AVISTA CORPORATION

FIVE-YEAR
LONG LAKE HED TAILRACE
DISSOLVED OXYGEN
MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.6(B)

Spokane River Hydroelectric Project
FERC Project No. 2545

Prepared By:
Golder Associates Inc.
Redmond, WA

April 14, 2015

[Page intentionally left blank]

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms and Abbreviations

%	percent
% saturation	percent of saturation
°C	degrees Celsius
7Q10	7-day average flow with a 10-year return period
AC	alternating current
Avista	Avista Corporation
BAR	barometric pressure
cfs	cubic feet per second
DNR	Washington Department of Natural Resources
DO	dissolved oxygen
DO%	dissolved oxygen percent of saturation
DO TMDL	Dissolved Oxygen Total Maximum Daily Load
DQO	data quality objective(s)
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
ft amsl	feet above mean sea level
Golder	Golder Associates Inc.
HED	hydroelectric development
m	meter(s)
mg/L	milligrams per liter
mm Hg	millimeters mercury (pressure)
MQO	measurement quality objective
MS5	Hydrolab® MS5 Multiprobe®
LLFB	monitoring station at Long Lake forebay
LLTR	monitoring station at Long Lake tailrace
PDT	Pacific Daylight Time
Project	Spokane River Project
REMI	Reservoir Environmental Management, Inc.
RMSE	root mean squared error
Spokane Tribe	Spokane Tribe of Indians
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 Background

Water quality monitoring results during the Spokane River Project (Project) relicensing process (HDR 2005) indicate that the Long Lake Hydroelectric Development (HED), at certain times of the year, discharged water that did not meet the applicable dissolved oxygen (DO) water quality standards. To address this issue, Avista Corporation (Avista) proposed to conduct a feasibility study to identify potential mechanisms to improve DO levels at the Long Lake HED discharge, evaluate which alternatives are reasonable and feasible, and implement selected alternative(s) to improve DO in the Long Lake HED discharge. Avista initiated this process while relicensing the Project with the Long Lake HED Phase I Aeration Study (HDR 2006).

Avista and the Spokane Tribe of Indians (Spokane Tribe) entered into a non-License Agreement, which addresses DO (and other water quality issues) on the Spokane Tribe's reservation. This Agreement 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 (total dissolved gas), and Temperature requirements at the Reservation boundary."

License Article 401, Appendix B, Condition 5.6(B) of the Washington Section 401 water quality certification (Ecology 2010a) required that Avista "*submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on the Long Lake HED DO Aeration Study 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.*
- *A monitoring plan to evaluate compliance (including avoidance of super-saturation) and coordinate results with the DO TMDL efforts."*

Avista submitted the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan to Washington State Department of Ecology (Ecology) as directed, and Ecology approved it on June 11, 2010 (Avista 2010). Shortly thereafter DO enhancement testing and monitoring was conducted (HDR and REMI 2010). On December 9, 2010, the Federal Energy Regulatory Commission (FERC; 2010) modified and approved the Feasibility and Implementation Plan. Avista's implementation of the FERC-approved Feasibility and Implementation Plan is documented in the 2011, 2012, and 2013 annual reports (Golder 2012, 2013, and 2014, respectively) required under the FERC approved Feasibility and Implementation Plan, which were submitted to Ecology, the Spokane Tribe, and FERC.

This report presents the results of the 2014 DO monitoring immediately downstream of Long Lake Dam for the year's low-flow period and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. Additionally, in accordance with the December 9, 2010 FERC Order (FERC

2010), this report also provides a summary of the monitoring results from the past five years (2010 through 2014); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether there is a need for additional DO measures and additional monitoring in the Long Lake Dam tailrace.

1.2 Objectives

The objectives of the DO monitoring plan (Avista 2010) 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 Total Maximum Daily Load (TMDL) efforts.

1.3 Five-Year Monitoring Period

DO, TDG, and temperature were monitored at both fixed stations and from a roving boat in the Spokane River below the Long Lake HED on September 1 and 2, 2010 to test the feasibility of turbine aeration (HDR and REMI 2010; Section 7.0 and Appendix C). In 2011 through 2014, the monitoring period for this study was from July 1 through October 31.

2.0 2014 METHODS

Water quality parameters that were recorded include DO concentration (milligrams per Liter [mg/L]), TDG (millimeters mercury [mm Hg]), and water temperature (°C). Water depth (meters [m]) was also recorded and used in conjunction with water temperature to evaluate the timing of water quality monitoring instruments being out of water and above the minimum TDG compensation depth.

2.1 Equipment and Calibration

Solinst® baraloggers were used to determine local barometric pressure. A primary barologger was deployed at the Long Lake pump house for the entire monitoring season. A back-up barologger was also deployed at the Long Lake pump house to provide local barometric pressure (BAR) data if the primary barologger failed. As an additional quality assurance measure, resulting site-specific barometric pressures were compared to corresponding values for the Spokane International Airport for each site visit. Spokane International Airport station sea-level barometric pressures were downloaded from the Weather

Underground[1] and adjusted by subtracting 37.05 mm Hg to account for the altitude of the Long Lake HED tailrace (1,365 feet above mean sea level [ft ams]).

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. A MS5 connected to an external alternating current (AC) power source was deployed at each of the two monitoring stations upon initial deployment with the goal of minimizing potential issues associated with low or no power supply. In addition, a second MS5 powered solely with internal batteries was deployed for long-term monitoring at the station below the dam and was used as a portable meter with a short power/data cable and a laptop computer to obtain spot measurements of DO, TDG, and temperature.

All Hach instruments used had undergone annual servicing by Hach and were factory calibrated before the 2014 monitoring season. Monitoring equipment was calibrated according to the manufacturer's instructions prior to deployment and on periodic site visits. Pre-deployment field verification included synchronizing the clocks, comparing each MS5's TDG pressure value with the silastic membrane removed to the ambient barometric pressure, confirming the patency of each MS5's TDG silastic membrane, and testing the barologgers to confirm that the recorded values were similar and comparable to those at the Spokane International Airport.

During service periods, each MS5 was retrieved and the pull time recorded. Each service session included verification of logging status and downloading the data to a portable field computer. The Solinst® barologgers also were downloaded during these service periods. Patency of the original TDG membrane was confirmed by observing a rapid increase in TDG pressure while pressurizing the sensor with soda water. The manufacturer's instructions were implemented to calibrate depth, DO sensors, and to verify the temperature sensors.

2.2 Station Facilities

For this study, MS5 long-term deployments were done at two permanent water quality monitoring facilities associated with Long Lake HED: 1) 0.6 mile downstream of the Long Lake Dam referred to as LLTR, and 2) in the Long Lake HED forebay referred to as LLFB (Table 2-1; Figure 2-1).

The permanent stations consisted of a 4-inch-diameter pipe stilling-well (standpipe), which was sealed at the pipe's submerged end to prevent the MS5 from falling out of the pipe. Each standpipe had 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. Each standpipe's top end is protected by an enclosed box containing AC power and data communication equipment. In 2012 Avista installed real-time data system to transmit MS5 water quality measurements

[1]On each site visit day, Spokane, WA KGEG barometric pressure data were downloaded from the History & Almanac section of http://www.wunderground.com/cgi-bin/findweather/getForecast?query=99219&sp=MKGEG.

from each of these long-term monitoring stations to the HED control room in the powerhouse. A coordinated team of Avista staff, including the HED Operators and water resource specialists, used the real-time DO and TDG values to select aeration valve openings for each o Unit with the goal of meeting the 8-mg/L DO criterion at LLTR without exceeding the 110-percent of saturation TDG criterion.

2.3 Spot Measurements

As a quality assurance measure, spot measurements of DO, TDG, and water temperature were made during instrument-servicing site visits at LLTR and LLFB, which were done at approximately 2-week intervals. As determined in 2011 based on paired spot measurements of water temperature, DO, and the percent of saturation of total dissolved gas (TDG%) for both sides of the river; the river is generally well mixed by the time water is 0.6 mile downstream of the Long Lake Dam, at the designated long-term monitoring station, LLTR (Golder 2012). Therefore, no spot measurements were conducted across the river during the 2014 monitoring season.

2.4 Data Collection and Processing

Parameters monitored at 15-minute log intervals with the instruments described above included:

- Barometric pressure (mm Hg)
- Air Temperature (°C)
- Depth (m)
- TDG (mm Hg)
- Dissolved Oxygen (mg/L)
- Water Temperature (°C)

In addition, percent of saturation for TDG and DO were computed based on measurements, as:

- TDG% = TDG in mm Hg / Barometric pressure in mm Hg x 100
- DO percent of saturation (DO%) was computed using equations in the National Park Service's DO Calculator (Thoma and Mailick n.d.)

Data downloaded to the laptop computer were transferred to an office server and were checked for errors using Microsoft Excel®. Erroneous data were identified, assigned data quality codes, and omitted from the final data set.

Long Lake HED operational logs were provided by Avista for the period of July 1 through October 31, 2014. These logs provide the HED's hourly discharges as generation and spill along with total discharge. They also identified aeration operations during the monitoring period.

2.5 Monitoring Difficulties

On October 15, pin-prick sized holes were observed in the optical DO sensor of MS5 #48764, which was connected to an external AC power source at LLTR. Since this condition can cause unrepresentative DO values, MS5 #48764 was replaced with MS5 #60375, which was used at this site throughout the remainder of the monitoring season. In order to avoid any potential non-representative DO values recorded with MS5 #48764, data from the second MS5 (#60376) that was maintained at the LLTR station throughout the monitoring season were used in this report. Deployment and maintenance of a second MS5 avoided the potential for a data gap or need for servicing the AC-powered MS5. In the future, Avista will continue the practice of deploying a second MS5 at this critical site, as needed.

3.0 2014 RESULTS

MS5s and barologgers were set to record data for approximately 11,800 15-minute periods (referred to as "continuous" data in this report) from July 1 through October 31 (Table 3-1). The primary barologger deployed at LLTR provided a complete (100 percent of the entire continuous monitoring period) data set for local barometric pressure. Temperature, DO, and TDG data were successfully obtained for 97 to 100 percent of the entire continuous monitoring period at both LLTR and LLFB (Appendix A, Table A-4). Spot measurements collected when long-term deployment and/or instrument downloads were conducted[2] were used for the quality assurance/quality control program described in Appendix A. Results of continuous measurements are displayed in Figures 3-1 through 3-9.

3.1 Discharge

Combined Long Lake HED generation, spill discharge, and seepage for the July 1 to October 31 monitoring period ranged from approximately 330 to 6,880 cubic feet per second (cfs) (Table 3-2). After July, the maximum hourly discharge at LL HED ranged from 4,830 cfs to 4,950 cfs for August through October. Average hourly discharge was greatest (3,255 cfs) in July, least (1,815 cfs) in August, and intermediate in September and October (2,033 and 2,655 cfs, respectively).

3.2 Water Temperature

Water temperature at the forebay intake (LLFB) reached its seasonal maximum of 21.9°C on July 22, and had daily fluctuations of up to 3°C (Figure 3-1). Tailrace (LLTR) water temperature increased from approximately 17°C at the beginning of July to approximately 20°C in late July (Figure 3-2). Water temperature was more variable at LLFB than LLTR throughout the entire July through October monitoring period. This is likely due to the complex dynamics of hydraulics and temperature in the forebay intake area. During generation periods corresponding measurements for LLFB and LLTR were within 2.7°C of one another (Figure 3-3).

[2] This occurred on July 11, July 22, August 8, August 22, September 3, September 15, September 26, October 15, and November 3.

3.3 Barometric Pressure

Site-specific barometric pressures ranged from 711 to 735 mm Hg based on the Solonist® barologger deployed at LLTR (Table 3-1).

3.4 Dissolved Oxygen

DO concentrations (recorded during generation and non-generation) were 3.2 to 10.8 mg/L for LLFB and 6.8 to 9.8 mg/L for LLTR (Table 3-1) with the greatest DO concentrations near the beginning and end of the monitoring period when the water was coolest, causing potential solubility for oxygen to be greatest (Figures 3-1 and 3-2). At LLTR, DO decreased to 8.0 mg/L on the morning of July 19 before HED generation was started for the day, although the first DO of less than 8.0 mg/L during generation occurred on July 23 at 23:00 PDT (Figure 3-4). Figure 3-4 displays DO and TDG% trends associated with the seasonal decrease in DO concentrations and aeration operations, which were initiated on July 24. Additional information on the HED's operations, use of spillgates, aeration operation, and the corresponding frequency of LLTR DO values less than 8.0 mg/L are presented in Table 3-3.

The relationships between DO at LLTR and LLFB along with the HED's operations are displayed in Figures 3-5 through 3-7. These figures show that the daily DO cycle at LLTR peaked near noon and was lowest in the morning, coinciding with the HED generating from near noon to near midnight. LLFB experienced a seasonal trend in DO decreasing from approximately 9 mg/L in early July to approximately 3 to 5 mg/L in mid-August and then remained less than 7 mg/L for the majority of the period through mid-October (Figure 3-1). The low LLFB DO values tended to increase during initiation of the HED's generation (Figures 3-5 through 3-7), which causes a substantial shift in the forebay's hydraulics. Although the DO concentration remained low at LLFB even during generation, aeration increased DO to 7.3 mg/L or more from its initiation on July 24 through August as measured at LLTR (Table 3-3, Figures 3-5 and 3-6). LLTR's elevated DO tended to decrease during the early morning hours before generation began for the day (Figures 3-5 through 3-7).

Long Lake HED discharges, monitored at LLTR, were less than the 8.0-mg/L DO criterion 12.6 percent of the time during the DO monitoring season (Table 3-3 and 3-4). DO concentrations of less than 8.0 mg/L occurred in HED discharges during all four months of the monitoring season (Table 3-4). These low DO concentrations were within 0.2 mg/L of 8.0 mg/ L (i.e. 7.8 and 7.9 mg/L) 64 percent of the time (Figure 3-8) with the minimum DO of 7.0 mg/L occurring in early September (Table 3-4). The 2014 aeration operations are summarized in Section 3.6.

DO and other water quality data monitored at LLTR when neither generation nor aeration occurred are summarized in Table 3-5. LLTR's minimum DO concentration for non-generation periods was 6.8 mg/L, which is 0.2 mg/L less than the minimum DO recorded during generation, and also occurred in early September. Non-generation DO values for LLTR were less than the 8.0-mg/L DO criterion for 43.0

percent of the 4,785 15-minute values (Table 3-5). As with generation periods, non-generation DO concentrations of less than 8.0 mg/L occurred in all four months of the monitoring season (Table 3-5). These low DO concentrations were within 0.2 mg/L of 8.0 mg/ L (i.e. 7.8 and 7.9 mg/L) 44 percent of the time.

Table 3-6 includes a summary of DO values for LLFB[3] along with LLTR during generation for comparative purposes. Even though the frequency for DO less than 8.0 mg/L during generation was 62.5 percent for LLFB at the HED's intake, it was only 12.3 percent at LLTR.

Calculated DO% saturation values ranged from approximately 36.2 to 124.0 percent for LLFB and 75.2 to 110.9 percent for LLTR (Table 3-1, Figure 3-9). DO% saturation for LLTR ranged from 76.6 to 110.6 percent during periods of generation. During the latter part of August through September, when DO of less than 8.0 mg/L was most frequent, aeration increased DO% to 76.6 to 101.3 percent of saturation (Table 3-4).

3.5 Total Dissolved Gas

The range of TDG% computed was 94.4 to 112.7 percent of saturation for LLFB and 95.5 to 113.9 percent of saturation for LLTR (Table 3-1). TDG% of Long Lake HED discharges, monitored at LLTR, were greater than the 110.0 percent of saturation criterion for 909 (12.2%) of the 7,441 values for generation (Table 3-7, Figure 3-8). Tables 3-3 and 3-4 provide additional insight into the HED operations coinciding with these high TDG% values. On July 23, the powerhouse tripped off-line, causing a spill of 1,900 cfs to occur. This resulted in one exceedance of the 110.0 percent of saturation criterion. All other exceedances of the 110.0 percent of saturation criterion occurred on days during aeration between August 4 and September 26.

3.6 2014 Aeration

Dissolved oxygen levels were monitored from July 1, 2014 through October 31, 2014. Avista operated the HED at varying capacities throughout this period. The spillway released greater than 200 cfs for a single hour, which occurred on July 23. Aeration operations were conducted between July 24 and October 21 using different aeration valve openings for Units 1, 2, 3, and 4. Aeration was conducted for a total of 2,282 unit-hours with 24 hours for a single unit, 805 hours for two units simultaneously, and 216 hours for three units simultaneously.[4] The various generating and aeration conditions along with comparisons of DO and TDG% during generation, as measured at LLTR to their applicable criteria, are summarized below and in Tables 3-3 and 3-4.

Key conclusions for the 2014 monitoring period, presented by month, are:

[3]The DO criterion of 8 mg/L is not directly applicable to LLFB.
[4]2,282 unit-hours = (1 unit x 24 hours) + (2 units x 805 hours) + (3 units x 216 hours)

- **July**: Aeration was initiated on July 24 and conducted daily to the end of the month with one to three units. This resulted in 164 unit-hours of aeration. These operations resulted in meeting the 8.0-mg/L DO criterion at a frequency of 99 percent late in the month. Aeration did not cause TDG% greater than the 110 percent criterion.
- **August**: Aeration was conducted daily throughout the month with up to three units simultaneously resulting in a total of 676 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 94 percent early in the month and 68 percent late in the month. These operations also resulted in elevating TDG% to greater than the 110 percent criterion at a frequency of 24 percent early in the month and 43 percent in the latter part of the month with a maximum TDG% of 113.9 percent of saturation.
- **September**: Aeration was conducted daily with up to three units simultaneously, for a total of 763 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 49 percent early in the month and 77 percent late in the month. These operations also resulted in elevating TDG% to greater than the 110 percent criterion throughout the month at a frequency of 39 percent early in the month and 24 percent in the latter part of the month with a maximum TDG% of 112.3 percent of saturation.
- **October**: In October, 681-unit-hours of aeration resulted in meeting the 8.0-mgL DO criterion 99 percent of the time. After October 21, there was no need for aeration to meet 8.0-mg/L DO criterion. Aeration did not cause TDG% of greater than the 110 percent criterion.

Results of this study demonstrate progress toward meeting the DO criterion through aeration at Units 1, 2, 3, and 4. Although aeration increased DO in powerhouse discharges satisfying the 8.0-mg/L DO criterion approximately 87 percent of the time (Table 3-4) and being within measurement accuracy (i.e., 7.8 mg/L or greater) 95 percent of the time (Figure 3-8), there were still periods when the DO criterion was not met for powerhouse discharges. Aeration operations maintained TDG% that was less than the upper limit of 110 percent of saturation criterion 87 percent of the time (Table 3-4). Avista will continue to refine the use of real-time DO and TDG measurements for selecting aeration valve openings, with the goal of providing additional improvements in DO while limiting adverse TDG% conditions.

4.0 FIVE-YEAR EVALUATION

Avista has made substantial progress toward addressing low DO concentrations of Long Lake HED discharges in accordance with the approved schedule (Figure 4-1). Avista initiated the process of determining reasonable and feasible measure(s) to address this issue during FERC relicensing of the Spokane River Project and has since identified turbine aeration as a reasonable and feasible measure, and progressively constructed and implemented aeration systems with a real-time water quality network linked from the compliance station at LLTR to the control room. Specific tasks have included:

- Conducted the Long Lake HED Phase I Aeration Study (HDR 2006).
- Selected and designed permanent water quality monitoring stations and developed a monitoring plan, then documented them in the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan (Avista 2010). Approval of this plan was obtained

from the Spokane Tribe on April 20, 2010, from Ecology on June 11, 2010, and from FERC with modifications on December 9, 2010.[5]

- Conducted and documented Phase II study components, which included:
  - Appling modeling tools to determine alternatives most likely to be effective (HDR and REMI 2010, Section 5.0 along with Appendix A and B).
  - Identifying the highest priority alternative to be field tested as turbine aeration with draft tube venting.
  - Preparing a Work Plan to test the effectiveness of highest priority alternative (HDR and REMI 2010, Section 6.0)
  - Implementing the Work Plan by testing turbine aeration on September 1 and 2 of 2010, and prepared a summary report (HDR and REMI 2010, Section 7.0 and Appendix C).
- Determined no additional aeration measures were necessary prior to implementing Phase III.
- Implemented Phase III construction of permanent modifications for the preferred alternative, which included assembly of air-inflow control devices that attach to each of the four draft tube intake ports and include an acoustic silencer, an air flow control valve, a bellmouth, and an "eyelid" type air baffle to enhance vacuum.
  - In 2011, installed air-inflow control devices on the four draft tube intake ports of Units 3 and 4, and conducted aeration operations between August 24 and October 19. Avista and Golder setup and maintained a system to continuously log LLTR water quality measurements onto a laptop computer in the pump house. Aeration valve openings were selected based on the logged DO and TDG values. Aeration was limited to a single unit at a time, even if more than one unit was operating.
  - In 2012, installed the air-inflow control devices on the four draft tube intake ports of Units 1 and 2. Avista also installed a radio-system to relay real-time water quality values from LLTR to the HED's plant, and conducted aeration operations between August 2 and October 14.[6] Avista used real-time DO and TDG values to select aeration valve openings for Units 1 and 2 with the goal of meeting the 8 mg/L DO criterion while maintaining a TDG of no more than 800 mm Hg[7] at LLTR during generation. Aeration included simultaneous use of air-inflow control devices on both Units 1 and 2.
  - In 2013, constructed two additional sets of air-inflow control systems. Avista also installed air-inflow control devices on the four draft tube intake ports of each of the HED's four units, upgraded the real-time water quality data communication to a fiber transmission system, and conducted aeration operations between August 6 and October 6. Avista used real-time water quality values to refine and implement a protocol to meet 8 mg/L DO without exceeding a TDG of 800 mm Hg. Aeration included simultaneous use of air-inflow control devices at as many as three units.

[5] The FERC (2010) order modifying and approving this plan also requires Avista to submit the annual and five-year DO Monitoring reports to Ecology and the Spokane Tribe by March 1 of each year following monitoring, allowing the agencies at least 30 days to review and comment prior to submitting the final reports with the FERC by April 15, and documenting consultation with these agencies.

[6] The air-inflow control devices installed on Units 1 and 2 in 2012 were the same ones that had been installed on Units 3 and 4 in 2011.

[7] A TDG of 800 mm Hg would be 110 percent of saturation at a local barometric pressure of 727 mm Hg (i.e. barometric pressure of 765 mm Hg at sea level).

- In 2014, air-inflow control systems on the four draft tube intake ports of each of the HED's four units and the real-time water quality data fiber-transmission communication system were operational, and aeration was conducted between July 24 and October 21. Avista used real-time water quality values to refine and implement a protocol to meet 8 mg/L DO without exceeding a TDG of 800 mm Hg. Aeration was conducted at all four units and included simultaneous use of air-inflow control devices at as many as three units.

- Monitored DO and other relevant conditions water quality conditions at monitoring stations including 0.6 mile downstream of Long Lake Dam, LLTR, from July 1 through October 30 of 2011, 2012, 2013, and 2014.
- Prepared and distributed annual DO monitoring reports (Golder 2012, 2013, and 2014) to Ecology, the Spokane Tribe, and FERC. This report also will be distributed to Ecology, the Spokane Tribe, and FERC.
- Coordinated results with the DO TMDL efforts. This included preparing the Lake Spokane DO Water Quality Attainment Plan (DO WQAP, Avista and Golder 2012), which discussed nine feasible potential measures to improve DO conditions. Ecology approved the DO WQAP on September 27, 2012 and FERC approved it on December 19, 2012 (FERC 2012). Avista summarized the baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions of the upcoming year in its annual reports (Avista 2014, 2015).

4.1 2010-2014 Monitoring Results

In 2010, the efficacy of conducting draft tube aeration to increase Long Lake HED plant discharge DO while maintaining TDG% less than the 110 percent of saturation criterion was tested and determined to be feasible (HDR and REMI 2010, Section 7.0 and Appendix C). During July through October of 2011 through 2014, Avista constructed and installed aeration equipment in Long Lake HED and used adaptive management with the monitored water quality results to determine the most effective aeration-valve openings. Table 4-1 shows the progression of implementing the DO Improvement Program and summarizes the monitoring results including the entire monitoring period (generation and non-generation).

Spring discharge was high and resulted in using the HED's spillgates to release flow for 15 days in 2011 and 5 days in 2012. In comparison, discharges in 2013 and 2014 were low and resulted in virtually no use of the spillgates to release flow downstream. These differences in discharge and spillgate use suggest less need for aeration in 2011 and 2012 than in 2013 and 2014. Nonetheless, DO monitoring results show that the DO 8.0-mg/L criterion was met more frequently in the HED's generation during 2013 and 2014 than in 2011 and 2012, and demonstrate improvements achieved through adaptive management.

4.2 Effectiveness for Meeting DO Criterion in Long Lake HED Discharge

The effectiveness of meeting the 8.0 mg/L DO criterion improved each year that the aeration system was expanded and real-time water quality network communication with the HED's control room was linked and improved. This is documented by aeration operations resulting in the HED's discharge meeting the 8.0 mg/L DO criterion with a frequency of 80.8 percent in 2011, 84.7 percent in 2012, and 91.5 percent in

2013. The HED's discharge met the 8.0 mg/L DO criterion 87.4 percent of the time in 2014, which was also more frequently than in 2011 and 2012. Comparison of these results shows an improvement in meeting the DO criterion even though average discharge was less with virtually no spill over the dam. The frequency of meeting the 110-percent TDG criterion was 99.9 percent in 2011, 96.2 percent in 2012, and 88.8 percent in 2013, and 86.6 in 2014. This reduction in the frequency of meeting the 110-percent TDG criterion was due to turbine aeration entraining all gasses present in the atmosphere, although the maximum TDG% resulting from aeration was 113.4 percent of saturation in 2013 and 113.9 percent of saturation in 2014.

Avista and others have implemented measures to address low DO in Lake Spokane. These measures have the potential to increase the DO concentration of water being withdrawn from Lake Spokane and thereby increase DO concentrations in discharges from the Long Lake HED. These measures include, but are not limited to:

- **Lake Spokane DO WQAP** - Avista prepared the Lake Spokane DO WQAP (Avista and Golder 2012), which discussed nine feasible potential measures to improve DO conditions. Upon receiving FERC approval (December 19, 2012), Avista began implementing the DO WQAP and preparing Annual Reports for 2013 and 2014 (Avista 2014, 2015, respectively), which provide a summary of the baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions of the upcoming year.
- **Carp Population Reduction Program** – During 2013 and 2014, a Lake Spokane Carp Population Abundance and Distribution Study consisting of a Phase I and Phase II component was completed. The purpose of this study was to better understand carp population abundance, distribution, and seasonal habitat use in order to investigate whether removal of carp would improve water quality in Lake Spokane. Additionally, the study helped define a carp population reduction program that may benefit Lake Spokane water quality.

  Results of the Phase I and II components are presented in the DO WQAP 2014 Annual Summary Report (Avista 2015). Based upon the results, the 2014 Annual Report includes a recommendation to implement a pilot study utilizing a combination of mechanical methods (including spring electrofishing, passive netting, and winter seining), to identify which is the most effective method to remove carp from Lake Spokane. Should Ecology agree with this recommendation, Avista will work with Ecology and the Washington Department of Fish and Wildlife (WDFW) on the pilot study and will obtain all required permits prior to its implementation.
- **Point Source Nutrient Load Reductions** – Upstream wastewater dischargers are implementing measures to reduce Spokane River point source nutrient loads from discharges in Washington and Idaho to meet the goal of the DO TMDL (Ecology 2010b).
- **Hangman Creek Basin Shoreline Stabilization and Agricultural Practices** - Avista continues to track plans and progress addressing erosion control in the Hangman Creek Basin by participating in meetings, including the Spokane Conservation District's Hangman Creek Bi-State Watershed Project and Ecology's Spokane River and Lake Spokane DO TMDL Advisory Committee meetings.

In addition, Avista and the Coeur d'Alene Tribe have acquired over 500 acres of farmland with straightened creek beds on upper Hangman Creek through implementation of one of Avista's Spokane River License Wetland Mitigation requirements. Site-specific wetland management plans are updated annually for these properties and include establishing long-term, self-sustaining native emergent, scrub-shrub and/or forested wetlands, riparian habitat and associated uplands, through preservation, restoration and enhancement activities. Since 2013, approximately 3,700 native tree and shrub species have been planted on this approximately 500 acre wetland complex.

- **Native Tree Plantings on Avista Shoreline Property** - Avista and the Stevens County Conservation District planted 300 trees consisting of native cottonwoods and willows along Lake Spokane's northern shoreline on Avista-owned property in April 2013. One of the areas planted consists of a very steep sandy slope. The trees in this location are expected to reduce natural sloughing of sediment, which may contain total phosphorous, into the river and enhance shoreline habitat.

- **Wetland Restoration/Enhancement** - Avista acquired a 109-acre parcel on the Little Spokane River, the Sacheen Springs property, to fulfill its 42.51 acre wetland mitigation requirement identified in Section 5.3.G of the Certification. This property contains over one-half mile of frontage along the West Branch of the Little Spokane River that contains a highly valuable wetland complex with approximately 59 acres of emergent, scrub-shrub and forested wetlands and approximately 50 acres of adjacent upland forested buffer. Several seeps, springs, perennial and annual creeks are also found on the property. The property was purchased "in fee" and Avista will pursue a conservation easement in order to protect the property in perpetuity. Avista is in the process of developing a detailed site-specific wetland management plan for the property. Avista completed a detailed site-specific wetland management plan and began implementing it upon its approval by Ecology and FERC in 2014.

- **Land Protection** - Avista has identified approximately 215 acres of land that is currently used for grazing under lease from the Washington State Department of Natural Resources (DNR). This land is located within the south half of Section 16 in Township 27 North, Rand 40 E.W. M. in Stevens County. Avista will continue pursuing a lease for the 215 acres of land from DNR with the intent of placing the land in conservation use.

  In addition, Avista owns more than 1,000 acres of land, of which 350 acres are located within 200 feet of the Lake Spokane shoreline at the downstream end of the reservoir. During 2014 Avista continued to protect these lands, which also serve as a buffer adjacent to other undeveloped Avista land.

- **Bulkhead Removal** - During 2012, Avista partnered with Ecology, the Spokane County Conservation District, and the Stevens County Conservation District through an Ecology grant to identify two to five homeowners and encourage them to convert their bulkheads to more naturalized shorelines. Progress to date includes the removal of an approximate 90-foot-long bulkhead located at the Staggs parcel in Spokane County and replacement of the bulkhead with a more naturalized shoreline.[8]

  During 2014, Avista continued to work with the Stevens County Conservation District to plan and permit a design for an additional bulkhead removal project on an Avista-owned shoreline parcel located in TumTum. The project would consist of replacing an approximate 90-foot-long bulkhead with native rocks and vegetation to provide a more naturalized shoreline. Avista anticipates this project will take place during winter 2015/2016, after all permits have been obtained and when the lake is drawn down.

[8] A time-lapse video produced by the Staggs features the bulkhead removal project is available for viewing at the following website: http://www.youtube.com/watch?v=luT0RZShJoY.

4.3 Need for Additional DO Enhancement Measures

Avista plans to continue draft tube aeration operations with adaptive management to refine effectiveness using real-time water quality monitoring results. Based on the effectiveness of the draft tube aeration program, combined with other measures being implemented to improve DO in Lake Spokane, no new or additional enhancement measures are necessary to meet the DO Water Quality Standard below Long Lake HED.

4.4 Need for Additional Monitoring

In order to adequately operate the draft tube aeration system for improving DO, but not causing the TDG criterion to be exceeded, there is a continued need for monitoring DO and TDG at LLTR and using the real-time data system to transmit water quality measurements from LLTR to the HED control room in the powerhouse. LLTR monitoring will follow the same procedures used in 2014, as described in the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan (Avista 2010). However, since water quality data from LLFB are not used for selecting aeration operations, Avista does not propose to continue monitoring at LLFB.

Additionally, Avista will cooperate with the Spokane Tribe to measure and evaluate water quality near Chamokane Creek, or at another mutually agreed upon site, downstream of Long Lake HED.

Avista will provide a summary of the aeration activities along with a summary of the corresponding DO and TDG monitoring results to Ecology and the Spokane Tribe following completion of the DO critical season.

5.0 REFERENCES

Avista Corporation (Avista). 2010. Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan, Washington 401 Certification, Section 5.6(B). Prepared by Golder Associates Inc. June 11.

______. 2014. Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2013 Annual Summary Report. Washington 401 Certification, Section 5.6. Spokane River Hydroelectric Project FERC Project No. 2545. January 31.

______. 2015. 2014. Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2014 Annual Summary Report. Washington 401 Certification, Section 5.6. Spokane River Hydroelectric Project FERC Project No. 2545. January 29.

Avista Corporation and Golder Associates Inc. (Avista and Golder). 2012. Lake Spokane Dissolved Oxygen Water Quality Attainment Plan. October 5.

Federal Energy Regulatory Commission (FERC). 2010. Project No. 2545-125 Order Modifying and Approving Dissolved Oxygen Feasibility and Implementation Plan for the Long Lake Development – Article 401. Issued December 9.

______. 2012. Project No. 2545-158 Order Modifying and Approving Water Quality Attainment Plan. Issued December 19.

Golder Associates Inc. (Golder). 2012. 2011 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. February 16.

______. 2013. 2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. April 10.

______. 2014. 2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. April 10.

HDR Engineering (HDR). 2005. Spokane River Hydroelectric Project Current Operations Water Quality Report. Prepared for Water Resources Work Group Spokane River Project Relicensing and Avista Utilities. May 9.

______. 2006. Final Report, Long Lake Hydroelectric Development Phase 1 Aeration Study. Prepared for Avista Utilities, Spokane, WA. June 1.

HDR Engineering and Reservoir Environmental Management, Inc. (HDR and REMI). 2010. Phase II Dissolved Oxygen Improvement Project Long Lake HED Hydroelectric Plant Discharge. Prepared for Avista, Spokane, WA. February 25.

Thoma, David and Matt Malick. n.d. Dissolved Oxygen and pH Calculator Read Me File. Version 1.0. U.S. Department of the Interior. National Park Service.

Washington State Department of Ecology (Ecology). 2010a. 401 Certification-Order Spokane River Hydroelectric Project, Certification Amended Order No. 7792, FERC License No. 2545, As amended May 8, 2009 by Order 6702. Prepared by Eastern Regional Office Water Quality Program staff, Spokane, WA. May 20.

______. 2010b. Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load Water Quality Improvement Report. Publication No. 07-10-073. Revised February 2010.

TABLES

Table 2-1: Long Lake HED Dissolved Oxygen Monitoring Stations

Station Code	Description	Latitude / Longitude (NAD83)	Monitoring Type
LLFB	Long Lake Forebay between Unit 3 and 4 intakes near centerline of intake (elevation 1499 feet)	47°37'48" / 117°31'47"	Long-term
LLTR	On left downstream bank, at a water pump house approximately 0.6 mile downstream from Long Lake dam	47°37'48"/ 117°31'47"	Long-term

Table 3-1: Summary of Continuous Water Quality Monitoring Results

Parameter	LLFB			LLTR		
	Minimum	Maximum	Count	Minimum	Maximum	Count
Date/Time (PDT)	7/1/2014 0:00	10/31/2014 23:45	11,808	7/1/2014 0:00	10/31/2014 23:45	11,808
Water Temperature (°C)	13.0	21.9	11,752	12.9	21.0	11,637
Dissolved Oxygen (mg/L)	3.2	10.8	11,752	6.8	9.8	11,445
BAR (mm Hg)	Used LLTR BAR			711	735	11,808
TDG (mm Hg)	678	804	11,734	692	822	11,616
TDG (% saturation)[1]	94.4	112.7	11,734	95.5	113.9	11,616
Dissolved Oxygen (% saturation)[1]	36.2	124.0	11,752	75.2	110.9	11,445

Notes:

1. TDG (% saturation) and DO (% saturation) calculated using site-specific barometric pressure data collected at LLTR and corrected for altitude.

Table 3-2: Monthly Outflow from Long Lake HED

Month - Year	Minimum Hourly Discharge (cfs)	Maximum Hourly Discharge (cfs)	Average Hourly Discharge (cfs)
July 2014	330	6,880	3,255
August 2014	390	4,950	1,815
September 2014	390	4,830	2,033
October 2014	330	4,830	2,655

Table 3-3: Summary of Exceedances of DO Criterion at LLTR During Generation

Period		Operations, Spill, and Aeration Characteristics			LLTR DO					LLTR TDG			
Start	Stop	Operations	Spill >200 cfs [1]	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Min DO (mg/L)	Min DO (%)	Total Number	Number >110.0%	Frequency >110.0%	Max TDG (%)
7/1/14 0:00	7/23/14 16:45	3 or 4 Units, Capacity varies, generation during portion of the day	No	No	1,427	0	0.0%	8.0	92.2	1,559	0	0.0%	109.3
7/23/14 17:00	7/23/14 17:45	3 Units, Capacity varies, Generation during portion of the day	Yes	No	4	0	0.0%	8.6	100.2	4	1	25.0%	113.0
7/23/14 18:00	7/24/14 11:45	2 Units, Capacity varies, Generation during portion of the day	No	No	36	2	5.6%	7.9	90.6	36	0	0.0%	106.4
7/24/14 12:00	7/25/14 14:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	57	7	12.3%	7.9	89.6	57	0	0.0%	108.9
7/25/14 15:00	7/28/14 11:30	3 or 4 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	130	0	0.0%	8.1	92.6	130	0	0.0%	107.4
7/28/14 11:45	8/12/14 23:45	3 or 4 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	634	25	3.9%	7.7	87.9	632	80	12.7%	112.7
8/13/14 0:00	8/14/14 1:00	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	37	7	18.9%	7.9	91.6	37	24	64.9%	111.3
8/14/14 1:15	8/15/14 22:00	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	87	3	3.4%	7.9	90.5	87	37	42.5%	112.6
8/15/14 22:15	8/16/14 22:15	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	45	0	0.0%	8.1	92.2	45	10	22.2%	111.9
8/16/14 22:30	8/19/14 22:00	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	125	3	2.4%	7.7	88.4	125	78	62.4%	112.7
8/19/14 22:15	8/21/14 22:15	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	85	0	0.0%	8.0	92.6	85	49	57.6%	113.9
8/21/14 22:30	8/27/14 21:00	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	212	116	54.7%	7.3	83.1	209	65	31.1%	113.1
8/27/14 21:15	9/4/14 14:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	319	173	54.2%	7.0	76.6	316	149	47.2%	112.0
9/4/14 15:00	9/5/14 9:45	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	37	14	37.8%	7.8	86.8	37	7	18.9%	111.3

Table 3-3: Summary of Exceedances of DO Criterion at LLTR During Generation

Period		Operations, Spill, and Aeration Characteristics			LLTR DO					LLTR TDG			
Start	Stop	Operations	Spill >200 cfs [1]	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Min DO (mg/L)	Min DO (%)	Total Number	Number >110.0%	Frequency >110.0%	Max TDG (%)
9/5/14 10:00	9/6/14 12:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	49	6	12.2%	7.7	85.6	49	1	2.0%	110.1
9/6/14 13:00	9/8/14 9:45	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	88	44	50.0%	7.6	84.9	88	47	53.4%	112.3
9/8/14 10:00	9/14/14 11:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	306	133	43.5%	7.3	79.6	306	118	38.6%	112.3
9/14/14 12:00	9/15/14 9:45	3 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	48	36	75.0%	7.5	83.0	48	10	20.8%	111.0
9/15/14 10:00	10/1/14 16:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	970	249	25.7%	7.4	80.4	965	233	24.1%	111.6
10/1/14 17:00	10/8/14 15:00	3 or 4 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	440	19	4.3%	7.7	81.4	440	0	0.0%	107.4
10/8/14 15:15	10/10/14 6:45	2 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	96	0	0.0%	8.1	85.8	96	0	0.0%	108.5
10/10/14 7:00	10/17/14 13:45	3 or 4 Units, Capacity varies, Generation during portion of the day	No	3 Units used sometime each day	462	0	0.0%	8.0	82.7	460	0	0.0%	108.1
10/17/14 14:00	10/21/14 15:00	4 Units, Capacity varies, Generation during portion of the day	No	2 Units used sometime each day	261	0	0.0%	8.4	87.1	261	0	0.0%	106.8
10/21/14 15:15	10/31/14 23:45	4 Units, Capacity varies, Generation during portion of the day	No	No	705	1	0.1%	7.9	79.3	705	0	0.0%	102.9
7/1/14 0:00	10/31/14 23:45	Cumulative of above operations without spill	No	Both Yes and No	6,660	838	12.6%	7.0	76.6	6,777	909	13.4%	113.9

Notes:

1. The only spill of >200 cfs occurred on July 23, 2014.

Golder Associates

Table 3-4: Semi-monthly Summary of Water Quality and HED Operations During Generation

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%				LLTR TDG%		
Start	Stop	Generation (hours)	Spill >200 cfs (hours)	Average Total Discharge (cfs)	Aeration (unit-hours)	Total Number 15-Min Values	Average Water Temp (°C)	Total Number 15-Min Values	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <80.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0% [1]
7/1/2014 0:00	7/15/2014 23:45	287	0	4,989	0	1,120	18.5	983	8.7	0.0%	983	96.3	110.6	0.0%	1,118	109.3	0.0%
7/16/2014 0:00	7/31/2014 23:45	215	1	4,097	164	845	19.6	845	7.9	1.1%	845	89.6	110.9	0.0%	842	113.0	0.1%
8/1/2014 0:00	8/15/2014 23:45	147	0	3,946	336	584	19.6	584	7.7	6.0%	584	87.9	102.5	0.0%	582	112.7	24.2%
8/16/2014 0:00	8/31/2014 23:45	164	0	3,537	340	646	19.2	646	7.3	31.7%	646	83.1	101.3	0.0%	643	113.9	43.2%
9/1/2014 0:00	9/15/2014 23:45	181	0	3,384	345	714	18.0	714	7.0	51.3%	714	76.6	100.6	2.5%	708	112.3	38.7%
9/16/2014 0:00	9/30/2014 23:45	223	0	3,209	419	880	16.8	880	7.4	23.1%	880	80.4	96.8	0.0%	878	111.6	24.5%
10/1/2014 0:00	10/15/2014 23:45	241	0	3,716	535	949	15.7	948	7.7	2.0%	948	81.4	94.7	0.0%	946	108.7	0.0%
10/16/2014 0:00	10/31/2014 23:45	265	0	3,731	144	1,060	13.9	1,060	7.9	0.1%	1,060	79.3	98.0	0.1%	1,060	106.9	0.0%
7/1/2014 0:00	10/31/2014 23:45	1,725	1	3,880	2,283	6,798	17.4	6,660	7.0	12.6%	6,660	76.6	110.9	0.3%	6,777	113.9	13.4%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.

Table 3-5: Semi-monthly Summary of Water Quality and HED Operations During Non-Generation

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%				LLTR TDG%		
Start	Stop	Non-Generation (hours)	Spill >200 cfs (hours)	Average Total Discharge (cfs)	Aeration (unit-hours)	Total Number 15-Min Values	Average Water Temp (°C)	Total Number 15-Min Values	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <80.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0% [1]
7/1/2014 0:00	7/15/2014 23:45	72	0	422	0	264	18.6	210	8.6	0.0%	212	0.0	106.5	0.9%	264	107.4	0.0%
7/16/2014 0:00	7/31/2014 23:45	169	0	442	0	676	19.5	676	7.4	11.7%	676	84.4	105.7	0.0%	676	107.5	0.0%
8/1/2014 0:00	8/15/2014 23:45	213	0	447	0	842	19.4	842	7.2	50.4%	848	0.0	101.9	0.7%	842	112.0	2.4%
8/16/2014 0:00	8/31/2014 23:45	219	0	421	0	862	18.9	862	7.3	74.6%	868	0.0	96.5	0.7%	862	112.6	11.3%
9/1/2014 0:00	9/15/2014 23:45	178	0	418	0	697	17.9	697	6.8	74.3%	705	0.0	102.4	2.4%	697	111.6	4.9%
9/16/2014 0:00	9/30/2014 23:45	136	0	430	0	547	16.8	547	7.2	64.0%	547	78.8	93.2	0.9%	547	111.0	7.9%
10/1/2014 0:00	10/15/2014 23:45	118	0	430	0	475	15.7	475	7.6	9.1%	475	80.5	93.9	0.0%	475	106.7	0.0%
10/16/2014 0:00	10/31/2014 23:45	119	0	330	0	476	14.0	476	7.6	9.9%	476	76.8	99.6	7.4%	476	106.2	0.0%
7/1/2014 0:00	10/31/2014 23:45	1,226	0	421	0	4,839	17.9	4,785	6.8	43.0%	4,807	0.0	106.5	1.5%	4,839	112.6	4.0%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.

Table 3-6: Summary of DO Less than 8 mg/L, DO Criterion Lower Limit

Parameter	LLFB			LLTR		
	Total Number	Number <8.0 mg/L DO [1]	Frequency <8.0 mg/L DO	Total Number	Number <8.0 mg/L DO [2]	Frequency <8.0 mg/L DO
Generation With Spill <200cfs	6,854	4,419	64.5%	6,656	838	12.6%
Generation With Spill >200 cfs [1,2]	4	1	25.0%	4	0	0.0%
All Generation	6,858	4,420	64.5%	6,660	838	12.6%
Non-Generation	4,894	4,203	85.9%	4,785	2,104	44.0%
All	11,752	8,623	73.4%	11,445	2,942	25.7%

Notes:

1. DO criterion of 8 mg/L is not directly applicable to LLFB.
2. Of the 7,293 measurements, 314 (4.3%) were less than 7.8 mg/L.

Table 3-7: Summary of TDG% Greater than 110%, TDG Criterion Upper Limit

Parameter	LLFB			LLTR		
	Total Number	Number >110% TDG	Frequency >110% TDG	Total Number	Number >110% TDG [2]	Frequency >110% TDG
Generation With Spill <200cfs	6,836	45	0.7%	6,773	908	13.4%
Generation With Spill >200 cfs [1,2]	4	0	0.0%	4	1	25.0%
All Generation	6,840	45	0.7%	6,777	909	13.4%
Non-Generation	4,894	0	0.0%	4,839	194	4.0%
All	11,734	45	0.4%	11,616	1,103	9.5%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.

2. Of the 7,441 measurements, 58 (0.8%) were greater than 112% TDG.

Table 4-1: Aeration Operations and Frequency of Meeting DO and TDG% Criteria

	2010 [a]	2011 [b]	2012 [c]	2013 [d]	2014
Long Lake HED Operations					
Average July - October Discharge (cfs)	nr	3,819	2,941	2,298	2,441
HED Units with Aeration	Tested aeration of Units 3 and 4	Units 3 and 4 with no more than 1 unit aerating at same time	Units 1 and 2 with up to 2 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time
Aeration start and end dates, respectively	September 1 and 2	August 24 and October 19	August 2 and October 14	August 6 and October 6	July 24 and October 21
Aeration Hours	25 unit-hours within 14 hours	684 unit-hours within 684 hours	1,687 unit-hours within 1,021 hours	1,562 unit-hours within 859 hours	2,282 unit-hours within 1,045 hours
Frequency LLTR Dissolved Oxygen ≥8.0 mg/L					
During Generation without Spillgate Use [e]	Test results indicate aeration could achieve DO of 7.5 and 8 mg/L while maintaining TDG% <110%	80.8% of 6,709 values	84.7% of 8,272 values	91.5% of 6,826 values	87.4% of 6,656 values
During Generation with Spillgate Use [f]		100.0% of 1,472 values	100.0% of 484 values	zero values	100.0% of 4 values
Entire Generation Period		84.2% of 8,181 values	85.5% of 8,756 values	91.5% of 6,826 values	87.4% of 6,660 values
Entire Monitoring Period (Both Generation and non-Generation)		67.2% of 11,787	67.6% of 11,786	75.0% of 11,772 values	74.3% of 11,445 values
Frequency LLTR TDG% ≤110.0%					
During Generation without Spillgate Use [e]	Test results documented that draft-chest aeration could cause TDG% >110%	99.9% of 6,676 values	96.2% of 8,262 values	88.8% of 6,825 values	86.6% of 6,773 values
During Generation with Spillgate Use [f]		0.7% of 1,467 values	4.3% of 484 values	zero values	75.0% of 4 values
Entire Generation Period		82.0% of 8,143 values	91.1% of 8,746 values	88.8% of 6,825 values	86.6% of 6,777 values
Entire Monitoring Period (Both Generation and non-Generation)		87.6% of 11,748	93.4% of 11,773	93.9% of 11,768 values	90.5% of 11,616 values

Notes:

nr = data not analyzed

[a] September 1 and 2, 2010 aeration testing is documented in HDR and REMI (2010, Section 7.0 and Appendix C).

[b] 2011 Monitoring is documented in Golder (2012).

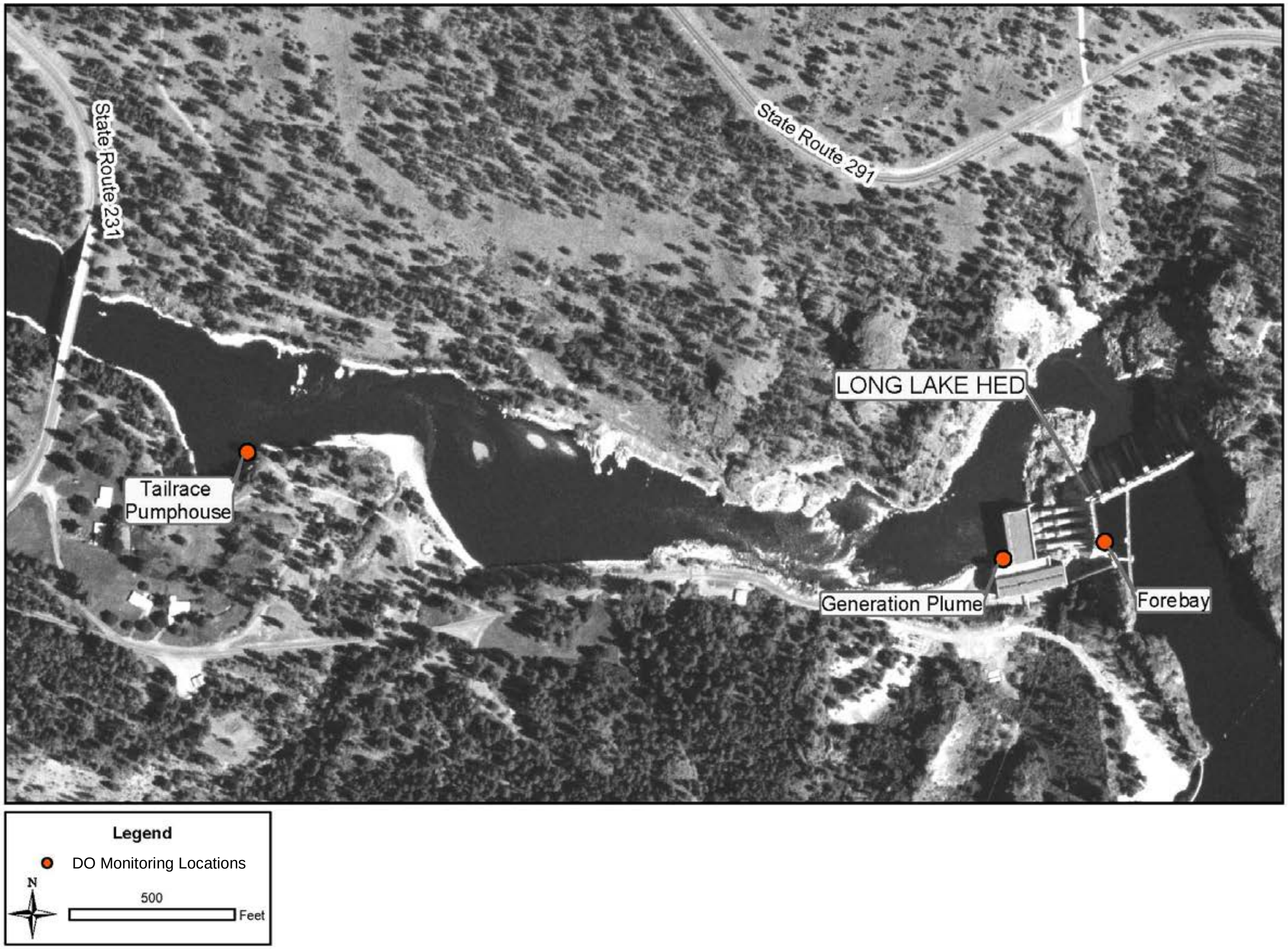
[c] 2012 Monitoring is documented in Golder (2013).

[d] 2013 Monitoring is documented in Golder (2014).

[e] Includes periods of <200 cfs spill in 2014.

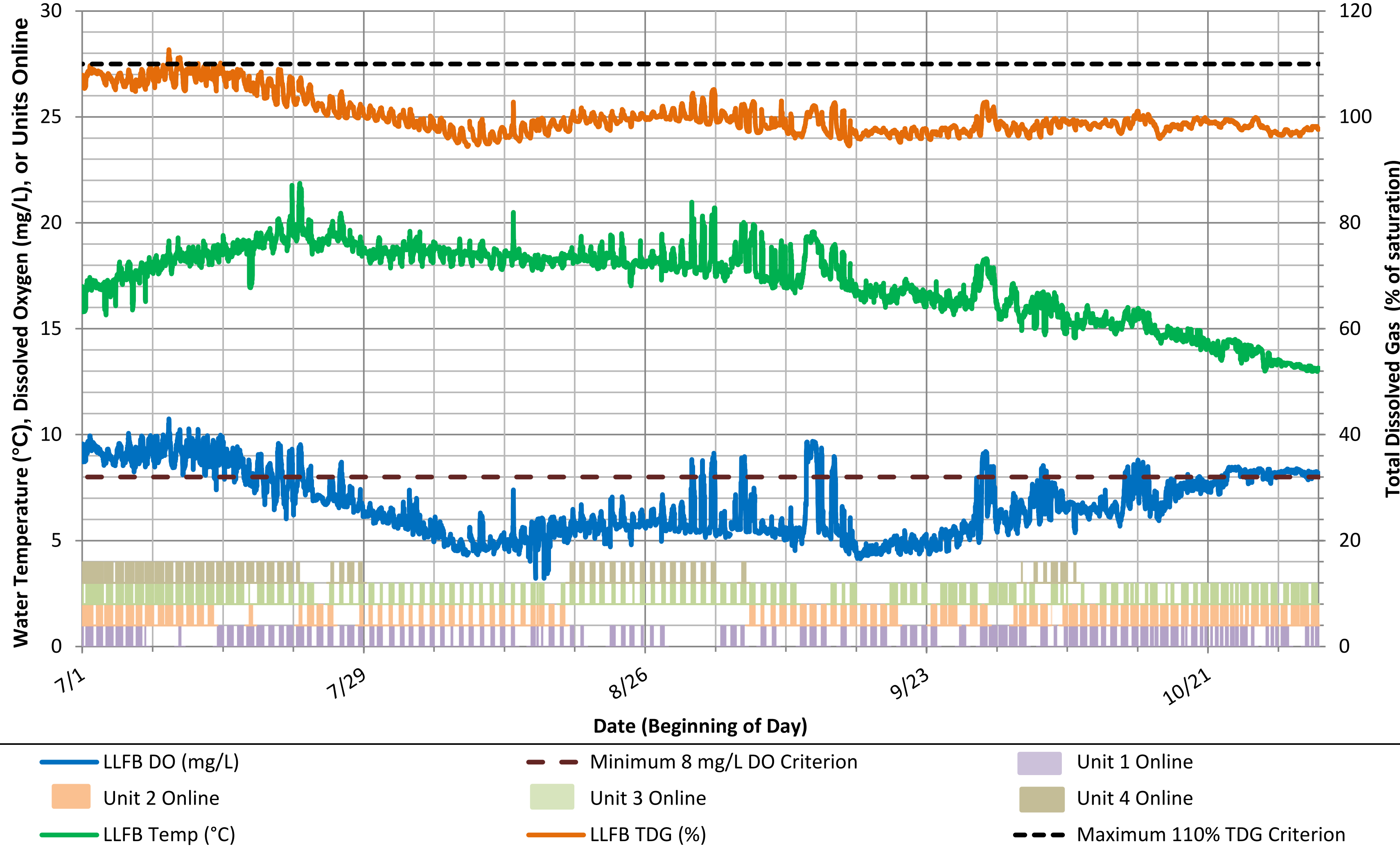
[f] Excludes periods of <200 cfs spill in 2014.

FIGURES



Source: Avista

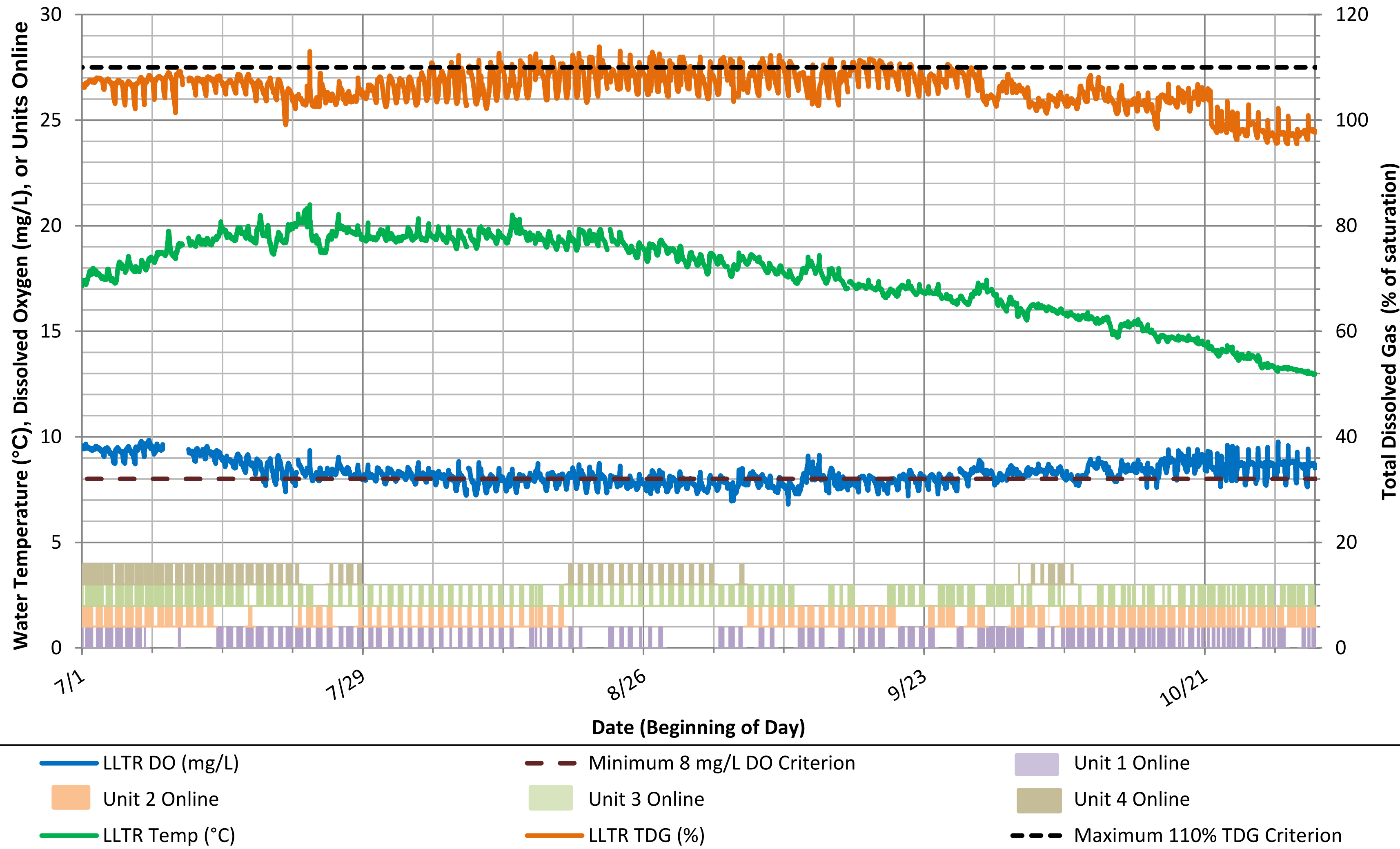
Figure 2-1: Long Lake HED Permanent Water Quality Monitoring Station Locations



Golder Associates

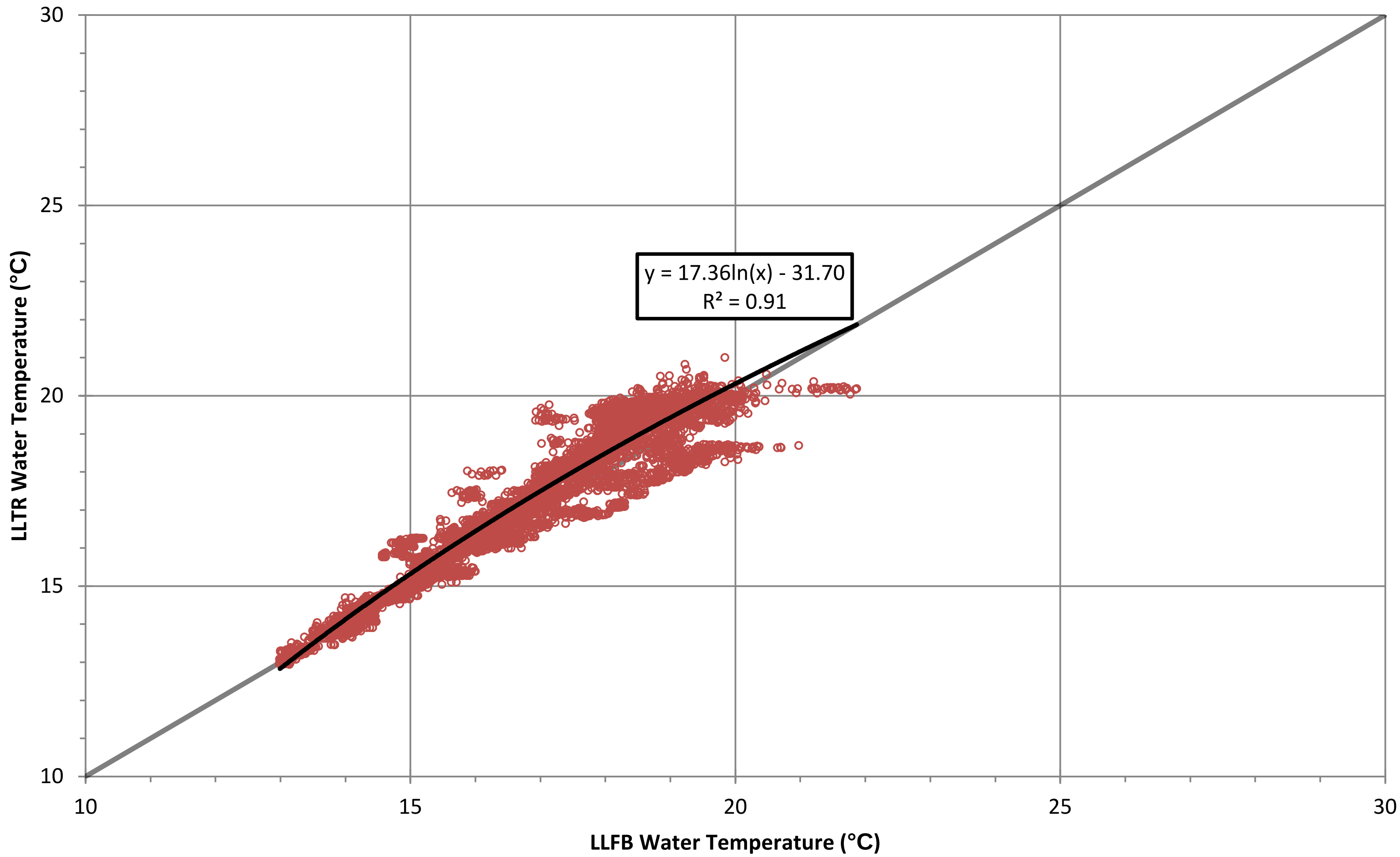
Title	LLFB Water Temperature, Dissolved Oxygen, TDG%, and Operations		
Project Name	LL DO Monitoring	Project No.	073-93081-12.500
Client Name	Avista	Date	February 27, 2015
FIGURE 3-1			

X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx



Golder Associates	Title	LLTR Water Temperature, Dissolved Oxygen, TDG%, and Operations	
	Project Name: LL DO Monitoring	Project No.: 073-93081-12.500	FIGURE 3-2
	Client Name: Avista	Date: February 27, 2015	

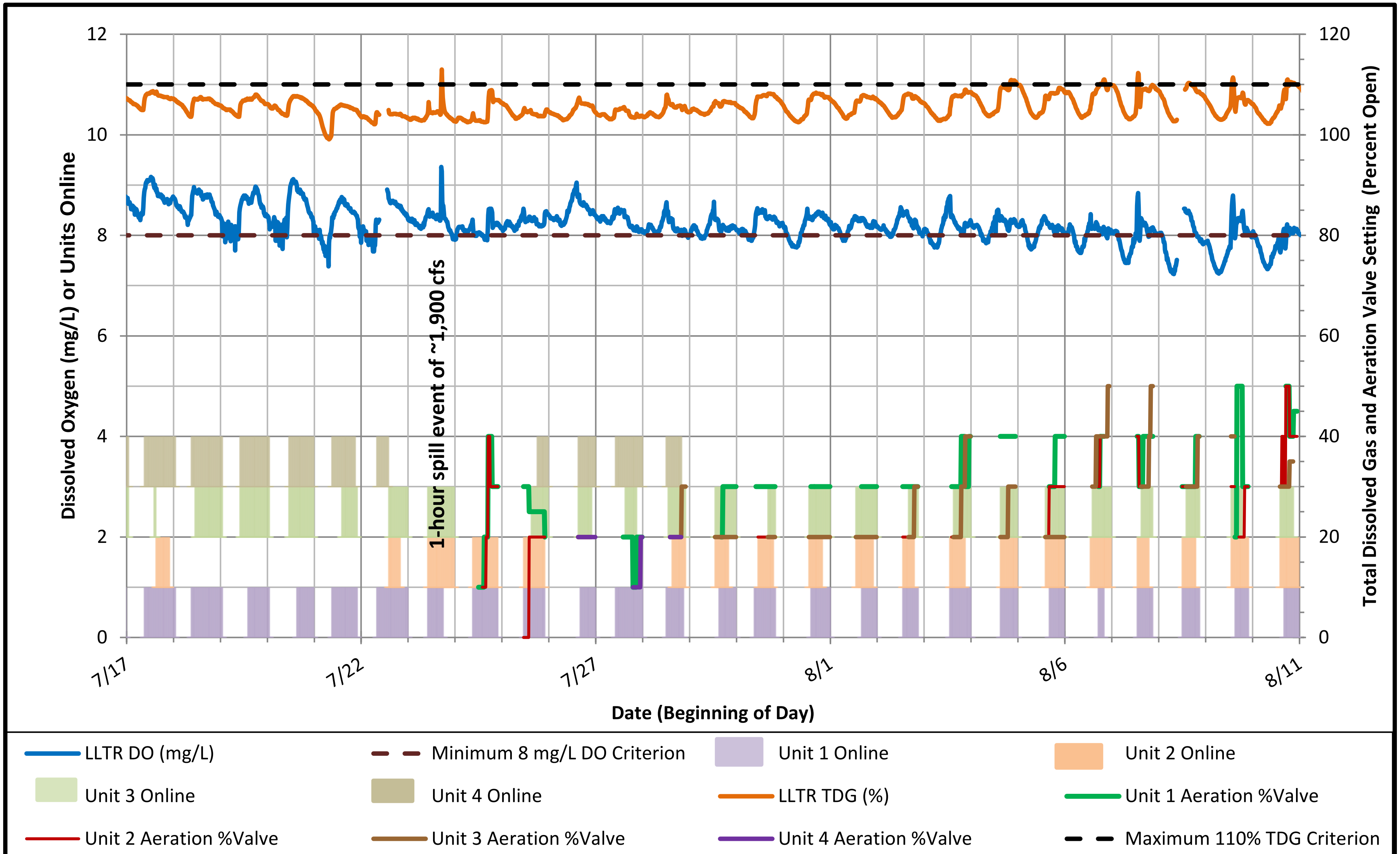
X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx



Title	Water Temperature Comparison for LLTR and LLFB during Generation		
Project Name	LL DO Monitoring	Project No. 073-93081-12.500	FIGURE 3-3
Client Name	Avista	Date February 27, 2015	

Golder Associates

X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx

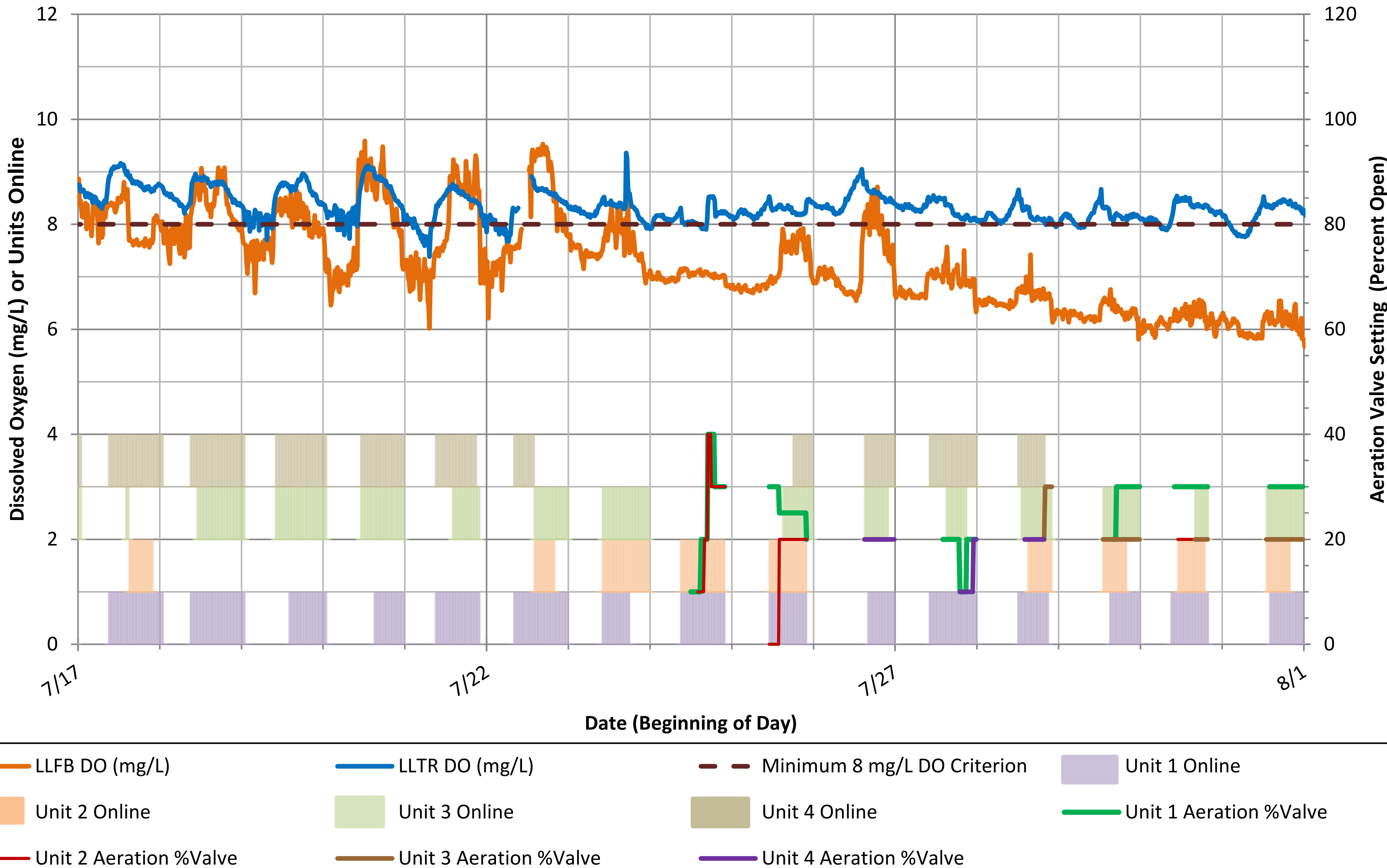


Golder Associates

Title	LLTR Dissolved Oxygen Concentration and TDG% with Operations, July 17 - August 11		
Project Name	LL DO Monitoring	Project No.	073-93081-12.500
Client Name	Avista	Date	February 27, 2015

FIGURE 3-4

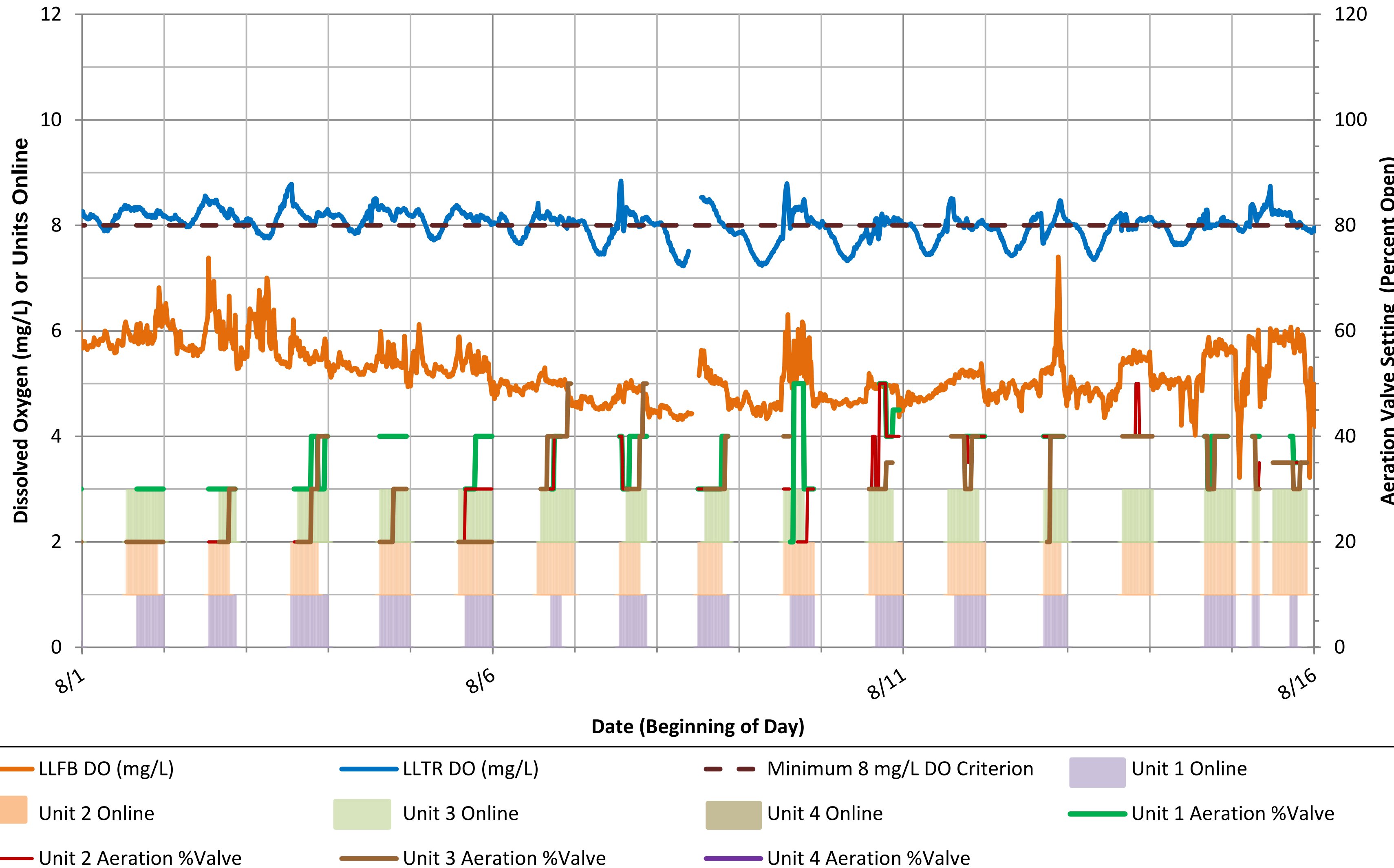
X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx



Golder Associates

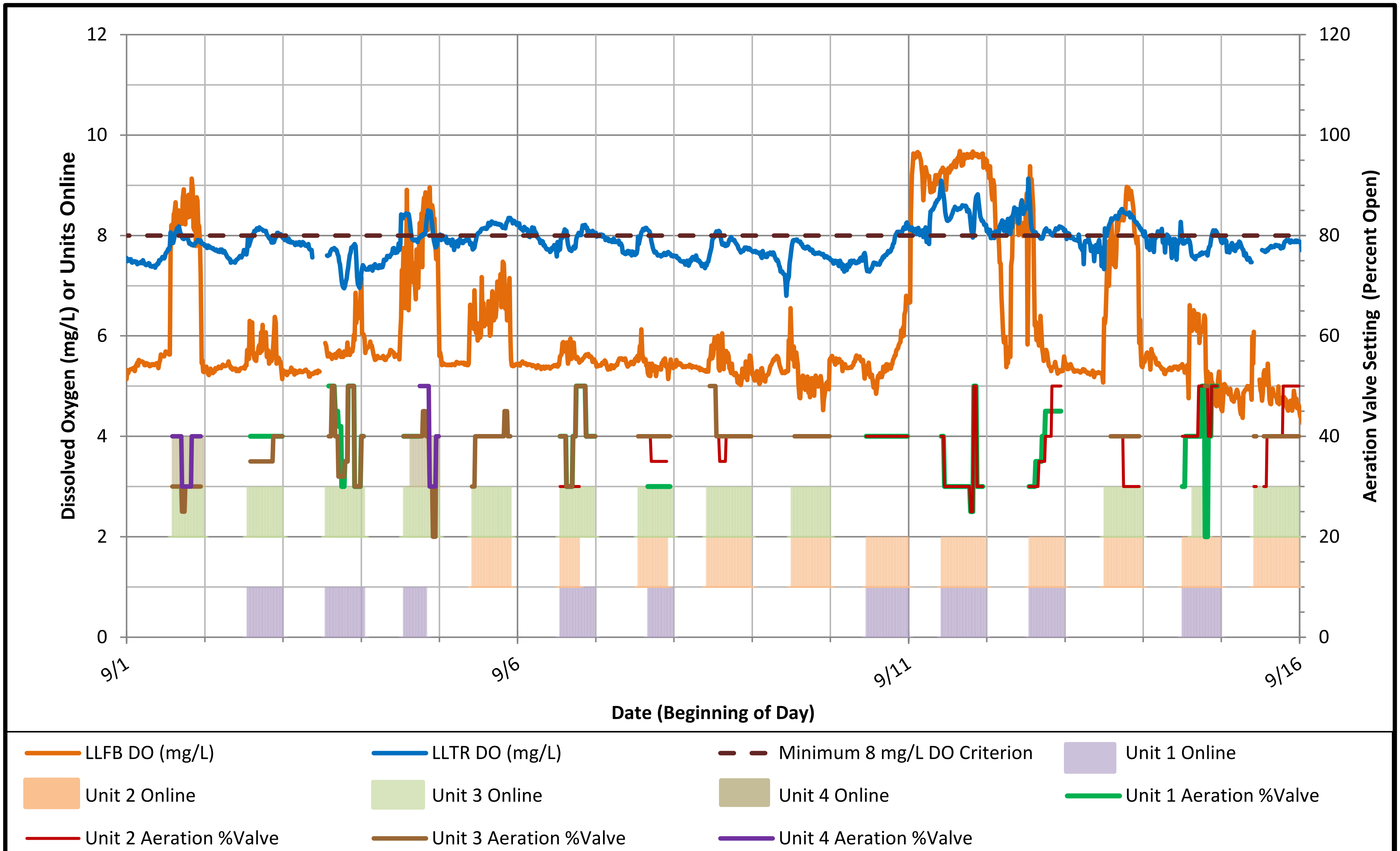
Title	Dissolved Oxygen Concentration with Operations, July 17 - August 1
Project Name	LL DO Monitoring
Project No.	073-93081-12.500
Client Name	Avista
Date	February 27, 2015
FIGURE	3-5

X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx



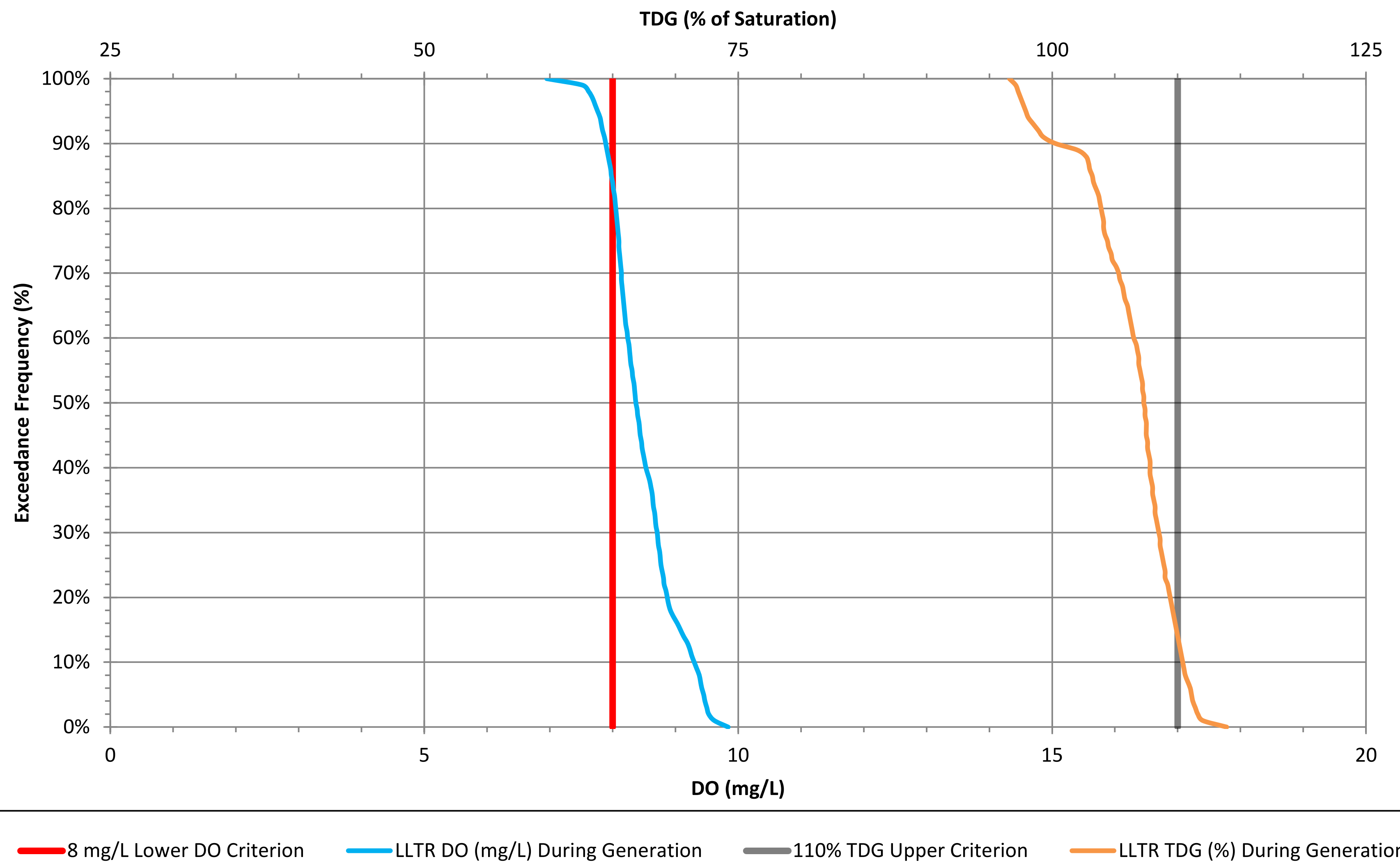
Golder Associates

Title	Dissolved Oxygen Concentration with Operations, August 1 - 16		
Project Name	LL DO Monitoring	Project No. 073-93081-12.500	FIGURE 3-6
Client Name	Avista	Date February 27, 2015	



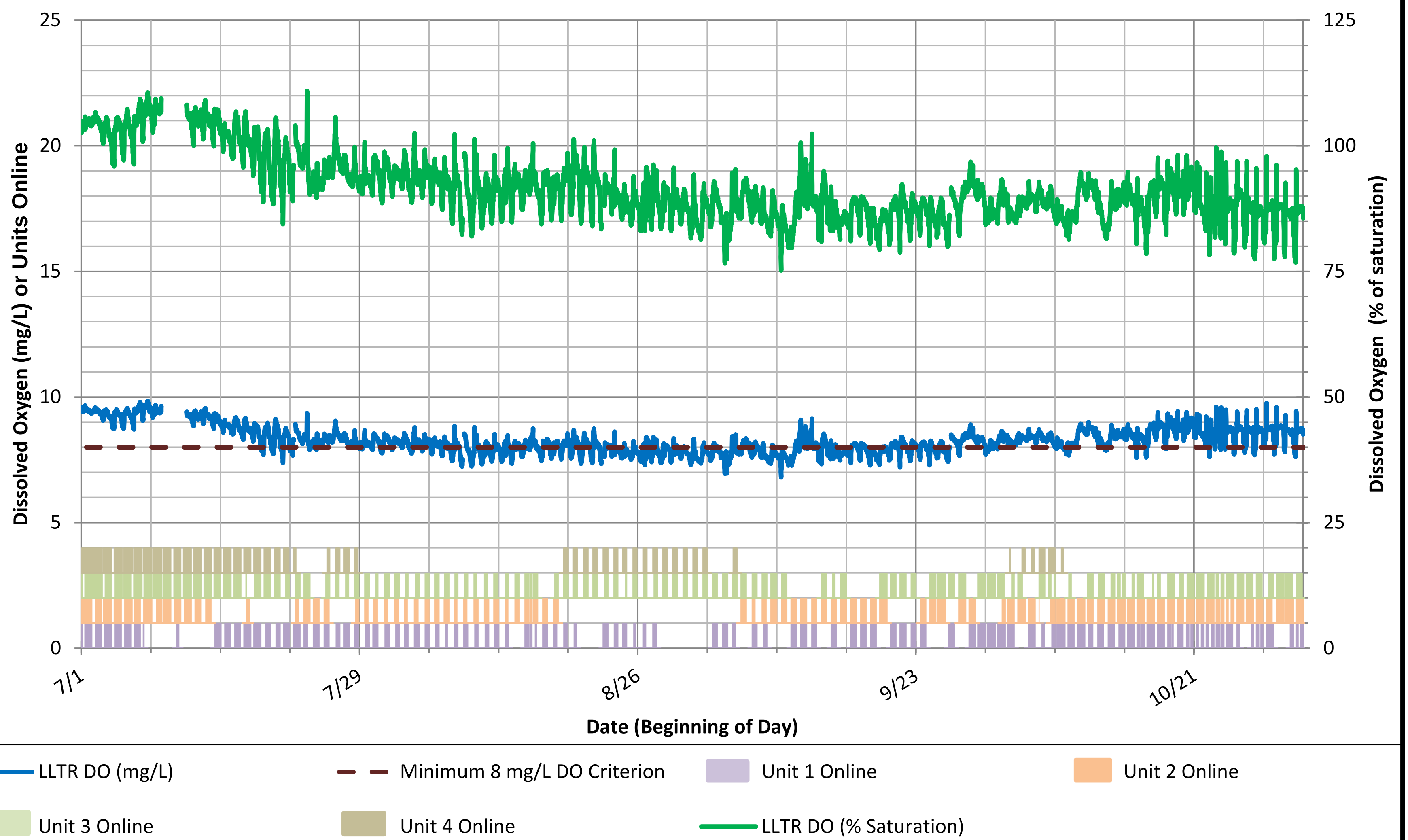
Golder Associates

Title	Dissolved Oxygen Concentration with Operations, September 1 - 16
Project Name	LL DO Monitoring
Project No.	073-93081-12.500
Client Name	Avista
Date	February 27, 2015
FIGURE	3-7



Golder Associates	Title: LLTR DO Concentration and TDG% Exceedance Frequency during Generation		
	Project Name: LL DO Monitoring	Project No. 073-93081-12.500	FIGURE 3-8
	Client Name: Avista	Date: February 27, 2015	

X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx



Golder Associates

Title: LLTR Dissolved Oxygen Concentration and Percent of Saturation along with Operations

Project Name	LL DO Monitoring	Project No.	073-93081-12.500
Client Name	Avista	Date	February 27, 2015

FIGURE 3-9

X:\Peeler\Avista LL DO Report 2015-02-27\20150226blm1725_LL_DO_Processed_Restricted.xlsx

Action	Task	2009	2010	2011	2012	2013	2014	2015
Structural Modifications	Phase II – Apply modeling tools to determine alternatives most likely to be effective		S	S	S			
	Phase II – Identify highest priority alternative to be field tested		S					
	Phase II – Prepare Work Plan to test effectiveness of highest priority alternative		S					
	Phase II – Implement Work Plan and prepare summary report		S					
	Phase II – Determine if additional aeration measures are necessary, and prepare/implement corresponding Work Plans for testing effectiveness of additional high priority aeration measures			(S)	(S)			
	Phase III - Construct permanent modifications for preferred alternative			S	S			
	Phase IV - Evaluate need for any additional DO enhancement measures					S	S	
Monitoring	Select/design permanent monitoring stations and develop monitoring plan	M	M					
	Prepare and implement Phase II water quality monitoring plan(s) for testing of high priority alternatives		M	(M)	(M)			
	Monitor DO and other relevant water quality conditions at the 0.6 mile downstream of Long Lake Dam (LLTR)		M	M	M	M	M	
	Annual Monitoring Report			M	M	M	M	
	Five-Year Report							M

Legend

S	Structural
M	Monitoring

() Only done if testing demonstrates need for additional Long Lake HED discharge aeration measures.

Note: The FERC (2010) Order Modifying and Approving this schedule included requiring Avista to submit the annual and five-year DO Monitoring reports to Ecology and the Spokane Tribe by March 1 of each year following monitoring (starting in 2011), allowing the agencies at least 30 days to review and comment prior to submitting the final reports with the FERC by April 15, and documenting consultation with these agencies.

Figure 4-1: Approved Long Lake HED DO Feasibility and Implementation Schedule

APPENDIX A
DATA QUALITY ANALYSIS

DATA QUALITY SUMMARY

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 measurement range, accuracy, precision, representativeness, completeness, and comparability. The range, accuracy, and resolution for each measured parameter are provided in Table A-1.

Table A-1: Range, Accuracy and Resolution of Parameters Recorded

Instrument and Parameter	Range	Accuracy	Resolution
MS5 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
MS5 Total Dissolved Gas	400 to 1300 mm Hg	± 0.1 % of span	1.0 mm Hg
MS5 Temperature	-5 to 50°C	± 0.10°C	0.01°C
MS5 Depth (0-25 meters)	0 to 25 meters	± 0.05 meter	0.01 meter
Barologger Relative Barometric Pressure	1.5 meter of water	± 0.1 cm of water	0.002% of full scale
Barologger Temperature	-10 to 40°C	± 0.05°C	0.003°C

Note: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [9]

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. Table A-2 presents MQOs selected during preparation of the Long Lake HED tailrace DO monitoring plan. The meter-specific root mean squared error (RMSE) of the calibration corrections applied after each calibration, and an overall RMSE for all meters compared to MQOs are shown in Table A-3.

Table A-2: Measurement Quality Objectives

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

[9] Hach Corporation. 2006. Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes User Manual. February 2006, Edition 3. Catalog Number 003078HY and Solinist. 2010. Levelogger Series (Levelogger Gold, Barologger Gold, Levelogger Junior, LTC Levelogger Junior and Rainlogger) User Guide - Software Version 3.4.0. August 17, 2010.

Table A-3: Difference between RMSE and MQOs by MS5

Part 1: Barometric Pressure (BAR), Total Pressure, and Total Dissolved Gas (TDG)

Meter IDs and Locations	RMSE [1]				MQO			RMSE - MQO			
	BAR[2] (mm Hg)	Total Pressure[3] (%)	TDG-cal[4] (%)	TDG-spot[5] (%)	BAR (mm Hg)	Total Pressure (%)	TDG (%)	BAR (mm Hg)	Total Pressure (%)	TDG-cal (%)	TDG-spot (%)
48762 (LLFB 6/24 – 11/03)	2.20	0.31	0.31	0.32	2	1	1	0.20	-0.69	-0.69	-0.68
60376 (LLTR 6/24 – 11/03)	1.17	0.16	0.16	0.32	2	1	1	-0.83	-0.84	-0.84	-0.68
Overall RMSE	1.73	0.24	0.24	N/A	2	1	1	-0.27	-0.76	-0.76	N/A

Notes:
Shaded values indicate exceedance of MQO.
[1] RMSE calculated for each meter during calibration checks and spot measurements from multiple meters.
[2] RMSE calculated from BAR measured during calibration compared to the TDG in air uncorrected reading.
[3] RMSE calculated as the difference in TDG in air uncorrected measured during calibration minus the BAR, then divided by the TDG and multiplied by 100%.
[4] RMSE calculated as TDG in air uncorrected measured during calibrations divided by the BAR and multiplied by 100%.
[5] RMSE calculated as the measured TDG in air uncorrected divided by the group average measured TDG for each of 8 occasions.
N/A - Not available, measurement not taken.

Root mean squared error (RMSE) = $\sqrt{\frac{\sum_{i=1}^{n}(x_{1,i} - x_{2,i})^2}{n}}.$

Table A-3 (Continued): Difference Between RMSE and MQOs by MS5,

Part 2: Temperature and Dissolved Oxygen (DO)

Meter IDs and Locations	RMSE				MQO		RMSE - MQO			
	Temperature[1]		DO[2]				Temperature[1]		DO[2]	
	Calibration (°C)	Spot (°C)	Calibration (mg/L)	Spot (mg/L)	Temp (°C)	DO (mg/L)	Calibration (°C)	Spot (°C)	Calibration (mg/L)	Spot (mg/L)
48762 (LLFB 6/24 – 11/03)	0.18	0.04	0.22	0.08	0.5	0.5	-0.32	-0.46	-0.28	-0.42
60376 (LLTR 6/24 – 11/03)	0.27	0.04	0.23	0.08	0.5	0.5	-0.23	-0.46	-0.27	-0.42
Overall RMSE	0.23	N/A	0.23	N/A	0.5	0.5	-0.27	N/A	-0.27	N/A

Notes:
Shaded values indicate exceedance of MQO.
[1] For Calibration, RMSE calculated from the difference between the meter and calibration thermometer at all calibration checks. Spot differences are differences between measured values from group average for 8 occasions.
[2] Calibration RMSE as difference of the pre-calibration measurement and calculated 100% saturation. Spot RMSE calculated as average difference between measured values from group average for 8 occasions.
N/A - Not available, measurement not taken

Root mean squared error (RMSE) = $\sqrt{\frac{\sum_{i=1}^{n}(x_{1,i} - x_{2,i})^2}{n}}$.

Golder Associates

Measurement Range

The measurement range, range of reliable readings of an instrument or measuring device, specified by the manufacturer is displayed in Table A-1 for each measured parameter. Maintenance of field sampling equipment was conducted in a manner consistent with the corresponding manufacturer's recommendations to provide reliable readings within each instrument's reported measurement range.

Bias

TDG meters, like other field monitoring instruments, are subject to bias due to systematic errors introduced by calibration, equipment hardware or software functioning, or field methods. Bias was minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

Precision

Precision refers to the degree of variability in replicate measurements and is typically defined by the instrument's manufacturer. Manufacturer values for the MS5 and barologger (Table A-1) were within MQOs.

Accuracy

Accuracy is a measure of confidence that describes how close a measurement is to its "true" value (low bias). Throughout this seasonal DO monitoring study, the MS5s underwent calibration and verification procedures.

Instrument accuracy was evaluated through the calibration and maintenance activities along with paired spot measurements (Table A-3). MQOs for DO, total pressure, TDG%, and temperature were met for both meters. The BAR 2-mm Hg MQO was exceeded by 0.20 mm Hg for the MS5 that was used for long-term deployments at LLFB (MS5 48762), primary due to a difference of 4 mm Hg on September 15.

Discharge and aeration data were obtained from Avista, which uses a well-established monitoring program. Golder Associates Inc. (Golder) reviewed the variability of these data to determine whether values were appropriate based on expectations. All discharge and aeration data were deemed acceptable.

Representativeness

Representativeness qualitatively reflects the extent to which sample data represent a characteristic of actual environmental conditions. For this project, representativeness was addressed through proper design of the sampling program to ensure that the monitoring locations were properly located and sufficient data were collected to characterize DO at that location.

Comparability

Comparability is the degree to which data can be compared directly to previously collected data. Comparability was achieved by consistently monitoring the same downstream long-term monitoring station (LLTR) monitored in the past and monitoring in the LLFB standpipe constructed in 2009 and used in 2010, 2011, 2012, and 2013.

Completeness

Completeness is the comparison between the quantity of data planned to be collected and how much usable data was actually collected, expressed as a percentage (Table A-4). The DO data collection period consisted of 11,808 15-minute periods. DO and all remaining parameters had completeness of at least 97 percent, which met the goal of 90 percent, for both LLTR and LLFB.

Table A-5 summarizes the number of specific DQ Codes applied to LLFB and LLTR data.

Table A-4: Project Completeness

	LLFB		LLTR	
	Count	**Completeness (%)**	**Count**	**Completeness (%)**
Monitoring Period	11,808	--	11,808	--
Water Temperature (°C)	11,752	100%	11,637	99%
Dissolved Oxygen (mg/L)	11,752	100%	11,445	97%
BAR (mm Hg)	Used LLTR BAR		11,808	100%
TDG (mm Hg)	11,734	99%	11,616	98%
TDG (% saturation)	11,734	99%	11,616	98%
DO (% saturation)	11,752	100%	11,445	97%

Table A-5: Number of Specific DQ Codes during the Monitoring Period

DQ Code	DQ Code Description	LLFB					LLTR						
		Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)
1002	Atypical long-term depth that corresponds with spot measurement	7	7	7	7	7	6	6	6	6	5	0	0
1001	Mass verification at location other than long-term monitoring station	0	0	0	0	0	2	2	2	2	2	0	0
997	Equilibrating after deployment	0	18	0	0	0	0	24	0	1	0	0	0
993	Out of water for calibration/servicing	22	22	22	22	22	49	49	49	49	49	0	0
992	Moved instrument; it is not at standard station or is out of water	27	27	27	27	27	74	71	74	74	73	0	0
888	Power loss	0	0	0	0	0	40	40	40	40	40	0	0
101	Less than "minimum operating voltage" (<7 volts) and other data do not appear reliable	0	0	0	0	0	0	0	0	191	191	0	0
-101	Less than "minimum operating voltage" (<7 volts), but other data appear reliable	0	0	0	0	0	243	243	243	52	52	0	0
-102	Between "minimum operating voltage" (<9 volts) and 7 volts, but other data appear reliable	0	0	0	0	0	603	603	603	603	603	0	0
-	Spot Measurement	0	0	0	0	0	8	8	8	8	8	1	1
-	Conversion from %Left	0	0	0	0	0	0	0	0	0	2	0	0
0	No data qualifiers	11,752	11,734	11,752	11,75	11,75	10,78	10,762	10,783	10,782	10,783	11,807	11,807
	Monitoring Period[1]	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808

APPENDIX B

CONSULTATION RECORD

AVISTA
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220-3727

February 27, 2015

Patrick McGuire, Water Quality Program
Washington Department of Ecology
Eastern Region Office
4601 N Monroe Street
Spokane, WA 99205-1295

RE: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project License, Appendix B, Sections 5.4 and 5.6.B, TDG and DO Reporting Requirements

Dear Mr. McGuire:

Ordering Paragraph E of the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License incorporated the Washington Department of Ecology (Ecology) Certification Conditions under Section 401 of the Federal Clean Water Act Water Quality Certification (Certification) as Appendix B of the License.

The following summarizes the status of the projects required under Section 5.4 of the Certification:

- *Long Lake Total Dissolved Gas (TDG) Monitoring.*
  In accordance with the approved Revised Long Lake HED TDG Compliance Schedule, Avista did not conduct TDG monitoring at its Long Lake Hydroelectric Development (HED) during 2014. Additionally, Avista will not be monitoring TDG during 2015 through 2017, during the Long Lake Dam spillway modification project for TDG abatement which is scheduled to be completed in 2017.

- *Nine Mile TDG Monitoring.*
  In accordance with Ecology's letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2014. As indicated in the Ecology Letter, Avista will resume monitoring TDG the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine units 1 and 2. This will ensure Nine Mile HED is operating under normal Project operations prior to resuming TDG monitoring. Also, as required by FERC in their September 24, 2014 letter, Avista will provide an update on our projected schedule to resume TDG monitoring, updates to the sediment bypass construction schedule, and our anticipated date of completion of replacement of turbine units 1 and 2 by September 1, 2015 to both Ecology and FERC.

The following summarizes the enclosed Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report (Five-Year Report) required under Section 5.6.B of the Certification:

The Five-Year Report includes the results of the 2014 Dissolved Oxygen (DO) monitoring immediately downstream of Long Lake Dam for the low-flow period of the year and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. Additionally, per the December 9, 2010 FERC Order, this report also provides a summary of the monitoring results from the past five years (2010-2014); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether additional DO measures and monitoring in the Long Lake Dam tailrace are needed.

As stated in the report, Avista plans to continue with the aeration program in 2015 and monitoring DO and TDG at the tailrace station (LLTR). However, Avista proposes to discontinue monitoring at the Long Lake Dam forebay station (LLFB) due to the variability caused by complex dynamics of the forebay intake area hydraulics.

With this, Avista is submitting the Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for Ecology's review and approval. We would like to receive any comments or recommendations that you may have by **March 31, 2015**, which will allow us time to file the report with FERC by April 15, 2015.

Please feel free to contact me at (509) 495-4643 if you have any questions or wish to discuss the report.

Sincerely,

Meghan Lunney

Meghan Lunney
Aquatic Resource Specialist

Enclosure (1)

cc: Chad Brown, Ecology
Brian Crossley, Spokane Tribe

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

April 13, 2015

Ms. Meghan Lunney
Aquatic Resource Specialist
Avista Corporation
1411 East Mission Avenue, MSC-1
Spokane, WA 99220-3727

RE: Request for Ecology Review and Approval – *2014 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.* Spokane River Hydroelectric Project, No. P-2545

Dear Ms. Lunney:

The Department of Ecology (Ecology) has reviewed the *2014 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* sent to Ecology on February 27, 2015. The report is a requirement of Section 5.4 of the 401 Certification and the Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, which is in accordance with Section 5.6.B of the 401 Certification.

Ecology APPROVES the *2014 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* as submitted.

Please contact me at (509) 329-3567 or pmcg461@ecy.wa.gov if you have any questions.

Sincerely,

Pat McGuire

Patrick McGuire
Eastern Region FERC License Coordinator
Water Quality Program

PDM:jab

cc: Elvin "Speed" Fitzhugh, Avista

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment
Ecology did not provide any comments in their approval letter.

Avista Response
No response is required.

AVISTA
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220-3727

February 27, 2015

Brian Crossley
Water & Fish Program Manager
Spokane Tribe Natural Resources
P.O. Box 480
Wellpinit, WA 99040

RE: Federal Energy Regulatory Commission's Spokane River Hydroelectric Project License, Appendix B, Sections 5.4 and 5.6.B, TDG and DO Reporting Requirements

Dear Mr. Crossley:

Ordering Paragraph E of the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License incorporated the Washington Department of Ecology (Ecology) Certification Conditions under Section 401 of the Federal Clean Water Act Water Quality Certification (Certification) as Appendix B of the License. Per Section 5.4 and Section 5.6.B of the Certification, and the October 2008 Settlement Agreement between Avista and the Spokane Tribe, Avista is submitting the following project status and a report for your review and comment.

The following summarizes the status of the projects required under Section 5.4 of the Certification:

- *Long Lake Total Dissolved Gas (TDG) Monitoring.*
  In accordance with the approved Revised Long Lake HED TDG Compliance Schedule, Avista did not conduct TDG monitoring at its Long Lake Hydroelectric Development (HED) during 2014. Additionally, Avista will not be monitoring TDG during 2015 through 2017, during the Long Lake Dam spillway modification project for TDG abatement which is scheduled to be completed in 2017.

- *Nine Mile TDG Monitoring.*
  In accordance with Ecology's letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2014. As indicated in the Ecology Letter, Avista will resume monitoring TDG the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine units 1 and 2. This will ensure Nine Mile HED is operating under normal Project operations prior to resuming TDG monitoring. Also, as required by FERC in their September 24, 2014 letter, Avista will provide an update on our projected schedule to resume TDG monitoring, updates to the sediment bypass construction schedule, and our anticipated date of completion of replacement of turbine units 1 and 2 by September 1, 2015 to both Ecology and FERC.

The following summarizes the enclosed Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report (Five-Year Report) required under Section 5.6.B of the Certification:

The Five-Year Report includes the results of the 2014 Dissolved Oxygen (DO) monitoring immediately downstream of Long Lake Dam for the low-flow period of the year and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. Additionally, per the December 9, 2010 FERC Order, this report also provides a summary of the monitoring results from the past five years (2010-2014); analyzes the effectiveness of the measures implemented to improve DO; and evaluates whether additional DO measures and monitoring in the Long Lake Dam tailrace are needed.

As stated in the report, Avista plans to continue with the aeration program in 2015 and monitoring DO and TDG at the tailrace station (LLTR). However, Avista proposes to discontinue monitoring at the Long Lake Dam forebay station (LLFB) due to the variability caused by complex dynamics of the forebay intake area hydraulics.

With this, Avista is submitting the Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for your review and comment. We would like to receive any comments that you may have by **March 31, 2015**, which will allow us time to file the report with FERC by April 15, 2015.

Please feel free to contact me at (509) 495-4643 if you have any questions or wish to discuss the report.

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosure (1)

cc: Patrick McGuire, Ecology

Spokane Tribal Natural Resources
P.O. Box 480 • Wellpinit, WA 99040 • (509) 626 - 4400 • fax 258 - 9600

3/30/2015

Megan Lunney
1411 East Mission Avenue
PO Box 3727 MSC-25
Spokane WA 99220

Dear Megan:

I have reviewed the 2014 dissolved oxygen and temperature monitoring reports with the assistance of DNR staff. These reports focus on Long Lake Dam and its effect on dissolved oxygen, total dissolved gas and temperature. The changes to dissolved oxygen at the tailrace of Long Lake are substantial. The monitoring data also indicates that the dissolved oxygen doesn't decline as precipitously as expected once generation stops. We appreciate the detail shown in the figures showing the daily range of dissolved oxygen concentrations. The standard at LLTR for dissolved oxygen is 8.0 mg/L and is not predicated upon whether power generation is occurring at Long Lake. The report could make this point clearer.

These comments from March 2014 should be considered:

- Additional questions and evaluations should be made to understand the potential for cooling the water through the DO tubes and the alternatives to "normal" operations that might improve the DO sags when the turbines are off. For example, could one turbine remain on during the night at a lower level to keep oxygen from declining?
- Analysis of the air temperature being used by the DO aeration as well as the concept of variable depth withdrawals should be addressed. The Temperature Attainment Plan is broad in its scope but should be willing to approach such topics.

Sincerely,

Brian Crossley
Water & Fish Program Manager
crossley@spokanetribe.com

cc: Patrick McGuire, Dept. of Ecology
BJ Kieffer, Director Dept. of Natural Resources
Matt Wynne, Tribal Council

SPOKANE TRIBE COMMENTS AND AVISTA RESPONSES

The majority of the Spokane Tribe's March 30, 2015 comment letter focused on the Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. These comments, and Avista's responses to them, are provided as follows.

Spokane Tribe Comment
The changes to dissolved oxygen at the tailrace of Long Lake are substantial. The monitoring data also indicates that the dissolved oxygen doesn't decline as precipitously as expected once generation stops.

Avista Response
Avista concurs that the changes to the dissolved oxygen (DO) levels are substantial, indicating the aeration system works to improve DO downstream of the dam.

Spokane Tribe Comment
We appreciate the detail shown in the figures showing the daily range of dissolved oxygen concentrations.

Avista Response
Avista will continue to provide this detail in future reporting.

Spokane Tribe Comment
The standard at LLTR for dissolved oxygen is 8.0 mg/L and is not predicated upon whether power generation is occurring at Long Lake. The report could make this point clearer.

Avista Response
Avista modified Sections 3.4, 3.6, and 4.1 of the report in order to clarify this and reviewed these revisions with the Spokane Tribe during a phone conversation on April 7, 2015. Additionally Table 4-1 was modified to include the frequency of meeting DO and TDG % Criteria, during the entire monitoring period (both generation and non-generation).

Spokane Tribe Comment
Additional questions and evaluations should be made to understand the potential for cooling the water through the DO tubes and the alternatives to "normal" operations that might improve the DO sags when the turbines are off. For example, could one turbine remain on during the night at a lower level to keep oxygen from declining?

Avista Response:
During our April 7th phone conversation, we revisited the configuration of the powerhouse and that running one turbine at night to aerate the tailrace isn't currently practical. This is because each turbine requires at least 1,200 cubic feet per second (cfs) to run, which frequently exceeds river inflows during the low-flow season. Avista will however, work to compare DO sags in the tailrace with those measured downstream by the Tribe near the mouth of Chamokane Creek, where the Tribe has determined the DO sags are much smaller.