# AVISTA CORPORATION

# 2012

# 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 10, 2013*

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# List of Acronyms and Abbreviations

| | |
|---|---|
| % 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 |
| 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. |
| 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 previous water quality monitoring indicate that Long Lake Hydroelectric Development (HED) at certain times of the year discharges water that does not meet the applicable dissolved oxygen (DO) water quality standards. To address this issue, Avista 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 are reasonable and feasible, and implement selected alternative(s) to improve DO of Long Lake HED discharges. Avista initiated this process with the Long Lake HED Phase I Aeration Study (HDR 2006). Avista issued a request for proposal (RFP) for conducting the Phase II Feasibility and Implementation Plan, and selected HDR as the contractor for this work in 2010.

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

Condition 5.6(B) of the Washington section 401 water quality certification (Ecology 2010) requires 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.*"

The Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan was approved by Washington State Department of Ecology (Ecology) 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 (Plan). The first annual report (Golder 2012a), required by the Plan was completed for work conducted in 2011. This second annual report documents Avista's implementation of the Plan in 2012.

# 2.0 LONG LAKE HED

## 2.1 Objectives

The objectives 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 efforts.

## 2.2 Monitoring Period

The 2012 monitoring period was from July 1 through October 31. High flows resulted in continued use of the Long Lake Dam spillways until July 6. Aeration valves were installed on Units 1 and 2 in June 2012. Aeration in 2011 was completed with one turbine at a time, however in 2012 Avista used both Units 1 and 2 during some periods. Both Units' aeration valve openings were recorded and displayed along with Long Lake HED tailwater DO and TDG levels. Units 3 and 4, which were used for aeration in 2011, were not used for aeration in 2012.

## 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 whether and when the water quality monitoring instruments emerged from the water and when they were above the minimum TDG compensation depth.

### *2.3.1 Equipment and Calibration*

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. Each MS5 deployed for extended periods[1] 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.

Solinst® barologgers were used to determine local barometric pressure. A primary and backup barologger were deployed at the Long Lake pumphouse, which is located 0.6 mile downstream of the

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

Long Lake Dam. 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 www.wunderground.com[2] 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]).

A MS5 equipped with a short power/data cable and a laptop computer were used as a portable DO meter to obtain spot measurements at long-term and short-term DO monitoring stations.

All Hach instruments used had undergone annual servicing by Hach and were factory calibrated before the 2012 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. Each service session included verification of logging status and downloading the data to a portable field computer. The Solinst® barologger also was 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, 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 LLTR, 2) in the Long Lake HED forebay referred to as LLFB, and 3) in the Long Lake HED Unit 4 generation plume referred to as LLGEN (Table 2-1; Figure 2-1). For the 2012 monitoring season, MS5 long-term deployments were done in LLTR and LLFB.

The permanent stations consisted of a length of 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

[2] 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.

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. A coordinated team of Avista staff, including the HED Operators and Hank Nelson, used the 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 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 approximately 3-week intervals (Table 2-1). Based on paired spot measurements of water temperature, DO, and 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. Therefore, no spot measurements were conducted across the river from monitoring station LLTR.

### 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 percent of saturation (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, 2012. These logs provide the HED's hourly discharges as generation and spill along with total discharge. In addition, Avista identified aeration operations during the monitoring period.

### 2.3.5 Monitoring Difficulties

During the 2012 DO monitoring season, one monitoring difficulty occurred. The MS5 deployed at LLFB had low battery power upon its recovery at the termination of the monitoring season. Review of the MS5's data show that it experienced power outages starting on October 31 at 9:15 Pacific Daylight Time (PDT), which resulted in a data gap on the last day of the monitoring season. Consultation with Avista staff suggests this event may have been associated with the HED's maintenance activities. To minimize the reoccurrence of a similar event, Avista has implemented a Standard Operating Procedure to maintain the backup AC power supply to the MS5 at this location and other long-term monitoring stations, recognizing however the power supply may be interrupted during maintenance or non-scheduled events.

## 2.4 Results

Results of 2012 DO monitoring season data collection activities are presented below. MS5s and barologgers were set up 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 virtually a complete data set for local barometric pressure. DO along with temperature and TDG data were successfully obtained for 98 to 100 percent of the entire monitoring period at both LLTR and LLFB (Appendix A, Table A-4). Spot measurements were collected when long-term deployment and/or instrument downloads were conducted; results were used for the quality assurance / quality control program described in Appendix A[3]. 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 11,091 cubic feet per second (cfs) (Table 2-3). Long Lake HED generation was at full capacity from July 1 to July 7. Maximum hourly discharge at LL HED ranged from 4,570 cfs to 6,320 cfs during August through October.

### 2.4.2 Water Temperature

Water temperature in the forebay (LLFB) increased from approximately 18°C at the beginning of July to approximately 26°C in late July (Figure 2-2). Tailrace (LLTR) water temperature increased from approximately 16°C at the beginning of July to approximately 21°C in late July (Figure 2-3). From early July through mid-October, temperature was more variable at LLFB than LLTR. During generation periods, corresponding measurements for LLFB and LLTR were within 6°C of one another with water temperatures at LLTR generally cooler than those at LLFB (Figure 2-4).

[3] This occurred on July 17, August 2, August 24, September 20, October 12, and November 1.

### 2.4.3 Barometric Pressure

Site-specific barometric pressures ranged from 710 to 734 mm Hg based on the Solinist® barologger deployed at LLTR (Table 2-2).

### 2.4.4 Dissolved Oxygen

Measured DO concentrations were 0.2 to 12.3 mg/L for LLFB and 4.5 to 11.5 mg/L for LLTR (Table 2-2). Greatest DO concentrations occurred near the beginning of the monitoring period when: 1) the water was near its coolest causing potential solubility for oxygen to be greatest and 2) spill occurred at the dam (Figures 2-2 and 2-3). DO generally decreased through July and August reaching approximately 8 mg/L at LLTR by late July. Figure 2-5 displays DO and TDG% trends illustrating the result of the initiation of aeration in the first week in August with aeration being sequentially increased over the first three weeks of August.

DO concentrations in Long Lake HED discharges, monitored at LLTR, were less than the 8.0-mg/L DO criterion 14.5 percent of the time during the DO monitoring season (Table 2-4). Table 2-4 also includes a summary of corresponding DO values for LLFB[4] for comparative purposes. LLTR DO remained greater than 8.0 mg/L throughout the entire period that Long Lake Dam's spillways were used. LLTR DO was less than 8 mg/L for 15.3 percent of the measurements during powerhouse discharge without spill, although roughly two-thirds of these low DO concentrations were within 0.2 mg/L of 8.0 mg/ L (i.e. 7.8 to 8.0 mg/L) (Figure 2-6). 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 2-5.

Calculated DO% saturation values ranged from approximately 3 to 152 percent for LLFB and 48 to 123 percent for LLTR (Table 2-2). DO% saturation at LLTR ranged from 105 to 123 percent during periods of generation with spill, from 66 to 116 percent during periods of generation without spill, and from 48 to 108 percent during periods of non-generation (Figure 2-7).

### 2.4.5 Total Dissolved Gas

The range of TDG% computed was approximately 89 to 123 percent of saturation for LLFB and 92 to 123 percent of saturation for LLTR (Table 2-2). TDG% of Long Lake HED discharges, monitored at LLTR, were only greater than 110 percent of saturation criterion for 315 (3.8%) of the 8,262 measurements taken during periods of generation without spill (Table 2-6, Figure 2-6). Table 2-5 provides additional insight into the HED operations coinciding with these high TDG% values. TDG% associated with spill is discussed in the 2012 Long Lake TDG Monitoring Report (Golder 2012b).

[4] The DO criterion of 8 mg/L is not applicable to LLFB.

## 3.0 DISCUSSION

Dissolved oxygen levels were monitored from July 1, 2012 through October 31, 2012. Avista operated the HED at varying capacities throughout this period. Spill occurred in early July, and aeration operations were conducted between August 2 and October 14 using different valve openings for Units 1 and 2 (Table 2-5 and Figure 2-5). The various generating and aeration conditions along with comparisons of DO during generation, as measured at LLTR, to the 8-mg/L criterion are summarized below and in Table 2-5.

- July 1 to July 14: Avista generated continuously throughout the day with and without spill. DO remained greater than the 8-mg/L criterion.
- July 15 to August 2: Avista generated at varying capacities and did not aerate. DO was less than the 8-mg/L criterion approximately 11 percent of the time.
- August 2 to October 14: Avista generated at varying capacities and aeration settings, including simultaneous aeration with Units 1 and 2. DO was less than the criterion approximately 21 percent of the time.
- October 14 to October 31: Avista generated at varying capacities and did not aerate. DO was less than the criterion approximately 10 percent of the time.

Results of this study demonstrate progress toward meeting the DO criterion through aeration at Units 1 and 2. Although the DO criterion was not met for all powerhouse discharge periods, powerhouse discharges satisfied the DO criterion approximately 85 percent of the time (Table 2-5), and were within measurement accuracy (i.e., 7.8 mg/L or greater) 94 percent of the time when spill was not occurring (Figure 2-6). Aeration operations typically maintained TDG% less than the 110 percent of saturation criterion (Figure 2-6). Avista will continue to refine use of real-time DO and TDG measurements for setting aeration valve openings, which may provide additional improvements in DO while limiting adverse TDG% conditions.

## 4.0 REFERENCES

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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 |
| LLGEN | Long Lake HED Unit 4 generation plume | 47°37'48" / 117°31'47" | None |
| LLTR | On left downstream bank, at a water pumphouse 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**

| | LLFB | | | LLTR | | |
|---|---|---|---|---|---|---|
| | **Minimum** | **Maximum** | **Count** | **Minimum** | **Maximum** | **Count** |
| Date/Time (PDT) | 7/1/2012 0:00 | 10/31/2012 23:45 | 11,808 | 7/1/2012 0:00 | 10/31/2012 23:45 | 11,808 |
| Water Temperature (°C) | 11.22 | 25.56 | 11,713 | 11.42 | 21.27 | 11,787 |
| Dissolved Oxygen (mg/L) | 0.2 | 12.3 | 11,604 | 4.5 | 11.5 | 11,786 |
| BAR (mm Hg) | used LLTR BAR | | | 710 | 734 | 11,807 |
| TDG (mm Hg) | 640 | 877 | 11,706 | 675 | 884 | 11,774 |
| TDG (% saturation)[1] | 88.6 | 122.6 | 11,705 | 92.3 | 122.6 | 11,773 |
| DO (% saturation)[1] | 2.5 | 152.2 | 11,603 | 48.0 | 123.4 | 11,785 |

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 2012 | 180 | 11,091 | 5,041 |
| August 2012 | 90 | 6,320 | 2,171 |
| September 2012 | 90 | 4,590 | 1,991 |
| October 2012 | 90 | 4,570 | 2,516 |

**Table 2-4: Summary of DO Less than 8 mg/L, DO Criterion Lower Limit, During Generation**

| | LLFB[1] | | | LLTR | | |
|---|---|---|---|---|---|---|
| **Operations** | **Total Number of Measurements** | **Number <8 mg/L DO [1]** | **Frequency <8 mg/L DO** | **Total Number of Measurements** | **Number <8 mg/L DO [2]** | **Frequency <8 mg/L DO** |
| Generation Without Spill | 8,086 | 3,559 | 44.0% | 8,272 | 1,269 | 15.3% |
| Generation With Spill | 484 | 0 | 0.0% | 484 | 0 | 0.0% |
| All Generation | 8,570 | 3,559 | 41.5% | 8,756 | 1,269 | 14.5% |

Notes:
[1] DO criterion of 8 mg/L is not applicable to LLFB.
[2] Of the 8,756 LLTR measurements, 463 (5.3%) were less than 7.8 mg/L.

**Table 2-5: Summary of Exceedances of DO Criterion at LLTR During Generation**

| Operations, Spill, and Aeration Characteristics | | | | LLTR | | | | |
|---|---|---|---|---|---|---|---|---|
| **Period** | **Operations** | **Spill** | **Aeration** | **Total Number of Measurements** | **Number <8 mg/L DO** | **Frequency <8 mg/L DO** | **Number <8 mg/L in First or Last Hour Recorded as Generating** | **Notes** |
| 7/1/12 00:00 to 7/6/12 00:45 | All 4 Units near full generation capacity, continuous generation throughout entire day "Generation with Spill" | Yes | No | 484 | 0 | 0.0% | 0 | |
| 7/6/12 1:00 to 7/7/12 23:45 | All 4 Units near full capacity (cumulative >5,900 cfs) continuous generation throughout entire day | No | No | 188 | 0 | 0.0% | 0 | |
| 7/8/12 0:00 to 7/14/12 23:45 | # Units varies, Capacity varies, continuous generation throughout the entire day | No | No | 667 | 0 | 0.0% | 0 | 1 |
| 7/15/12 0:00 to 8/2/12 11:45 | # Units varies, Capacity varies | No | No | 1,420 | 161 | 11.3% | 47 | 2 |
| 8/2/12 12:00 to 8/8/12 18:45 | # Units varies, Capacity varies | No | Unit 1 sometime each day | 350 | 106 | 30.3% | 31 | 3 |
| 8/8/12 19:00 to 8/15/12 23:45 | # Units varies, Capacity varies | No | Units 1 and 2 used together sometime each day | 416 | 38 | 9.1% | 25 | 4 |
| 8/16/12 0:00 to 8/29/12 13:45 | # Units varies, Capacity varies | No | Unit 1 sometime each day | 756 | 173 | 22.9% | 74 | 5 |
| 8/29/12 14:00 to 10/14/12 22:45 | # Units varies, Capacity varies | No | Units 1 and 2 used together sometime each day | 3,043 | 641 | 21.1% | 210 | 6 |
| 10/14/12 23:00 to 10/31/12 23:45 | # Units varies, Capacity varies | No | No | 1,432 | 150 | 10.5% | 38 | 7 |
| 7/6/12 1:00 to 10/31/12 23:45 | Cumulative of above operations without spill | No | Both Yes and No | 8,272 | 1,269 | 15.3% | 425 | |

Notes:

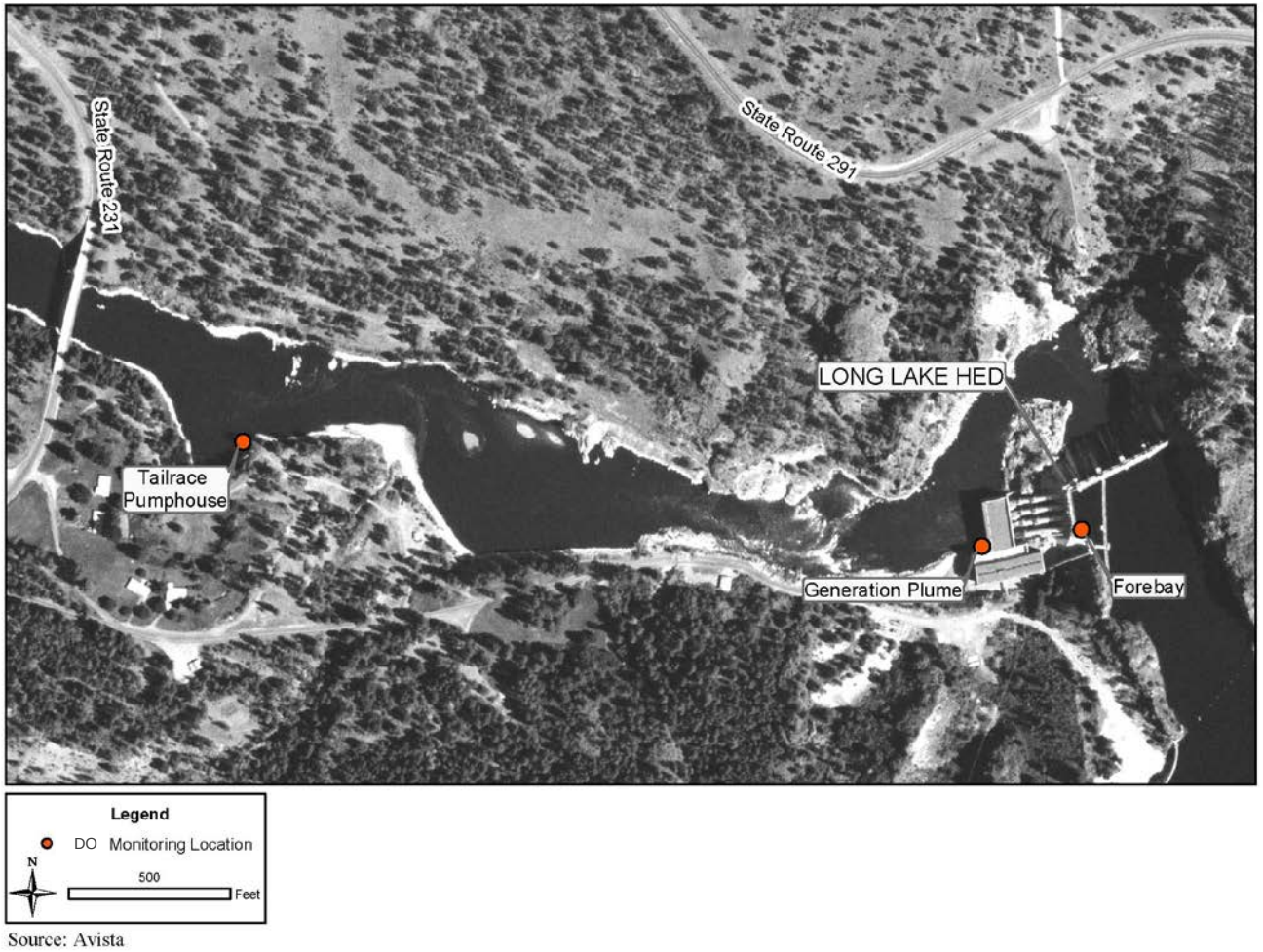
1. Maximum TDG at LLTR was 111.4 percent of saturation, although it was 122.6 percent of saturation at LLFB. TDG% values exceeded 110 percent of saturation less often at LLTR than LLFB (90 at LLTR versus 364 at LLFB).
2. Periods of non-generation occurred on July 15 along with July 20 through August 2. Minimum DO was 7.3 mg/L and 84 percent of saturation, and maximum TDG was 110.3 percent of saturation.
3. Periods of non-generation occurred each day. Minimum DO was 7.1 mg/L and 82 percent of saturation, and maximum TDG was 109.4 percent of saturation.
4. Periods of non-generation occurred each day. Minimum DO was 6.9 mg/L and 80 percent of saturation, and maximum TDG was 113.1 percent of saturation.
5. Periods of non-generation occurred each day. Minimum DO was 6.4 mg/L and 75 percent of saturation, and maximum TDG was 110.3 percent of saturation.
6. Periods of non-generation occurred each day. Minimum DO was 5.8 mg/L and 66 percent of saturation, and maximum TDG was 114.6 percent of saturation.
7. Periods of non-generation occurred on October 14 through October 20, October 25, October 26, and October 27. Minimum DO was 6.9 mg/L and 68 percent of saturation, and maximum TDG was 100.0 percent of saturation.

**Table 2-6: Summary of TDG% Greater than 110%, TDG Criterion Upper Limit, During Generation**

| | LLFB | | | LLTR | | |
|---|---|---|---|---|---|---|
| **Operations** | **Total Number of Measurements** | **Number >110% TDG** | **Frequency >110% TDG** | **Total Number of Measurements** | **Number >110% TDG** | **Frequency >110% TDG** |
| Generation Without Spill | 8,188 | 812 | 9.9% | 8,262 | 315 | 3.8% |
| Generation With Spill [1,2] | 484 | 484 | 100.0% | 484 | 463 | 95.7% |
| All Generation | 8,672 | 1,296 | 14.9% | 8,746 | 778 | 8.9% |

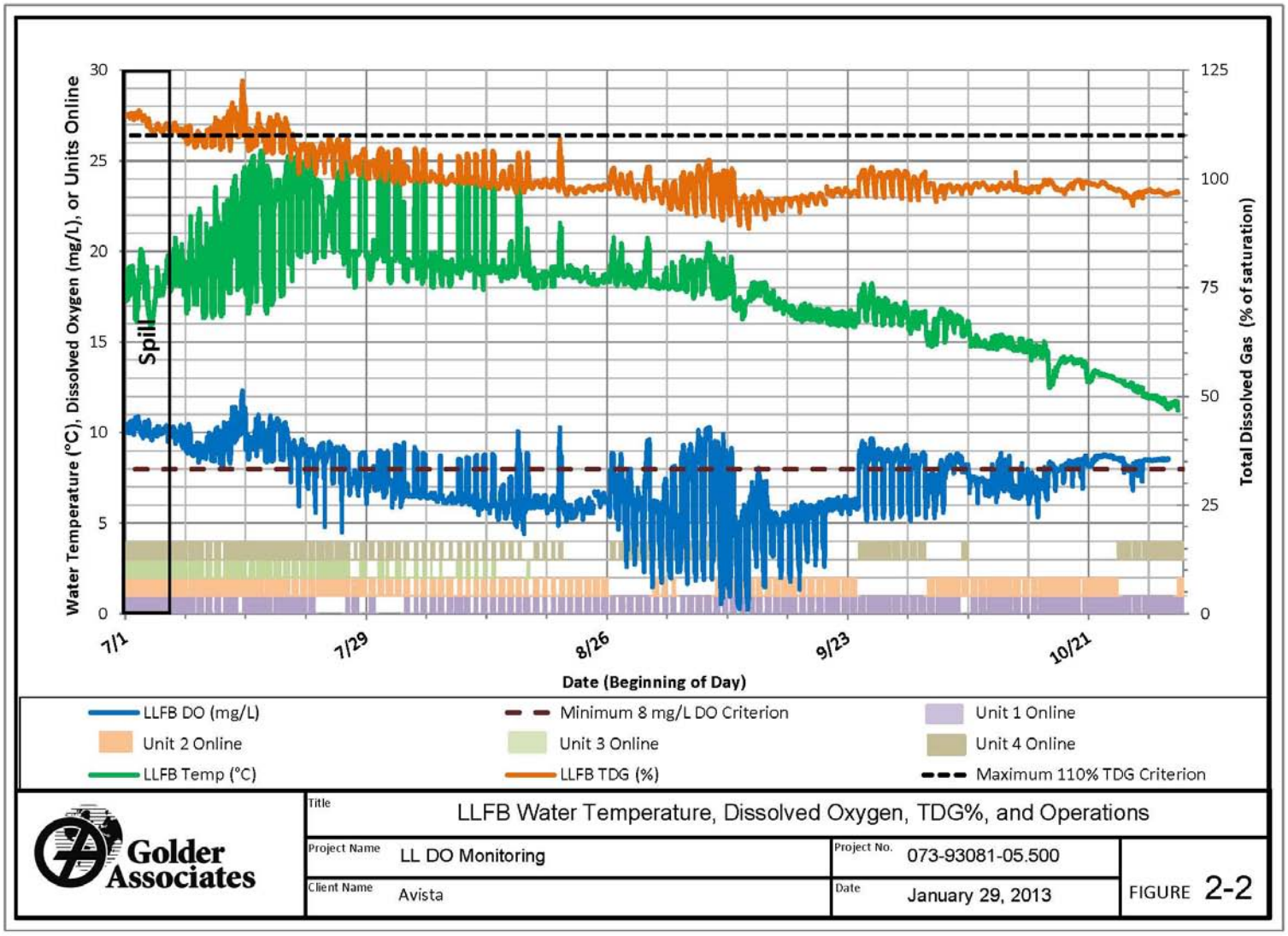
Notes:
[1] 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.
[2] TDG exceedances during spill are discussed in 2012 Long Lake Total Dissolved Gas Monitoring Report (Golder 2012b).

# 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. | 073-93081-05.500 |
| Client Name | Avista | Date | January 29, 2013 |

FIGURE 2-2

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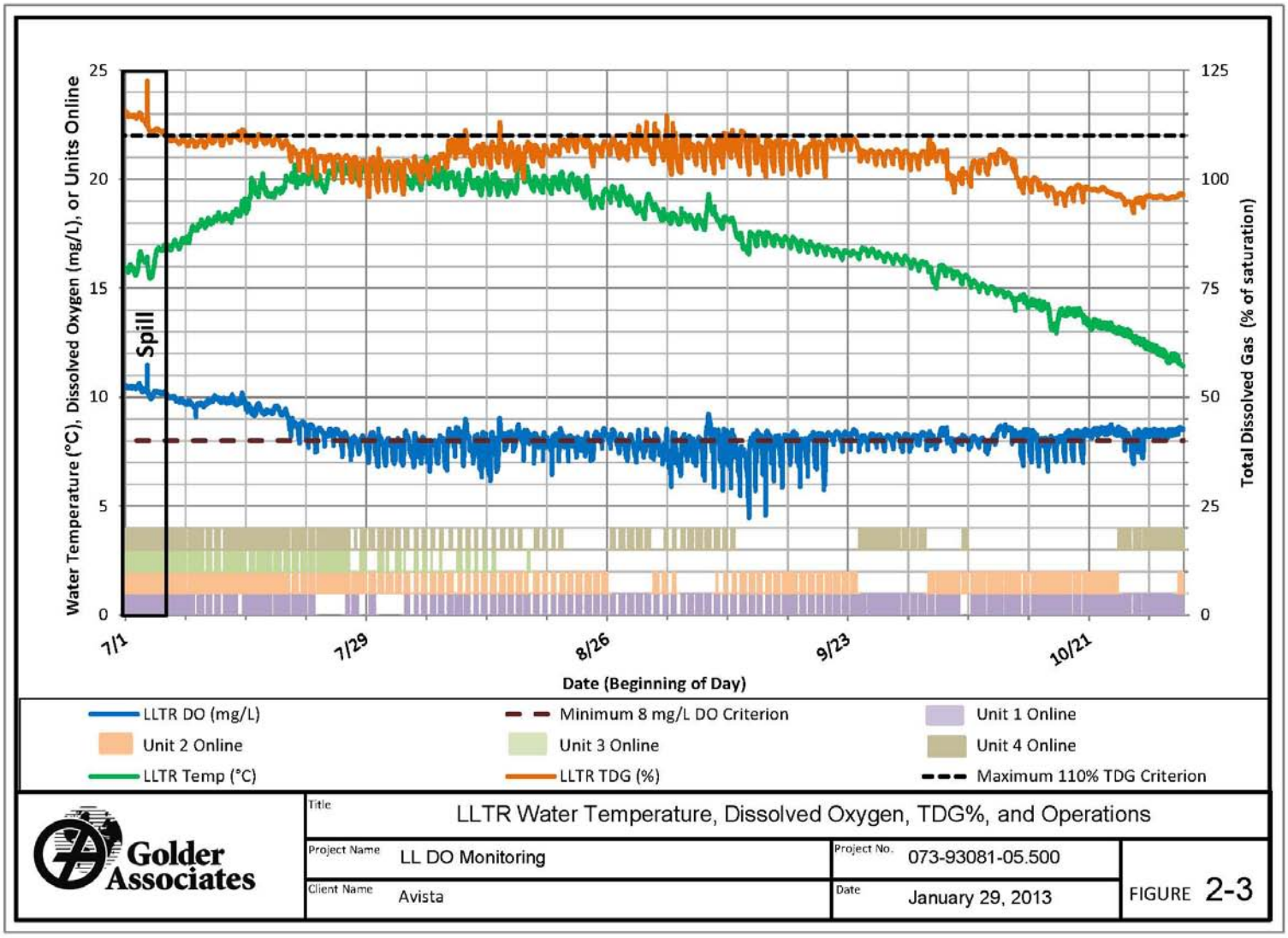


Golder Associates

| | | | |
|---|---|---|---|
| Title | LLTR Water Temperature, Dissolved Oxygen, TDG%, and Operations | | |
| Project Name | LL DO Monitoring | Project No. 073-93081-05.500 | FIGURE 2-3 |
| Client Name | Avista | Date January 29, 2013 | |

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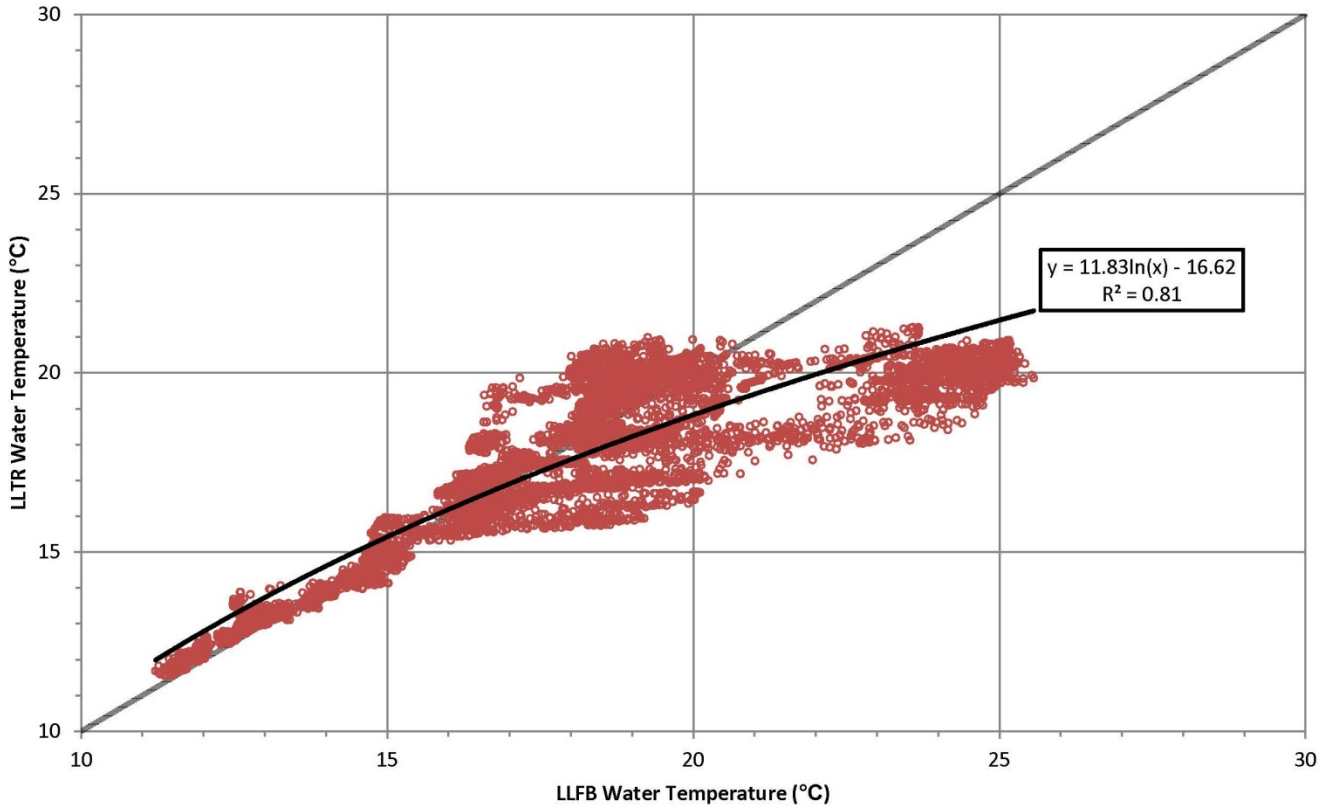


Golder Associates

| | | | |
|---|---|---|---|
| Title | Water Temperature Comparison for LLTR and LLFB during Generation | | |
| Project Name | LL DO Monitoring | Project No. | 073-93081-05.500 |
| Client Name | Avista | Date | January 29, 2013 |

FIGURE 2-4

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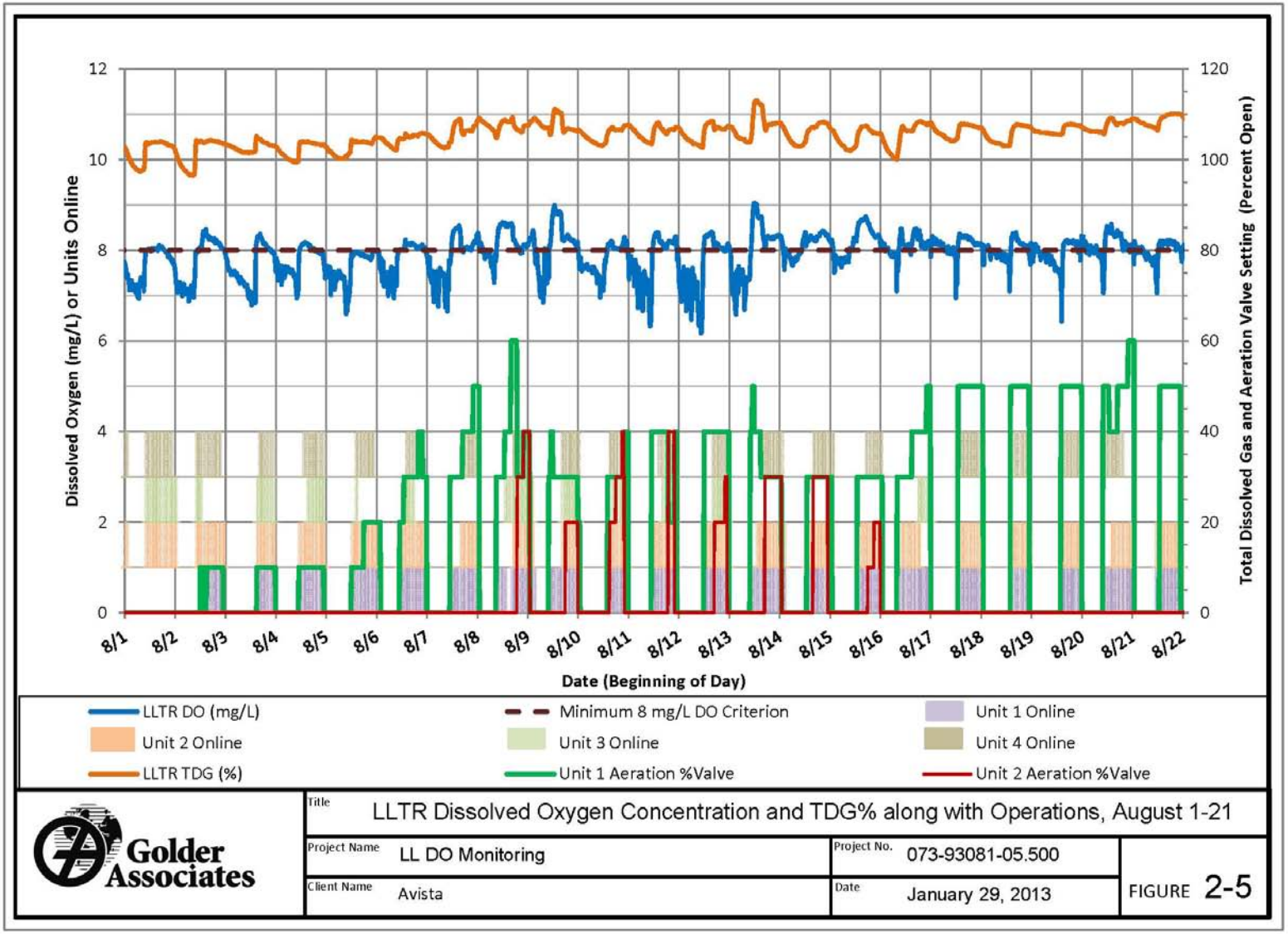


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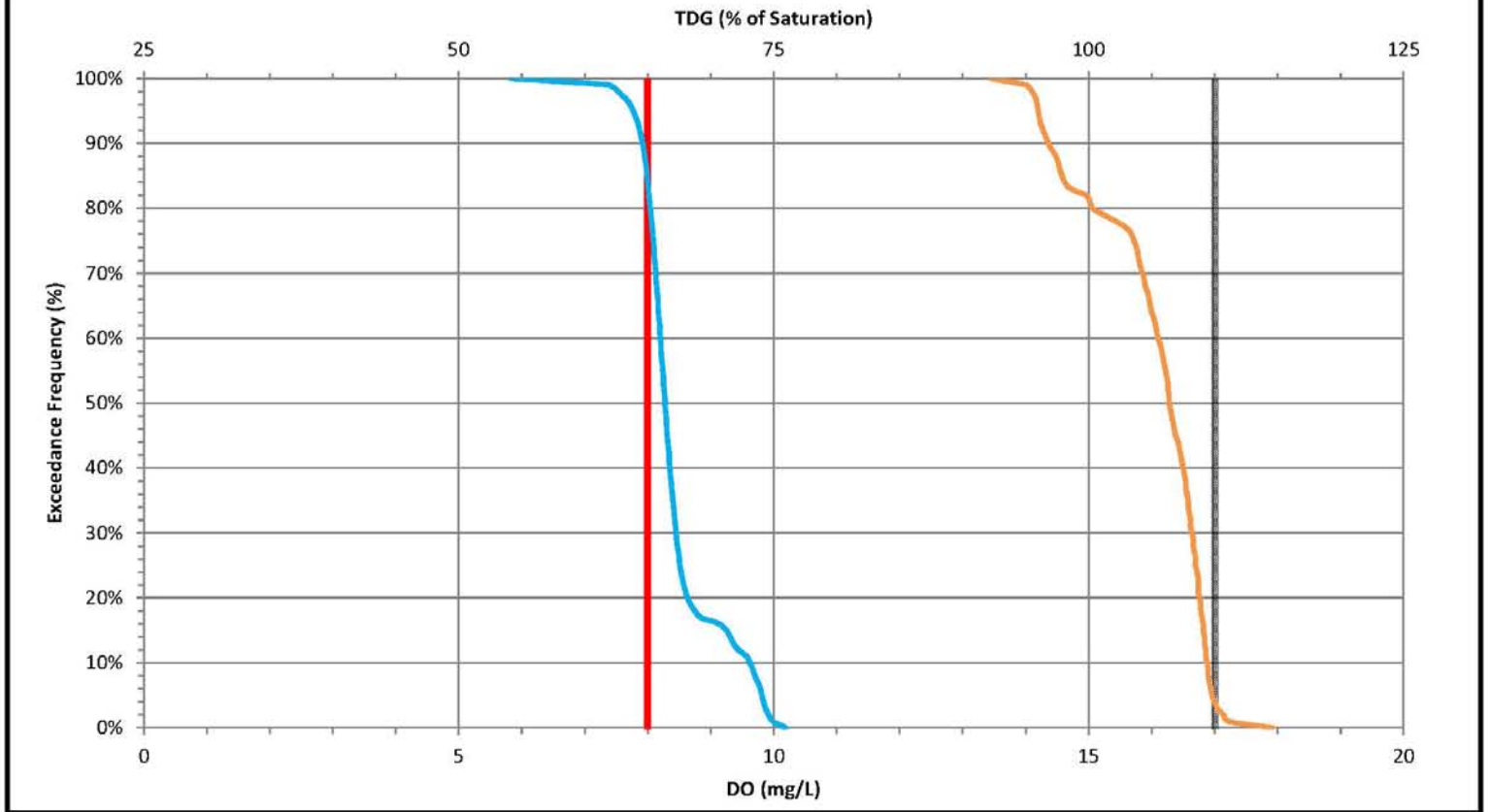
| | | | |
|---|---|---|---|
| Title | LLTR Dissolved Oxygen Concentration and TDG% along with Operations, August 1-21 | | |
| Project Name | LL DO Monitoring | Project No. 073-93081-05.500 | FIGURE 2-5 |
| Client Name | Avista | Date January 29, 2013 | |

J:\Doc-Dev\2007\073-93081 Avista_Mattax\x05\ph 500\012113blm1 LL_HED_Processed_Data_2012-Restricted.xlsx




Golder Associates

Title: LLTR DO Concentration and TDG% Exceedance Frequency during Generation without Spill

| | | | |
|---|---|---|---|
| Project Name | LL DO Monitoring | Project No. | 073-93081-05.500 |
| Client Name | Avista | Date | January 29, 2013 |

FIGURE 2-6

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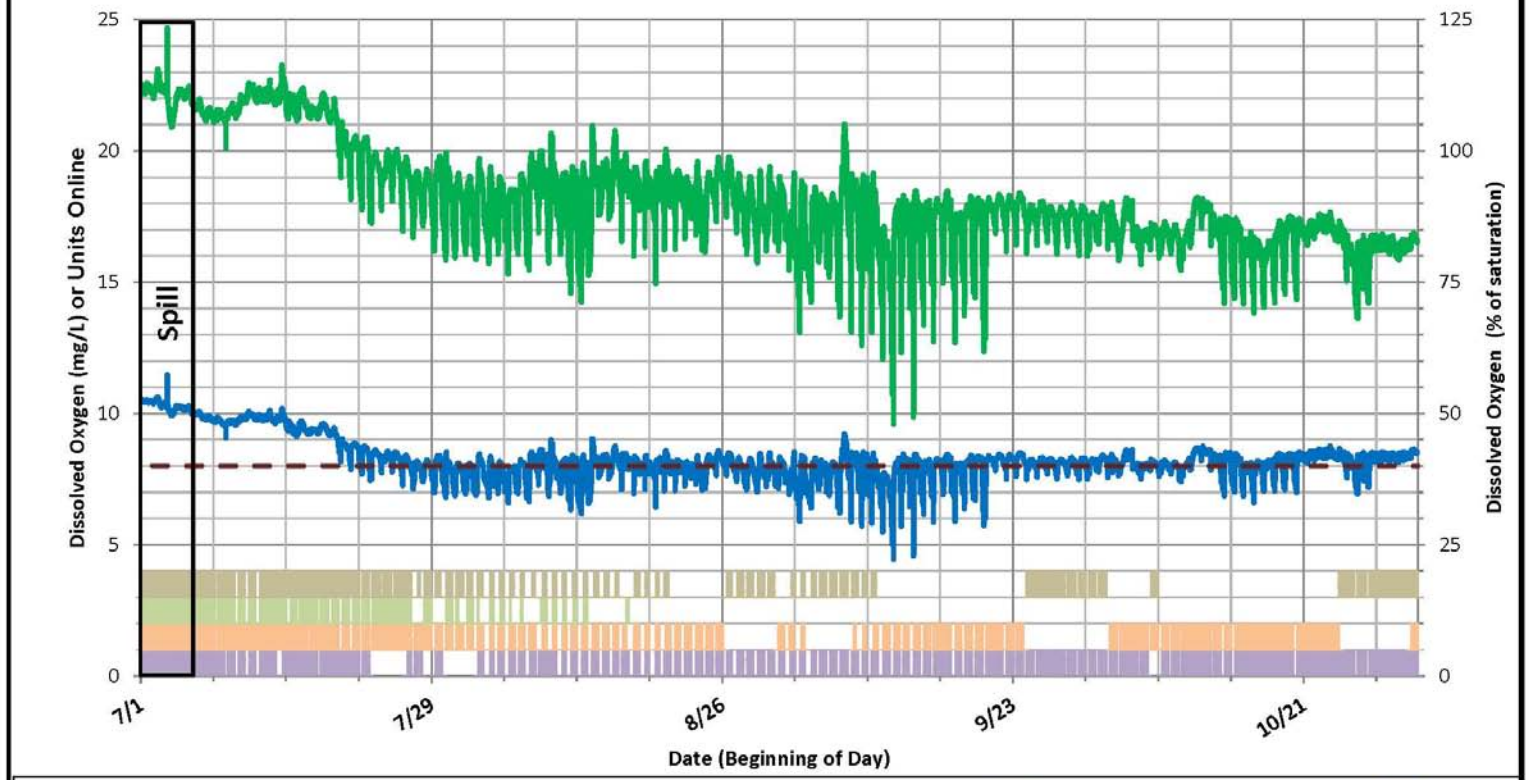


Golder Associates

| | | | |
|---|---|---|---|
| Title | LLTR Dissolved Oxygen Concentration and Percent of Saturation along with Operations | | |
| Project Name | LL DO Monitoring | Project No. 073-93081-05.500 | FIGURE 2-7 |
| Client Name | Avista | Date January 29, 2013 | |

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# 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<br>± 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 [5]

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 |

[5] Hach Corporation. 2006. Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes User Manual. February, 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.

**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 |
| 48763 (LLFB 6/28 - 7/13) | 2.00 | 0.28 | 0.28 | N/A | 2 | 1 | 1 | 0.00 | -0.72 | -0.72 | N/A |
| 48764 (LLFB 7/13-11/01) | 0.89 | 0.12 | 0.12 | N/A | 2 | 1 | 1 | -1.11 | -0.88 | -0.88 | N/A |
| 60376 (LLTR 6/28 -11/01) | 1.41 | 0.20 | 0.20 | N/A | 2 | 1 | 1 | -0.59 | -0.80 | -0.80 | N/A |
| Overall RMSE | 1.29 | 0.18 | 0.18 | N/A | 2 | 1 | 1 | -0.71 | -0.82 | -0.82 | 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.
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) |
| 48763 (LLFB 6/28 - 7/13) | 0.06 | N/A | 0.58 | N/A | 0.5 | 0.5 | -0.44 | N/A | 0.08 | N/A |
| 48764 (LLFB 7/13-11/01) | 0.10 | N/A | 0.10 | N/A | 0.5 | 0.5 | -0.40 | N/A | -0.40 | N/A |
| 60376 (LLTR 6/28 -11/01) | 0.12 | N/A | 0.13 | N/A | 0.5 | 0.5 | -0.38 | N/A | -0.37 | N/A |
| Overall RMSE | 0.11 | N/A | 0.20 | N/A | 0.5 | 0.5 | -0.39 | N/A | -0.30 | 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.
[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 generally minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings. This included using a spreadsheet to ensure correct calculation of BAR from weather station and barologger data.

## Precision

Precision refers to the degree of variability in replicate measurements. Instrument precision was evaluated through the calibration and maintenance activities along with paired spot measurements. 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 after July 13, 2012. The MS5 deployed at LLFB exceeded the DO MQO by less than 0.1 mg/L during the pre-calibration check on July 13, 2012.

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

## Accuracy

Accuracy is a measure of confidence that describes how close a measurement is to its "true" value, or the combination of high precision and low bias. Throughout this seasonal DO monitoring study, the MS5s underwent verification procedures. All differences between DO, TDG pressure, temperature, depth, and barometric pressure were recorded and these differences were discussed in the previous section.

## 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.

## 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. Data completeness for all parameters met or exceeded the goal of at least 90 percent for both LLFB and LLTR. Virtually a complete data set was obtained for both LLFB and LLTR.

Table A-5 summarizes the number of specific DQCodes 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) | 11,713 | 99% | 11,787 | 100% |
| Dissolved Oxygen (mg/L) | 11,604 | 98% | 11,786 | 100% |
| BAR (mm Hg) | used LLTR BAR | | 11,807 | 100% |
| TDG (mm Hg) | 11,706 | 99% | 11,774 | 100% |
| TDG (% saturation) | 11,705 | 99% | 11,773 | 100% |
| DO (% saturation) | 11,603 | 98% | 11,785 | 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 | 5 | 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 997 | Equilibrating after deployment | 0 | 7 | 0 | 3 | 0 | 0 | 13 | 0 | 1 | 0 | 0 | 0 |
| 994 | Parameter not monitored during the monitoring period | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 993 | Out of water for calibration/servicing | 26 | 26 | 26 | 26 | 26 | 21 | 21 | 21 | 21 | 21 | 1 | 1 |
| 991 | Instrument not deployed at typical long-term depth | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 889 | Power loss/ late probe turn on | 57 | 57 | 57 | 57 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 101 | Less than "minimum operating voltage" (<7 volts) and other data do not appear reliable | 0 | 0 | 0 | 106 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -101 | Less than "minimum operating voltage" (<7 volts), but other data appear reliable | 189 | 189 | 189 | 83 | 189 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -102 | Between "minimum operating voltage" (<9 volts) and 7 volts, but other data appear reliable | 554 | 554 | 554 | 554 | 554 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1002 | Corresponds with spot measurement | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 6 | 6 | 6 | 0 | 0 |
| -1003 | Corresponds with spot measurement at nearby station | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| No DQ Code | | 10,973 | 10,966 | 10,973 | 10,970 | 10,973 | 11,780 | 11,768 | 11,780 | 11,780 | 11,780 | 11,807 | 11,807 |
| Monitoring Period | | 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, 2013

Ms. Marcie Mangold, 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 Ms. Mangold:

Ordering Paragraph E of the Spokane River Hydroelectric Project License (Federal Energy Regulatory Commission Project No. 2545) 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 submits the following reports for your review and comment.

**Section 5.4: Total Dissolved Gas**
There are three components related to Total Dissolved Gas in this filing, which include the following:

1. *2012 Long Lake Total Dissolved Gas Monitoring Report, Golder Associates, February 2013.* As required by the Total Dissolved Gas (TDG) Water Quality Attainment Plan (WQAP) and the Washington TDG Monitoring Plan, this enclosed report provides the results of monitoring TDG at Avista's Long Lake Hydroelectric Development (HED) during 2012. Avista proposes to continue implementing the same monitoring plan at the Long Lake HED in 2013.

2. *Long Lake Hydroelectric Development (HED) Total Dissolved Gas Abatement Phase III Feasibility Study, Draft Report, NHC, November 19, 2012.* The Phase III Feasibility Study documents the progress of building the physical model and hydraulic testing of using deflectors on the modeled Long Lake Dam spillway. Additionally, the Phase III Feasibility Study documents the detailed physical scale modeling of the Long Lake HED and the development and implementation of the various model scenarios that were tested to reduce TDG, based on the findings of Phase II studies. It also includes estimated TDG performance, construction cost estimates, and preliminary geotechnical analysis of the various alternatives that were tested. Specifics related to TDG performance and construction costs are discussed in the Summary and Conclusions section of the Phase III Feasibility Study.

   Based on the results of the study, Avista has determined that the best alternative to mitigate for TDG produced by the Long Lake HED is a modified Alternative 1 (Spill Bay 7-8 Deflectors), that includes substantial rock removal from the rock outcropping below the two spill bays, and additional deflectors on spill bays 3-6. The deflectors will help eliminate the plunging flow that causes the high TDG levels and the rock removal will allow the spill bay 7 and 8 deflectors to develop a skimming flow in the same manner that the deflectors do for spill bays 3-6.

1411 East Mission Avenue
PO Box 3727
Spokane, Washington 99220-3727

800.227.9187
www.avistautilities.com

3. *Revised Long Lake HED TDG Compliance Schedule.* The July 9, 2010 Long Lake Dam TDG WQAP included a compliance schedule to address TDG production at Long Lake Dam. During the modeling process it was determined that additional unplanned alternatives needed to be assessed to thoroughly evaluate their potential to reduce TDG production. This required us to extend the compliance schedule by up to two years and allowed us to modify Alternative 1, which we believe will have the best TDG reduction performance. With this, we have revised the compliance schedule, which still has us completing the project within 10 years (2020) of both Ecology and Federal Energy Regulatory Commission (FERC) approval of the TDG WQAP. We have enclosed the revised compliance schedule for Ecology's approval.

In accordance with the Ecology letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2012. 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.

**Section 5.6: Dissolved Oxygen**
This is the second annual monitoring report required under the FERC approved Dissolved Oxygen (DO) Feasibility and Implementation Plan. This report illustrates the seasonal changes in DO immediately downstream of the dam during the low flow period of the year and summarizes the use of draft tube aeration to boost DO levels in the river. In addition to the aeration equipment installed on turbine units 3 and 4 during 2011, Avista installed aeration equipment on turbine units 1 and 2 during June of 2012. Besides providing a full season of DO data below the dam, the report details the success of the aeration system. Avista plans to continue with the aeration program in 2013.

With this, Avista is submitting the 2012 Long Lake Total Dissolved Gas Monitoring Report, the Long Lake Hydroelectric Development (HED) Total Dissolved Gas Abatement Phase III Feasibility Study, the Revised Long Lake HED TDG Compliance Schedule, and the 2012 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, 2013, which will allow us time to file the attachments with FERC by April 15, 2013.

Please feel free to contact me at (509) 495-4998 if you have any questions or wish to discuss the reports. We would also like to meet with you, at your convenience, to discuss our recommendations related to the Phase III Feasibility Study.

Sincerely,

Speed Fitzhugh

Elvin "Speed" Fitzhugh
Spokane River License Manager

Enclosures (4)

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

March 19, 2013

Mr. Elvin "Speed" Fitzhugh
Spokane River License Manager
Avista Corporation
1411 East Mission Ave., MSC-1
Spokane, WA 99220-3727

RE: Request for Comments – Spokane River Hydroelectric Project No. 2545
2012 Long Lake Dam Total Dissolved Gas Monitoring Report,
Long Lake Hydroelectric Development TDG Abatement Phase III Feasibility Study,
Revised Long Lake HED TDG Compliance Schedule, and 2012 Long Lake HED Tailrace
Dissolved Oxygen Monitoring Report – Washington 401 Certification, Section 5.4(D) and 5.6(B)

Dear Mr. Fitzhugh:

The Department of Ecology (Ecology) has reviewed the following documents emailed to us on February 28, 2013 and would like to provide the comments detailed below:

1. *2012 Long Lake Total Dissolved Gas Monitoring Report, Golder Associates, February 2013*

   We recognize that monitoring difficulties often occur due to power failure and approve the standard operating procedure that has been developed to maintain backup AC power supply to the monitoring station. If difficulties continue to occur due to power loss, another alternative may need to be considered.

   Although the data showed that total dissolved gas (TDG) exceeded the 110% water quality standard in the tailrace for all data 4,159 data pairs, Ecology acknowledges that while you are actively working on your compliance schedule identified in your TDG abatement plan, you are in compliance with your 401 water quality certification.

2. *Long Lake Hydroelectric Development (HED) Total Dissolved Gas Abatement Phase III Feasibility Study, Draft Report, NHC, November 19, 2012*

   In reviewing the feasibility study, the construction costs, geotechnical analysis and estimated TDG performance using Alternative 1, appear to be the best choice. Ecology agrees with Avista's determination that Alternative 1 is the best alternative to mitigate for TDG produced by Long Lake HED.

3. *Revised Long Lake HED TDG Compliance Schedule*

   Prior to completion of the physical model, Ecology was aware that the eight year compliance schedule that was developed in the TDG water quality attainment plan (WQAP) would need to be adjusted to accommodate for the physical model testing and monitoring. The 401 Certification did allow for a 10 year compliance schedule to achieve water quality standards for TDG at Long Lake HED.

Ecology supports the extension of the eight year compliance schedule in the original TDG WQAP to a 10 year compliance schedule. The additional two years will allow for adequate monitoring and adaptive management of the newly engineered deflectors. We fully understand that this lapse in schedule is due to the complex challenges, including but not limited to physical constraints associated with the tailrace, of reducing TDG at Long Lake HED and agree that the additional modeling and/or assessment efforts are appropriate.

We request that the new compliance schedule be added to the future TDG annual reports with a section discussing progress towards meeting the dates within the compliance schedule.

4. *2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report*

The data presented in the report were very helpful in portraying the entire picture, especially Table 2-5, *Summary of Exceedances of DO Criterion at LLTR During Generation*. We recommend that you continue to use this reporting format in future annual reports.

We recognize that it is a delicate balancing act maintaining water quality compliance with DO and TDG concentrations with the effects of temperature. Ecology approves the methods used for maximizing your efficiency in maintaining higher DO concentrations and lower TDG concentrations in the Long Lake HED tailrace and look forward to the continued success in refining these methods.

We thank you for the opportunity to comment. Please contact me by phone at (509) 329-3450 or by email at dman461@ecy.wa.gov if you have any further questions.

Sincerely,

D. Marcie Mangold

D. Marcie Mangold
Water Quality Program

DMM:dw
cc: Brian Crossley, Spokane Tribe of Indians
Meghan Lunney, Avista
David Knight, Ecology/WQP

# ECOLOGY COMMENTS AND AVISTA RESPONSES

**These comments and responses pertain specifically to the 2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.**

**Ecology Comment**
Ecology indicated that the data presented in the 2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report was very helpful in portraying the entire picture, especially Table 2-5, *Summary of Exceedances of DO Criterion at LLTR During Generation*, and recommended that Avista continue to use this reporting format in future annual reports.

**Avista Response**
Avista agrees and will continue to use the same data presentation format in future monitoring reports.

February 28, 2013

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 Spokane River Hydroelectric Project License (Federal Energy Regulatory Commission Project No. 2545) 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 submits the following reports for your review and comment.

**Section 5.4: Total Dissolved Gas**
There are three components related to Total Dissolved Gas in this filing, which include the following:

1. *2012 Long Lake Total Dissolved Gas Monitoring Report, Golder Associates, February 2013.* As required by the Total Dissolved Gas (TDG) Water Quality Attainment Plan (WQAP) and the Washington TDG Monitoring Plan, this enclosed report provides the results of monitoring TDG at Avista's Long Lake Hydroelectric Development (HED) during 2012. Avista proposes to continue implementing the same monitoring plan at the Long Lake HED in 2013.

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   Based on the results of the study, Avista has determined that the best alternative to mitigate for TDG produced by the Long Lake HED is a modified Alternative 1 (Spill Bay 7-8 Deflectors), that includes substantial rock removal from the rock outcropping below the two spill bays, and additional deflectors on spill bays 3-6. The deflectors will help eliminate the plunging flow that causes the high TDG levels and the rock removal will allow the spill bay 7 and 8 deflectors to develop a skimming flow in the same manner that the deflectors do for spill bays 3-6.

3. *Revised Long Lake HED TDG Compliance Schedule.* The July 9, 2010 Long Lake Dam TDG WQAP included a compliance schedule to address TDG production at Long Lake Dam. During the modeling process it was determined that additional unplanned alternatives needed to be assessed to thoroughly evaluate their potential to reduce TDG production. This required us to extend the compliance schedule by up to two years and allowed us to modify Alternative 1, which we believe will have the best TDG reduction performance. With this, we have revised the compliance schedule, which still has us completing the project within 10 years (2020) of both Ecology and Federal Energy Regulatory Commission (FERC) approval of the TDG WQAP. We have enclosed the revised compliance schedule for Ecology's approval.

In accordance with the Ecology letter dated February 17, 2012, Avista did not conduct TDG monitoring at its Nine Mile HED during 2012. 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.

**Section 5.6: Dissolved Oxygen**
This is the second annual monitoring report required under the FERC approved Dissolved Oxygen (DO) Feasibility and Implementation Plan. This report illustrates the seasonal changes in DO immediately downstream of the dam during the low flow period of the year and summarizes the use of draft tube aeration to boost DO levels in the river. In addition to the aeration equipment installed on turbine units 3 and 4 during 2011, Avista installed aeration equipment on turbine units 1 and 2 during June of 2012. Besides providing a full season of DO data below the dam, the report details the success of the aeration system. Avista plans to continue with the aeration program in 2013.

With this, Avista is submitting the 2012 Long Lake Total Dissolved Gas Monitoring Report, the Long Lake Hydroelectric Development (HED) Total Dissolved Gas Abatement Phase III Feasibility Study, the Revised Long Lake HED TDG Compliance Schedule, and the 2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for your review. We would like to receive any comments that you may have by March 28, 2013, which will allow us time to file the attachments with FERC by April 15, 2013.

Please feel free to contact me at (509) 495-4998 if you have any questions or wish to discuss the reports. We would also like to meet with you, at your convenience, to discuss our recommendations related to the Phase III Feasibility Study.

Sincerely,

Speed Fitzhugh

Elvin "Speed" Fitzhugh
Spokane River License Manager

Enclosures (4)

cc: Marcie Mangold, Ecology

## Lunney, Meghan

**From:** Brian Crossley [crossley@SpokaneTribe.com]
**Sent:** Tuesday, April 09, 2013 12:44 PM
**To:** Lunney, Meghan
**Cc:** Casey Flanagan
**Subject:** RE: 2012 Long Lake HED Temperature Monitoring Report

Casey Flanagan and I have reviewed the annual monitoring reports for TDG, Temperature and TDG-sorry about the delay. A couple of comments: Casey did notice better dissolved oxygen in our water quality data collected down at the Bible Camp. There appears to be some attenuation of dissolved oxygen even when the turbines are not turning. The only other item concerning temperature is if you have given thought to whether there is an increase in temperature from aerating by the draft tube method and if so; could that be reduced by providing a cooler air source?

We did notice that for TDG; sampling started on April 20th when TDG was already above 110%; any reason for this? I also noticed on Figure 2-4 (TDG report) that there are several 3% drops in LLGEN TDG and did not see a reason for these drops other than they were right before the data didn't meet DQO's.

---

**From:** Lunney, Meghan [Meghan.Lunney@avistacorp.com]
**Sent:** Thursday, February 28, 2013 1:10 PM
**To:** Brian Crossley
**Cc:** Mangold, Marcie (ECY); Fitzhugh, Speed (Elvin); Goloborodko, Yelena
**Subject:** 2012 Long Lake HED Temperature Monitoring Report

Brian,
Attached is the 2012 Long Lake HED Temperature Monitoring Report (Temperature Monitoring Report) which was completed in accordance with the Long Lake Dam Reservoir and Tailrace Temperature Water Quality Attainment Plan, required by the Spokane River Hydroelectric Project License (License) Appendix B, Section 5.5.B of the Washington Department of Ecology Section 401 Water Quality Certification.

Per the October 2008 Settlement Agreement between Avista and the Spokane Tribe, we request your review and comment by **March 28, 2013**. This will allow us time to incorporate your comments and recommendations as appropriate, and submit the Temperature Monitoring Report to FERC by **April 15, 2013**. In addition to this e-mail, I am also mailing you a hard copy.

Please give me a call at 509-495-4643 if you have any questions.

Thanks!

Meghan Lunney
Aquatic Resource Specialist
Avista Utilities
(509) 495-4643

# SPOKANE TRIBE COMMENTS AND AVISTA RESPONSES

**These comments and responses pertain specifically to the 2012 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report.**

**Spokane Tribe Comment**
Casey (Spokane Tribe) indicated she noticed better dissolved oxygen in the Tribe's water quality data collected at the Bible Camp, which is located downstream of the Long Lake HED Project Boundary. The Tribe noted there appears to be some attenuation of dissolved oxygen even when the turbines are not turning.

**Avista Response**
Avista expects the dissolved oxygen improvements in the tailrace would also show up downstream, which is consistent with the Tribe's comment.

**Spokane Tribe Comment**
Has Avista given thought to whether there is an increase in temperature from aerating by the draft tube method and if so; could that be reduced by providing a cooler air source?

**Avista Response:**
Avista asked HDR in 2011, following the 2010 testing of the draft tube aeration system, to evaluate whether introducing air into the draft chest had an effect on downstream water temperature. HDR completed an evaluation based upon the temperature data that was collected in 5-minute intervals during field testing of the draft tube aeration system. HDR determined, that based upon the field data, when air is allowed to flow into the draft tube, there is no discernible difference in water temperature in the tailrace. They further indicated that this is due to the small amount of air introduced into the flow path (~80 to 100 standard cubic feet per second), which is very small compared to the total flow of water (~800 to 1,500 cubic feet per second) passing through the draft tube. They also indicated another reason tailrace water temperature was unaffected, is that the air temperature (~25 degrees Celsius) is close to the water temperature (~17 to 18 degrees Celsius) and that mixing with air and water only occurs for about 10 to 15 seconds while the air is flowing out of the draft tube and into the tailrace.

HDR did note however, that an increase in water temperature did occur when hydropower generation was turned on and water was withdrawn from the reservoir forebay. The water pulled in through the intakes was about 1 to 2 degrees Celsius warmer than the tailrace water temperature, this most likely reflects the thermal stratification affecting water temperature in the forebay.