AVISTA CORPORATION

2022

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:

April 14, 2023

[Page intentionally left blank]

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Objectives 2
2.0 METHODS 2
2.1 Equipment and Calibration 2
2.2 Station Facilities 3
2.3 Spot Measurements 4
2.4 Data Collection and Processing 4
2.5 Monitoring Difficulties 4
3.0 RESULTS 5
3.1 Discharge 5
3.2 Water Temperature 5
3.3 Barometric Pressure 5
3.4 Dissolved Oxygen 5
3.5 Total Dissolved Gas 6
3.6 Aeration 6
4.0 DISCUSSION 8
4.1 Need for Additional Monitoring 9
5.0 REFERENCES 10

LIST OF TABLES

Table 2-1 Long Lake HED dissolved oxygen monitoring station.
Table 3-1 Summary of 2022 continuous water quality monitoring results.
Table 3-2 Monthly outflow from Long Lake HED.
Table 3-3 Summary of exceedances of dissolved oxygen and total dissolved gas at LLTR during generation.
Table 3-4 Semi-monthly summary of water quality and operations during generation.
Table 3-5 Semi-monthly summary of water quality and operations during non-generation.
Table 3-6 Summary of dissolved oxygen less than 8.0 mg/L, dissolved oxygen criterion lower limit.
Table 3-7 Summary of total dissolved gas (%) greater than 110.0%, the total dissolved gas criterion upper limit.
Table 4-1 Aeration operations and frequency of meeting dissolved oxygen and total dissolved gas criteria.
Table A-1 Range, accuracy and resolution of parameters recorded.
Table A-2 Measurement quality objectives.
Table A-3 Difference between RMSE and MQOs by MS5.
Table A-4 ID number, and deployment station and timeframe of MS5s used in 2022.
Table A-5 Project completeness.
Table A-6 Number of specific DQ Codes during the monitoring period, July 1 at 0:00 PT through October 31 at 23:45 PT of 2022.

LIST OF FIGURES

Figure 2-1 Long Lake HED long-term water quality monitoring locations.
Figure 3-1 LLTR 2022 water temperature (°C), dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations.
Figure 3-2 LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, July 1 – July 31.
Figure 3-3 LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, August 1 – August 31.
Figure 3-4 LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, September 1 – September 30.
Figure 3-5 LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, October 1 – October 31.
Figure 3-6 LLTR dissolved oxygen (mg/L) concentration and total dissolved gas (% of saturation) exceedance frequency during generation.
Figure 3-7 LLTR dissolved oxygen concentration (mg/L) and percent of saturation and operations.

LIST OF APPENDICES

Appendix A Data Quality Analysis
Appendix B Consultation Record

LIST OF ACRONYMS AND ABBREVIATIONS

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

1.0 INTRODUCTION

1.1 Background

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

Avista and the Spokane Tribe of Indians (Spokane Tribe) entered into a non-License Agreement, which addresses DO (and other water quality issues) on the Spokane Tribe's reservation. This Agreement commits Avista to "work collaboratively [with the Spokane Tribe] to develop and carry out feasibility studies and implementation actions pertaining to the goal of meeting the DO, TDG (total dissolved gas), and Temperature requirements at the Reservation boundary."

License Article 401, Appendix B, Condition 5.6(B) of the Washington Section 401 water quality certification (Ecology 2010a) required that Avista "*submit to Ecology a Detailed Phase II Feasibility and Implementation Plan based on the Long Lake HED DO Aeration Study within one year of license issuance (by June 17, 2010), choosing one or several options to implement. The plan shall contain:*

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

Avista submitted the Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan to Washington State Department of Ecology (Ecology) as directed, and Ecology approved it on June 11, 2010 (Avista 2010). Shortly thereafter, DO enhancement testing and monitoring was conducted (HDR and REMI 2010). On December 9, 2010, the Federal Energy Regulatory Commission (FERC; 2010) modified and approved the Feasibility and Implementation Plan. Avista's implementation of the FERC-approved Feasibility and Implementation Plan is documented in the 2011, 2012, and 2013 annual reports (Golder 2012, 2013, and 2014 respectively). Avista's 2014 annual report (Golder 2015) documented 2014 DO conditions along with the Five-Year summary report required under the FERC approved Feasibility and Implementation Plan, which were submitted to Ecology, the Spokane Tribe, and FERC.

Avista has continued to implement this DO enhancement strategy, which includes documenting the 2015 through 2021 actions in an annual report (Golder and Mattax Solutions 2016, Golder and Mattax Solutions 2017, Avista 2018, 2019, 2020, 2021, and 2022a respectively). The 2016 annual report (Golder and Mattax Solutions 2017) presented the results of the 2016 DO conditions along with an analysis of the monitoring results from the past seven years (2010 through 2016). This current report presents the results of the 2022 DO monitoring immediately downstream of Long Lake Dam for the year's low-flow period and summarizes the use of draft tube aeration to boost DO levels in the river below the dam's tailrace. Additionally, a summary of the 2022 data quality is provided in Appendix A and a record of consultation with Ecology and the Spokane Tribe is provided in Appendix B.

1.2 Objectives

The objectives of the DO monitoring plan (Avista 2010) are to:

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.

2.0 METHODS

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

2.1 Equipment and Calibration

Solinst® barologgers were used to determine local barometric pressure. A primary barologger was deployed at the Long Lake HED pump house for the entire monitoring season. A back-up barologger was also deployed at the pump house for the entire monitoring season to provide local barometric pressure (BAR) data if the primary barologger failed. As an additional quality assurance measure, resulting site-specific barometric pressures were compared to corresponding values for the Spokane International Airport for each site visit. Spokane International Airport station sea-level barometric pressures were downloaded from the Weather Underground[1] and adjusted by subtracting 37.05 mm Hg to account for the altitude of the Long Lake HED tailrace (1,365 feet above mean sea level [ft ams]).

Hydrolab® MS5 Multiprobe® (MS5) instruments with TDG, optical DO, temperature, and depth sensors were used. A MS5 connected to an external alternating current (AC) power source was used upon initial deployment with the goal of minimizing potential issues associated with low or no power supply. In addition, a second MS5 powered solely on internal batteries was deployed

[1]On each site visit day, Spokane, WA KGEG barometric pressure data were downloaded from the History section of: Spokane, WA Weather History | Weather Underground (wunderground.com).

for long-term monitoring and was paired with the AC-powered MS5 to obtain spot measurements of DO, TDG pressure, and temperature.

All Hach instruments used had undergone annual servicing by Hach and were factory calibrated before the 2022 monitoring season. Monitoring equipment was calibrated according to the manufacturer's instructions prior to deployment and on periodic site visits. Pre-deployment field verification included synchronizing the clocks, comparing each MS5's TDG pressure value with the silastic membrane removed to the ambient barometric pressure, confirming the patency of each MS5's TDG silastic membrane, and testing the barologgers to confirm that the recorded values were similar and comparable to those at the Spokane International Airport.

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

2.2 Station Facilities

For this monitoring, MS5 long-term deployments were done at a water quality monitoring facility located 0.6 mile downstream of Long Lake Dam, referred to as LLTR (Table 2-1; Figure 2-1). In agreement with Ecology, the water quality monitoring facilities in the Long Lake HED forebay, referred to as LLFB, was not used in 2022, since water quality conditions at LLTR, not LLFB, are used to refine aeration operations at the Long Lake HED powerplant.

The permanent station at LLTR consisted of a 4-inch-diameter pipe stilling-well (standpipe), which was sealed at the pipe's submerged end to prevent the MS5 from falling out of the pipe. The 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. The standpipe's top end is protected by an enclosed box containing AC power and data communication equipment.

During periods of low tailrace water elevations, the MS5 was removed from the permanent stilling well, placed inside a perforated PVC pipe, and placed directly on the streambed, as near to the outlet of the permanent station's stilling well as possible to ensure the MS5 was consistently under water.

In 2012, Avista installed a real-time data system to transmit MS5 water quality measurements from the LLTR long-term monitoring stations to the HED control room in the powerhouse. A coordinated team of Avista staff, including the HED Operators and water resource specialists, used LLTR's real-time DO and TDG pressure values to select aeration valve openings for each Unit with the goal of meeting the 8-mg/L DO criterion at LLTR without exceeding the 110-percent of saturation TDG criterion.

2.3 Spot Measurements

As a quality assurance measure, spot measurements of DO, TDG pressure, and water temperature were made continuously throughout the sampling season by pairing a secondary MS5 with the primary MS5. The river is generally well mixed at LLTR, as was determined in 2011 based on paired spot measurements of water temperature, DO, and the percent TDG, for both sides of the river (Golder 2012). Therefore, no spot measurements were conducted across the river during the 2022 monitoring season.

2.4 Data Collection and Processing

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

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

In addition, percent of saturation for TDG was computed based on measurements, as:

- TDG = TDG in mm Hg / Barometric pressure in mm Hg x 100

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

Long Lake Dam's operations are monitored and recorded by Avista's internal plant control software which were used to output aeration operations, river discharge passing over the dam's spillway, the discharge passing through the dams units, and a total discharge on a 15 minute basis for the extent of the DO monitoring period.

2.5 Monitoring Difficulties

Very few monitoring difficulties were encountered in 2022.

The DO monitoring plan (Avista 2010) calls for a mass field verification of the MS5s before initial deployment for DO monitoring begins on July 1. Due to spill occurring up until the end of June and staff availability in early July, mass verification of the MS5s didn't occur until July 14.

No other difficulties were encountered. All MS5s met data quality objectives (DQOs) and measurement quality objectives (MQOs) and were sent in for factory maintenance after the monitoring season.

3.0 RESULTS

MS5s and barologgers were set to record data for approximately 11,808 15-minute periods (referred to as "continuous" data in this report) from July 1 through October 31 (Table 3-1). Two barologgers deployed at LLTR provided a complete (100 percent of the entire continuous monitoring period) data set for local barometric pressure. All parameters were recorded for 99% of the monitoring period or greater (Appendix A, Table A-4). Spot measurements collected when long-term deployment and/or instrument downloads were conducted[2], were used for the quality assurance/quality control program described in Appendix A.

3.1 Discharge

Combined Long Lake HED generation, spill discharge, and seepage for the July 1 to October 31 monitoring period ranged from approximately 210 to 6,659 cubic feet per second (cfs) (Table 3-2). The maximum discharge occurred in July, when discharge reached 6,659 cfs. Maximum discharge was 4,769 cfs, 4,769 cfs, and 5,186 cfs in August, September, and October, respectively. Average discharge was greatest (3,892 cfs) in July, least (1,692 cfs) in September, and intermediate in August and October (1,699 and 2,615 cfs, respectively).

3.2 Water Temperature

Tailrace (LLTR) water temperature ranged from 12.5°C to 20.8°C during the monitoring season with the maximum temperature of 20.8°C occurring on July 31 (Table 3-1; Figure 3-1). Water temperatures began cooling around late August and steadily cooled to below 13°C at the end of October (Figure 3-1).

3.3 Barometric Pressure

Site-specific barometric pressures ranged from 712 to 733 mm Hg based on the Solonist® barologgers deployed at LLTR (Table 3-1).

3.4 Dissolved Oxygen

LLTR DO concentrations (recorded during generation and non-generation) ranged from 6.1 to 10.9 mg/L with the greatest consistent DO concentrations near the beginning of the monitoring period (Figure 3-1). Dissolved oxygen initially decreased to below 8.0 mg/L on July 23 and consistently fell below 8.0 mg/L through mid-October (Figure 3-1). Aeration was used for a short duration on July 1 and then consistently from July 22 through October 27. Figures 3-2 through 3-5 display DO and TDG trends along with aeration operations throughout the progression of the low flow season. These figures show that the daily DO cycle at LLTR peaked in the early afternoon and was lowest in the morning, coinciding with the HED generating schedule. Additional information on the HED's operations, use of spillgates, aeration operation, and the corresponding frequency of LLTR DO values less than 8.0 mg/L are presented in Table 3-3.

During periods of generation, DO values at LLTR were less than the 8.0-mg/L criterion 27.1 percent of the time during the DO monitoring season (Table 3-3 and 3-4). DO concentrations

[2] This occurred on June 28, July 14, July 28, August 9, August 26, September 8, September 15, October 4, October 18, and October 31.

remained above 8.0 mg/L in early July and late October. Of the DO measurements below 8.0 mg/L, 27 percent were within 0.2 mg/L of 8.0 mg/L (i.e. 7.8 and 7.9 mg/L, Figure 3-6) with the minimum DO of 6.2 mg/L occurring in the first half of September (Table 3-4). The 2022 aeration operations are summarized in Section 3.6.

DO and other water quality parameters monitored at LLTR when neither generation nor aeration occurred are summarized in Table 3-5. LLTR's minimum DO concentration for non-generation periods was 6.1 mg/L, which occurred in the last two weeks of August. Non-generation DO values for LLTR were less than the 8.0-mg/L DO criterion for 67.6 percent of the measured values (Table 3-5). Non-generation DO concentrations of less than 8.0 mg/L occurred at less than 1% of the time in the last two weeks of the monitoring season, but occurred throughout the rest of the monitoring season during non-generation (Table 3-5). These low DO concentrations were within 0.2 mg/L of 8.0 mg/L (i.e. 7.8 and 7.9 mg/L) 14 percent of the time.

Table 3-6 includes a summary of DO values for the entire July 1 through October 31 monitoring season. The frequency for DO less than 8.0 mg/L was greater during non-generation times than when the HED was generating.

DO% saturation values ranged from approximately 68.1 to 118.9 percent for LLTR (Table 3-1, Figure 3-7). DO% saturation for LLTR ranged from 68.1 to 118.9 percent during periods of generation (Table 3-4) and from 69.7 to 103.2 percent during non-generation (Table 3-5).

3.5 Total Dissolved Gas

The range of TDG percent from July 1 to October 31 was 95.6 to 117.4 percent of saturation for LLTR (Table 3-1). Percent TDG reached the maximum TDG value and was greater than the 110% criterion from July 1 to July 10, when Long Lake HED operations were periodically spilling and not associated with aeration operations (Table 3-7). TDG% associated with spill is discussed in the 2022 Long Lake TDG Monitoring Report (Avista 2023). The maximum TDG percent encountered while Long Lake HED was following aeration operations was 111.9 percent.

Long Lake HED discharges monitored at LLTR were greater than the 110 percent criterion for 1,162 (16.5 percent) of the 7,032 values during generation without spill (Table 3-7, Figure 3-6). Tables 3-3 and 3-4 provide additional insight into the HED operations coinciding with these TDG values over 110%. TDG% was also greater than the 110 percent of saturation criterion during early July when spill occurred at Long Lake Dam, although these elevated values were not associated with aeration operations. Exceedances of the 110 percent of saturation criterion occurred a few times in late July and then more consistently in August through mid-September (Figures 3-3 and 3-4). TDG was also greater than the 110 percent of saturation criterion during non-generation in this period with an overall frequency of 3.3 percent of the monitoring season (Table 3-7).

3.6 Aeration

Dissolved oxygen levels were monitored from July 1 through October 31, 2022. Avista operated the HED at varying capacities throughout this period with spill occurring in the early part of July. Aeration was used for a short time on July 1, then consistently from July 22 through

October 27, using different aeration valve openings for Units 1, 2, 3, and 4. Aeration was conducted for a total of 2,705 unit-hours with 23 hours for a single unit, 1,107 hours for two units simultaneously, 156 hours for three units simultaneously, and 0 unit-hours for four units simultaneously.[3] The various generating and aeration conditions along with comparisons of DO and TDG during generation, as measured at LLTR to their applicable criteria, are summarized below and in Tables 3-3 and 3-4.

Key conclusions for the 2022 monitoring period, presented by month, are:

- **July**: Spilling occurred from July 1 to July 17 and generation was continuous during this time. Aeration was conducted on July 1 and then not again until July 22 through the end of the month, with two to three units being used simultaneously, resulting in a total of 404 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 100 percent the first half of the month,98.8 percent in the second half of the month, and 98.4% for the entire month. Aeration operations resulted in elevating TDG to greater than the 110 percent criterion at a frequency of 3.3 percent for the month once aeration started, with a maximum TDG of 111.6 percent of saturation.
- **August**: Aeration was used continuously during generation for the entire month of August, with one to three units being used simultaneously, resulting in a total of 758 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 47.3 percent the first half of the month, 1.1 percent in the second half of the month, and 26.6% for the entire month. These operations also resulted in elevating TDG to greater than the 110 percent criterion at a frequency of 25.2 percent in the first half of the month,18.2 percent in the second half of the month, and 22% for the entire month, with a maximum TDG of 111.9 percent of saturation.
- **September**: Aeration was conducted daily in September with two to three units simultaneously, for a total of 725 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 0.0 percent in the first half of the month,58.7 percent in the second half of the month, and 32.3% for the entire month. These operations also resulted in elevating TDG to greater than the 110 percent criterion in the first half of the month at a frequency of 20.3 percent, 18.3 percent in the second half of the month, and 19.2% for the entire month, with a maximum TDG of 111.3 percent of saturation.
- **October**: Aeration was conducted through October 27 with one to three units being used simultaneously, for a total of 814 unit-hours of aeration. These operations resulted in DO meeting the 8.0-mg/L criterion at a frequency of 94.6 percent in the first half of the month, 99.9 percent in the second half of the month, and 97.4% for the entire month, TDG was not greater than the 110 percent criterion in October.

From July 1 through October 31 of 2022, daily aeration enabled DO in powerhouse discharges to meet the 8.0-mg/L DO criterion approximately 72.9 percent of the time (Table 3-4) and to be

[3] 2,705 unit-hours = (1 unit x 23 hours) + (2 units x 1,107 hours) + (3 units x 156 hours)

within 0.2 mg/L (i.e., 7.8 mg/L or greater) 80.2 percent of the time (Figure 3-6). Aeration operations maintained TDG that was less than the upper limit of 110 percent of saturation criterion 87.9 percent of the time (Table 3-4). Avista will continue to refine the use of real-time DO and TDG pressure measurements for selecting aeration valve openings, with the goal of providing additional improvements in DO while limiting adverse TDG conditions.

4.0 DISCUSSION

Avista continues to refine its efforts towards addressing low DO concentrations in Long Lake HED discharges. The 2022 percentage of DO concentration values greater than or equal to 8.0 mg/L represent 72.9 percent of the entire generation period and 59.0 percent of the entire monitoring period (both generation and non-generation; Table 4-1). Including the entire July 1 to October 31 monitoring period, percent TDG was below the 110 percent criterion 81.0 percent of the season during generation and 86.4 percent (including both generation and non-generation; Table 4-1). When Long Lake HED was following aeration operation (post-July 17 at 21:15), percent TDG was below the 110 percent criterion 89.6 percent of the season during generation and 92.4 percent of the monitoring period. With these results, Avista plans to continue draft tube aeration operations with adaptive management to improve the effectiveness, using real-time water quality monitoring results.

Avista and others have also implemented measures to improve DO upstream of Long Lake dam. This includes upstream wastewater dischargers working to reduce their point source nutrient loads as well as efforts by Ecology and local conservation districts to reduce nutrient loads from non-point sources (e.g. tributaries and groundwater) in both Washington and Idaho in order to meet the goal of the Spokane River and Lake Spokane DO Total Maximum Daily Load (Ecology 2010b). Additionally, Avista has been implementing its Lake Spokane DO Water Quality Attainment Plan (DO WQAP, Avista and Golder 2012) since 2012 with implementation activities completed summarized in the Lake Spokane DO WQAP Ten Year Report (Avista 2022b).

Avista is currently working with Ecology and the Spokane Tribe to determine future implementation measures that will improve both DO and temperature conditions upstream of Long Lake Dam and anticipates operating under a new compliance schedule for the Lake Spokane Temperature and Dissolved Oxygen Attainment Plans (WQAP) which are currently being developed and discussed. The new schedules will include improvement measures and ensure a biological protective balance upstream and downstream of Long Lake Dam. Improvements made upstream will seek to reduce temperatures and the need for aeration for depleted DO to the downstream tailrace waters.

Based on the effectiveness of the draft tube aeration program, combined with other measures being implemented to improve DO in Lake Spokane, along with the development of new Temperature and DO WQAPs no new or additional enhancement measures are proposed for Long Lake Tailrace waters in 2023.

4.1 Need for Additional Monitoring

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

Avista will continue to monitor DO and TDG at LLTR and will work with Ecology and the Spokane Tribe to provide annual reports of the aeration, DO and TDG monitoring results following completion of the DO critical season.

5.0 REFERENCES

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

______. 2018. 2017 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. Washington 401 Certification, Section 5.6(B). Spokane River Hydroelectric Project FERC Project No. 2545. April 13.

______. 2019. 2018 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. Washington 401 Certification, Section 5.6(B). Spokane River Hydroelectric Project FERC Project No. 2545. April 12.

______. 2020. 2019 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. Washington 401 Certification, Section 5.6(B). Spokane River Hydroelectric Project FERC Project No. 2545. April 14.

______. 2021. 2020 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. Washington 401 Certification, Section 5.6(B). Spokane River Hydroelectric Project FERC Project No. 2545. April 15.

______. 2022a. 2021 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report. Washington 401 Certification, Section 5.6(B). Spokane River Hydroelectric Project FERC Project No. 2545. April 14.

______. 2022b. Lake Spokane Dissolved Oxygen Water Quality Attainment Plan Ten Year Report. Washington 401 Certification, Section 5.6. Spokane River Hydroelectric Project FERC Project No. 2545. February 1.

______. 2023. 2022 Draft Long Lake Dam Total Dissolved Gas Oxygen Monitoring Report. Washington 401 Certification, Section 5.4(D). Spokane River Hydroelectric Project FERC Project No. 2545. March.

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

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

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

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

______. 2015. Five-Year Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. April 14.

Golder Associates Inc. and Mattax Solutions LLC (Golder and Mattax Solutions). 2016. 2015 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. April 11.

______. 2017. 2016 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report, Washington 401 Certification, Section 5.6(B). Prepared for Avista Corporation. April 12.

Avista and Golder Associates Inc. 2012. Lake Spokane Dissolved Oxygen Water Quality Attainment Plan, Washington 401 Certification, Section 5.6. Spokane River Hydroelectric Project FERC Project No. 2545. October 5.

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

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

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

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

Washington State Department of Ecology (Ecology). 2010b. Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load, Water Quality Improvement Report. Publication No. 07-10-073. Revised February 2010.

TABLES

Table 2-1. Long Lake HED dissolved oxygen monitoring station.

Station Code	Description	Latitude / Longitude (NAD83)	Monitoring Type
LLTR	On left downstream bank, at a water pump house approximately 0.6 mile downstream from Long Lake dam	47°37'48"/ 117°31'47"	Long-term

Table 3-1. Summary of 2022 continuous water quality monitoring results.

Parameter	LLTR		
	Minimum	Maximum	Count
Date/Time (PDT)	7/1/2022 0:00	10/31/2022 23:45	11,808
Water Temperature (°C)	12.5	20.8	11,776
Dissolved Oxygen (mg/L)	6.1	10.9	11,776
BAR (mm Hg)	712	733	11,808
TDG (mm Hg)	690	850	11,726
TDG (% of saturation)	95.6	117.4	11,726
Dissolved Oxygen (% of saturation)	68.1	118.9	11,776

Table 3-2. Monthly outflow from Long Lake HED.

Month - Year	Minimum Discharge (cfs)	Maximum Discharge (cfs)	Average Discharge (cfs)
July 2022	210	6,659	3,892
August 2022	210	4,769	1,699
September 2022	210	4,769	1,692
October 2022	210	5,186	2,615
July through October 2022	210	6,659	2,478

Table 3-3. Summary of exceedances of dissolved oxygen and total dissolved gas at LLTR during generation.

Period		Operations, Spill, and Aeration Characteristics			LLTR DO					LLTR TDG			
Start	Stop	Operations	Spill	Aeration	Total Number	Number DO <8.0 mg/L	Frequency DO <8.0 mg/L	Min DO (mg/L)	Min DO (%)	Total Number	Number >110.0%[1]	Frequency >110.0%[1]	Max TDG (%)
7/1/22 0:00	7/10/22 23:45	2 to 4 units, capacity varies, generation during portion of the day	0 to 2,582 cfs	3 units used on 7/1	960	0	0.0%	9.3	102.7	960	820	85.4%	117.4
7/11/22 0:00	7/22/22 1:30	2 to 3 units, capacity varies, generation during portion of the day	No	No units used	1,026	0	0.0%	8.0	90.4	1,023	0	0.0%	109.8
7/22/22 1:45	7/28/22 14:00	2 to 3 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	533	6	1.1%	7.7	87.7	531	9	1.7%	111.6
7/28/22 14:15	7/29/22 21:00	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	104	9	8.7%	7.8	89.0	104	12	11.5%	110.2
7/29/22 21:15	8/3/22 18:45	2 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	294	7	2.4%	7.7	87.1	294	26	8.8%	110.5
8/3/22 19:00	8/8/22 7:45	2 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	210	54	25.7%	7.0	80.2	210	28	13.3%	111.9
8/8/22 8:00	8/8/22 8:15	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	2	2	100.0%	7.6	86.3	2	0	0.0%	107.3
8/8/22 8:30	8/21/22 14:45	1 to 2 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	657	598	91.0%	6.6	75.5	654	213	32.6%	111.9
8/21/22 15:00	8/21/22 15:15	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	2	2	100.0%	7.9	90.5	2	2	100.0%	110.5
8/21/22 15:15	8/24/22 13:45	2 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	131	128	97.7%	6.6	75.2	131	13	9.9%	111.4
8/24/22 14:00	9/1/22 14:45	1 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	304	300	98.7%	6.4	74.1	304	66	21.7%	111.3
9/1/22 15:00	9/6/22 21:45	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	178	178	100.0%	6.4	72.4	178	0	0.0%	109.5
9/6/22 22:00	9/20/22 12:45	1 to 3 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	658	655	99.5%	6.2	68.1	653	244	37.4%	111.3
9/20/22 13:00	9/26/22 16:45	2 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	302	39	12.9%	7.4	79.7	300	11	3.7%	110.6
9/26/22 16:45	9/27/22 21:45	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	77	4	5.2%	7.7	82.9	77	8	10.4%	110.1
9/27/22 22:00	10/3/22 14:45	2 to 3 units, capacity varies, generation during portion of the day	No	2 units used sometime each day	297	53	17.8%	7.3	79.2	297	0	0.0%	109.4
10/3/22 15:00	10/5/22 21:00	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	122	6	4.9%	7.7	81.5	111	0	0.0%	108.5
10/4/22 20:15	10/21/22 6:00	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	1,028	41	4.0%	7.6	79.7	1,008	0	0.0%	106.6
10/21/22 6:15	10/31/22 23:45	2 to 3 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	842	0	0.0%	8.1	79.7	842	0	0.0%	100.8
7/1/22 0:00	10/31/22 23:45	1 to 4 units, capacity varies, generation during portion of the day	No	3 units used sometime each day	7,673	2,078	27.1%	6.2	68.1	7,627	1,451	19.0%	117.4

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

Table 3-4. Semi-monthly summary of water quality and operations 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	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <90.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0%[1]
7/1/22 0:00	7/15/22 23:45	354	115	4,894	11	1,403	17.7	1,403	8.8	0.0%	1,403	98.7	118.9	0.0%	1,400	117.4	58.6%
7/16/22 0:00	7/31/22 23:45	336	17	3,343	393	1,338	19.1	1,338	7.7	1.2%	1,338	87.7	103.6	0.8%	1,336	111.6	3.3%
8/1/22 0:00	8/15/22 23:45	204	0	3,111	415	814	19.6	814	6.9	52.7%	814	78.8	100.0	38.3%	811	111.9	25.2%
8/16/22 0:00	8/31/22 23:45	165	0	3,194	344	659	19.5	659	6.4	98.9%	659	74.1	92.7	93.9%	659	111.4	18.2%
9/1/22 0:00	9/15/22 23:45	156	0	3,313	337	619	18.4	619	6.2	100.0%	619	68.1	85.8	100.0%	615	111.1	20.3%
9/16/22 0:00	9/30/22 23:45	190	0	3,158	389	756	17.3	756	6.4	41.3%	756	70.3	97.4	68.7%	753	111.3	18.3%
10/1/22 0:00	10/15/22 23:45	227	0	3,492	511	903	16.1	903	7.6	5.4%	903	79.9	96.9	84.4%	892	109.4	0.0%
10/16/22 0:00	10/31/22 23:45	296	0	3,652	305	1,181	14.1	1,181	7.8	0.1%	1,181	79.7	93.4	98.4%	1,161	103.8	0.0%
7/1/22 0:00	10/31/22 23:45	1,926	132	3,631	2,703	7,673	17.6	7,673	6.2	27.1%	7,673	68.1	118.9	52.2%	7,627	117.4	19.0%

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

Table 3-5. Semi-monthly summary of water quality and operations during non-generation.

Period		HED Operations				LLTR Water Temperature		LLTR DO			LLTR DO%				LLTR TDG%		
Start	Stop	Non-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	Min DO (mg/L)	Frequency <8.0 mg/L	Total Number 15-Min Values	Min DO%	Max DO%	Frequency <90.0%	Total Number 15-Min Values	Max TDG%	Frequency >110.0%[1]
7/1/22 0:00	7/15/22 23:45	0	0	#N/A	0	0	#N/A	0	#N/A	#N/A	0	#N/A	#N/A	#N/A	0	#N/A	#N/A
7/16/22 0:00	7/31/22 23:45	48	0	210	0	194	19.3	194	7.7	32.0%	194	86.7	103.2	26.8%	194	110.4	1.0%
8/1/22 0:00	8/15/22 23:45	155	0	210	0	622	19.4	622	6.6	90.0%	622	75.0	96.1	83.1%	622	111.2	1.8%
8/16/22 0:00	8/31/22 23:45	219	0	210	0	874	19.3	874	6.1	99.9%	874	70.0	94.5	99.9%	871	110.8	1.7%
9/1/22 0:00	9/15/22 23:45	204	0	210	0	818	18.4	818	6.3	100.0%	818	69.7	83.4	100.0%	818	110.7	4.5%
9/16/22 0:00	9/30/22 23:45	170	0	210	0	681	17.3	681	6.8	51.7%	681	74.4	96.5	86.0%	681	111.6	10.4%
10/1/22 0:00	10/15/22 23:45	131	0	210	0	524	16.1	524	7.4	15.3%	524	78.5	90.7	97.3%	524	109.3	0.0%
10/16/22 0:00	10/31/22 23:45	88	0	210	0	353	14.3	353	7.9	0.8%	353	78.4	88.4	100.0%	353	103.1	0.0%
7/1/22 0:00	10/31/22 23:45	1,017	0	210	0	4,066	17.9	4,066	6.1	67.6%	4,066	69.7	103.2	91.2%	4,063	111.6	3.3%

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

Table 3-6. Summary of dissolved oxygen less than 8.0 mg/L, dissolved oxygen criterion lower limit.

Parameter	LLTR Total Number	LLTR Number <8.0 mg/L DO	LLTR Frequency <8.0 mg/L DO
Generation With Spill > 200 cfs	517	0	0.0%
Generation With Spill ≤ 200 cfs	3	0	0.0%
Generation Without Spill [1]	7,154	2,078	29.0%
All Generation [1]	7,673	2,078	27.1%
Non-Generation [2]	4,066	2,748	67.6%
All	11,776	4,826	41.0%

Notes:

1. Of the 7,673 measurements, 1,518 (19.8%) were less than 7.8 mg/L.
2. Of the 4,066 measurements, 2,372 (58.3%) were less than 7.8 mg/L.

Table 3-7. Summary of total dissolved gas (%) greater than 110.0%, the total dissolved gas criterion upper limit.

Parameter	LLTR		
	Total Number	Number >110% TDG [2]	Frequency >110% TDG
Generation With Spill > 200 cfs [1]	514	281	54.7%
Generation With Spill <200cfs	3	0	0.0%
Generation Without Spill	7,110	1,170	16.5%
All Generation [2]	7,627	1,451	19.0%
Non-Generation [3]	4,063	136	3.3%
All	11,690	1,587	13.6%

Notes:

1. 110% TDG criterion is not applicable when discharge exceeds the 7-day average flow with a 10-year return period, which is referred to as the 7Q10.
2. Of the 7,627 measurements, 593 (7.8%) were greater than 112%.
3. Of the 4,063 measurements, 0 (0.0%) were greater than 112%.

Table 4-1. Aeration operations and frequency of meeting dissolved oxygen and total dissolved gas criteria. 2010 - 2017 data is reported in the 2021 and preceding annual reports.

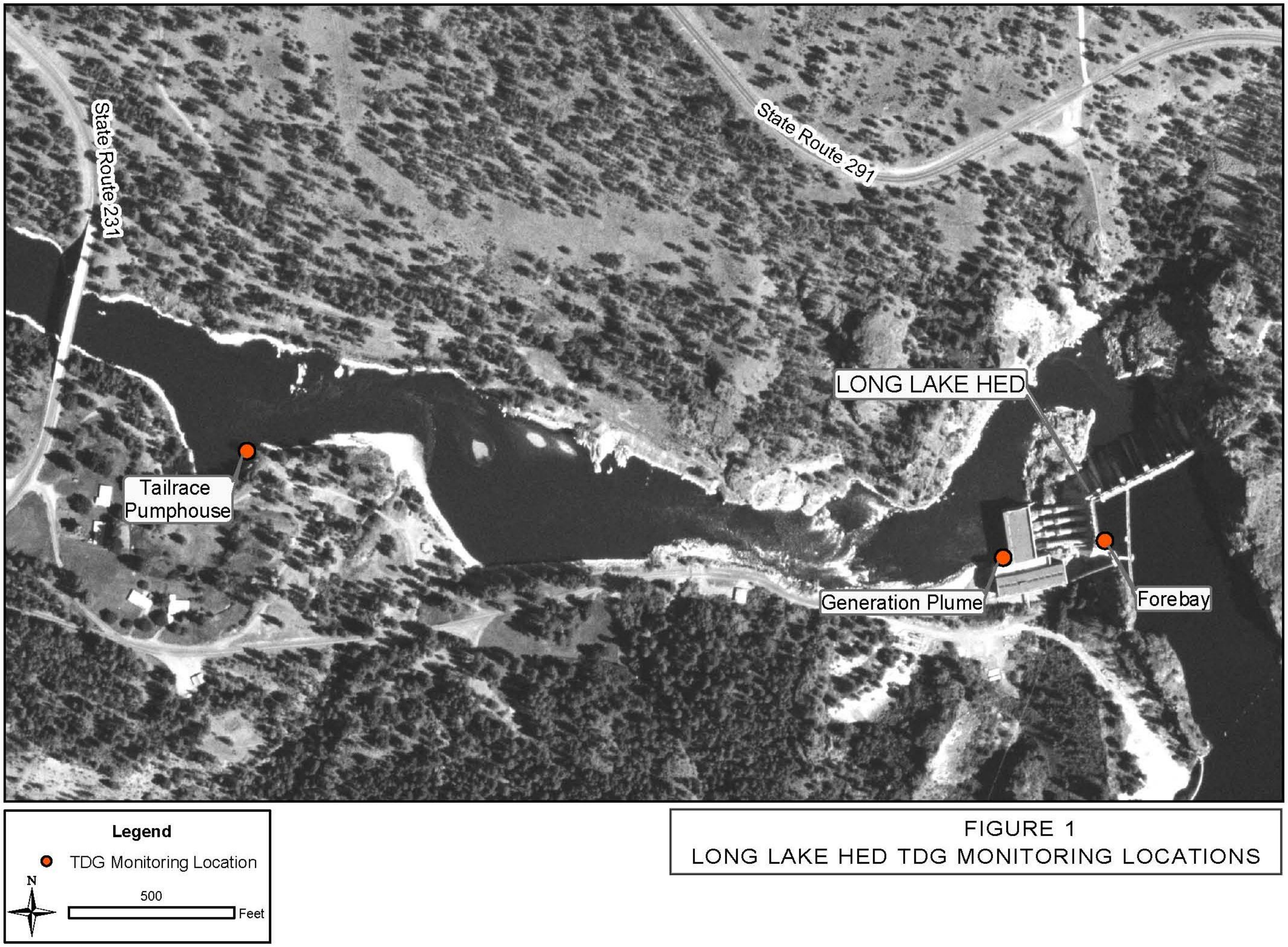
	2018[a]	2019[a]	2020[a]	2021[a]	2022[a]
Long Lake HED Operations					
Average July - October Discharge (cfs)	2,210	1,155	2,188	1,707	2,478
HED Units with Aeration	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 4 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time	Units 1, 2, 3, and 4 with up to 3 units aerating at same time
Aeration start and end dates, respectively	August 1 and October 8	July 2 and October 8	August 8 and October 20	July 17 and October 23	July 1 and October 23
Aeration Hours	1,657 unit-hours within 701 hours	437 unit-hours within 201 hours	1,700 unit-hours within 818 hours	1,750 unit-hours within 883 hours	2,705 unit-hours within 1,286 hours
Frequency LLTR Dissolved Oxygen ≥8.0 mg/L					
During Generation without Spillgate Use	90.8% of 6,231 values	94.4% of 6,198 values	88.8% of 6,519 values	88.3% of 5,516 values	71.0% of 7,157 values
During Generation with Spillgate Use	zero values	zero values	zero values	zero values	100.0% of 517 values
Entire Generation Period	90.8% of 6,231 values	94.4% of 6,198 values	88.8% of 6,519 values	88.3% of 5,516 values	72.9% of 7,673 values
Entire Monitoring Period (Both Generation and non-Generation)	80.8% of 11,762 values	78.6% of 11,410 values	74.7% of 11,776 values	70.7% of 11,630 values	59.0% of 11,776 values
Frequency LLTR TDG% ≤110.0%					
During Generation without Spillgate Use	95.9% of 6,211 values	97.3% of 5,687 values	90.4% of 6,489 values	92.6% of 5,570 values	83.5% of 7,113 values
During Generation with Spillgate Use	zero values	zero values	zero values	zero values	45.3% of 514 values
Entire Generation Period	95.9% of 6,211 values	97.3% of 5,687 values	90.4% of 6,489 values	92.6% of 5,570 values	81.0% of 7,627 values
Entire Monitoring Period (Both Generation and non-Generation)	97.3% of 11,731 values	98.5% of 10,594 values	93.2% of 11,735 values	96.0% of 11,722 values	86.4% of 11,690 values

Notes:

nr = data not analyzed

[a] 2018, 2019, 2020, and 2021 monitoring is documented in Avista (2019, 2020, 2021, and 2022).

FIGURES



Source: Avista

Figure 2-1: Long Lake HED long-term water quality monitoring locations.

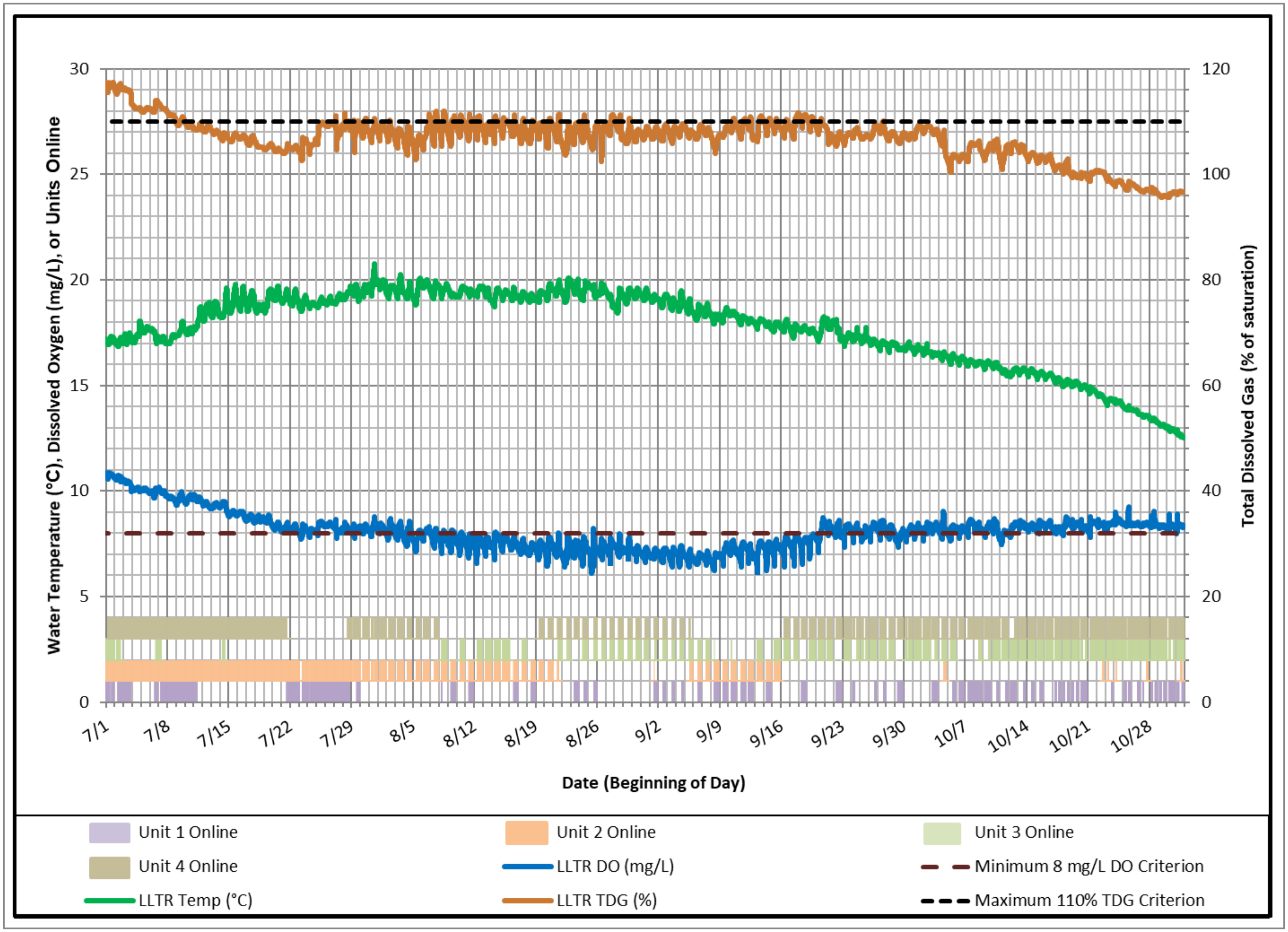


Figure 3-1: LLTR 2022 water temperature (°C), dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations.

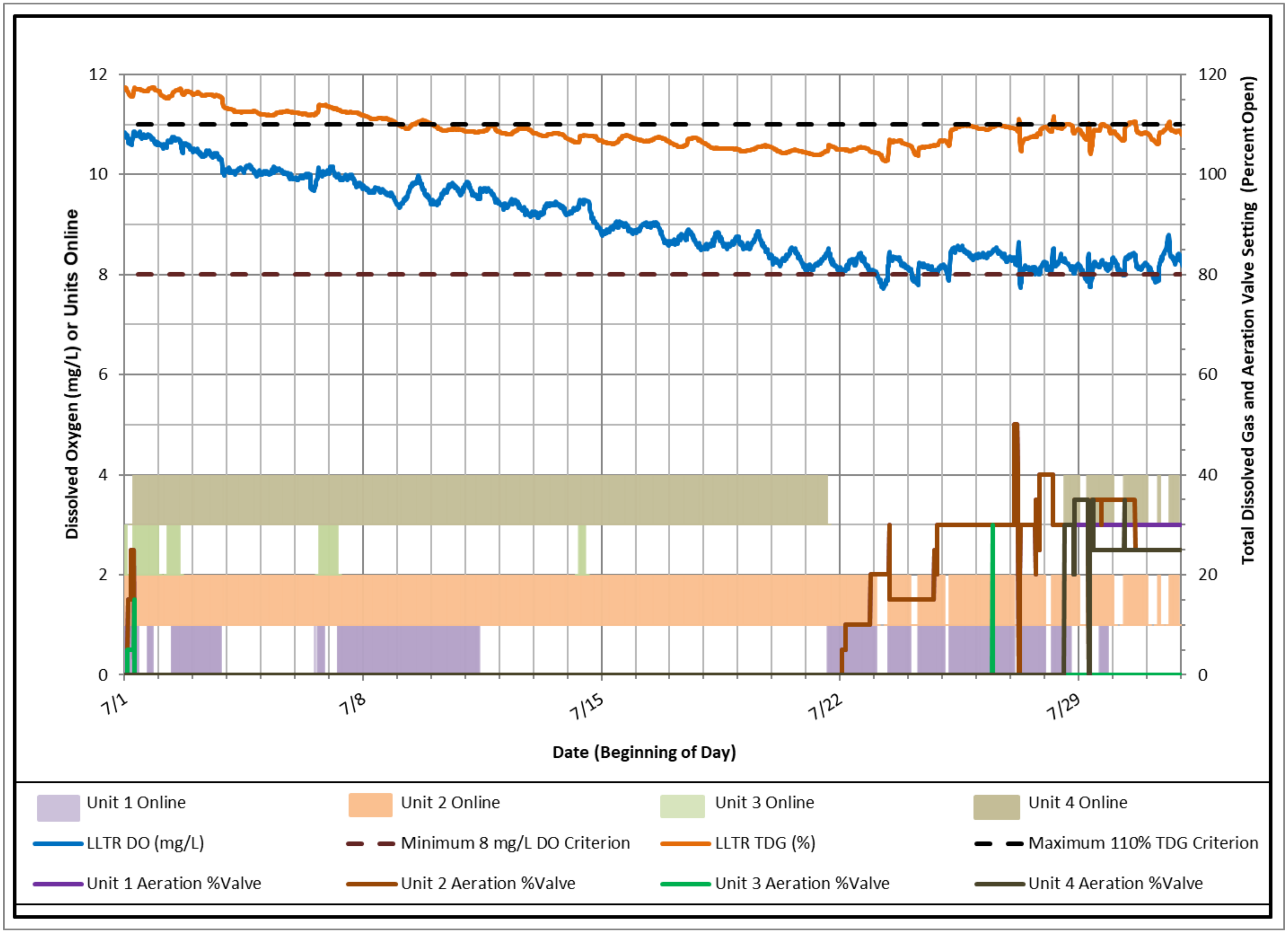


Figure 3-2: LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, July 1 – July 31.

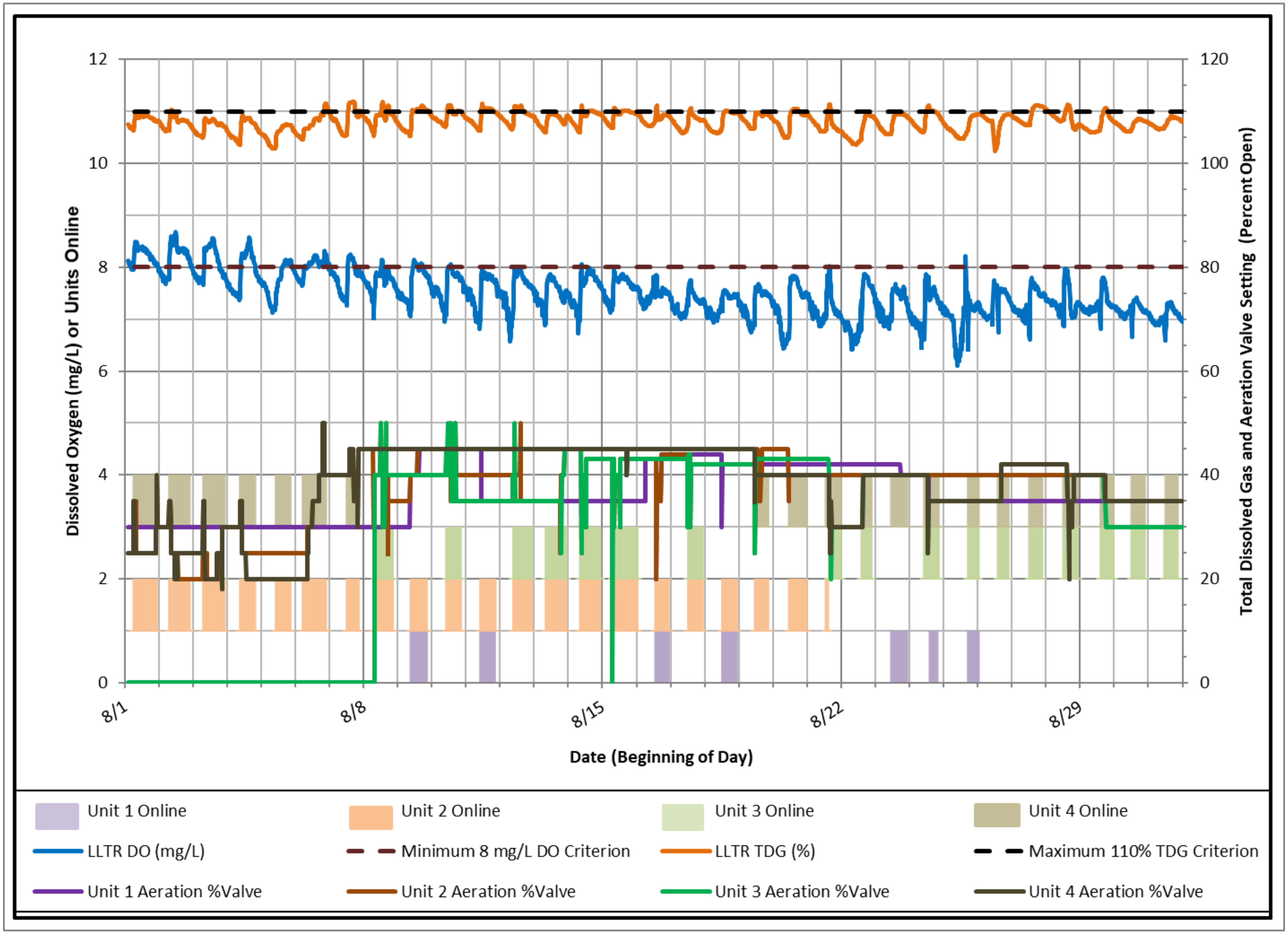


Figure 3-3: LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, August 1 – August 31.

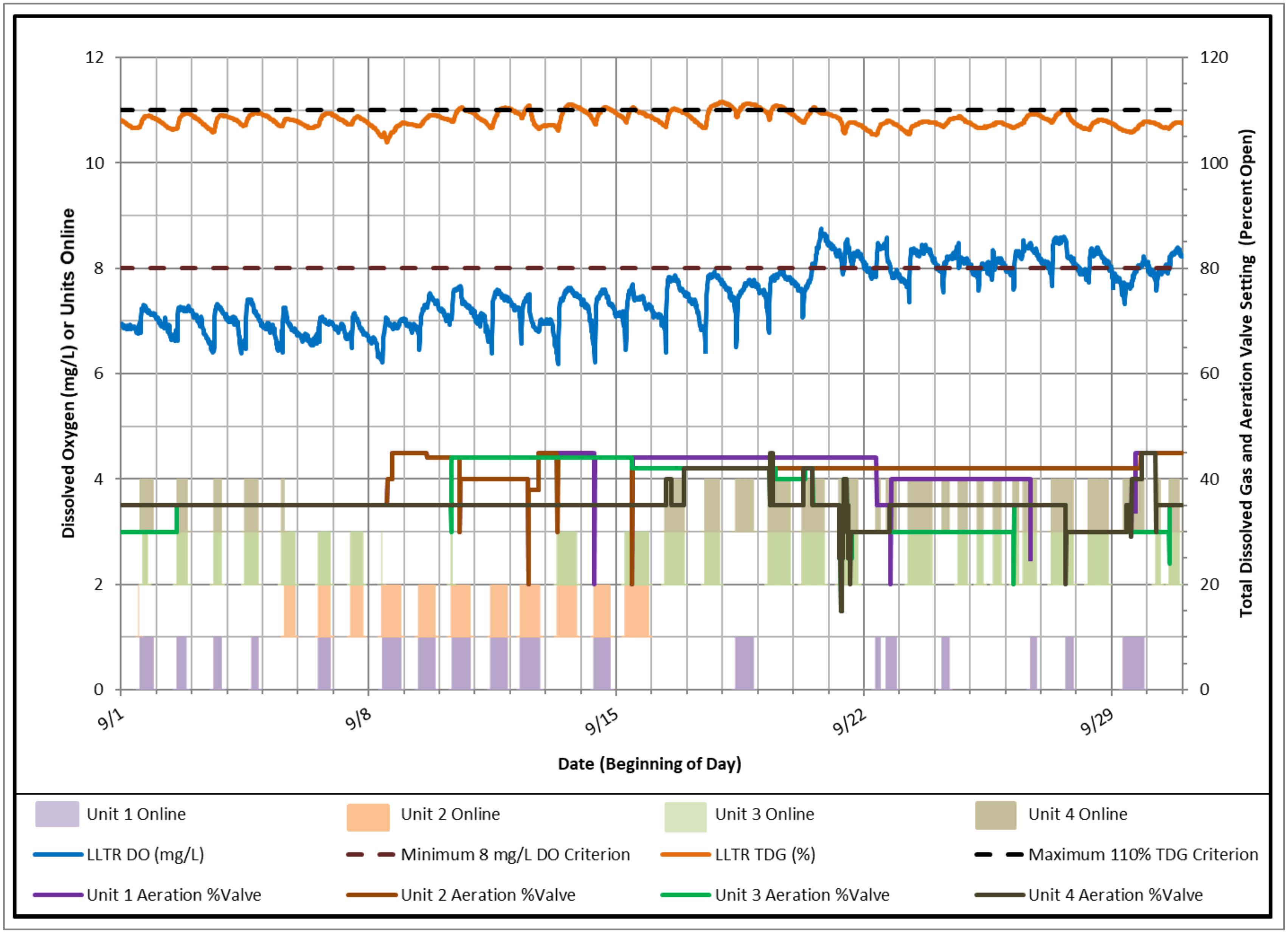


Figure 3-4: LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, September 1 – September 30.

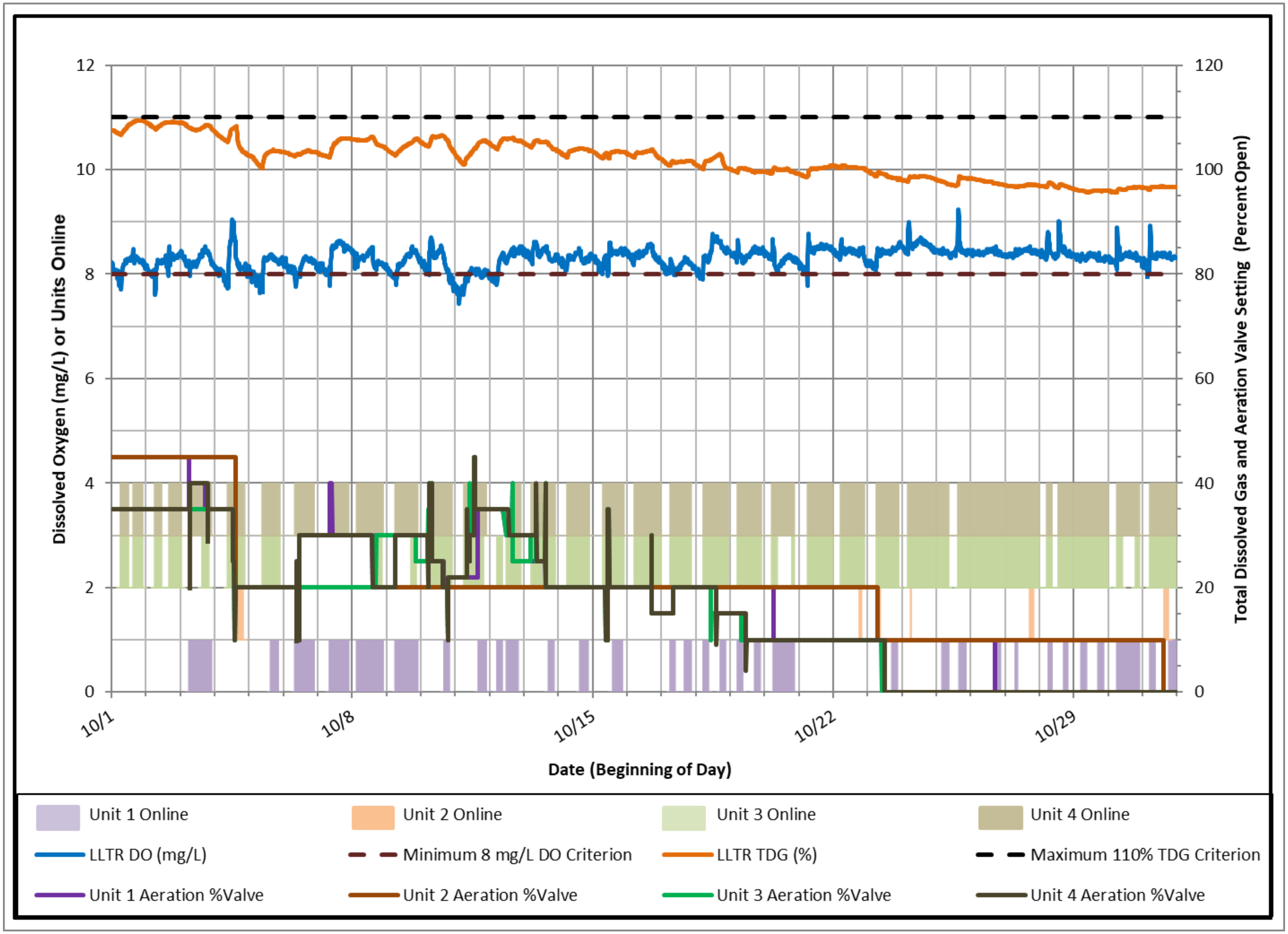


Figure 3-5: LLTR dissolved oxygen (mg/L), total dissolved gas (% of saturation), and operations, October 1 – October 31.

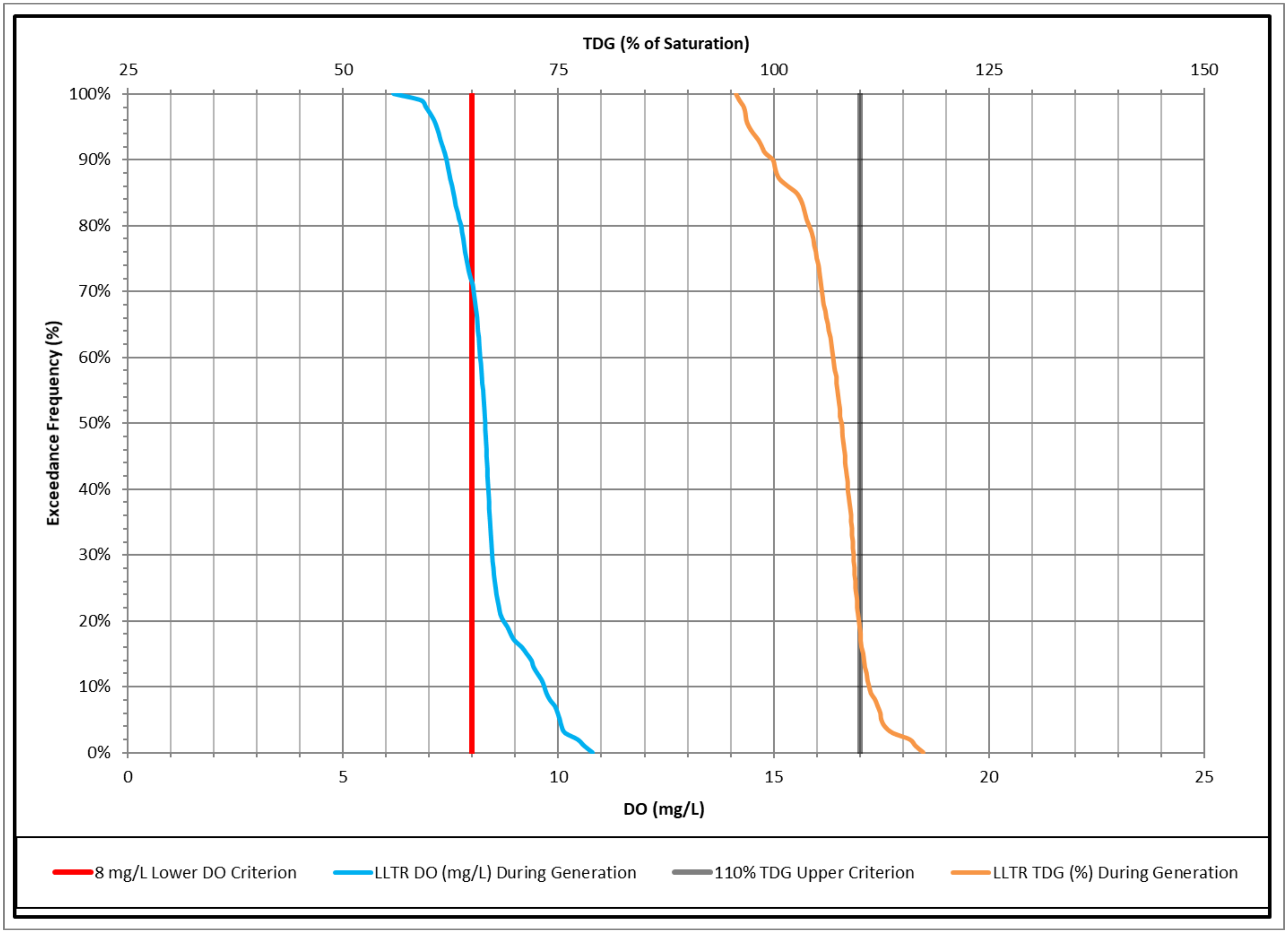


Figure 3-6: LLTR dissolved oxygen (mg/L) concentration and total dissolved gas (% of saturation) exceedance frequency during generation.

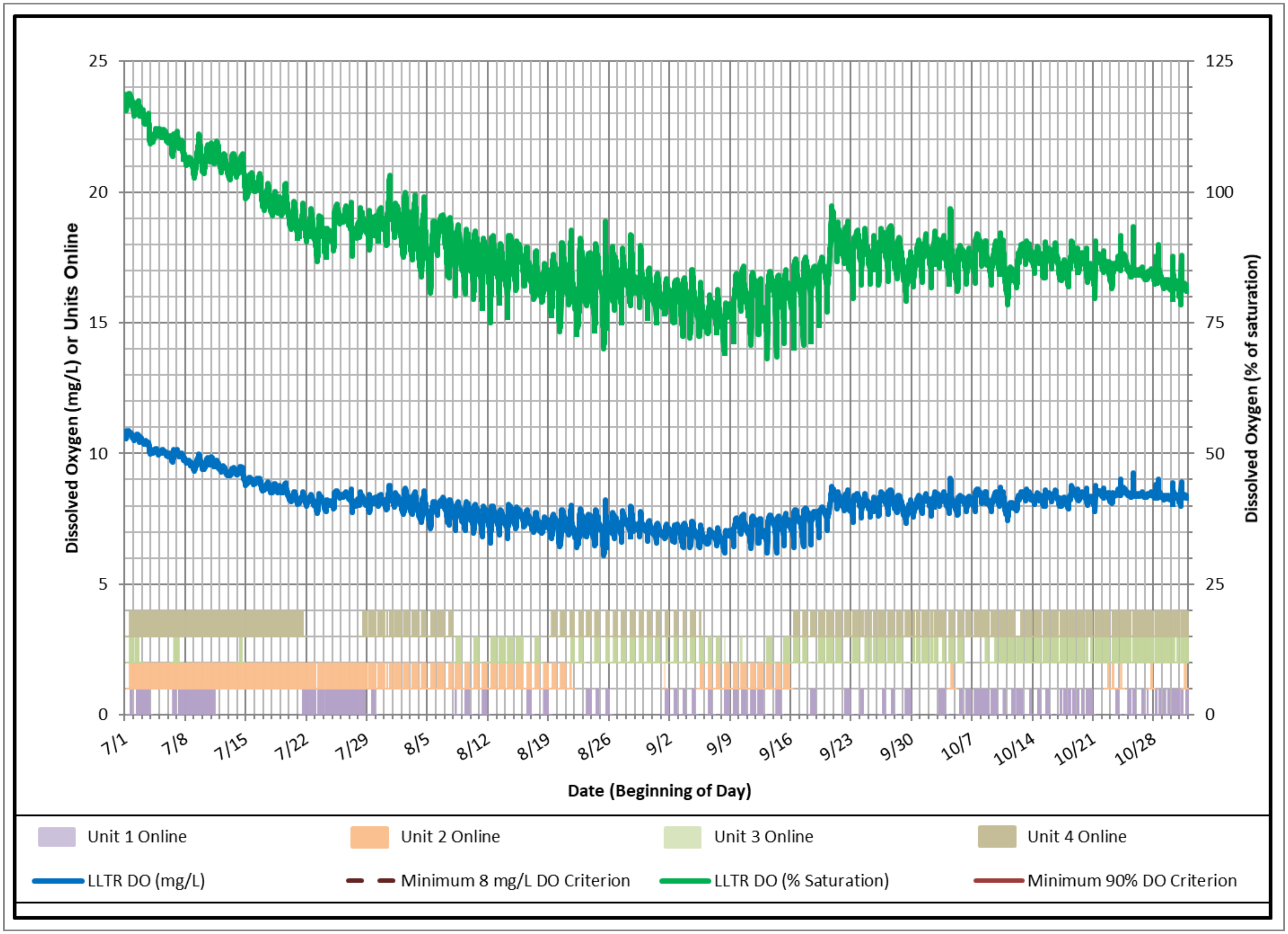


Figure 3-7: LLTR dissolved oxygen concentration (mg/L) and percent of saturation and operations.

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 Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg
MS5 Dissolved Oxygen	0 to 30 mg/L	±0.01 mg/L for 0 to 8 mg/L ±0.02 mg/L for >8 mg/L	0.01 mg/L
MS5 Temperature	-5 to 50°C	±0.10°C	0.01°C
MS5 Depth (0-25 meters)	0 to 25 meters	±0.05 meters	0.01 meters
Barologger Relative Barometric Pressure		±0.05 kPa	0.002% FS
Barologger Temperature	-10 to 50°C	±0.05°C	0.003°C

Notes: Sources: Hach MS5 User Manual and Solinist Levelogger User Guide [4]

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-4 shows which MS5 was deployed at each monitoring location during the sampling period.

Table A-2. Measurement quality objectives.

Parameter	MQOs
Barometric Pressure	2 mmHg
Temperature	0.5°C
Total Pressure	1% (5 to 8 mmHg)
TDG%	1%
Dissolved Oxygen	0.5 mg/L

[4] Hach Corporation. 2006. Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes User Manual. February 2006, Edition 3. Catalog Number 003078HY and Solinist. 2021. Levelogger Series 5 User Guide. September 15, 2021.

Table A-3. Difference between RMSE and MQOs by MS5.
Table Part 1: Barometric Pressure (BAR), Total Pressure, Total Dissolved Gas (TDG)

LLHED TDG Monitoring	RMSE [1]				MQO				RMSE - MQO (positive shaded values denote exceedance of MQO)			
Meter and Site IDs	BAR[2]	Total Pressure[3]	TDG-cal[4]	TDG-spot	BAR	Total Pressure	TDG	TDG	BAR	Total Pressure	TDG-cal	TDG-spot
	mm Hg	%	%	mm Hg	mm Hg	%	%	mmHg	mm Hg	%	%	mm Hg
48762	0.67	0.09	0.09	3.09	2	1	1	5	-1.33	-0.91	-0.91	-1.91
48763	2.00	0.28	0.28	2.25	2	1	1	5	0.00	-0.72	-0.72	-2.75
48764	0.00	0.00	0.00	3.00	2	1	1	5	-2.00	-1.00	-1.00	-2.00
Overall RMSE	0.95	0.13	0.13	2.78	2	1	1	5	-1.05	-0.87	-0.87	-2.22

[1] RMSE calculated for each meter during calibration checks while in use and between 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%

Table A-3 (Continued). Difference between RMSE and MQOs by MS5
Table Part 2: Temperature and Dissolved Oxygen (DO)

LLHED DO Monitoring	RMSE				MQO		RMSE - MQO (positive shaded values denote exceedance of MQO)			
Meter and Site IDs	Temperature[1]		Dissolved Oxygen[2]		Temp	DO	Temperature[1]		Dissolved Oxygen[2]	
	Calibration	Spot	Calibration	Spot			Calibration	Spot	Calibration	Spot
	ºC	ºC	mg/L	mg/L	ºC	mg/L	ºC	ºC	mg/L	mg/L
48762	0.04	0.00	0.04	0.01	0.5	0.5	-0.46	-0.50	-0.46	-0.49
48763	0.06	0.00	0.04	0.00	0.5	0.5	-0.44	-0.50	-0.46	-0.50
48764	0.04	0.00	0.05	0.29	0.5	0.5	-0.46	-0.50	-0.45	-0.21
Overall RMSE	0.04	0.00	0.05	0.10	0.5	0.5	-0.46	-0.50	-0.45	-0.40

[1] For Calibration, RMSE calculated from the difference between the meter and calibration thermometer at all calibration checks while the meter was in use. Spot differences are average differences between measured values from group average.

[2] Calibration RMSE as difference of the calculated pre-calibration and post-calibration measurement. Spot RMSE calculated as average difference between measured values from group average.

N/A - No value reported or not applicable

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

Table A-4. ID number, and deployment station and timeframe of MS5s used in 2022.

Deployment Timeframe	LLTR	LLTR2
7/1 - 7/14	48764	48763
7/14 - 7/28	48762	48764
7/28 - 8/9	48762	48764
8/9 - 8/26	48762	48764
8/26 - 9/8	48762	48764
9/8 - 9/20	48762	48764
9/20 - 10/4	48762	48764
10/4 - 10/18	48762	48764
10/18 - 10/31	48762	48764

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 all parameters were met for all meters used in the 2022 monitoring season.

Discharge data were obtained from Avista's internal plant control software and is found to be accurate and reliable.

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.

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-5). The DO data collection period consisted of 11,808 15-minute periods. All parameters exceeded the goal of 90 percent completeness. Table A-6 summarizes the number of specific DQ Codes applied to LLTR data.

Table A-5. Project completeness.

	LLTR	
	Count	**Completeness (%)**
Monitoring Period	11,808	--
Water Temperature (°C)	11,776	100%
Dissolved Oxygen (mg/L)	11,776	100%
Dissolved Oxygen (% of saturation)	11,776	100%
BAR (mm Hg)	11,808	100%
TDG (mm Hg)	11,726	99%
TDG (% of saturation)	11,726	99%

Table A-6. Number of Specific DQ Codes during the Monitoring Period, July 1 at 0:00 PT through October 31 at 23:45 PT of 2022.

DQ Code	DQ Code Description	LLTR						
		Temp (°C)	TDG (mmHg)	Depth (meters)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)
999	Instrument logging data before deployment at monitoring station	3	3	3	3	3	0	0
998	Out of water after recovery	2	2	2	2	2	0	0
997	Equilibrating after deployment	0	50	0	0	0	0	0
993	Calibration/servicing	27	27	27	27	27	0	0
0	No data qualifiers	11,768	11,718	11,768	11,768	11,768	11,808	11,808
-1002	Corresponds with spot measurement	8	8	8	8	8	0	0
	Monitoring Period[1]	11,808	11,808	11,808	11,808	11,808	11,808	11,808

Notes:

1. Monitoring period was from July 1, 2022 at 0:00 PT to October 31, 2022 at 23:45 PT.
2. Mass verifications were conducted on July 14, 2022.

APPENDIX B

CONSULTATION RECORD

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

February 28, 2023

Jordan Bauer, Hydropower Compliance Coordinator
Washington Department of Ecology
Eastern Regional Office
4601 N Monroe Street
Spokane, WA 99205-1295

Subject: **Federal Energy Regulatory Commission's Spokane River Hydroelectric Project License, Appendix B, Sections 5.4 and 5.6.B, Long Lake TDG, Nine Mile TDG and Long Lake DO Reporting Requirements**

Dear Jordan:

Ordering Paragraph E of the Federal Energy Regulatory Commission (FERC) Spokane River Hydroelectric Project License incorporated the Washington Department of Ecology (Ecology) Certification Conditions under Section 401 of the Federal Clean Water Act Water Quality Certification (Certification) as Appendix B of the License. Per Sections 5.4 and 5.6.B of the Certification, Avista is submitting the following project status and 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:

- *2022 Long Lake Total Dissolved Gas Monitoring Report.*
  Avista completed the Long Lake Dam Spillway Modification Project in December 2016. Following completion of the project, Avista monitored TDG to assess the effectiveness of the modifications and to evaluate spillgate operational protocols. The enclosed 2022 Long Lake TDG Monitoring Report provides the results of the TDG monitoring completed during 2022. It also includes an assessment of TDG monitoring since monitoring was extended for an additional three years in 2020.

  The three-year monitoring extension (2020 – 2022) did not accomplish the goal to obtain additional data at flows near the 7Q10 (32,000 cfs) as river flows fell short of the targeted flows. Therefore, Avista proposes to conduct annual TDG monitoring at Long Lake Dam for an additional three years (2023 through 2025), following the same Long Lake HED TDG Monitoring Plan and reporting structure used in previous annual monitoring

  As this additional monitoring data is collected, Avista will consult and engage with Ecology and the Spokane Tribe to discuss the milestones achieved in the WQAP including the Phase I, II, and III Feasibility Studies, Spillway Modification construction, effectiveness monitoring, spillgate protocols to reduce TDG, identification of data gaps, and impacts or patterns based upon hydrology, water temperature, dissolved oxygen, upstream environmental conditions and incoming TDG levels.

During 2025, Avista, Ecology and the Spokane Tribe will have a pathway and schedule of next steps in accordance with the regulatory tools outlined in WAC 173-201A-510(5).

- *2022 Nine Mile Dam Total Dissolved Gas Monitoring Report*
  Per Section 5.4(C), Avista shall collect TDG data for two years when flows occur during the 7Q10 median flow (25,400 cfs) or higher. In February 2012, Ecology approved Avista's request to delay TDG monitoring at Nine Mile Dam pending the completion of the turbine units 1 and 2 replacement project, the sediment bypass system and associated intake deck and trashrack cleaning system upgrades. These projects were completed by 2018 and TDG monitoring resumed in 2019.

  The enclosed 2022 Nine Mile HED Total Dissolved Gas Monitoring Report provides the results of TDG monitoring conducted for Nine Mile HED during 2022, as well as a summary of the two years of TDG data collected post-construction. Monitoring results from 2019 and 2022 demonstrate that Nine Mile Dam did not contribute TDG compared to upstream levels, except for a time period from June 14 to June 25, 2022 when TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values.

  Based on the inconsistencies seen in the relationship between forebay TDG and tailrace TDG in the two years of monitoring, Avista proposes monitoring TDG annually until flows reach or are near the median 7Q10, in order to better assess the influence Nine Mile Dam has on TDG, without the influence/impact from high sediment loading. Avista will submit a three-year summary report following the next year flow conditions have been met.

Section 5.6.B: Dissolved Oxygen
The enclosed 2022 Long Lake HED Tailrace Dissolved Oxygen (DO) Monitoring Report provides the results of the 2022 DO monitoring immediately downstream of Long Lake Dam for the low-flow period of the year and summarizes the use of draft tube aeration to increase DO levels in the river below the dam's tailrace. Avista plans to continue with the aeration program in 2023 and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

Attached, please find the 2022 Long Lake TDG Monitoring Report, 2022 Nine Mile Dam TDG Monitoring Report, and the 2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for the Ecology's review and approval. We would like to receive any comments or recommendations that you may have by **March 31, 2023**, which will allow us time to file these reports with FERC by April 15, 2023.

Please feel free to contact me at (509) 495-4084 or Meghan Lunney at (509) 495-4643 if you have any questions or wish to discuss the report.

Sincerely,

Chris Moan
Fisheries Habitat Biologist

Enclosures (3)

cc: Brian Crossley, Spokane Tribe
Conor Giorgi, Spokane Tribe
Meghan Lunney, Avista

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Eastern Region Office
4601 North Monroe St., Spokane, WA 99205-1295 • 509-329-3400

March 23, 2023

Chris Moan
Avista Corp.
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220

RE: Request for Ecology Review and Comment – Avista 2022 Long Lake Tailrace HED Dissolved Oxygen, Long Lake Total Dissolved Gas, and Nine Mile Total Dissolved Gas Monitoring Reports – Spokane River FERC Project No. 2545

Dear Chris Moan:

The Department of Ecology (Ecology) has reviewed Avista's submittal of the "2022 Long Lake Total Dissolved Gas Monitoring Report", "2022 Nine Mile Dam Total Dissolved Gas Monitoring Report", and "2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report". These reports were received by Ecology on February 28, 2023, via email. The reports were completed in accordance with Sections 5.4(C & D) and 5.6(B) of Ecology's 401 Certification (Certification) and consistent with Spokane River Hydroelectric Project No. 2545 (License) Appendix B.

In summary of the enclosed comments, we have highlighted the following for Avista to pursue:

1. Develop and submit a new Water Quality Attainment Plan (WQAP) for TDG at Long Lake Dam according to WAC 173-201A-510(5) "Compliance schedule for dams". We encourage using the attached guidance document for developing a WQAP with reasonable and feasible TDG abatement measures. A compliance schedule developed with the WQAP must identify the necessary time of up to ten years to evaluate and implement the proposed TDG abatement measures.
2. Using the enclosed guidance document, please prepare a TDG WQAP submittal schedule for Long Lake Dam for Ecology review by April 14, 2023.
3. Continue TDG monitoring at Nine Mile Dam to evaluate TDG dynamics at or higher than the median 7Q10 flows at the Spokane River gage according to Section 5.4(C) of the Certification. Furthermore, continued monitoring is needed to evaluate Hangman Creek's influence on TDG.
4. Continue monitoring DO and TDG at the Long Lake Dam Tailrace Station according to the aeration program's adaptive management measures.

Ecology looks forward to working with Avista during development of the next TDG WQAP at Long Lake Dam. We think it would be beneficial to meet and discuss reasonable and feasible TDG abatement measures for the WQAP given the data collected and past implementation projects. We appreciate the regular conversations and look forward to connecting soon. Please contact me with any questions at (509) 688-9403 or jordan.bauer@ecy.wa.gov.

Sincerely,

Jordan Bauer
Hydropower Compliance Coordinator
Water Quality Program

JB:red
Enclosures
cc: Meghan Lunney, Avista
Chad Atkins, Ecology
Brian Crossley, Spokane Tribe
Conor Giorgi, Spokane Tribe

Avista 2022 TDG Annual Reports and Long Lake HED Tailrace DO/TDG Annual Report
Ecology Review and Comment

2022 Long Lake TDG Monitoring Report ECY review and comment.

Comment No.	Section	Page No.	Comment/Questions
1	2.5	5	Last bulleted item – I think July 14th was meant as the last data recorded at LLGEN and not June 14th? July 14th would match dates further into the document.
2	4.0	7	We suggest including some language explaining how varying flows effect TDG exceedances as in past years' discussion sections and reports. It appears TDG response downstream in the tailrace is dependent on incoming flows and TDG values.
3	5.0	7	Paragraph 2 – Spill gate testing and effectiveness monitoring during the 2017 and 2018 seasons concluded the structural modifications are effective at reducing TDG from pre-construction TDG levels. This analysis included spreading out gate levels more evenly and decreasing TDG further between discharges of approximately 6.5kcfs-13.3kcfs. To supplement these results, we recommend additional gate testing at greater discharges to evaluate opportunities for further maximizing TDG reductions during a higher flow spectrum.
4	5.0	8	Paragraph 3 "Comparing…" – This is a good level of evaluation here, especially the last sentence. Using this further when describing TDG at varying discharge regimes will be beneficial for future abatement investigations and determining the greatest level of TDG reduction (magnitude, duration, frequency).
5	5.0	8	Third bullet – How was this conclusion decided? We did not see discussion on this comparison in the report that would help us understand this conclusion.
6	6.0	9	Though a three-year extension for the TDG compliance schedule was granted in the past for monitoring effectiveness, we typically don't permit extensions but rather request a new compliance schedule be developed. Additionally, we haven't seen a flow year get even to the median 7Q10 value since 2017, therefore there's uncertainty that we see flows near the 7Q10 in the next three years. We believe from instances of continued TDG exceedances, especially during higher flows, there's reason to pursue evaluation and possible implementation of new TDG abatement measures. Actions identified in the final bullet list of the report can be included in determining new TDG abatement actions and pertinent evaluation methods within a new compliance schedule. Therefore, development of a new TDG water quality attainment plan and compliance schedule is the appropriate next step in accordance with WAC 173-201A-510(5) at Long Lake Dam consistent with the 401 Certification Section 5.4(D).

2022 Nine Mile Dam TDG Monitoring Report

Comment No.	Section	Page No.	Comment/Questions
1	3.6	6	Last paragraph – We appreciate Avista adding this notification.
2	4.0	7	Last paragraph, sentence 4 – According to the Hangman Creek USGS monitoring location #12424000 flows peaked at 5,410 cfs on June 14th at 4:45PM (see Hangman Creek #12424000). Consider revising the peak flow value unless the value is referring to a different monitoring location. If that's the case, please include the monitoring site ID.
3	4.0, 5.4, 6.0	7-9	4.0 and 5.4, last paragraphs and Section 6.0 – Ecology agrees more data collection is needed to understand the impacts of Hangman Creek high episodic discharges into the Spokane River during spill events and TDG response at Nine Mile Dam. It is largely unclear how Hangman water quality data effects TDG and how the relationship between NMFB and NMTR respond. Additionally, the median 7Q10 of 25,400 cfs at the Spokane River gage (USGS 12422500) has not been met during annual monitoring periods since the construction projects at Nine Mile Dam were completed. Though flows during 2019 and 2022 came close, we agree continued monitoring is beneficial to further evaluate TDG at Nine Mile Dam. We disagree the data is erroneous during increase flows from Hangman Creek, since QAQC spot checks supported the results and TDG increases were observed at the LLGEN TDG values downstream at Long Lake Dam. There may be more to understand how Hangman Creek discharges influence TDG. Hangman Creek typically reaches high flows earlier in the year than seen in 2022 when TDG levels increase from Spokane River flows over Spokane Falls. There may be some level of interaction explaining the higher TDG at NMTR given how TDG saturation equilibrates from the higher discharges of Hangman Creek with the Spokane River during these periodic events. Additional data collection will hopefully shed some light on these uncertainties. Please provide more information on why nutrients and sediments were assumed to be impacting TDG from Hangman Creek (e.g., cited literature, previous TDG studies). At constant TDG levels, natural environmental conditions impacting TDG typically include barometric pressure, biological activity, and temperature.

2022 Long Lake HED Tailrace DO Monitoring Report ECY review and comment.

Comment No.	Section	Page No.	Comment/Questions
1	General Comment	-	Ecology agrees continued monitoring is needed in the tailrace and during aeration to effectively manage and operate periods of aeration. As mentioned, continued upstream DO, temperature, and TDG water quality attainment plan improvements should only continue to benefit downstream DO conditions.

Ecology Guidance for Preparing a Dam Compliance Schedule Request and Water Quality Attainment Plan
March 2023

This Washington Department of Ecology (Ecology) guidance presents a recommended series of actions for dam owners to pursue to achieve an approvable Water Quality Attainment Plan (WQAP) and compliance schedule in accordance with WAC 173-201A-510(5). Dam owners are encouraged to begin preparations for a WQAP submittal at a minimum one year prior to the due date. As an example, a dam owner may begin working through the guidance actions during the final year(s) of a dam compliance schedule to ensure a new schedule and WQAP is approved by Ecology and begins immediately thereafter. We suggest dam owners consult with Ecology early and often during the recommended guidance process.

The following actions outline a strategy for dam owners to choose reasonable and feasible implementation projects to meet water quality standards, engage key stakeholders, and develop an approvable WQAP:

1. Assemble a WQAP project team with pertinent personnel (e.g., consultants, in-house engineering personnel, etc.) to consider projects for evaluation and implementation as part of the WQAP. The assembled team will review and/or modify past project alternatives and propose new projects in preparation of an extensive list of potential improvement actions. For all potential projects, water quality improvements may include any one or combination of the following factors to achieve compliance:
    - Magnitude
    - Duration
    - Frequency

    Incremental improvement made to any of these factors must be considered to achieve the highest attainable water quality condition if numeric criteria cannot be met.

2. Develop or revise evaluation criteria for ranking and prioritizing projects that are considered reasonable and feasible to achieve the maximum water quality condition. Submit the developed evaluation criteria to Ecology for review and comment.

3. Finalize the criteria and prepare a preliminary list of potential projects from the original extensive list to begin outlining the WQAP. The list of prioritized projects could be informed by the criteria, preliminary modelling, and existing science on water quality improvement strategies, as appropriate.

4. Once the reasonable and feasible list of actions is prepared, the dam owner should hold a series of advisory workshops (see No. 5) to vet actions, decisions, and assumptions made developing the list and evaluation criteria.

5. Form an advisory group including the WQAP project team, regulatory agencies, tribes, and experts in water resources specific to reservoir management, design, and function. Engage the advisory group in a series of workshops facilitated by the dam owner to include the following content:
    - Introduce the general project background and need for water quality attainment of WA water quality standards, past project proposals, evaluation criteria, and the developed reasonable and feasible list of actions and how each measure was evaluated using the criteria.

- Based on the information presented, the dam owner will request from the group any additional implementation projects and alternatives. This may include supplementary water quality studies or data collection needs to support project evaluation and implementation proposals.

2. Following the series of workshops, a final evaluation criteria and vetted project list would be integrated into a draft WQAP for Ecology review and comment. At a minimum, the draft must include all parts of WAC 173-201A-510(5)(b) and the developed evaluation criteria as an attachment.

3. Once having addressed Ecology's comments, we recommend the dam owner present the WQAP to the advisory workgroup and/or broader group of stakeholders for final review. The dam owner should consider recommendations from this review and finalize for Ecology approval and subsequent submittal to the appropriate federal agency.

Ecology Proposed WQAP Submittal Schedule

The following table may be revised based on project scope and conversations between Ecology and the dam owner. Ecology recommends dam owners work with the agency to agree on a schedule incorporating each of the defined tasks to ensure the final WQAP submittal due date is met.

Task No.	Task	Time Required (days)	Notes
1 & 2	Assemble Project team, create comprehensive list of project ideas, and develop evaluation criteria	60	Dam owner schedules advisory meetings ~100 days out
2	Ecology review and comment of evaluation criteria	20	
3	Dam owner addresses Ecology comments and finalizes evaluation criteria	20	
4 & 5	Dam owner prioritizes projects using criteria and presents project proposals to advisory workgroup	10	Approximately three workshops facilitated over 10-day period. Dam owner schedules final advisory group meeting ~100 days out during last workshop.
6a	Dam owner updates project list and develops draft WQAP for Ecology review and comment	45	
6b	Ecology review and comment of draft WQAP	30	
7a	Dam owner addresses Ecology comments and presents to advisory group	30	
7b	Dam owner makes final changes to WQAP based on meeting presentation and submits to Ecology for final approval	10	
7c	Ecology approves WQAP and dam owner submits to the federal agency	10	
	Total	235 or ~8 months	

ECOLOGY COMMENTS AND AVISTA RESPONSES

Ecology Comment
4. Continue monitoring DO and TDG at the Long Lake Dam Tailrace Station according to the aeration program's adaptive management measures.

Avista Response
Avista will continue monitoring DO and TDG at Long Lake Dam in 2023.

ECOLOGY COMMENTS AND AVISTA RESPONSES

2022 Long Lake HED Tailrace DO Monitoring Report ECY review and comment.

#	Section	Page No.	Ecology Comment/Questions	Avista Response
1	General Comment	-	Ecology agrees continued monitoring is needed in the tailrace and during aeration to effectively manage and operate periods of aeration. As mentioned, continued upstream DO, temperature, and TDG water quality attainment plan improvements should only continue to benefit downstream DO conditions.	Avista will continue monitoring DO and TDG at Long Lake Dam in 2023.

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

February 28, 2023

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

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

Dear Brian:

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

- *2022 Long Lake Total Dissolved Gas Monitoring Report.*
  Avista completed the Long Lake Dam Spillway Modification Project in December 2016. Following completion of the project, Avista monitored TDG to assess the effectiveness of the modifications and to evaluate spillgate operational protocols. The enclosed 2022 Long Lake TDG Monitoring Report provides the results of the TDG monitoring completed during 2022. It also includes an assessment of TDG monitoring since monitoring was extended for an additional three years in 2020.

  The three-year monitoring extension (2020 – 2022) did not accomplish the goal to obtain additional data at flows near the 7Q10 (32,000 cfs) as river flows fell short of the targeted flows. Therefore, Avista proposes to conduct annual TDG monitoring at Long Lake Dam for an additional three years (2023 through 2025), following the same Long Lake HED TDG Monitoring Plan and reporting structure used in previous annual monitoring

  As this additional monitoring data is collected, Avista will consult and engage with Ecology and the Spokane Tribe to discuss the milestones achieved in the WQAP including the Phase I, II, and III Feasibility Studies, Spillway Modification construction, effectiveness monitoring, spillgate protocols to reduce TDG, identification of data gaps, and impacts or patterns based upon hydrology, water temperature, dissolved oxygen, upstream environmental conditions and incoming TDG levels.

During 2025, Avista, Ecology and the Spokane Tribe will have a pathway and schedule of next steps in accordance with the regulatory tools outlined in WAC 173-201A-510(5).

- *Nine Mile Dam TDG Monitoring Report*
  Per Section 5.4(C), Avista shall collect TDG data for two years when flows occur during the 7Q10 median flow (25,400 cfs) or higher. In February 2012, Ecology approved Avista's request to delay TDG monitoring at Nine Mile Dam pending the completion of the turbine units 1 and 2 replacement project, the sediment bypass system and associated intake deck and trashrack cleaning system upgrades. These projects were completed by 2018 and TDG monitoring resumed in 2019.

  The enclosed 2022 Nine Mile HED Total Dissolved Gas Monitoring Report provides the results of TDG monitoring conducted for Nine Mile HED during 2022, as well as a summary of the two years of TDG data collected post-construction. Monitoring results from 2019 and 2022 demonstrate that Nine Mile Dam did not contribute TDG compared to upstream levels, except for a time period from June 14 to June 25, 2022 when TDG in the tailrace increased, correlated with an increase in river flows, but TDG in the forebay did not increase, resulting in tailrace TDG values being greater than forebay values.

  Based on the inconsistencies seen in the relationship between forebay TDG and tailrace TDG in the two years of monitoring, Avista proposes monitoring TDG annually until flows reach or are near the median 7Q10, in order to better assess the influence Nine Mile Dam has on TDG, without the influence/impact from high sediment loading. Avista will submit a three-year summary report following the next year flow conditions have been met.

Section 5.6.B: Dissolved Oxygen
The enclosed 2022 Long Lake HED Tailrace Dissolved Oxygen (DO) Monitoring Report provides the results of the 2022 DO monitoring immediately downstream of Long Lake Dam for the low-flow period of the year and summarizes the use of draft tube aeration to increase DO levels in the river below the dam's tailrace. Avista plans to continue with the aeration program in 2023 and to continue monitoring DO and TDG at the Long Lake Dam Tailrace Station.

Attached, please find the 2022 Long Lake TDG Monitoring Report, 2022 Nine Mile Dam TDG Monitoring Report, and the 2022 Long Lake HED Tailrace Dissolved Oxygen Monitoring Report for the Spokane Tribe's review and comment. We would like to receive any comments or recommendations that you may have by **March 31, 2023**, which will allow us time to file these reports with FERC by April 15, 2023.

Please feel free to contact me at (509) 495-4084 or Meghan Lunney at (509) 495-4643 if you have any questions or wish to discuss the report.

Sincerely,

Chris Moan
Fisheries Habitat Biologist

Enclosures (3)

cc: Jordan Bauer, Ecology
Conor Giorgi, Spokane Tribe
Meghan Lunney, Avista

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

3/30/2023

Chris Moan
1411 East Mission Avenue
PO Box 3727 MSC-25
Spokane WA 99220

Dear Chris:

I have reviewed the 2022 total dissolved gas reports for Long Lake and Nine Mile Dams and the 2022 dissolved oxygen report for Long Lake Dam with the assistance of Brian Crossley, Water & Fish Program Manager.

In 2016, spill deflectors were installed on Long Lake Dam to help mitigate total dissolved gas impacts. In 2022 Avista recorded TDG levels between 105%-118.7% at LLTR. Although this is an improvement from TDG levels recorded prior to the spill deflector installation, TDG levels are still exceeding the 110% saturation standard below 7Q10 flows. We read in the report the specific dates that LLTR and LLGEN exceeded 110% standard, but it was unclear what percentage of the sampling season the locations exceeded the standard. Please provide percentages (monthly or throughout the entire season) that both locations exceeded 110%. With dam operations being modified over time to better regulate TDG concentrations below Long Lake Dam, we hope that total dissolved gas concentrations continue to be reduced so that native species are not critically impacted. We promote future monitoring and adaptive management to effectively maintain low TDG during spring runoff.

When reviewing the TDG report for Nine Mile Dam we acknowledge that total dissolved gas concentrations both above and below the dam are exceeding the 110% standard. The report does show that for a majority of the season NMTR had a lower TDG than NMFB, and that for 10% of the study period NMTR exceeded levels seen at NMFB. Avista states they believe that data where NMTR exceeded NMFB was erroneous, and was higher because of impacts from high nutrients and sediments in the water column. Please explain how increased levels of nutrients and sediments can result in higher total dissolved gas levels, and how this anomaly is not seen every year when Hangman Creek freshet occurs.

The dissolved oxygen mitigation continues to be modified and improved below Long Lake dam. However, as noted in previous comments of annual reports, dissolved oxygen declines and dips below 8mg/L when the Long Lake Dam is not generating. These declines in dissolved oxygen can negatively impact native species that reside in this reservoir and reduce their already limited available habitat during that time. While reading the document we found the conclusions difficult to interpret when the percent exceedances or compliances were split within a month. We suggest Avista lists the date range for the percentages, as well as add what percent of DO or TDG readings exceeded or complied over the entire month so there is more clarity and comparability. We encourage Avista to continue their efforts in improving water quality at Nine Mile Dam, in Long Lake (Lake Spokane) and at Long Lake Dam so native species can benefit from those efforts within the reservoirs as well as downstream in Reservation waters.

Sincerely,

C. Flanagan

Casey Flanagan
Water & Fish Project Manager
caseyf@spokanetribe.com

cc: Jordan Bauer, Dept. of Ecology
Chad McCrea, Director Dept. of Natural Resources
Brian Crossley, Water and Fish Program Manager

SPOKANE TRIBE COMMENTS AND AVISTA RESPONSES

Spokane Tribe Comment

The dissolved oxygen mitigation continues to be modified and improved below Long Lake dam. However, as noted in previous comments of annual reports, dissolved oxygen declines and dips below 8mg/L when the Long Lake Dam is not generating. These declines in dissolved oxygen can negatively impact native species that reside in this reservoir and reduce their already limited available habitat during that time. While reading the document we found the conclusions difficult to interpret when the percent exceedances or compliances were split within a month. We suggest Avista lists the date range for the percentages, as well as add what percent of DO or TDG readings exceeded or complied over the entire month so there is more clarity and comparability. We encourage Avista to continue their efforts in improving water quality at Nine Mile Dam, in Long Lake (Lake Spokane) and at Long Lake Dam so native species can benefit from those efforts within the reservoirs as well as downstream in Reservation waters.

Avista Response

Entire month (and semi-month) percentages for DO and TDG reading exceedances and the referenced date range were added to the text in Section 3.6. Additionally, Tables 3-4 and 3-5 provide a summary of the average, minimum DO and maximum TDG observed during both generation and non-generation along with the frequency of exceedance split up in semi-monthly timeframes, with the associated date ranges provided. We look forward to continuing working with the Spokane Tribe in 2023 to provide additional clarity with presentation of the data.