AVISTA CORPORATION

2013
LONG LAKE HED TAILRACE
DISSOLVED OXYGEN
MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.6(B)

Spokane River Hydroelectric Project
FERC Project No. 2545

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April 10, 2014

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% 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
Certification	Washington Department of Ecology Section 401 Water Quality Certification
cfs	cubic feet per second
DO	dissolved oxygen
DO TMDL	Spokane River and Lake Spokane 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)
MOA	Memorandum of Agreement
MQO	measurement quality objective
MS5	Hydrolab® MS5 Multiprobe®
LLFB	monitoring station at Long Lake forebay
LLGEN	monitoring station at Long Lake HED Unit 4 generation plume
LLTR	monitoring station at Long Lake tailrace
LLTRSP1	monitoring station across the river from LLTR
LLGEN_Spot	monitoring station between Long lake powerhouse and LLTR
PDT	Pacific Daylight Time
REMI	Reservoir Environmental Management, Inc.
Reservation	Spokane Tribe of Indians Reservation
RFP	request for proposal
RMSE	root mean squared error
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation

1.0 INTRODUCTION

Results of water quality monitoring conducted during relicensing of the Spokane River Project (HDR 2005) indicate that 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 discharge of Long Lake HED, evaluate which alternatives were reasonable and feasible, and implement selected alternative(s) to improve DO in the Long Lake HED discharge. Avista initiated this process with the Long Lake HED Phase I Aeration Study (HDR 2006) in 2005.

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 the Spokane Tribe of Indians Reservation (Reservation). Throughout the implementation of the MOA, Avista has worked collaboratively with the Spokane Tribe to develop and carry out feasibility studies and implementation actions pertaining to the goal of meeting the DO standard on the Reservation.

On June 18, 2009, the Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Project, FERC Project No. 2545 (FERC 2009), which incorporated the Washington Department of Ecology (Ecology) Section 401 Water Quality Certification (Certification; Ecology 2010a) as Appendix B. Section 5.6(B) of the Certification and Article 401 of the FERC license required Avista to submit a Detailed Phase II Feasibility and Implementation Plan (Plan), based on the Long Lake HED DO Aeration Study, to Ecology and FERC within one year of license issuance (by June 17, 2010), choosing one of several options to implement. The Plan provided:

- An 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 Total Maximum Daily Load (TMDL) efforts.

Avista submitted the Plan to 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, FERC (2010) modified and approved the Plan. The first annual report (Golder 2012) documented Avista's implementation of the FERC-approved Plan for activities conducted in 2011, the second annual report (Golder 2013) documented DO monitoring conducted during 2012, and this third annual report documents DO monitoring conducted during 2013. A summary of the 2013 data quality is provided in Appendix A and a record of consultation with Ecology and the Spokane Tribe is provided in Appendix B.

2.0 LONG LAKE HED

2.1 Objectives

The objectives of the DO monitoring, a component of the 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.

2.2 Monitoring Period

The 2013 monitoring period for this study was from July 1 through October 31. Aerating in 2013 was done with all four units and as many as three units at a time. Each unit's aeration valve openings were recorded and displayed along with Long Lake HED tailwater DO and TDG levels.

2.3 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. DO monitoring stations were field serviced at approximately 2- to 3-week intervals during the monitoring period. In addition, barometric pressure (BAR; mm Hg) was recorded.

2.3.1 Equipment and Calibration

Solinst® barologgers were used to determine local barometric pressure, BAR. A primary barologger was deployed at the Long Lake Tailrace site (LLTR) for the entire monitoring season. A back-up barologger was also deployed at this site to provide 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]).

[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.

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. Each MS5 deployed for extended periods[2] was connected to an external alternating current (AC) power source upon initial deployment with the goal of minimizing potential issues associated with low or no power supply. A MS5 equipped with a short power/data cable and a laptop computer was used as a portable meter to obtain spot measurements of DO, TDG, and temperature at long-term DO monitoring stations.

All MS5 instruments used had undergone annual servicing by Hach Hydromet Technical Support & Service and were factory calibrated before the 2013 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 the MS5s' TDG pressure value, with the silastic membrane removed, to the ambient barometric pressure, confirming the patency of the MS5's TDG silastic membrane, and testing the barologgers to confirm that the recorded values were similar and comparable to the Spokane International Airport.

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

2.3.2 Station Facilities

Permanent water quality monitoring facilities are constructed at three locations associated with Long Lake HED: 1) 0.6 mile downstream of the Long Lake Dam referred to as Long Lake Tailrace, LLTR 2) in the Long Lake HED forebay referred to as LLFB, and 3) and in the Long Lake HED Unit 4 generation plume referred to as LLGEN (Table 2-1; Figure 2-1). For this study, MS5 long-term deployments were done in LLTR and LLFB throughout the DO monitoring season.

Each permanent station consists of a 4-inch-diameter pipe stilling-well (standpipe), which is sealed at the pipes submerged end to prevent the MS5s 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 a real-time data system to transmit MS5 water quality measurements from each long-term monitoring station (LLTR, LLGEN, and LLFB) to the HED control room in the powerhouse.

[2] AC power was not connected to MS5s used during spot measurements.

Aeration valves have been installed on all four Long Lake HED turbine units allowing aeration in 2013 to be completed with a combination of all four units. Each unit's aeration valve openings were recorded and displayed along with Long Lake HED tailwater DO and TDG levels. 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 of the generation units with the goal of increasing DO to the 8-mg/L DO criterion or greater at LLTR without exceeding the 110-percent of saturation TDG criterion.

2.3.3 Spot Measurements

As a quality assurance measure, spot measurements of DO, TDG, and water temperature were made at each DO monitoring station being serviced during the site visits, which were done at approximate 2- to 3-week intervals. Based on paired measurements[3] of water temperature, DO, and TDG percent of saturation (TDG%) for both sides of the river, the river is generally well mixed by the time water reaches LLTR (Golder 2012). Therefore, no spot measurements were conducted across the river.

2.3.4 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, TDG% was computed based on measurements, as:

- TDG% = TDG in mm Hg / Barometric pressure in mm Hg x 100
- DO percent 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 removed from the final data set.

Long Lake HED operational logs were provided by Avista for the period of July 1 through October 31, 2013 to provide the HED's hourly discharges for generation and spill along with total discharge. They also identified aeration valve operations during the monitoring period.

[3] Data pairs consisted of spot measurements taken at LLTRSP1, across the river from LLTR, and coinciding measurements for LLTR during steady aeration operations in 2011 (Golder 2012).

2.3.5 Monitoring Difficulties

On July 18, data downloaded from MS5 #48762 at LLFB indicated it had not been recording DO values since the previous site visit. This resulted in a gap in LLFB DO values from June 28 at 11:45 Pacific Daylight Time (PDT) through July 18 at 12:00 PDT. Upon inspecting the MS5, it was determined that this may have been due to an inadvertent programming error. To minimize the likelihood of similar events in the future, we adopted new procedures, in which the field crew verifies the MS5s are programmed and operating correctly approximately every two weeks.

2.4 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 2-2). The barologger deployed at LLTR provided a complete data set for local barometric pressure. Temperature and TDG data were successfully obtained for 99 to 100 percent of the entire continuous monitoring period at both LLTR and LLFB (Appendix A, Table A-4). DO data were obtained for 99.7 percent of the continuous monitoring period for LLTR, although DO data obtained for LLFB were limited to 85 percent of the continuous monitoring period primarily due to the data gap described above in Monitoring Difficulties. Spot measurements were collected when long-term deployment and/or instrument downloads were conducted[4]; results were used for the quality assurance/quality control program described in Appendix A. Results of continuous measurements are displayed in Figures 2-2 through 2-5.

2.4.1 Discharge

Combined Long Lake HED generation, spill discharge, and seepage for the July 1 to October 31 monitoring period ranged from approximately 90 to 6,140 cubic feet per second (cfs) (Table 2-3). The Long Lake Dam spillway was not used during the 2013 DO monitoring season. Maximum hourly discharge at LL HED ranged from 4,590 cfs to 4,740 cfs during August through October.

2.4.2 Water Temperature

Daily average water temperature at LLFB was near its seasonal maximum (19°C to 21°C) from the beginning of July into early August, and had daily fluctuations of up to 9°C (Figure 2-2). Tailrace (LLTR) water temperature increased from approximately 17°C at the beginning of July to approximately 20°C in late July and remained warmer than 19°C through early September (Figure 2-3). From early July through late September, temperature was more variable at LLFB than LLTR. This is likely due to the complex dynamics of hydraulics and temperature in the forebay intake area. During generation periods[5],

[4]This occurred on June 28, July 18, August 1, August 15, September 3, September 26, October 14, and November 1.

[5] To account for the travel time of powerhouse discharges to reach the water quality compliance monitoring station at LLTR, LLTR water quality values within an hour of generation startup were omitted from all analyses of generation periods.

corresponding measurements for LLFB and LLTR were within 7°C[6] of one another, and the temperatures at LLTR were generally cooler than at LLFB (Figure 2-4).

2.4.3 Barometric Pressure

Site-specific barometric pressures ranged from 708 to 736 mm Hg based on the Solonist® barologger deployed at LLTR (Table 2-2).

2.4.4 Dissolved Oxygen

Measured DO concentrations were 0.8 to 10.8 mg/L for LLFB and 4.9 to 10.0 mg/L for LLTR (Table 2-2). Greatest DO concentrations occurred near the end of the monitoring period when the water was coolest (less than 13.0°C) causing potential solubility for oxygen to be greatest (Figures 2-2 and 2-3). At LLTR, DO decreased to approximately 8 mg/L during the first week of August. Figure 2-5 displays DO and TDG% trends illustrating the increase in DO concentration in response to initiating aeration on August 6 and continuing throughout August.

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 2-4. Long Lake HED discharges, monitored at LLTR, were less than the 8.0-mg/L DO criterion 8.5 percent of the time during the DO monitoring season (Table 2-4), with concentrations below 8.0 mg/L in August, September, and early October (Table 2-5). These low DO concentrations were within 0.2 mg/L of the 8.0 mg/L criterion (i.e. 7.8 and 7.9 mg/L) 70 percent of the time (Figure 2-6). The minimum DO concentration during generation of 6.9 mg/L occurred in on the morning of September 16 as generation was being reduced and aeration was ceasing (Table 2-5).

Table 2-6 includes a summary of DO values for LLFB[7] along with LLTR during generation for comparative purposes. The frequency for DO less than 8.0 mg/L was 8.5 percent in the HED's discharges measured at LLTR even though 50.8 percent of observations did not meet the criterion at the HED's intake, LLFB.

Calculated DO% saturation values ranged from 9 to 133 percent for LLFB and 53 to 113 percent for LLTR (Table 2-2). DO% saturation for LLTR ranged from 76 to 113 percent during periods of generation, all of which were without spill (Figure 2-7). During the latter part of August through September, when DO of less than 8.0 mg/L was most frequent, aeration had increased DO% to 78 to 98 percent of saturation (Table 2-5).

2.4.5 Total Dissolved Gas

TDG% ranged from 89 to 116 percent of saturation for LLFB and 95 to 113 percent of saturation for LLTR (Table 2-2). TDG%, monitored at LLTR, was greater than the 110 percent of saturation criterion for 763

[6] Ninety percent of these corresponding LLFB and LLTR temperatures were within 2.5°C of each other.
[7] The DO criterion of 8 mg/L is not directly applicable to LLFB.

(11.2%) of the 6,825 measurements made during generation, all of which were without spill (Table 2-7, Figure 2-6). Tables 2-4 and 2-5 provide additional insight into the HED operations (i.e. unit generation and aeration along with spill) coinciding with these high TDG% values, which all occurred during aeration in late August through late September. TDG% associated with the earlier spill season is discussed in the 2013 Long Lake TDG Monitoring Report (Golder 2014).

2.5 Schedule

Avista has made substantial progress toward addressing low DO concentrations of Long Lake HED discharges in accordance with the approved schedule (Figure 2-8). Avista initiated the process of determining reasonable and feasible measure(s) to address this issue during FERC relicensing of the Spokane River Project, 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 HED's control room. Specific tasks have included:

- Conducted the Long Lake HED Phase I Aeration Study during relicensing of the Spokane River Project (HDR 2006).
- Selected and designed permanent water quality monitoring stations, developed a monitoring plan, and incorporated these items 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.[8] Phase II study components included:
  - Applied modeling tools to determine alternatives most likely to be effective (HDR and REMI 2010, Section 5.0 along with Appendix A and B).
  - Identified highest priority alternative to be field tested as turbine aeration with draft chest venting.
  - Prepared Work Plan to test effectiveness of highest priority alternative (HDR and REMI 2010, Section 6.0)
  - Implemented 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 with acoustic silencers and air flow control valves that attach to each of the four draft tube intake ports. They were completed in 2011 and 2012 with testing and associated refinements occurring in 2013.
- Monitored DO and other relevant water quality conditions in the forebay (LLFB) and 0.6 mile downstream of Long Lake Dam (LLTR), from July 1 through October 30 of 2011, 2012, and 2013.

[8]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.

- Prepared and distributed annual DO monitoring reports (Golder 2012, 2013, and this report).
- Coordinated results with the DO TMDL efforts. This included preparation of the Lake Spokane DO Water Quality Attainment Plan (DO WQAP, Avista and Golder 2012), which discussed nine feasible potential measures to improve DO conditions. Approval of the DO WQAP was obtained from Ecology on September 27, 2012 and from FERC on December 19, 2012 (FERC 2012). Avista documented implementation of the DO WQAP in its 2013 DO WQAP Annual Report (Avista 2014).

Avista plans to implement the following schedule to complete the remaining Long Lake Dam DO abatement tasks:

- 2014:
  - Implement turbine aeration, based on real-time water quality measurements.
  - Monitor DO and other relevant water quality conditions at LLFB and LLTR from July 1 through October 30.
  - Continue to coordinate results with the DO TMDL efforts.
  - Continue to evaluate the need for additional DO enhancement measures, based on the aeration monitoring results.
- 2015: Prepare and distribute five-year monitoring report, which will document the effectiveness of measures implemented to improve DO in the Long Lake HED tailrace.

In addition to Long Lake HED turbine aeration, Avista and others have implemented measures to address low DO in Lake Spokane. These measures also have the potential to increase DO downstream from Lake Spokane. These measures include:

- Avista's continued implementation of the DO WQAP (Avista and Golder 2012).
- Dischargers reducing Spokane River point-source nutrient loads from discharges in Washington and Idaho to meet the goal of the DO TMDL (Ecology 2010b).
- Others reducing Spokane River nonpoint source loads from Hangman Creek, Little Spokane River, Coulee Creek, Deep Creek, and groundwater inflow to meet the goal of the DO TMDL (Ecology 2010b).

3.0 DISCUSSION

3.1 2013 Aeration

Dissolved oxygen levels were monitored from July 1, 2013 through October 31, 2013. Avista operated the HED at varying capacities throughout this period. Aeration operations were conducted on 859 hours between August 6 and October 6 using different aeration valve openings for generating Units 1, 2, 3, and 4. Aeration was conducted for a total of 1,562 unit-hours with 164 hours for a single unit, 1374 hours for two units simultaneously, and 24 hours for three units simultaneously. 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 2-4 and 2-5.

Key conclusions for the 2013 monitoring period, presented by month, are:

- July: There was no need for aeration to meet the 8.0-mg/L DO criterion 100 percent of the time, even though there was an absence of spill in 2013 in contrast to 2010, 2011, and 2012.
- August: Aeration was initiated on August 6 and conducted daily throughout the month with up to two units simultaneously resulting in a total of 529 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at an approximate frequency of 90 percent early in the month and 77 percent late in the month. However, it also resulted in elevating TDG% to greater than the 110 percent criterion (maximum TDG of 112 percent of saturation) in the latter part of the month at a frequency of approximately 27 percent.
- September: Aeration was conducted daily with up to three units simultaneously, for a total of 867 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion for 82 percent of observations made during the month. However, it also resulted in elevating TDG% to greater than the 110 percent criterion (maximum TDG of 113 percent of saturation) throughout the month at a frequency of approximately 33 percent.
- October: In early October, 167-unit-hours of aeration resulted in meeting the 8.0-mgL DO criterion 98 percent of the time. After October 6, there was no need for aeration to meet the 8.0-mg/L DO criterion

Results of this study demonstrate progress toward meeting the DO criterion through aeration at generating Units 1, 2, 3 and 4. Although the DO criterion was not met for all powerhouse discharge periods, powerhouse discharges satisfied the DO criterion approximately 91 percent of the time (Table 2-5), and were within measurement accuracy (i.e., 7.8 mg/L or greater) 97 percent of the time (Figure 2-6). Aeration operations did not exceed the 110 percent of TDG saturation criterion 89 percent of the time (Table 2-5). Avista will continue to refine the use of real-time DO and TDG measurements for selecting aeration valve openings, which may provide additional improvements in DO while limiting adverse TDG% conditions.

3.2 Effectiveness for Meeting the DO Criterion in Long Lake HED Discharge

In 2013, during the July through October monitoring season, powerhouse discharges satisfied the DO criterion approximately 91 percent of the time. As a result of increasing DO through the aeration operations, other dissolved gasses increased as well, causing TDG% to increase up to 113 percent of saturation. This led us to monitor both parameters closely to prevent improvements in DO from adversely increasing TDG.

The effectiveness of meeting the 8.0 mg/L DO criterion has improved each year as the aeration system was expanded and real-time water quality network communication with the HED's control room was linked and improved. Comparison of results from 2013, which had no spill events, with non-spill periods for other years shows improvement annually even though the summer flow for 2013 was substantially less than other years.[9] Aeration operations resulted in meeting the 8.0 mg/L DO criterion 81 percent in 2011, 85 percent in 2012, and 91 percent in 2013. The frequency of meeting the 110-percent TDG criterion was 100 percent in 2011, 96 percent in 2012, and 89 percent in 2013. This reduction in the frequency of meeting the 110-percent TDG criterion (the maximum during the aeration operations in 2013 was 113 percent of saturation) was due to turbine aeration entraining all gasses present in the atmosphere. We will continue to evaluate the effectiveness of the draft tube aeration operations in 2014 and anticipate, based on this year's as well as 2012 and 2011, that no new or additional enhancement measures will be necessary to meet the DO Water Quality Standard below Long Lake HED.

[9] Lake Spokane mean daily summer (June – October) inflow 7,828 cfs in 2011, 5,768 cfs in 2012, and 3,035 cfs in 2013 (Tetra Tech 2014).

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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 2-2: Summary of Continuous Water Quality Monitoring Results

Parameter	LLFB			LLTR		
	Minimum	Maximum	Count	Minimum	Maximum	Count
Date/Time (PDT)	7/1/2013 0:00	10/31/2013 23:45	11,808	7/1/2013 0:00	10/31/2013 23:45	11,808
Water Temperature (°C)	11.3	25.0	11,753	11.1	20.4	11,771
Dissolved Oxygen (mg/L)	0.8	10.8	10,079	4.9	10.0	11,772
BAR (mm Hg)	Used LLTR BAR			708	736	11806
TDG (mm Hg)	637	835	11,750	684	816	11,770
TDG (% saturation)[1]	89	116	11,748	95	113	11,768
Dissolved Oxgen (% saturation)[1]	9	133	10,077	53	113	11,769

Notes:

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

Table 2-3: Monthly Outflow from Long Lake HED

Month - Year	Minimum Hourly Discharge (cfs)	Maximum Hourly Discharge (cfs)	Average Hourly Discharge (cfs)
July 2013	150	6,140	2,593
August 2013	90	4,610	1,834
September 2013	90	4,590	1,913
October 2013	150	4,740	2,857

Table 2-4: Summary of Exceedances of DO Criterion at LLTR, During Generation

Period		Operations, Spill, and Aeration Characteristics			LLTR DO			LLTR TDG			Note #
Start	Stop	Operations	Spill	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Total Number	Number >110%	Frequency >110%	
7/1/13 0:00	7/15/13 23:45	All 4 Units near full generation capacity, generation during portion of day "Generation without Spill"	No	No	848	0	0.0%	848	0	0.0%	1
7/16/13 0:00	8/5/13 23:45	3 Units near full capacity, generation during portion of the day	No	No	905	31	3.4%	904	0	0.0%	2
8/6/13 0:00	8/7/13 0:00	3 Units, Capacity varies, Generation during portion of the day	No	Unit 4 sometime each day	57	13	22.8%	57	0	0.0%	3
8/7/13 0:15	8/8/13 23:45	2 Units, Capacity varies, Generation during portion of the day	No	Unit 4 sometime each day	144	4	2.8%	144	0	0.0%	4
8/9/13 0:00	8/17/13 18:45	2 Units, Capacity varies, Generation during portion of the day	No	Unit 1 sometime each day	437	63	14.4%	437	0	0.0%	5
8/17/13 19:00	9/19/13 13:45	2 Units, Capacity varies, Generation during portion of the day	No	Units 1 and 4 used together sometime each day	1,722	331	19.2%	1,722	562	32.6%	6
9/19/13 14:00	9/21/13 19:00	2 Units, Capacity varies, Generation during portion of the day	No	Units 2 and 4 used together sometime each day	147	3	2.0%	147	91	61.9%	7
9/21/13 19:15	9/23/13 0:00	2 Units, Capacity varies, Generation during portion of the day	No	Units 1 and 4 used together sometime each day	73	14	19.2%	73	7	9.6%	8
9/23/13 0:15	9/26/13 15:45	2 Units, Capacity varies, Generation during portion of the day	No	Units 1 and 2 used together sometime each day	185	68	36.8%	185	79	42.7%	9
9/26/13 16:00	9/28/13 0:00	2 Units, Capacity varies, Generation during portion of the day	No	Units 1 and 2 used together sometime each day	90	19	21.1%	90	0	0.0%	10
9/28/13 0:15	9/28/13 12:45	2 Units, Capacity varies, Generation during portion of the day	No	Units 2 and 3 used together sometime each day	16	12	75.0%	16	0	0.0%	11
9/28/13 13:00	9/28/13 21:00	3 Units, Capacity varies, Generation during portion of the day	No	Units 1, 2 and 3 used together sometime each day	33	0	0.0%	33	0	0.0%	12
9/28/13 21:15	10/4/13 20:00	2 Units, Capacity varies, Generation during portion of the day	No	Units 2 and 3 used together sometime each day	349	23	6.6%	349	24	6.9%	13
10/4/13 20:15	10/5/13 20:45	2 Units, Capacity varies, Generation during portion of the day	No	Units 1 and 3 used together sometime each day	99	0	0.0%	99	0	0.0%	14
10/5/13 21:00	10/6/13 8:45	2 Units, Capacity varies, Generation during portion of the day	No	Unit 1 sometime each day	17	0	0.0%	17	0	0.0%	15
10/6/13 9:00	10/7/13 15:45	2 Units, Capacity varies, Generation during portion of the day	No	No	109	0	0.0%	109	0	0.0%	16
10/7/13 16:00	10/31/13 23:45	3 Units, Capacity varies, Generation during portion of the day	No	No	1,595	0	0.0%	1,595	0	0.0%	17
7/1/13 0:00	10/31/13 23:45	Cumulative of above operations without spill	No	Both Yes and No	6,826	581	8.5%	6,825	763	11.2%	

Notes:

1. Periods of non-generation ocurred each day. Minimum DO was 8.4 mg/L and 96 percent of saturation, and maximum TDG was 108.0 percent of saturation.
2. Periods of non-generation ocurred each day. Minimum DO was 7.1 mg/L and 81 percent of saturation, and maximum TDG was 107.1 percent of saturation.
3. Periods of non-generation ocurred each day. Minimum DO was 6.9 mg/L and 79 percent of saturation, and maximum TDG was 104.8 percent of saturation.
4. Periods of non-generation ocurred each day. Minimum DO was 7.2 mg/L and 82 percent of saturation, and maximum TDG was 105.9 percent of saturation. No aeration for 2 hours during generation.
5. Periods of non-generation ocurred each day. Minimum DO was 6.5 mg/L and 75 percent of saturation, and maximum TDG was 109.0 percent of saturation. Includes one 4 hour period with unit 1 and 4 aeration on 8/16/13.
6. Periods of non-generation ocurred each day. Minimum DO was 6.7 mg/L and 76 percent of saturation, and maximum TDG was 112.3 percent of saturation.
7. Periods of non-generation ocurred each day. Minimum DO was 7.4 mg/L and 83 percent of saturation, and maximum TDG was 111.3 percent of saturation.
8. Periods of non-generation ocurred each day. Minimum DO was 7.1 mg/L and 79 percent of saturation, and maximum TDG was 110.7 percent of saturation.
9. Periods of non-generation ocurred each day. Minimum DO was 7.3 mg/L and 80 percent of saturation, and maximum TDG was 113.4 percent of saturation.
10. Periods of non-generation ocurred each day. Minimum DO was 7.9 mg/L and 86 percent of saturation, and maximum TDG was 107.7 percent of saturation.
11. Periods of non-generation ocurred each day. Minimum DO was 7.6 mg/L and 82 percent of saturation, and maximum TDG was 108.5 percent of saturation.
12. Periods of non-generation ocurred each day. Minimum DO was 8.0 mg/L and 87 percent of saturation, and maximum TDG was 109.9 percent of saturation.
13. Periods of non-generation ocurred each day. Minimum DO was 7.4 mg/L and 76 percent of saturation, and maximum TDG was 111.3 percent of saturation.
14. Periods of non-generation ocurred each day. Minimum DO was 8.0 mg/L and 82 percent of saturation, and maximum TDG was 102.9 percent of saturation.
15. Periods of non-generation ocurred each day. Minimum DO was 8.2 mg/L and 85 percent of saturation, and maximum TDG was 101.9 percent of saturation.
16. Periods of non-generation ocurred each day. Minimum DO was 8.1 mg/L and 84 percent of saturation, and maximum TDG was 100.6 percent of saturation.
17. Periods of non-generation ocurred each day. Minimum DO was 8.2 mg/L and 84 percent of saturation, and maximum TDG was 101.8 percent of saturation.

Table 2-5: Semi-monthly Summary of HED Operations and Water Quality During Generation

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%			LLTR TDG%		
Start	Stop	Generation (hours)	Spill (hours)	Average Total Discharge (cfs)	Aeration (unit-hours)	Total Number 15-Min Values	Average Water Temp (°C)	Total Number 15-Min Values	Frequency <8.0 mg/L	Min DO (mg/L)	Total Number 15-Min Values	Min DO%	Max DO%	Total Number 15-Min Values	Frequency >110%	Max TDG%
7/1/13 0:00	7/15/13 23:45	227	0	3,310	0	848	18.6	848	0.0%	8.4	848	97	110	848	0.0%	108
7/16/13 0:00	7/31/13 23:45	178	0	1,919	0	648	19.8	648	0.0%	8.2	648	95	113	647	0.0%	107
8/1/13 0:00	8/15/13 23:45	218	0	2,053	139	815	19.6	815	9.7%	7.2	815	82	101	815	0.0%	109
8/16/13 0:00	8/31/13 23:45	211	0	1,628	390	781	19.4	781	22.9%	7.5	781	85	98	781	26.6%	112
9/1/13 0:00	9/15/13 23:45	221	0	1,808	419	822	18.6	822	13.0%	7.3	822	83	98	822	31.6%	112
9/16/13 0:00	9/30/13 23:45	235	0	2,018	448	862	17.2	863	23.4%	6.9	862	78	97	863	34.2%	113
10/1/13 0:00	10/15/13 23:45	257	0	2,530	167	960	14.3	960	1.5%	7.4	960	76	90	960	0.0%	107
10/16/13 0:00	10/31/13 23:45	287	0	3,164	0	1,089	12.2	1,089	0.0%	8.8	1,089	86	94	1,089	0.0%	101
7/1/13 0:00	10/31/13 23:45	1,834	0	2,304	1,562	6,825	17.4	6,826	8.5%	6.9	6,825	76	113	6,825	11.2%	113

Table 2-6: Summary of DO Less than 8.0 mg/L, DO Criterion Lower Limit, During Generation

Parameter	LLFB			LLTR		
	Total Number	Number <8.0 mg/L DO [1]	Frequency <8.0 mg/L DO [1]	Total Number [2]	Number <8.0 mg/L DO [2, 3]	Frequency <8.0 mg/L DO [2, 3]
Generation Without Spill	6,303	3,201	50.8%	6,826	581	8.5%
Generation With Spill	0	0	not applicable	0	0	not applicable
All Generation	6,303	3,201	50.8%	6,826	581	8.5%

Notes:

1. DO criterion of 8 mg/L is not directly applicable to LLFB.
2. To account for travel time of powerhouse discharge to LLTR, excluded values in first hour of generation.
3. Of the 6,826 measurements, 175 (2.4%) were less than 7.8 mg/L.

Table 2-7: Summary of TDG% Greater than 110%, TDG Criterion Upper Limit, During Generation

Parameter	LLFB			LLTR		
	Total Number	Number >110% TDG	Frequency >110% TDG	Total Number [2]	Number >110% TDG [2]	Frequency >110% TDG [2]
Generation Without Spill	7,303	100	1.4%	6,825	763	11.2%
Generation With Spill [1,2]	0	0	not applicable	0	0	not applicable
All Generation	7,303	100	1.4%	6,825	763	11.2%

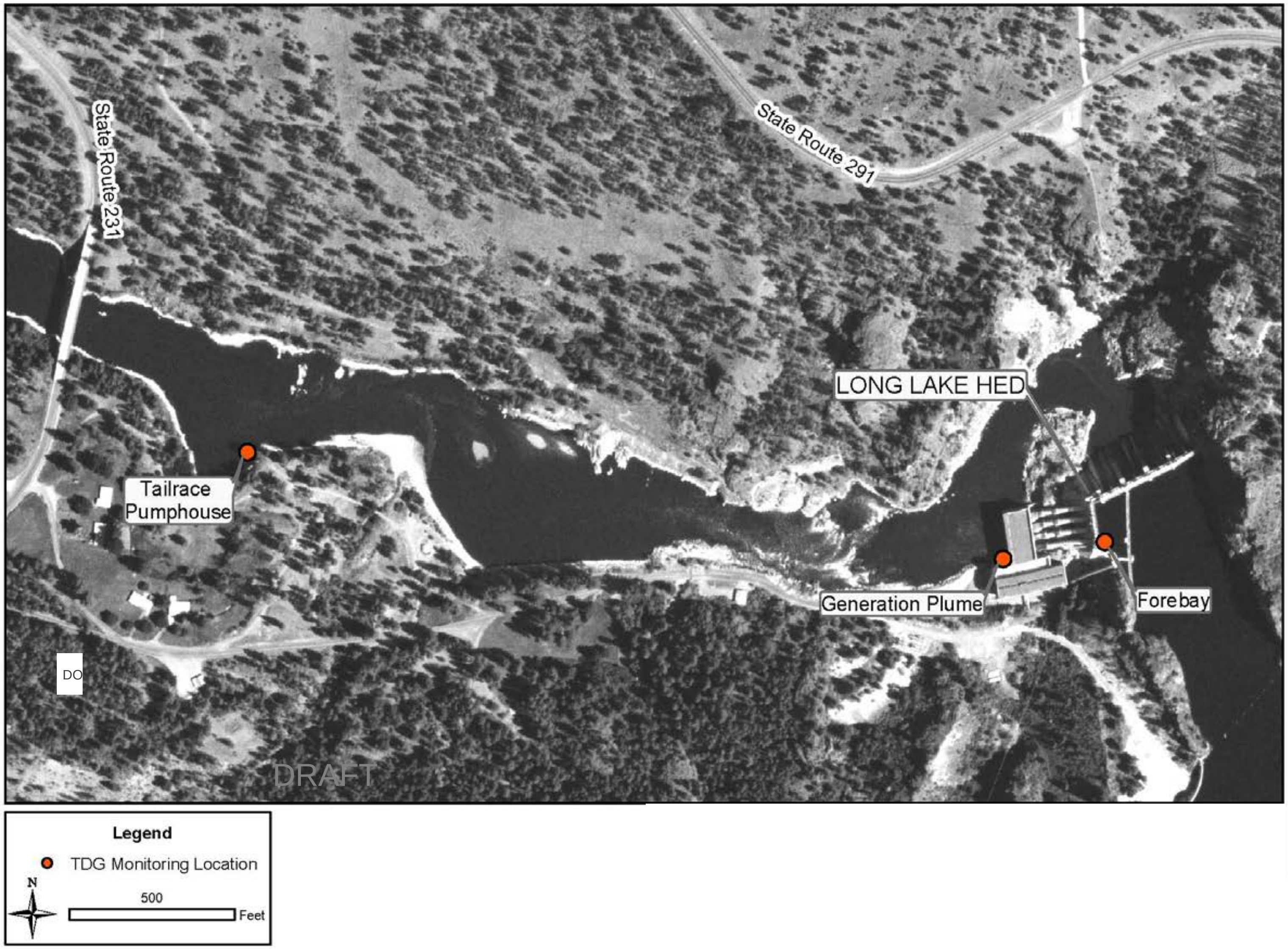
Notes:

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. To account for travel time of powerhouse discharge to LLTR, excluded values in first hour of generation.

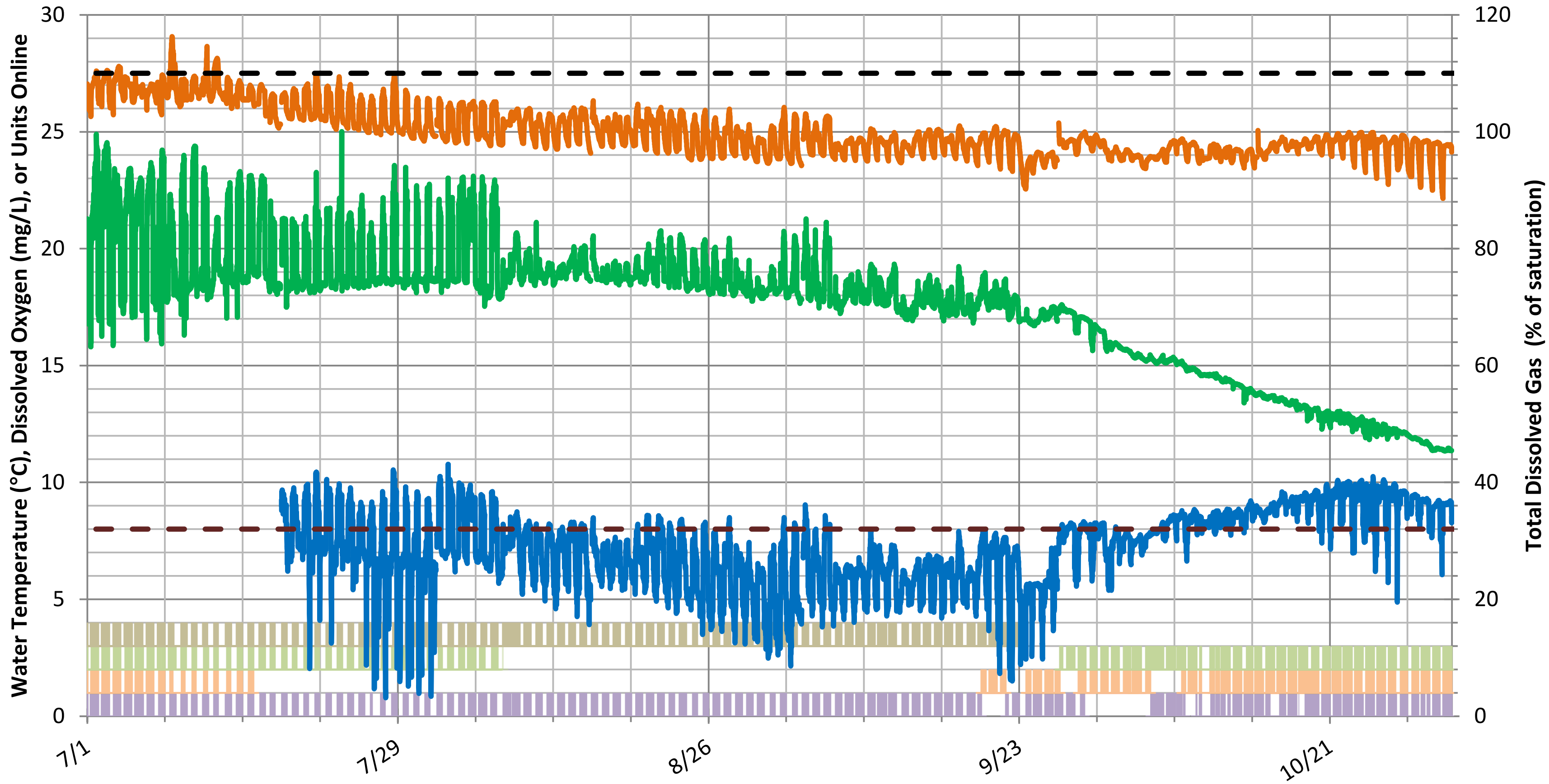
3. TDG exceedances during earlier spill season are discussed in 2013 Long Lake Total Dissolved Gas Monitoring Report (Golder 2014).

FIGURES



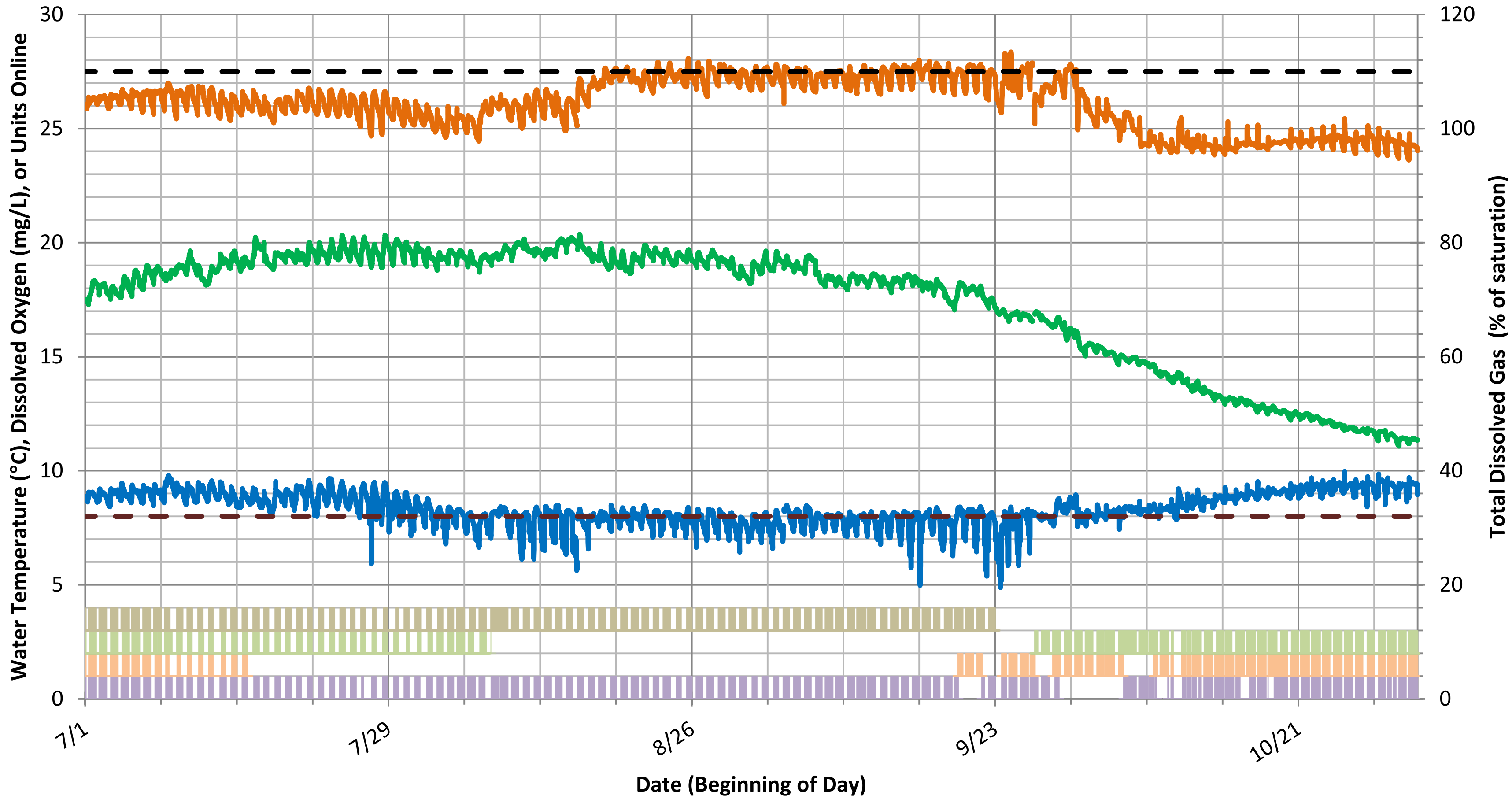
Source: Avista

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.: 073-93081-08.500	FIGURE 2-2
	Client Name: Avista	Date: February 27, 2014	

022714blm1_LL_DO_Processed_Data_2013-Restricted.xlsx

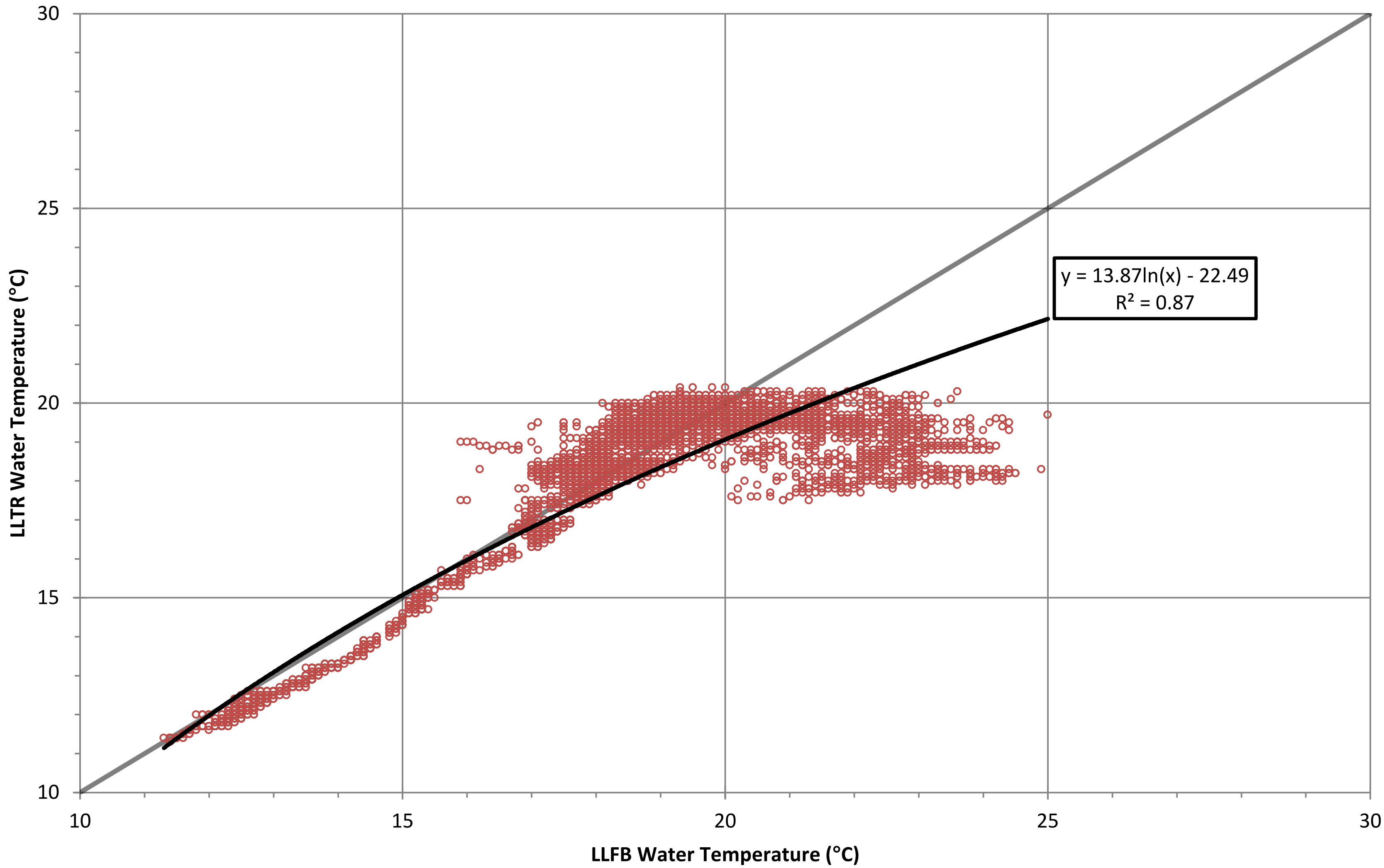


Golder Associates

Title	LLTR Water Temperature, Dissolved Oxygen, TDG%, and Operations		
Project Name	LL DO Monitoring	Project No.	073-93081-08.500
Client Name	Avista	Date	February 27, 2014

FIGURE 2-3

022714blm1_LL_DO_Processed_Data_2013-Restricted.xlsx

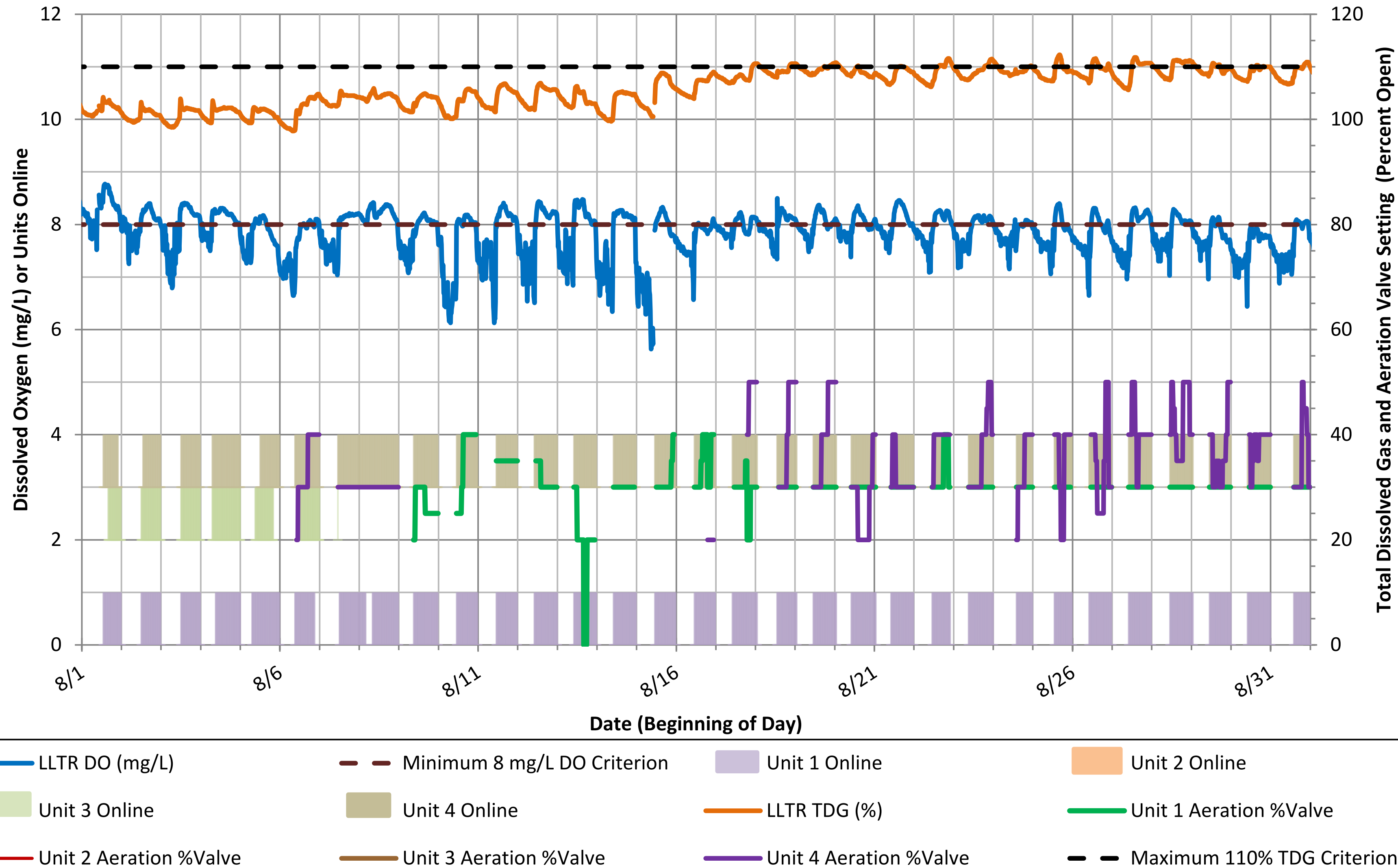


Golder Associates

Title	Water Temperature Comparison for LLTR and LLFB During Generation		
Project Name	LL DO Monitoring	Project No.	073-93081-08.500
Client Name	Avista	Date	February 27, 2014

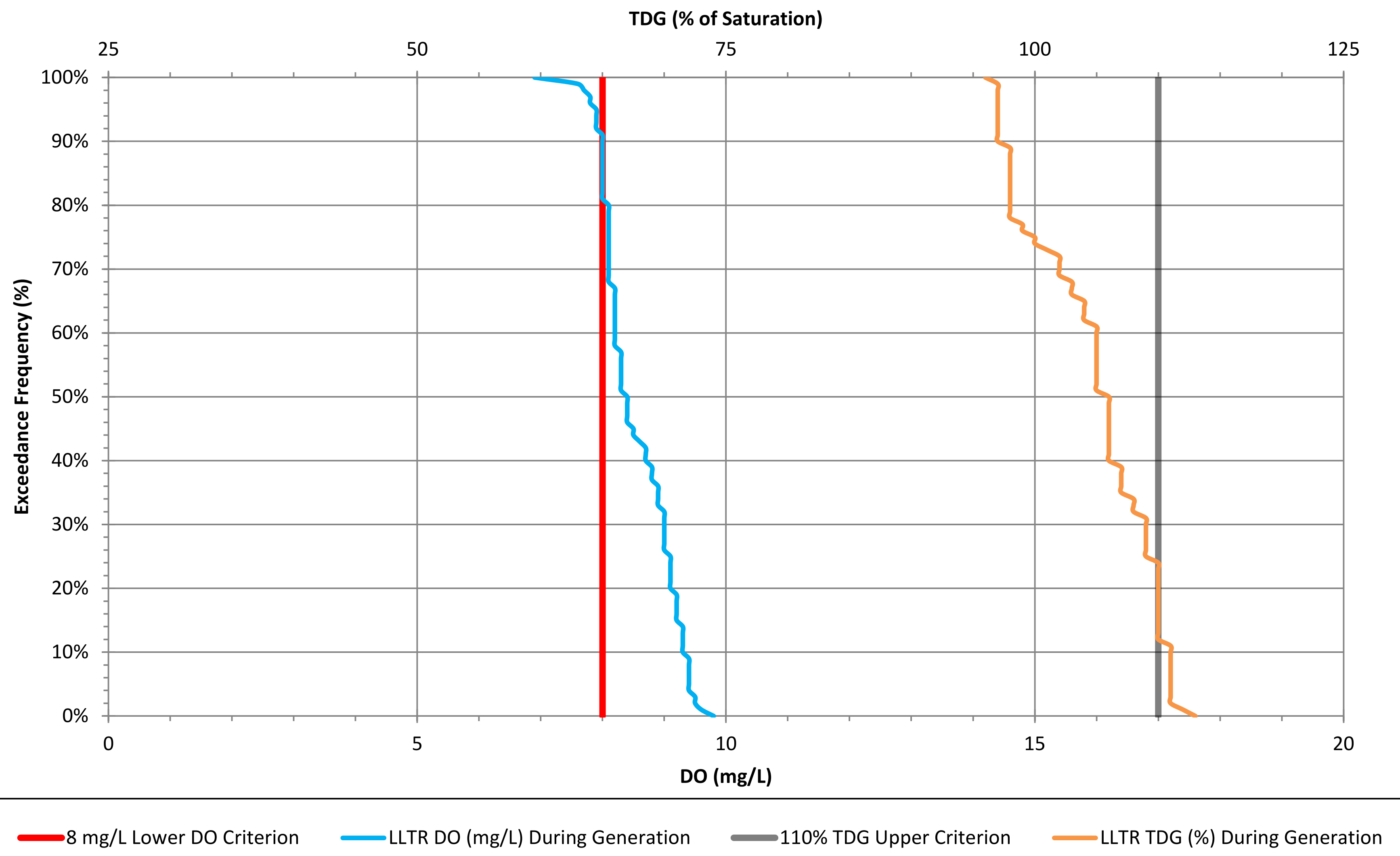
FIGURE 2-4

022714blm1_LL_DO_Processed_Data_2013-Restricted.xlsx



Golder Associates

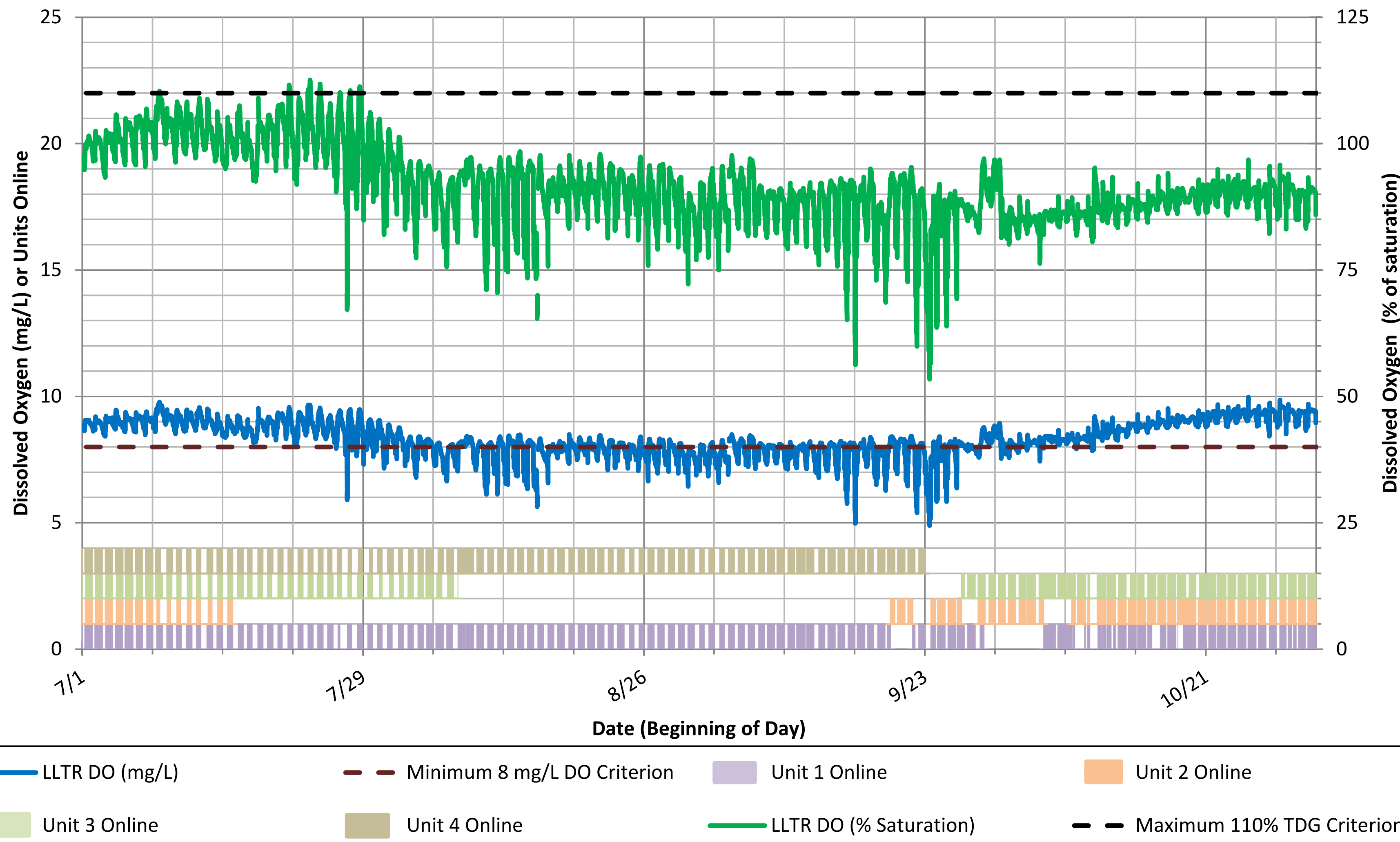
Title	LLTR Dissolved Oxygen Concentration and TDG% along with Operations, August		
Project Name	LL DO Monitoring	Project No. 073-93081-08.500	FIGURE 2-5
Client Name	Avista	Date February 27, 2014	



Golder Associates

Title	LLTR DO Concentration and TDG% Exceedance Frequency during Generation
Project Name	LL DO Monitoring
Project No.	073-93081-08.500
Client Name	Avista
Date	February 27, 2014
FIGURE	2-6

022714blm1_LL_DO_Processed_Data_2013-Restricted.xlsx



Golder Associates

Title	LLTR Dissolved Oxygen Concentration and Percent of Saturation along with Operations		
Project Name	LL DO Monitoring	Project No.	073-93081-08.500
Client Name	Avista	Date	February 27, 2014

FIGURE 2-7

022714blm1_LL_DO_Processed_Data_2013-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 2-8: 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

Notes: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [10]

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

[10] 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]	Total Pressure[3]	TDG-cal[4]	TDG-spot[5]	BAR	Total Pressure	TDG	BAR	Total Pressure	TDG-cal	TDG-spot
48762 (LLFB 6/28-10/14)	1.41	0.20	0.20	1.00	2	1	1	-0.59	-0.80	-0.80	0.00
48764 (LLTR 6/28-10/14)	1.07	0.15	0.15	1.00	2	1	1	-0.93	-0.85	-0.85	0.00
60375 (LLTR 8/15-9/26; LLGEN 11/1)	1.12	0.15	0.15	1.00	2	1	1	-0.88	-0.85	-0.85	0.00
60376 (LLTR 6/28-10/14)	0.93	0.13	0.13	1.00	2	1	1	-1.07	-0.87	-0.87	0.00
Overall RMSE	1.78	0.25	0.25	1.00	2	1	1	-0.22	-0.75	-0.75	0.00

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.
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)

	RMSE				MQO		RMSE - MQO			
	Temperature[1]		DO[2]				Temperature[1]		DO[2]	
Meter IDs and Locations	**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 6/28-10/14)	0.12	0.39	0.17	0.36	0.5	0.5	-0.38	-0.11	-0.33	-0.14
48764 (LLTR 6/28-10/14)	0.16	0.03	0.12	0.70	0.5	0.5	-0.34	-0.47	-0.38	0.20
60375 (LLTR 8/15-9/26; LLGEN 11/1)	0.08	0.01	0.25	0.23	0.5	0.5	-0.42	-0.49	-0.25	-0.27
60376 (LLTR 6/28-10/14)	0.16	0.30	0.26	0.63	0.5	0.5	-0.34	-0.20	-0.24	0.13
Overall RMSE	0.14	0.27	0.20	0.58	0.5	0.5	-0.36	-0.23	-0.30	0.08
48762 (LLFB 6/28-10/14)	0.12	0.39	0.17	0.36	0.5	0.5	-0.38	-0.11	-0.33	-0.14

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.
[2] Calibration RMSE as difference of the pre-calibration measurement and calculated 100% saturation. Spot RMSE calculated as difference between measured values from group average.
N/A - Not available, measurement not taken

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

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 BAR, total pressure, TDG%, and temperature were met for all meters. The DO MQO was met by all the long-term MS5s deployed at LLTR and LLFB, although two of the spot meters exceeded the 0.5 mg/L MQO for DO.

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, and 2012.

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 approximately 11,800 15-minute periods. Although the completeness of DO data for LLFB did not meet the goal of at least 90 percent, it did meet the expectation of greater than 80 percent. DO for LLTR and all remaining parameters had completeness of at least 99 percent. The apparent reason for the DO data gap at LLFB was incorrect programming of the MS5. To address this issue, the programming was checked by two staff during each subsequent site visit.

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)	11,753	100%	11,771	100%
Dissolved Oxygen (mg/L)	10,079	85%	11,772	100%
BAR (mm Hg)	Used LLTR BAR		11,806	100%
TDG (mm Hg)	11,750	100%	11,770	100%
TDG (% saturation)	11,748	99%	11,768	100%
DO (% saturation)	10,077	85%	11,769	100%

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	6	6	6	6	6	0	0	0	0	0	0	0
997	Equilibrating after deployment	0	3	0	0	0	0	2	0	0	0	0	0
994	Parameter not monitored during the monitoring period	0	0	0	1,674	0	0	0	0	0	0	0	0
993	Out of water for calibration/servicing	17	15	15	15	15	36	15	15	15	15	0	0
992	Moved instrument; it is not at standard station or is out of water	1	1	1	1	1	0	0	0	0	0	0	0
991	Instrument not deployed at typical long-term depth	31	31	31	31	31	0	0	0	0	0	0	0
-1002	Corresponds with spot measurement	0	0	0	0	0	6	6	6	6	6	0	0
0	No data qualifiers	11,753	11,752	11,755	10,081	11,755	11,766	11,785	11,787	11,787	11,787	11,808	11,808
	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

Notes:
1. Monitoring period was July 1, 2012 at 0:00 PDT to October 31, 2012 at 23:45 PDT.

APPENDIX B

CONSULTATION RECORD

February 28, 2014

Mr. 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, 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. In accordance with Section 5.4 and Section 5.6 of the Certification, Avista is submitting the following reports for your review and approval.

Section 5.4: Total Dissolved Gas
There are two components related to Total Dissolved Gas (TDG), which include the following:

1. *2013 Long Lake Total Dissolved Gas Monitoring Report, Golder Associates, February 2014.* The enclosed 2013 Long Lake TDG Monitoring Report provides the results of monitoring TDG at Avista's Long Lake Hydroelectric Development (HED) during 2013. In accordance with the approved Revised Long Lake HED TDG Compliance Schedule, Avista will not be monitoring TDG during 2014 through 2016, during the Long Lake Dam spillway modification project for TDG abatement.

2. *Nine Mile TDG Monitoring.*
In accordance with the Ecology letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile Hydroelectric Development (HED) during 2013. 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 requested by Ecology in the February 17, 2012 letter, Avista will provide an update on the progress of the turbine removal and replacement by September 1, 2014.

Section 5.6: Dissolved Oxygen
The enclosed 2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report illustrates the seasonal changes in DO immediately downstream of Long Lake Dam during the low flow period of

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the year and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. Besides providing a full season of DO data below the dam, the report details the success of the aeration system, which is installed on all four units. Avista plans to continue with the aeration program in 2014.

With this, Avista is submitting the 2013 Long Lake Total Dissolved Gas Monitoring Report and the 2013 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 28, 2014, which will allow us time to file the reports with FERC by April 15, 2014.

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

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosures (2)

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

APR - 7 2014

April 4, 2014

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 – *2013 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 *2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* sent to Ecology on January 31, 2014. The report is a requirement in Section 5.6.B of the 401Water Quality Certification.

Ecology APPROVES the *2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report* as submitted. The report meets the 401 Water Quality Certification conditions and requirements for Section 5.6.B.

In addition, we would like to provide the following comments:

Ecology encourages Avista to continue using an adaptive management approach that incorporates yearly data analysis and evaluates long term trends. There is an understanding that the 2014 D.O. and TDG monitoring data will potentially require adjustments to the turbine aeration strategy.

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:jb

cc: Elvin "Speed" Fitzhugh, Avista
Brian Crossley, Spokane Tribal Natural Resources

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment

Ecology encourages Avista to continue using an adaptive management approach that incorporates yearly data analysis and evaluates long term trends. There is an understanding that the 2014 D.O. and TDG monitoring data will potentially require adjustments to the turbine aeration strategy.

Avista Response

Avista agrees and will continue to use an adaptive management approach utilizing yearly data and long-term trends. Avista will also continue to refine the use of real-time DO and TDG measurements for selecting aeration valve openings, which may provide additional improvements in DO while limiting adverse TDG% conditions.

February 28, 2014

Brian Crossley
Spokane Tribe of Indians
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, TDG and DO Reporting Requirements

Dear Mr. Crossley:

Ordering Paragraph E of the Federal Energy Regulatory Commission Project (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. In accordance with Section 5.4 and Section 5.6 of the Certification, and per the October 2008 Settlement Agreement between Avista and the Tribe, Avista is submitting the following reports for your review and comment.

Section 5.4: Total Dissolved Gas
There are two components related to Total Dissolved Gas (TDG), which include the following:

1. *2013 Long Lake Total Dissolved Gas Monitoring Report, Golder Associates, February 2014.* The enclosed 2013 Long Lake TDG Monitoring Report provides the results of monitoring TDG at Avista's Long Lake Hydroelectric Development (HED) during 2013. In accordance with the approved Revised Long Lake HED TDG Compliance Schedule, Avista will not be monitoring TDG during 2014 through 2016, during the Long Lake Dam spillway modification project for TDG abatement.

2. *Nine Mile TDG Monitoring.*
   In accordance with the Ecology letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile Hydroelectric Development (HED) during 2013. 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 requested by Ecology in the February 17, 2012 letter, Avista will provide an update on the progress of the turbine removal and replacement by September 1, 2014.

Section 5.6: Dissolved Oxygen
The enclosed 2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report illustrates the seasonal changes in DO immediately downstream of Long Lake Dam during 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. Besides providing a full season of DO data below the dam, the report details the success of the aeration system which is installed on all four units. Avista plans to continue with the aeration program in 2014.

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With this, Avista is submitting the 2013 Long Lake Total Dissolved Gas Monitoring Report and the 2013 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 28, 2014, which will allow us time to file the reports with FERC by April 15, 2014.

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

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosures (2)

cc: Patrick McGuire, Ecology

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

3/28/2014

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

Dear Megan:

I have reviewed the 2013 dissolved oxygen, total dissolved gas and temperature monitoring reports with the assistance of DNR staff and would like to present various concerns. These reports focus on Long Lake Dam and its effect on dissolved oxygen, total dissolved gas and temperature. 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. This fact is obviously excluded from the discussion and the calculations. Figure 2-3 of the DO Report shows clearly that the DO was not at or above 8 mg/L 91 percent of the time. Table 2-5 of the same report fails to show where the 91% attainment is calculated from except the combined row at the bottom which includes dates when aeration was not occurring. The sum of the frequencies below 8 mg/L is 70% which appears to represent the concentrations in Figure 2-3. The minimum DO concentration "during generation is identified however the minimum during non-generation is not. Similar exclusions were in previous reports. The statements in section 3.2 are incorrect as to pertaining to "meeting the standard". I am requesting the appropriate reports be modified to address these exclusions.

Figure 2-5 suggests that regardless of aeration; turbine generation improves oxygen (Aug 1-6). An analysis and presentation of a daily cycle would be helpful to determine average daily increases from aeration and the extent of DO loss during non-generation and non-aeration.

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?

It was my understanding from talking to Avista staff that generation is not necessary at Long Lake to meet the 200-500 cfs minimum flow requirement at Little Falls during Lake Roosevelt drawdown. On page 5 it suggests that the flow dropped to approximately 90 cfs. How is the minimum flow met downstream during this period?

I have no significant comments on the Temperature or TDG Reports. 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 28, 2014 comment letter focused on the 2013 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. These comments, and Avista's responses to them, are provided as follows.

Spokane Tribe Comment

The standard at LLTR for dissolved oxygen (DO) is 8.0 mg/L and is not predicated upon whether power generation is occurring at Long Lake. This fact is obviously excluded from the discussion and the calculations. Figure 2-3 of the DO Report shows clearly that the DO was not at or above 8 mg/L 91 percent of the time. Table 2-5 of the same report fails to show where the 91% attainment is calculated from except the combined row at the bottom which includes dates when aeration was not occurring. The sum of the frequencies below 8 mg/L is 70% which appears to represent the concentrations in Figure 2-3. The minimum DO concentration "during generation is identified however the minimum during non-generation is not. Similar exclusions were in previous reports. The statements in section 3.2 are incorrect as to pertaining to "meeting the standard". I am requesting the appropriate reports be modified to address these exclusions.

Avista Response

During a meeting on April 3, 2014, Avista and the Spokane Tribe (Tribe) discussed the Tribe's comments, the majority of which focused on DO. During this meeting, Avista and the Tribe agreed that it wasn't necessary to modify this year's report but rather to include the requested information (DO concentrations during the periods when the units at Long Lake Dam are operating, as well as when they are not operating) in the 2014 and future reports. This will better clarify and identify DO concentrations at all times of the monitoring season (generation and non-generation).

Spokane Tribe Comment

Figure 2-5 suggests that regardless of aeration; turbine generation improves oxygen (Aug 1-6). An analysis and presentation of a daily cycle would be helpful to determine average daily increases from aeration and the extent of DO loss during non-generation and non-aeration.

Avista Response:

As we discussed in the April 3rd meeting, Avista will provide an analysis and presentation of DO through the daily cycles to show increases from aeration and the extent of DO loss during non-generation and non-aeration. This additional information will provide greater insight into comparisons of DO levels in the Long Lake Tailrace with those collected by the Tribe in the Spokane River near Chamokane Creek, which is located approximately 1.3 miles downstream of Long Lake Dam.

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:

As we discussed in the April 3rd meeting, running one turbine at night to aerate the tailrace isn't currently practical because the turbine design requires approximately 1,200 cubic feet per second (cfs) to run. During this meeting, Avista and the Tribe agreed a good place to start is to work collaboratively to compare DO sags in the tailrace with those measured downstream in the Spokane River near Chamokane Creek, where the Tribe has determined the DO sags are much smaller. The reduction in the downstream DO sag is very positive sign upon which we hope to work with the Tribe to further improve in the future.

Spokane Tribe Comment

It was my understanding from talking to Avista staff that generation is not necessary at Long Lake to meet the 200-500 cfs minimum flow requirement at Little Falls during Lake Roosevelt drawdown. On page 5 it suggests that the flow dropped to approximately 90 cfs. How is the minimum flow met downstream during this period?

Avista Response:

You are correct in that generation at Long Lake is not necessary to meet the 200-500 cfs minimum flow requirement for Little Falls HED. This minimum flow requirement is achieved solely through our Little Falls HED operations regardless of Long Lake Dam water releases.