February 1, 2010) collected from the Spokane River approximately 1.5 miles downstream of Long Lake HED, 275 feet upstream of the confluence with Chamokane Creek, in 2007-2009 suggest that DO is less than 8.0 mg/L most of the time in the months of August and September. DO of less than 8.0 mg/L was recorded at a moderate frequency in the months of October and July and rarely in June.

[3] Data collected in October 2008 and later are preliminary and their quality have not yet been approved by Ecology.

3.0 DO MONITORING AND REPORTING

3.1 Objectives

The objectives of the Long Lake HED Tailrace DO Monitoring Plan are:

1. Improve the understanding of the seasonal timing and magnitude of DO levels in the Long Lake HED tailrace, particularly as they relate to the applicable water quality standards
2. Obtain data for aeration feasibility studies for the Long Lake dam, powerhouse, and tailrace
3. Document the effectiveness of meeting the DO water quality standards through measure(s) implemented to increase DO levels of Long Lake HED discharges
4. Document super-saturation caused by measure(s) implemented to increase DO levels of Long Lake HED discharges
5. Coordinate results with DO TMDL efforts

3.2 Monitoring Stations

The overall long-term monitoring strategy will consist of DO monitoring at a location 0.6 mile downstream of the Long Lake Dam (LLTR). Monitoring results from this station will document compliance of the Long Lake HED tailrace with the DO water quality standard. As discussed below, the data from the long-term monitoring station will need to be supplemented with additional water quality data to meet the multiple objectives for this monitoring plan.

TABLE 3-1

Permanent Long Lake HED DO Monitoring Stations

Station Code	Description	UTM Coordinates	Monitoring Type
LLTR	On left downstream bank, at a water pumphouse approximately 0.6 mile downstream from Long Lake dam	11T 436381E 5298603N	Long-term
LLFB	Behind trash rack between Unit 3 and 4 head gates	11T 437153E 5298493N	Potential Short-term Phase II Feasibility Testing[1]
LLGEN	Long Lake HED Unit 4 generation plume	11T 437069E 5298473N	Potential Short-term Phase II Feasibility Testing[1]

[1] The Phase II Feasibility Study Work Plan will identify any need to use this and/or other monitoring stations for the collection of data to be used for evaluating the feasibility of potential aeration measures.

Avista and its contractor will conduct aeration feasibility studies to evaluate and test the ability to aerate water discharged from Long Lake HED. Data needed for these studies will be supplied by the long-term monitoring station supplemented with water quality data from selected short-term monitoring station(s), as needed. The need and location for data from additional stations will be determined on a case-by-case to be consistent with the work plan that will be developed by the Phase II Feasibility Consultant for the Long Lake HED tailrace aeration alternatives evaluated by Avista. We anticipate that short-term or spot water quality monitoring will occur in the Long Lake HED forebay and in the Spokane River between the powerhouse and the pumphouse (LLTR) to support the Phase II aeration feasibility study. Monitoring to support the Phase II aeration feasibility study will begin at least one week before planned testing, which is scheduled for sometime in August or September 2010.

Permanent water quality monitoring station facilities were designed for the Long Lake HED tailrace (LLTR), Long Lake HED forebay near the Unit 3 and 4 intakes (LLFB), Long Lake HED Unit 4 generation plume (LLGEN) stations by Avista personnel with technical assistance from Golder. The permanent stations will consist of a length of 4-inch-diameter aluminum pipe stilling-well (standpipe), which is sealed at the pipe's submerged end to prevent the water quality sensor from falling out of the pipe. Each standpipe will have ½-inch-diameter perforations along its sides and a hole at the bottom to provide water exchange between the interior and exterior of the pipe and limit accumulation of sediment and debris in the bottom of the pipe. The standpipe will be anchored to the concrete pier adjacent to Unit 4 at LLFB, anchored to the concrete base of the pumphouse and a rock outcrop at LLTR, and anchored to the south wall of the switchroom on the outside of the powerhouse at LLGEN. Depending on the perceived need for security, the top end of each standpipe will be protected by either a locked metal access door and break-out box attached to the end of the pipe, or simply by a threaded metal cap. Armored flex conduit will be used to protect data power cables should external power and/or remote download capability be implemented at the station. A full description of these permanent monitoring stations and the configuration of each station are provided in Golder (2009).

3.3 Monitoring Equipment

The monitoring equipment used for this DO monitoring study also will be used for TDG monitoring associated with the Long Lake and Nine Mile HEDs (Golder 2010). This equipment will include Hydrolab® MS5 instruments with Optical Luminescent Dissolved Oxygen, TDG, temperature, and depth sensors obtained from Hach Company Inc. (Hach). The MS5's internal battery pack will provide power the unit during spot measurements and deployments at stations without an alternating current power source. The deployed MS5s will be serviced at approximately 2- to 3-week intervals to calibrate the TDG sensor, download recorded data, and to replenish the batteries, as needed.

Local barometric pressure will be monitored at the Long Lake HED pumphouse and powerhouse with a barologger manufactured by Solinst®. Data recorded by this instrument will be corrected, as appropriate to account for differences in elevations between its elevation and the elevation of other Long Lake HED DO monitoring stations. The data from the barologger installed at the Long Lake HED pumphouse or powerhouse will serve as a backup source of barometric pressure data in case the barologger at the other location fails. The barologgers will be deployed at both monitoring stations throughout the Long Lake HED DO monitoring season.

3.4 Monitoring Procedures

DO monitoring will occur during the months of July through October, and will be coordinated with TDG monitoring for Long Lake HED (Golder 2010). Water quality parameters that will be recorded consist of DO concentration (mg/L), TDG (mm Hg), and water temperature (°C). Water depth (meters) also will be recorded and used in conjunction with water temperature to identify if and when MS5s emerge from the water and when MS5s are above the minimum TDG compensation depth. The range, accuracy, and resolution for each measured parameter are provided in Table 3-2. Even though external alternating current power will be used for most of the monitoring, internal battery voltage will be recorded to monitor power consumption and determine any need for battery replacement. To produce a consistent set of measurements, MS5s that are deployed will be programmed to sample and record values on the hour and at 15, 30, and 45 minutes after the hour. This will be accomplished by delaying sampling and logging until the beginning of the next 15-minute period and logging at 15-minute intervals. Spot monitoring will be conducted to enable evaluation of the representativeness and quality of data recorded by the deployed MS5s. Data quality will be maintained and documented through a calibration and maintenance along with data quality control and quality assurance processes, as discussed below.

TABLE 3-2

Range, Accuracy and Resolution of Parameters That Will Be Recorded Under the Long Lake HED TDG Monitoring Plan

Parameter	Range	Accuracy	Resolution
Dissolved Oxygen	0 to 30 mg/L	± 0.01 mg/L for 0 to 8 mg/L ± 0.02 mg/L for >8mg/L	0.01 mg/L
Temperature	-5 to 50°C	±0.10°C	0.01°C
Total Dissolved Gas	400 to 1300 mm Hg	±0.1 % of span	1.0 mm Hg
Depth (0-25 meters)	0 to 25 meters	±0.05 meter	0.01 meter
Barometric Pressure	500 to 800 mm Hg	±3.5 mm Hg within 6 months of zero calibration at 25°C	0.1 mm Hg
Relative Barometric Pressure	1.5 meter, typically 30-100 cm	0.1 cm	0.002% of full scale

3.4.1 Calibration and Maintenance

3.4.1.1 External Barometer Calibration

Barometric pressure will be measured with a Hydrolab Surveyor 4a, Solinst® barologger or equivalent instrumentation. These instruments will be maintained following the corresponding manufacturer's instructions. Before using one of these instruments for pre- or post-deployment field verification sessions, the values recorded by it will be compared to a known National Institute of Standards and Technology (NIST) pressure source at either a nearby USGS gage station or airport.

3.4.1.2 Annual Factory Calibration and Servicing

Each year before deployment of the DO monitoring equipment, all MS5s will be sent to Hach for factory calibration and adjustment. In years that the MS5s are also used to monitor TDG in the high-flow season, factory servicing likely will occur before the TDG monitoring season. Annual factory calibration is a critical component that will help ensure reliable recording of quality data. Factory calibration also will provide an auditable track to verify equipment has been maintained in proper working order.

3.4.1.3 Pre-Deployment Field Verification

Each year, field personnel will conduct pre-deployment field testing no more than one month before the planned initial deployment of MS5s. This will include the following steps for each instrument to be used for DO monitoring:

- The clock of each MS5 and Solinst® barologger will be synchronized to the correct date and time, and then a test will be done to confirm that each instrument will log and download data.
- The TDG silastic membrane will be removed from each MS5 and the recorded TDG value will be compared to ambient barometric pressure of a recently calibrated external barometer (either a Surveyor 4a or the Solinst® barologger).
- A mass verification of the MS5s will be conducted, likely at the LLTR monitoring station. The timing mass verification will be coordinated with TDG post-deployment activities. Each unit will be delay started to the same time and set to log data at one-minute intervals. All units will then be tied together and deployed so that each units TDG sensor is at a depth of about 10 feet below the water's surface. After a total deployment period of approximately one hour, the units will be downloaded and concurrent DO, TDG, water temperature, depth, at the 20 and 50 minute mark will be compared for all units and any differences noted.
- The barologgers also will be tested to confirm that they record values similar to one another.

3.4.1.4 Deployment Maintenance and Servicing

During each service period, each MS5 will be retrieved and the pull time recorded. The Solinst® barologgers also will be downloaded. Each service session will include verification of logging status and downloading the data to a portable field computer. The Solinst® barologgers also will be downloaded. For each data file downloaded, field staff will record the data file name and location along with the logged data start and end dates and times. If the MS5 has lost power, field staff will attempt to determine the cause of the power loss by confirming the status of the AC power supply and checking and replacing the backup batteries, as needed. If the MS5 was operational upon retrieval, field staff will record the internal and external voltage reading as reported by the unit.

DO, TDG, temperature, and depth sensors will be calibrated according to the manufacturer's instructions and the difference between the pre- and post- calibrated value(s) recorded. Calibration of the DO sensor will be done using one of the following three methods, which are provided by the manufacturer (Hach 2006):

1. Air saturated water, which is performed by applying air saturated water to the sensor[4]
2. Water saturated air, which is performed by maintaining a consistent temperature and placing the sensor in the calibration cup partially filled with water to ensure a relative humidity of 100 percent without the water touching the sensor
3. Known calibration standard, which involves placing the sensor into a solution with a known concentration of oxygen

Patency of the original TDG membrane will be confirmed by pressurizing the sensor with soda water and all damaged, unresponsive TDG membranes will be marked. Each MS5's TDG membrane will be removed, cleaned and allowed to dry. With the TDG sensor exposed to air, the barometric pressure will be recorded and compared to a barometric pressure reading from either a Surveyor 4a or a Solinst® barologger. A one-point calibration will be conducted if the TDG pressure reading in air differs from the secondary source by more than 2 mm Hg. Once calibrated, a new membrane will be installed and patency confirmed by again pressurizing the sensor with soda water. Air temperature, depth and internal battery voltage also will be recorded.

Once all sensors are calibrated, the field crew will initiate and verify data logging. Initiating data logging will include synchronizing the logger clock, ensuring the correct parameters are selected for logging, confirming that the logging interval is set to 15 minutes, and setting the delay log start time to the nearest quarter hour interval (ie.15, 30, 45 or 60 minute mark each hour). The logging end date will be set to one year after start up. This step is crucial to avoid premature shutdown of the unit. To confirm log initiation, the field crew will select the audible tone feature so that each unit emits a series of beeps prior to logging and a single beep while in standby mode. Upon confirmation of logging, the meter will be reinstalled in the standpipe, and the deployment time recorded. Before leaving the area, all doors and locks will be checked and noted in the written log to verify the station is secure.

3.4.1.5 Post-Recovery Field Verification

At the end of each annual DO monitoring season, all MS5s and Solinst® barologgers used during the monitoring season will undergo post-verification following procedures nearly identical to pre-deployment field verification, with the exception that mass *in situ* verification will not be conducted. All differences in DO, TDG, temperature, depth, and barometric pressure will be recorded and these differences, if substantial, will be used to qualify and correct the data for periods when the unit was out of calibration.

[4] This method can be performed in the field, but requires knowing the local barometric pressure.

3.4.2 Data Quality Control and Quality Assurance

Golder will document records of factory calibration in its project files. This will include records of when the equipment is sent to and received from the manufacturer along with a record of servicing done by the manufacturer. All calibration done by Golder, as outlined above, will be recorded on datasheets specific to the purpose. The hardcopies for all field forms will be scanned and saved as PDF files on a Golder file server. As a redundant protective measure field notes and calibration forms will also be photocopied and the original stored in a fire-proof area.

During the first DO monitoring season, data will be downloaded at approximately 2-week intervals in conjunction with DO instrument maintenance and calibration. After the first DO monitoring season, data downloads will occur at approximately 3-week intervals for a portion or all of the DO monitoring season unless results of the first season's monitoring indicate that the DO sensor needs to be serviced more frequently than every 3-weeks. In the absence of an automated download system, data download will be conducted in conjunction with DO instrument maintenance and calibration. Both the MS5 and Solinst® barologger data downloaded will be documented in the field for each datasheet. Excel® spreadsheets will be used to inspect all downloaded data and verify the start and end dates. A backup copy of the electronic file will be saved to a USB drive as well as on the computer. Once a station's data download has been successful and verified, the MS5 will be initialized under delay start mode with the integrated audible tone feature in to verify the unit is logging data. If a remote data download system is incorporated into the design of any Long Lake HED stations, it will be possible to download data for the station(s) more frequently and field visits for the purpose of downloading will be reduced or eliminated. Automated remote status checks of each DO station could be used for early identification of any problems.

Golder will use Excel® spreadsheets to identify and remove outliers from downloaded data and operations data provided by Avista. A second reviewer will verify the "cleaned" data and then all data along with qualifiers will be imported into an Access® database. The cleaned data will be plotted using either Excel or Access during the initial review process, and to provide figures for interim memorandums, if required. It is likely that a more sophisticated charting package, such as Sigmaplot®, will be required for final report figures of DO and discharge data, especially during Long Lake HED aeration testing.

Data quality objectives (DQOs) and Measurement Quality Objectives (MQOs) are the quantitative and qualitative terms used to specify how good the data need to be to meet the project's specific monitoring objectives. DQOs for measurement data, also referred to as data quality indicators, include precision, accuracy, measurement range, representativeness, completeness, and comparability. MQOs are the performance or acceptance thresholds or goals for the project's data, based primarily on the data quality indicators precision, bias, and sensitivity. The measurement quality objectives (MQOs) that will be used for this monitoring plan are displayed in table 3-3. Golder will calculate and report the station-specific root mean squared error (RMSE) of the calibration corrections applied after each calibration, and an overall RMSE for each station based on the average time for calibration corrections.

Table 3-3
Measurement Quality Objectives (MQOs)

Parameter	MQOs
Dissolved Oxygen	0.5 mg/L
Temperature	0.5ºC
Barometric Pressure	2 mm Hg
Total Pressure	1% (5 to 8 mm Hg)
TDG%	1%

DO meters, like other field monitoring equipment, are subject to bias due to systematic errors introduced by calibration, equipment hardware or software functioning, or field methods. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings. No DQOs are being set for bias.

Precision refers to the degree of variability in replicate measurements; however, the precision of the results from continuous monitoring instruments cannot be estimated from replicate measurements. Therefore, the potential variability of DO results may be indicated by agreement among the simultaneous results from two or more instruments, either during calibration or in the field. Instrument precision will be evaluated through the calibration and maintenance activities described in Section 3.4.1. MQOs and DQOs for DO will be met if DO meter readings are within 0.5 mg/L of spot measurements taken using portable MS5s. If MQOs are not met, the differences will be evaluated but the data will not be qualified or discarded unless other information indicates a problem with the data.

DO saturation levels are dependent upon barometric pressure readings so MQOs are also necessary for the spot measurements of barometric pressure taken using portable Hydrolabs. The target for this project will be an MQO of 2 mm Hg for the field barometer readings. The barometric pressure MQO will be evaluated by paired readings with a field barometer, Hydrolab pressure sensor with the TDG membrane removed, or a known National Institute of Standards and Technology (NIST) pressure source at either a nearby USGS gage station or airport.

Water temperature also will be monitored because it can directly influence DO. Since this is a parameter of secondary importance to the study, DQOs have not been established, but an MQO has been set at 0.5°C. Data will be reported if post-calibration shows that the temperature is within the MQO. Data that do not fall within the MQO will not be reported.

TDG measurements also will be collected to identify supersaturated conditions. Since this is also a parameter of secondary importance to this study, DQOs have not been set but an MQO has been set at 1 percent of saturation.

TDG percent of saturation measurements are dependent on barometric pressure readings so MQOs are also necessary for the barometric pressure measurements taken using portable Hydrolabs and Solinst® baraloggers. The target for this project will be an MQO of 2 mm Hg for the field barometer readings. The barometric pressure MQO will be evaluated by paired readings with a field barometer, Hydrolab pressure sensor with the TDG membrane removed, or a known National Institute of Standards and Technology (NIST) pressure source at either a nearby USGS gage station or airport.

The quality of existing data will be evaluated where available. Data from sources within well-established programs will be acceptable based on the credibility of the source (such as the National Weather Service or U.S. Geological Survey data). The variability of data will be reviewed to evaluate whether it is appropriate based on expected values and comparison between data sets. Data with too much or too little variability will not be used.

Accuracy is a measure of confidence that describes how close a measurement is to its "true" value, or the combination of high precision and low bias. Refer to table 3-2 for the accuracy of each measured parameter. At the end of each seasonal DO monitoring study, all MS5s and Solinst® baraloggers used for the monitoring season will undergo post-verification procedures as described in Section 3.4.1.5. All differences between DO, TDG, temperature, depth, and barometric pressure will be recorded and these differences, if substantial, used to qualify and correct the data for periods when the unit was out of calibration.

Measurement Range is the range of reliable readings of an instrument or measuring device, as specified by the manufacturer. Refer to table 3-2 for the range for each measured parameter. Annual maintenance of field sampling equipment will be conducted in a manner consistent with the manufacturer’s recommendations and records of all maintenance activities will be recorded and included with the field notes.

Representativeness qualitatively reflects the extent to which sample data represent a characteristic of actual environmental conditions. For this project, representativeness will be addressed through proper design of the sampling program which will ensure that the monitoring locations are properly located and sufficient data are collected to characterize DO at that location. This includes comparing spot measurements at both the long-term monitoring station and at other stations to confirm complete mixing.

Completeness is the comparison between the amount of data that has been planned to be collected versus how much usable data is actually collected, expressed as a percentage. The timing for the end of the TDG monitoring season may delay initiating DO monitoring and/or result in gaps in the data early in the DO monitoring season. In addition, data may be determined to be unusable in the validation process. If the data set does not meet the completeness designated for the project, its use may be limited. A project completeness of greater than 80% is expected under normal operating conditions. If project completeness falls below 80%, then corrective measures, including resampling or reanalysis, will be evaluated. Completeness will be evaluated and documented throughout all monitoring activities and corrective actions taken as warranted on a case-by-case basis.

Comparability is the degree to which data can be compared directly to previously collected data. Comparability will be achieved for this project by consistently monitoring at the same long-term monitoring station, which has been monitored in the past and is a long-term monitoring station for the Long Lake HED TDG Monitoring Plan.

3.5 Study Coordination and Schedule

Effective coordination and communication is critical to successfully meeting the objectives identified in section 3.1. This is particularly challenging due to the various levels of communication which are needed (i.e., agency, management, and field) and multiple parties (Avista, Ecology, Spokane Tribe, FERC, Golder and the Feasibility Study Consultant) being involved in different aspects of this effort. Figure 3-1 and table 3-4 show the organization and communication channels associated with this monitoring effort. Avista will directly communicate with Ecology, the Spokane Tribe, and the FERC.

For the feasibility study, Avista, Golder, and the consultant selected to conduct the Long Lake HED tailrace aeration feasibility study (Feasibility Study Consultant), will communicate as a team keeping each other informed of technical needs, Long Lake HED operational schedules, and any challenges that occur in meeting the needed products. Avista has selected HDR/DTA to be the Phase II Feasibility Study Consultant. HDR/DTA will work with Avista and Golder to prepare a Work Plan for the aeration feasibility tests including overall monitoring needs. Then Golder, in consultation with Avista and HDR/DTA, will prepare the specific water quality monitoring plan for the test period. The Golder DO Project Manager will ensure that the DO Monitoring Plan is implemented concurrently with tests of Long Lake HED tailrace aeration measures. The Feasibility Study Consultant and Golder will coordinate all monitoring and operational testing efforts with Avista’s Long Lake HED Plant Manager and ensure information regarding timing and implementation are relayed to field personnel responsible for implementing the aeration measures and concurrent DO monitoring. Golder will collect, compile and conduct a quality review of the DO data and Long Lake HED operations data, which are provided by Avista. Then the results of DO monitoring will be communicated to the Feasibility Study Consultant Project Manager and the Avista License Implementation Team. The Avista License Implementation Team will be responsible for communicating study progress and results to Ecology, the Spokane Tribe, and the FERC. Any requests for additional information will be submitted to the Avista License Implementation Team, who will communicate these requests to the Feasibility Study Consultant Project Manager and/or Golder DO Project Manager, as appropriate. In the field, it is assumed that the engineering and DO field personnel will likely operate independently of each other.

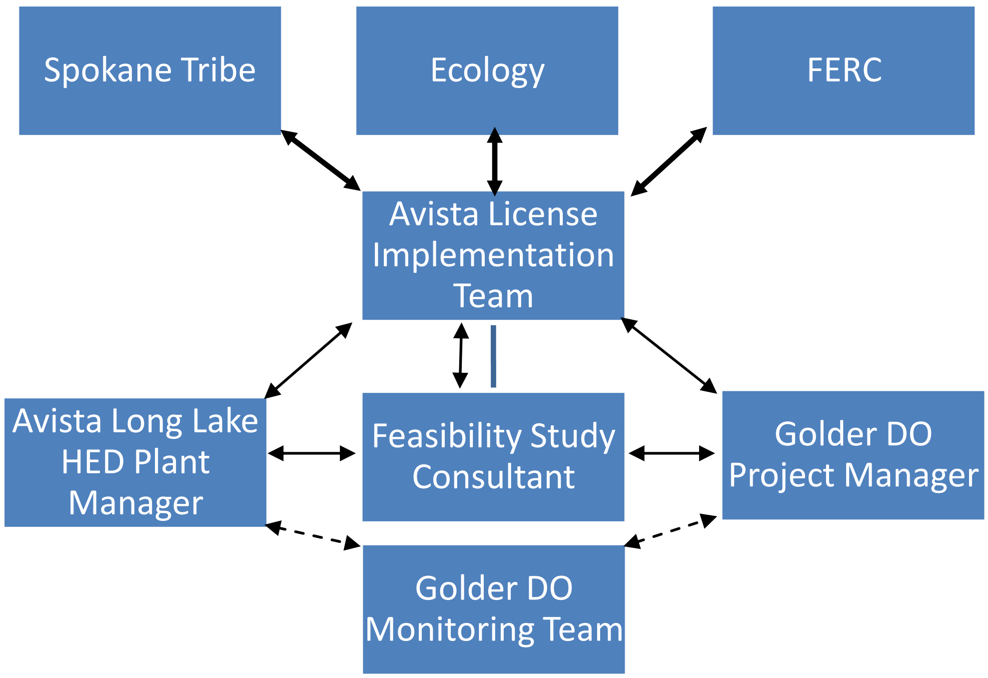

Figure 3-1. Project Organization and Communication Channels for Long Lake HED Tailrace DO Monitoring Plan

Thick solid arrows indicate agency and public communication, thin solid arrows indicate management level communication, dashed arrows indicate field level communication.

Table 3-4
Long Lake HED Tailrace DO Monitoring Plan Project Contacts

Position	Name
Ecology	Marcie Mangold
FERC	George Taylor
Spokane Tribe	Brian Crossley
Avista License Implementation Team	Speed Fitzhugh, Hank Nelson
Avista Long Lake Plant Manager	Bill Maltby
Golder DO Project Manager	Brian Mattax
Golder DO Monitoring Team	Paul Grutter, Max Birdsell
Feasibility Study Consultant	John Koreny

Following the selection and implementation of aeration measures to be tested, Golder will collect, compile and conduct a quality review of the DO data and Long Lake HED operations data, which are provided by Avista. Golder will use the “cleaned data” to evaluate the effectiveness of measures implemented and identify any need for additional feasibility studies to reduce the dam’s DO production, and communicate this information to the Avista License Implementation Team. The Avista License Implementation Team will determine an approach to meet identified needs. As for the feasibility study period, the Avista License Implementation Team will be responsible for communicating study progress and results to Ecology, the Spokane Tribe, and the FERC.

Phase II studies to identify reasonable and feasible Long Lake Dam aeration measures will begin in 2010, and aeration feasibility studies for Long Lake HED discharges are expected to continue for 2-3 years. Following selection of reasonable and feasible measure(s) to enhance DO levels in the Long Lake HED tailwater, these measure(s) will be implemented. Seasonal monitoring will continue to be done at the long-term DO station annually to document the effectiveness of complying with the DO water quality standard. Documentation of two consecutive years of meeting the DO water quality standard will be considered sufficient to demonstrate compliance with the standard.

3.6 Adaptive Revisions to Monitoring Plan

The signatories to this monitoring plan recognize that there may be advantages to monitoring DO at specific locations and times, which have not been identified in this plan, to better determine the feasibility of specific potential Long Lake HED discharge aeration measures. The Avista License Implementation Team and Feasibility Study Consultant will jointly identify desired changes in the:

- Timing and duration of DO monitoring
- Installation of new temporary monitoring stations
- Increased frequency of data reporting
- Additional spot DO measurements

The Avista License Implementation Team will communicate these desires with the Golder DO Project Manager, who will provide Avista feedback on the perceived need for requested changes. Should Avista decide to request a change in this monitoring plan, the Avista License Implementation Team will notify Ecology, the Spokane Tribe, and FERC of the desired change and provide the rationale for the requested change. All changes will be dependent upon approval by Ecology and the FERC prior to implementation.

3.7 Reporting

Following each of the first four annual DO monitoring seasons, Golder will compile all data collected during the previous DO monitoring season and prepare an Annual Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. These annual reports will include time series charts of DO along with river flows, charts of DO in the forebay compared with DO for the pumphouse, and if appropriate, identify aeration test periods. Each annual report will include a description of any proposed changes to this monitoring plan with supporting rationale. Avista will submit annual reports to Ecology, the Spokane Tribe, and the FERC during the five years of monitoring.

Following the fifth annual DO monitoring season, Golder will prepare a Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, which summarizes monitoring results from all five years of monitoring and focuses on the effectiveness of measures implemented to improve DO in the Long Lake HED tailrace. This report also will evaluate whether there is a need for additional DO monitoring in the Long Lake HED tailrace. Monitoring will end following the fifth monitoring season unless the Five-Year report identifies a need for additional DO monitoring.

In addition to the reports described above, Golder will work with Avista and its Aeration Feasibility Consultant(s) to provide data in a timely manner for feasibility studies. The format and content of interim reports will be defined through a discussion between the Avista License Implementation Team, Golder DO Project Manager and the Feasibility Study Consultant(s). Golder will conduct QA/QC on all data before inclusion in any interim report and/or transmittal of the data to the Feasibility Consultant(s). Before beginning the planned aeration tests, the Feasibility Study Consultant, Avista License Implementation Team, and Golder DO Project Manager will establish a reporting schedule so that personnel and appropriate resources can be assigned. A reporting schedule for any data collection activities after the Phase II feasibility study is completed will be established, as needed.

4.0 LITERATURE CITED

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APPENDIX A

CONSULTATION RECORD

Consultation associated with development and approval of the Long Lake HED Tailrace Dissolved Oxygen Monitoring Plan included:

- August 7, 2009 - Avista submitted to Ecology for review and approval its draft Water Quality Monitoring and Quality Assurance Project Plan and draft Technical Memorandum for Long Lake and Nine Mile HED Monitoring Stations, and provided these documents to the Spokane Tribe
- August 13, 2009 - Ecology provided comments and approved the draft Water Quality Monitoring and Quality Assurance Project Plan and draft Technical Memorandum for Long Lake and Nine Mile HED Monitoring Stations
- August 13, 2009 - Avista filed with FERC its Water Quality Monitoring and Quality Assurance Project Plan pursuant to Article 401(A)(12)
- September 17, 2009 - FERC issued order modifying and approving Water Quality Monitoring and Quality Assurance Project Plan pursuant to Article 401(A)(12)
- January 18, 2010 - Avista (Tim Vore) requested dissolved oxygen data from Spokane Tribe (Chris Butler)
- February 1, 2010 - Spokane Tribe (Chris Butler) emailed Avista (Tim Vore and Hank Nelson) dissolved oxygen data that the Spokane Tribe collected for their Tshimikain Site, 275 feet upstream of the confluence with Chamokane Creek, in 2007, 2008, and 2009
- March 1, 2010 - Avista (Hank Nelson) submitted Draft Long Lake HED Tailrace Dissolved Oxygen Monitoring Plan to Spokane Tribe (Brian Crossley)
- March 31, 2010 - Spokane Tribe (Brian Crossley) provided comments on Draft Long Lake HED Tailrace Dissolved Oxygen Monitoring Plan to Avista (Hank Nelson)

APPENDIX B

COMMENTS AND RESPONSES

Nelson, Hank

From: Brian Crossley [crossley@spokanetribe.com]
Sent: Wednesday, March 31, 2010 11:39 AM
To: Nelson, Hank
Subject: RE: DO Monitoring at Long Lake Discharge...

Hank, our review was completed a while ago; just got buried.

1 On pg. 8 Golder talked about some data; I believe those were grab samples during the day and would not catch the low DO levels that we are seeing at night when respiration occurs. I just hope the improvements aren't based on 6 mg/l low.

2 Chris mentioned on page 15 about getting the data following QA

3 Appendix A, the Tribes site is 275 feet upstream of confluence of Chamokane Creek

Have a good one

Brian

From: Nelson, Hank [mailto:hank.nelson@avistacorp.com]
Sent: Monday, March 01, 2010 2:52 PM
To: crossley@spokanetribe.com
Cc: Fitzhugh, Speed (Elvin)
Subject: DO Monitoring at Long Lake Discharge...

Brian,

Attached is a cover letter and draft DO monitoring plan for your review. I'll put a hard copy in the mail. <<DO cover.docx>> <<021810blm1_Draft Long Lake Tailrace DO Monitoring Plan_blm.docx>>

Hank

Table B-1

Responses to Comments

Comment #	Response
Comments on Draft Plan	
1	We recognize the limitation of using Ecology's spot measurements. Therefore, we requested the Spokane Tribe's DO data to provide a more comprehensive understanding of DO conditions downstream of the Long Lake HED. The goal of the ongoing Phase II aeration studies is to evaluate potential measures to aerate Long Lake HED discharges to meet the Spokane Tribe's DO water quality standard. Implementation of this monitoring plan will evaluate the effectiveness of measures implemented to accomplish this goal.
2	Following Spokane Tribe's request for water quality data collected for this plan, Avista and Golder will coordinate providing appropriate data.
3	We revised text in Section 2.4 and Appendix A to clarify the location of the Spokane Tribe's water quality monitoring station.