AVISTA CORPORATION

2011

NINE MILE HED

TOTAL DISSOLVED GAS

MONITORING REPORT

WASHINGTON 401 CERTIFICATION, SECTION 5.4(D)

Spokane River Hydroelectric Project
FERC Project No. 2545

Prepared By:
Golder Associates Inc.
Redmond, WA

February 16, 2012

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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
ABS	acrylonitrile-butadiene-styrene piping
AC	alternating current
amsl	above mean sea level
Avista	Avista Corporation
BAR	barometric pressure
cfs	cubic feet per second
DO	dissolved oxygen
DQO	data quality objective(s)
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
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®
NM3	monitoring station at dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile HED powerhouse
NMFB	monitoring station at Nine Mile forebay
NMTR	monitoring station at Nine Mile tailrace
PDT	Pacific Daylight Time
PME	protection, mitigation, and enhancement measure
RMSE	root mean squared error
Spokane Tribe	Spoke Tribe of Indians
TDG	total dissolved gas, as pressure
TDG%	total dissolved gas, as percent of saturation
WQC	Amended section 401 water quality certification

1.0 INTRODUCTION

Avista Corporation (Avista) recognizes the need to monitor potential negative effects of total dissolved gas (TDG) production caused by water spilling through the Nine Mile Dam spillway, and as a result proposed a protection, mitigation, and enhancement measure (PME) as part of its license application to the Federal Energy Regulatory Commission (FERC) (Avista 2005a). This PME, referred to as SRP-WQ-1 "Total Dissolved Gas Control and Mitigation Program", includes TDG monitoring and evaluation to better determine specific HED influence(s) on TDG levels, preferred spill gate operating protocols, and to evaluate project-related TDG control and abatement measures.

Washington State Department of Ecology (Ecology) issued and amended a section 401 water quality certification (WQC) for Avista's four Spokane River Project hydroelectric developments (HEDs) that are located in Washington (Ecology 2009). This WQC addresses the Upper Falls, Monroe Street, Nine Mile, and Long Lake HEDs. Section 5.4 of this WQC provides Avista's requirements to address the HEDs' effects on TDG.

On June 18, 2009, FERC issued a license for the Spokane River Project (FERC 2009). Article 401(a) of this license requires Avista to file the TDG monitoring plan required by WQC section 5.4(A) for approval prior to implementation.

Avista consulted with Ecology and the Spokane Tribe of Indians (Spokane Tribe) in preparation of the required TDG monitoring plan, which addresses TDG associated with spills from the Long Lake and Nine Mile HEDs (Golder 2010). Ecology approved this plan on March 17, 2010, and Avista filed this Ecology-approved plan with the FERC on March 26, 2010.

On December 14, 2010, FERC approved this monitoring plan.

2.0 MONITORING REQUIREMENTS AND OBJECTIVE

Section 5.4(C) of the WQC specifically mandates:

"The Licensee shall monitor TDG in the forebay and near the end of the aerated zone (the area of bubble entrainment and dissipation) of Nine Mile Dam. The Licensee shall collect TDG data for two years when flows occur during the 7Q10 median flow of 25,400 cfs or higher at the Spokane gage (USGS 12422500). The flows may or may not be consecutive years. If within these two years, the data show that Nine Mile Dam is not exceeding the 110 percent TDG criterion then Ecology will consider the dam in compliance with the 110 percent water quality standards criterion for TDG of 110 percent saturation and may allow the Licensee to cease or reduce this monitoring.

If any modifications to the dam such as construction (i.e. installation of a rubber dam), the Licensee shall collect TDG data for two years when flows occur during the 7Q10 median flow of 25,400 cfs or higher at the Spokane gage (USGS 12422500) after such installation or construction has occurred. The flows may or may not be consecutive years.

*The Licensee shall develop a compliance schedule if Nine Mile Dam is **creating** TDG greater than 110 percent."*[1]

In the fall of 2010, Avista modified the Nine Mile Dam spillway by replacing the two tiers of 5-foot-high flashboards with a pneumatically controlled metal gate. The new spillway control structure consists of three individual metal hinged gates supported with rubber bladders that are inflated or deflated to raise and lower the three gate sections either in unison or independently (Figure 2-1). There is a 160-foot-wide center gate and a 30-foot wide gate on each side that are used for trash and debris removal. During high flows, one or more gate(s) is lowered to allow flow to overtop it/them. When fully lowered, the metal leaf closely conforms to the existing spillway crest profile.

The monitoring plan allows Avista to decide whether to monitor TDG in a given year based in part on snowpack and runoff forecasts.

The objective for TDG monitoring associated with Nine Mile Dam is:

- Collect two years of data during high-flow seasons with at least 25,400 cfs at the Spokane gage (USGS 12422500) to evaluate whether the Nine Mile Dam with the modified spillway causes exceedances of the TDG standard.

2.1 Monitoring Period

Avista decided to monitor TDG in 2011 based on the forecasts of snowpack and runoff which indicated a high flow year. A high flow year is a year in which the Spokane River gage at Spokane (USGS

[1] Emphasis added.

12422500) is expected to have a daily average flow of 25,400 cfs or greater. TDG monitoring in 2011 began on March 23 and ended on July 19.

2.2 Methods

Monitoring for this study was conducted using Hydrolab® MS5 Multiprobe® (MS5) instruments and a Solinst® barologger. Details are provided below.

2.2.1 Monitoring Stations

Monitoring was conducted at two long-term (referred to as continuous) deployment stations and one spot measurement station (Table 2-1).

The Nine Mile forebay (NMFB) and Nine Mile tailrace (NMTR) stations were previously used for seasonal TDG monitoring. Station NMFB was located within the Nine Mile HED compound and was secured from vandalism. At this station, TDG monitoring equipment was protected by an ABS housing that deployed on a bottom-weighted steel cable at a minimum depth of 12 feet below full pool elevation of 1606.6 feet (i.e., 1,594.6 feet or lower) to ensure the TDG probe remained below the compensation depth.

The NMTR station is located in a publically accessible area; hence it was deployed in secure housing. In 2009, Avista personnel repaired, reinforced, and extended the standpipe to allow the station to be accessed during high flow conditions yet maintain the TDG instrument below compensation depth during the spill season.

Station NM3 is located on the right downstream bank, at a dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile HED powerhouse. This station is far enough downstream to ensure complete cross-bank mixing during high flows.

2.2.2 Equipment and Calibration

Water quality parameters recorded include TDG pressure (millimeters mercury [mm Hg]), dissolved oxygen (DO) concentration (milligrams per liter [mg/L]), and water temperature (°C). Water depth (meters) also was 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.

MS5 instruments with TDG, optical DO, temperature, and depth sensors were deployed. After the first download, a power/data cable was used to connect the MS5 at NMFB to an external alternating current (AC) power source to improve reliability in power supply and provide a means to confirm MS5 setups following re-deployment. The MS5 at NMTR was not connected to AC-power source, since no AC power supply was in the area.

A Solinst® barologger was deployed at the Nine Mile forebay to provide local barometric pressure. As an additional quality assurance measure, resulting site-specific barometric pressures were compared to corresponding values for the Spokane International Airport. Spokane International Airport station sea-level daily ranges for barometric pressure were downloaded from www.wunderground.com and adjusted by subtracting 43.6 mm Hg to account for the altitude of the Nine Mile HED forebay (1,607 feet above mean sea level [ft amsl]).

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

Monitoring equipment was calibrated according to the manufacturer's instructions prior to deployment and on periodic site visits. All instruments used were factory calibrated before the 2011 monitoring season. Pre-deployment field verification included: 1) synchronizing the clocks, 2) comparing the MS5s' TDG pressure value with the silastic membrane removed to the ambient barometric pressure, 3) confirming the MS5s' patency of the TDG silastic membrane, and 4) 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 MS5 and Solinst® barologger data to a portable field computer. Patency of the original TDG membrane was confirmed by observing a rapid increase in TDG pressure while pressurizing the sensor with soda water. Depth, temperature, and DO sensors were calibrated according to the manufacturer's instructions.

2.2.3 Spot Measurements

Spot measurements of TDG, water temperature, and DO were made at each of the TDG monitoring stations during the site visits. Spot measurements also were taken at NM3.

2.2.4 Data Collection and Processing

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

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

In addition, TDG percent of saturation (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 were checked for errors using Microsoft Excel®. Erroneous data were identified, assigned data quality codes, and removed from the final data set.

Nine Mile HED operational logs, provided by Avista, were the source of generation and spill discharge data for the 2011 TDG monitoring period.

2.2.5 Monitoring Difficulties

The following three situations caused monitoring difficulties during the 2011 TDG monitoring season for Nine Mile Dam.

The NMTR MS5 was inadvertently set to record values at 1 hour, instead of 15 minute, intervals on June 5. Following this event, we deployed the MS5 in the NMTR stilling well with a data cable attached which enabled using a laptop to confirm the MS5 had been set up correctly. We recommend use of the data cable at this station when practical. Extreme high-flow events can flood the entire stilling well and damage the data cable. Therefore, the data cable should be removed before extreme high-flow events.

During the last servicing/downloading event of the 2011 season, the long-term MS5 at LLFB had a small crack in the battery housing and was flooded. This MS5 could not be fully downloaded in the field, although all data was subsequently downloaded after opening the MS5 and allowing it to air dry. Therefore, no data gaps resulted from this event. The MS5 was sent to the manufacturer for repair.

The need for Avista's MS5s to undergo manufacturer repair/service limited the availability of a roving MS5 for spot measurements. When repair service occurred on the roving MS5, we weighed the benefits and practicality of conducting different types of monitoring (e.g., spot measurement and long-term deployments), and used the available instruments for the purposes that would be most beneficial.

2.3 Results

The results of data collection activities during the 2011 TDG monitoring season are presented below. MS5s and barologgers were set to record data for 11,320 15-minute periods (referred to as "continuous" data in this report) from March 23 to July 19 (Table 2-2). A complete data set for barometric pressure data was obtained from the barologger deployed at NMFB. TDG data were successfully obtained for close to 100 percent of the NMFB continuous monitoring periods and 92 percent of the NMTR continuous monitoring periods. Spot measurements were collected on March 23, April 5, April 15, April 28, May 18, June 5, June 17, June 30, and July 19, which are the dates when continuous data were downloaded (Table 2-3). A spot measurement was not taken during the May 12 download because all MS5s were at Hach for servicing or deployed at long-term monitoring stations. A spot measurement was also not taken during the May 18 download at NMFB because the purpose of the site visit was to replace the batteries in the MS5. Results of continuous and spot measurements are displayed in Figures 2-2 through 2-5.

2.3.1 Discharge

Combined Nine Mile HED generation and spill discharge for the March 21 through July 19 monitoring period ranged from 5,200 to approximately 35,200 cfs (Figure 2-2). Discharge through the Nine Mile Dam spillway ranged from approximately 2,900 to 32,440 cfs. Units 2 and 3 were the only ones used during the monitoring period.

2.3.2 Water Temperature

Water temperature in the forebay (NMFB) and tailrace (NMTR) increased from approximately 4°C in late March to approximately 18°C in mid-July (Figure 2-2). Corresponding temperatures measured at the two continuous stations were within 0.2°C of one another. NMTR temperature tended to be slightly warmer than NMFB (Figure 2-2).

2.3.3 Barometric Pressure

Site-specific barometric pressures ranged from 706 to 728 mm Hg based on the Solonist® barologger deployed at NMFB (Figure 2-3).

2.3.4 Total Dissolved Gas

TDG pressure for NMFB was greater than corresponding values for NMTR during the majority of the spill period. Exceptions to this trend consistently occurred during the highest discharge period, May 16 through June 3, and occurred frequently at the lowest discharges monitored in 2011 (Figure 2-3). Comparisons of NM3 spot measurements with NMTR continuous data suggests that degassing likely occurs in the 1.0-mile-long reach between these sites (Figure 2-3).

TDG% computed ranged from 104 to 123 percent of saturation for NMFB and 108 to 124 percent of saturation for NMTR (Figure 2-4).[2] TDG% greater than 120 percent of saturation was recorded during 40 percent of the monitoring period for NMFB and during 30 percent of the monitoring period for NMTR and was generally associated with spills of greater than 20,000 cfs. The frequency of continuous TDG% values that exceeded the 110 percent of saturation criterion was 93 percent for NMFB and 98 percent NMTR.

2.3.5 Dissolved Oxygen

Measured DO concentrations were 9.1 to 14.5 mg/L for NMFB and 9.0 to 13.6 mg/L for NMTR (Figure 2-5). The greatest DO concentrations occurred in April, near the beginning of the monitoring period when temperature was near its lowest. Calculation of DO percent of saturation ranged from 98 to 127 percent at NMFB and 99 to 122 percent at NMTR.

[2] The minimum depth for the continuous MS5 at NMFB was around 4 meters and generally above 1.5 meters at NMTR. The MS5s remained below the compensation depth during the monitoring period.

2.4 Discussion

Nine Mile HED operations were not representative of normal operations during the 2011 TDG monitoring season. Three of the HED's four generators were not operating at full capacity, and the sediment bypass tunnel was plugged. Unit 4 was being rebuilt, Unit 1 was not operational, and Unit 2 was operated at about one half its capacity to minimize damage to the turbine. Therefore generation discharges were substantially less than would have occurred under typical operations. Although the combined hydraulic capacity of the four units is 6,500 cfs (Avista 2005b), the maximum generation discharge was approximately 2,400 cfs.

Figure 2-6 displays the percent of total discharge that actually occurred along with what would have occurred if the four units and the bypass tunnel were operated at their full hydraulic capacity. The proportion of spill, which is generally the cause of TDG production, would have generally been between 10 and 60 percent less than that which occurred during the 2011 TDG monitoring season (Figure 2-7). The frequency of TDG exceeding 110 percent of saturation (Table 2-4) is not representative of what would occur under normal operations. To evaluate compliance of the modified spillway with the TDG standard, TDG should be monitored under normal operations.

3.0 REFERENCES

Avista Corporation (Avista). 2005a. Spokane River Hydroelectric Project, FERC Project No. 2545, Application for New License, Major Project – Existing Dam, Volume II: Applicant-Prepared Preliminary Draft Environmental Assessment. Avista Corporation, Spokane, Washington. July.

Avista. 2005b. Spokane River Hydroelectric Project, FERC Project No. 2545, Final Application for New License, Major Project – Existing Dam, Volume I: Exhibits A, B, C, D, F, G, and H. Avista Corporation, Spokane, Washington. July.

Federal Energy Regulatory Commission (FERC). 2009. Project Nos. 2545-091, 12606-000, Order issuing new license and approving annual charges for use of reservation lands. Issued June 18. 167 pp.

Golder Associates Inc. (Golder). 2010. Washington Total Dissolved Gas Monitoring Plan. Prepared for Avista Corporation. March 26.

Washington State Department of Ecology (Ecology). 2009. 401 Certification-Order Spokane River Hydroelectric Project, Certification-Order No. 5492, FERC License No. 2545, As amended May 8, 2009 by Order 6702. Prepared by Eastern Regional Office Water Quality Program staff, Spokane, WA. May 8.

TABLES

Table 2-1: Nine Mile Dam TDG Monitoring Stations

Station Code	Description	Latitude / Longitude (NAD83)	Monitoring Type
NMFB	In the middle of a walkway used to access the Nine Mile HED powerhouse, immediately downstream from trash boom	47°46'29" / 117°32'41"	Continuous
NMTR	On left downstream bank, approximately 0.2 mile downstream from the face of the Nine Mile HED powerhouse	47°46'38" / 117°32'44"	Continuous
NM3	On right downstream bank, at a dock on Shoemaker Lane, approximately 1.2 miles downstream of the Nine Mile HED powerhouse	47°47'19" / 117°31'56"	Spot

Table 2-2: Summary of Continuous Monitoring Results

Parameter	NMFB			NMTR		
	Minimum	Maximum	Count	Minimum	Maximum	Count
Date/Time (PDT)	3/23/2011 14:30	7/19/2011 12:15	11,320	3/23/2011 16:45	7/19/2011 14:30	11,320
Water Temperature (°C)	4.1	18.6	11,299	4.17	18.75	10,439
DO (mg/L)	9.1	14.6	11,293	9.0	13.6	10,437
BAR (mm Hg)	706.0	728.3	11,307	Used NMFB BAR		
TDG (mm Hg)	742	881	11,281	775	887	10,407
TDG (% saturation)[1]	103.8	123.0	11,272	108.2	123.7	10,389

Notes:
1. TDG (% saturation) calculated using site-specific barometric pressure (BAR) data collected at NMFB and corrected for altitude.

Table 2-3: NM3 Spot Measurement Results

Date Time (PDT)	Water Temperature (°C)	DO (mg/L)	TDG (mm Hg)	NM3 BAR (mm Hg)	TDG (% of saturation)
3/23/2011 19:00	4.7	11.5	811	714	113.6
4/5/2011 16:45	4.9	13.4	846	717	118.0
4/15/2011 13:30	5.2	13.7	843	722	116.7
4/28/2011 16:15	7.0	13.0	830	717	115.7
5/18/2011 16:30	9.7	13.1	875	715	122.4
6/5/2011 17:15	12.4	12.0	858	716	119.8
6/17/2011 12:45	12.7	11.9	862	717	120.2
6/30/2011 12:45	15.3	11.1	831	719	115.5
7/19/2011 16:30	18.1	9.8	782	Not recorded	#N/A

Table 2-4: Summary of TDG Exceedances of 100 Percent of Saturation when Total Discharge was Less Than or Equal to Ecology-Specified 7Q10 of 32,000 cfs

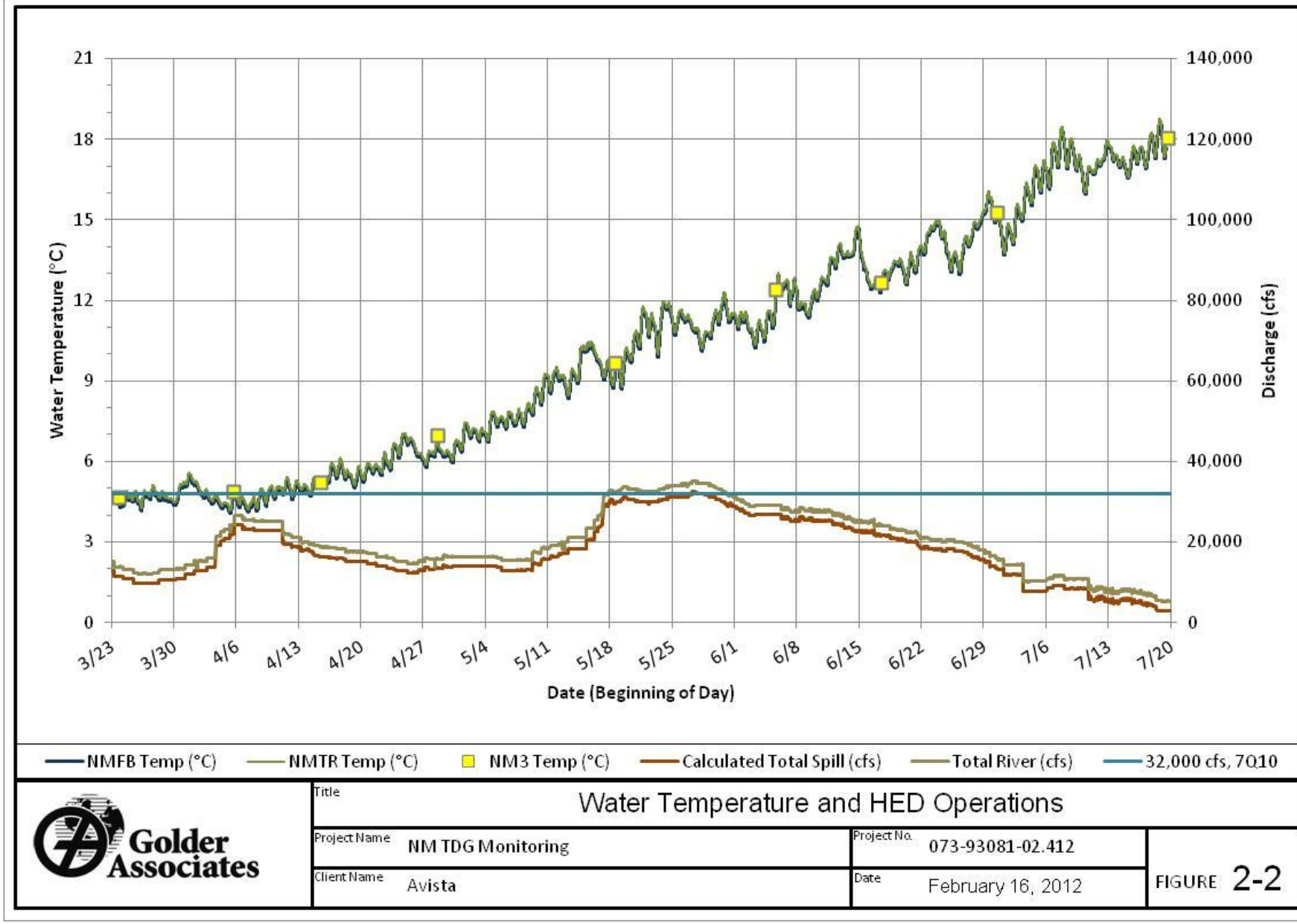
	NMFB			NMTR		
# of records that exceeded 110% saturation	9,143			8,865		
total # of records	11,272			10,389		
Periods when TDG exceeded 110% saturation (PDT)[1]	3/23/2011 15:45	to	5/17/2011 20:45	3/23/2011 17:45	to	5/17/2011 20:45
	5/31/2011 3:00	to	7/4/2011 3:30	5/31/2011 3:00	to	7/16/2011 10:30
	7/4/2011 8:30	to	7/5/2011 3:15	7/16/2011 18:45	to	7/16/2011 19:00
	7/5/2011 8:00	to	7/10/2011 2:15	7/17/2011 16:45	to	7/17/2011 23:15
	7/10/2011 11:30	to	7/10/2011 22:45	7/18/2011 18:30	to	7/18/2011 21:15
	7/11/2011 15:15	to	7/11/2011 20:00			
	7/12/2011 15:15	to	7/12/2011 20:45			

Notes:

1. Flow exceeded the 7Q10 from 5/17/2011 21:00 to 5/31/2011 02:45.

FIGURES

Figure 2-1: Photograph of Nine Mile Dam with Pneumatically Controlled Metal Gate, March 24, 2011 (approximate discharge 11,400 cfs from spillway and 13,800 cfs total)

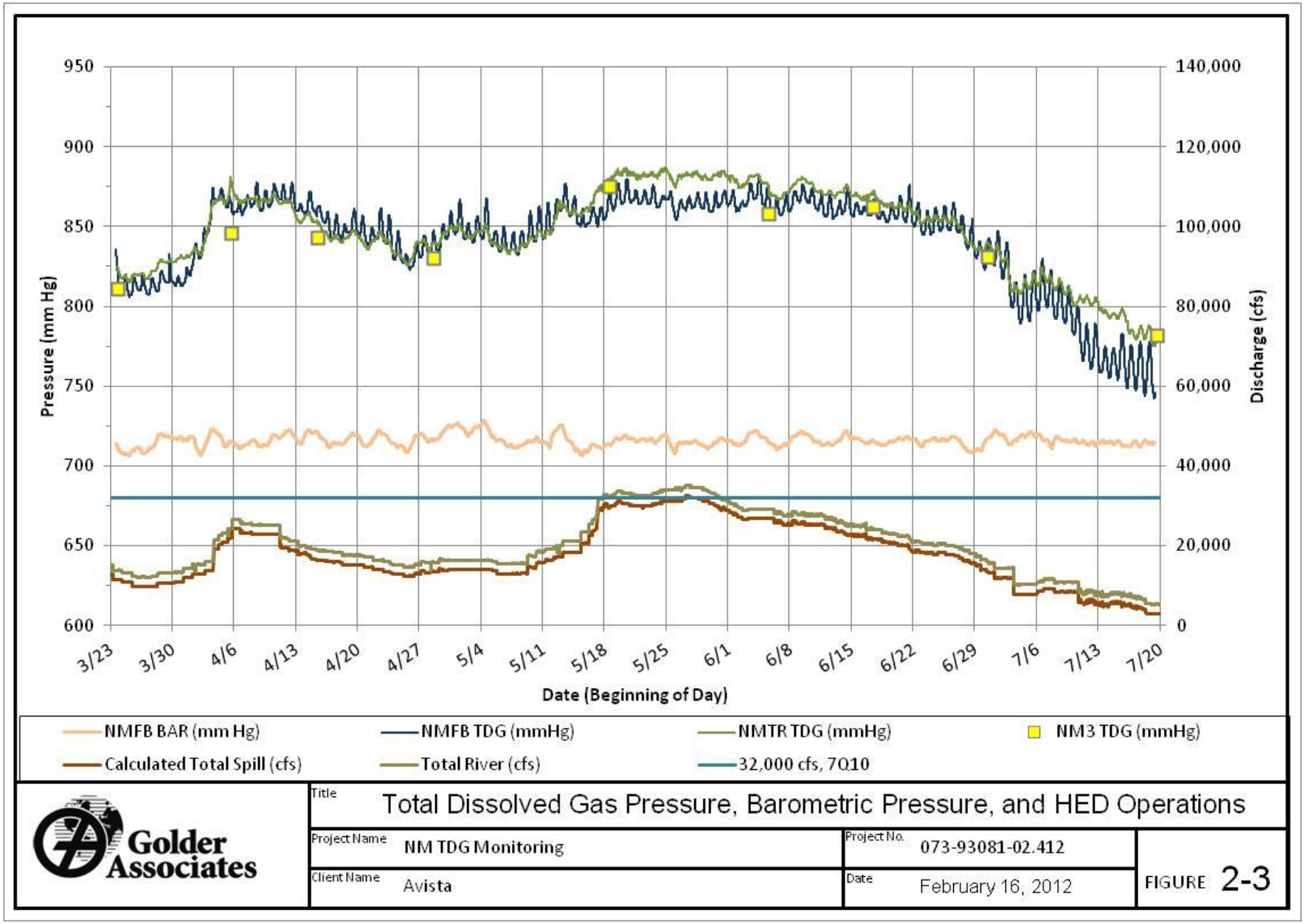


Golder Associates

Title: Water Temperature and HED Operations

Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 16, 2012

FIGURE 2-2

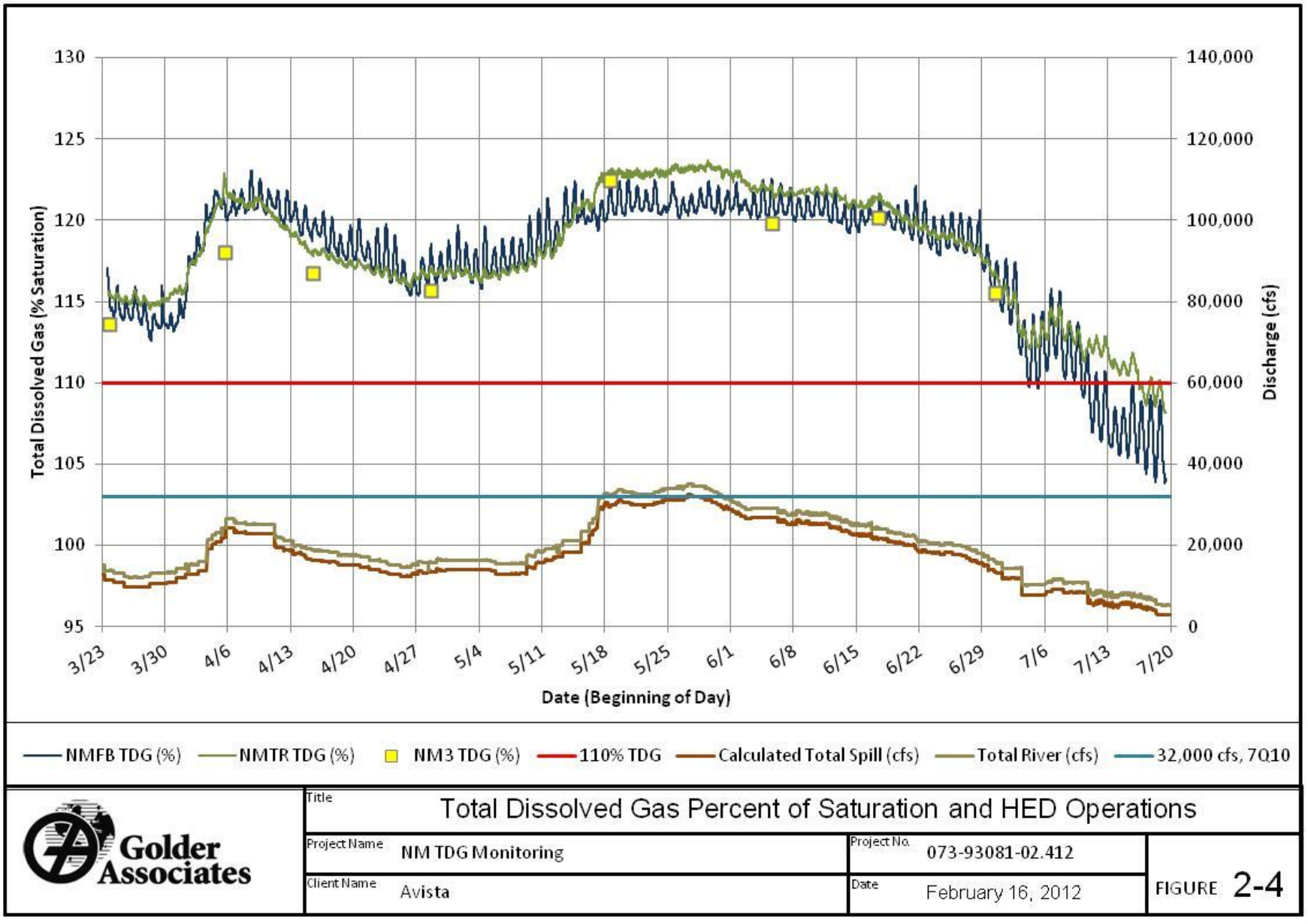


Golder Associates

Title: Total Dissolved Gas Pressure, Barometric Pressure, and HED Operations

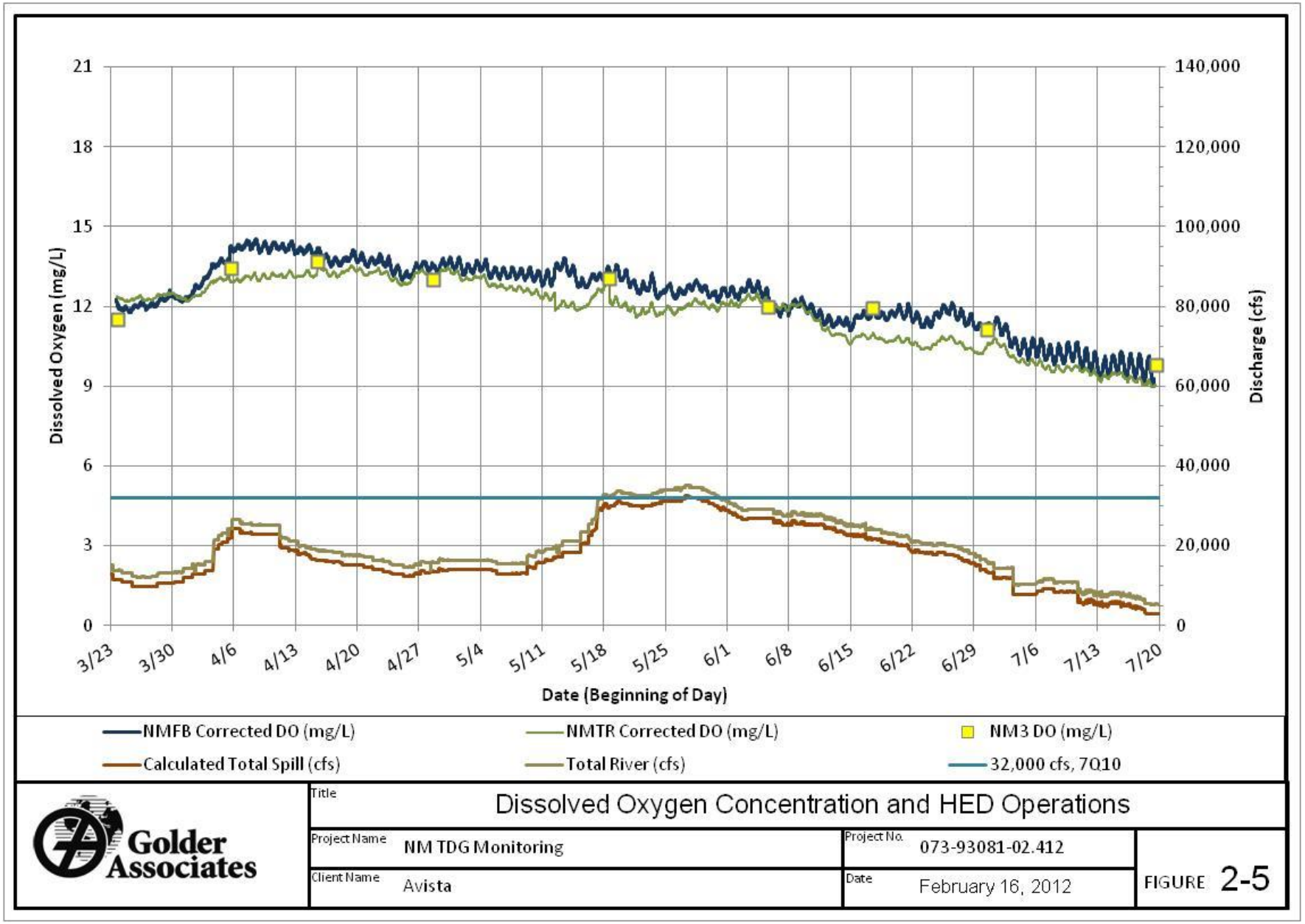
Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 16, 2012

FIGURE 2-3



Golder Associates

Title	Total Dissolved Gas Percent of Saturation and HED Operations		
Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 16, 2012
			FIGURE 2-4

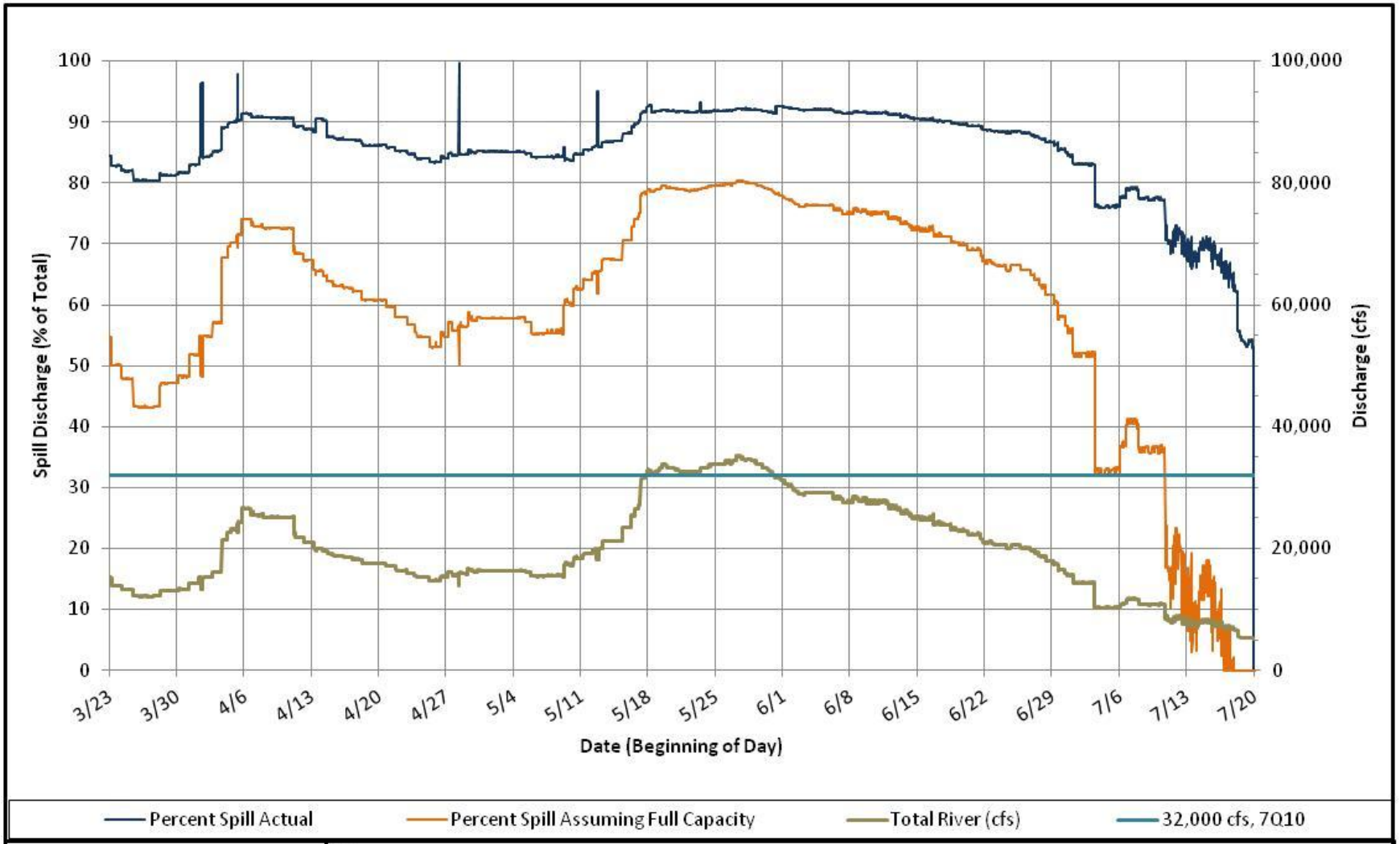


Golder Associates

Title: Dissolved Oxygen Concentration and HED Operations

Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 16, 2012

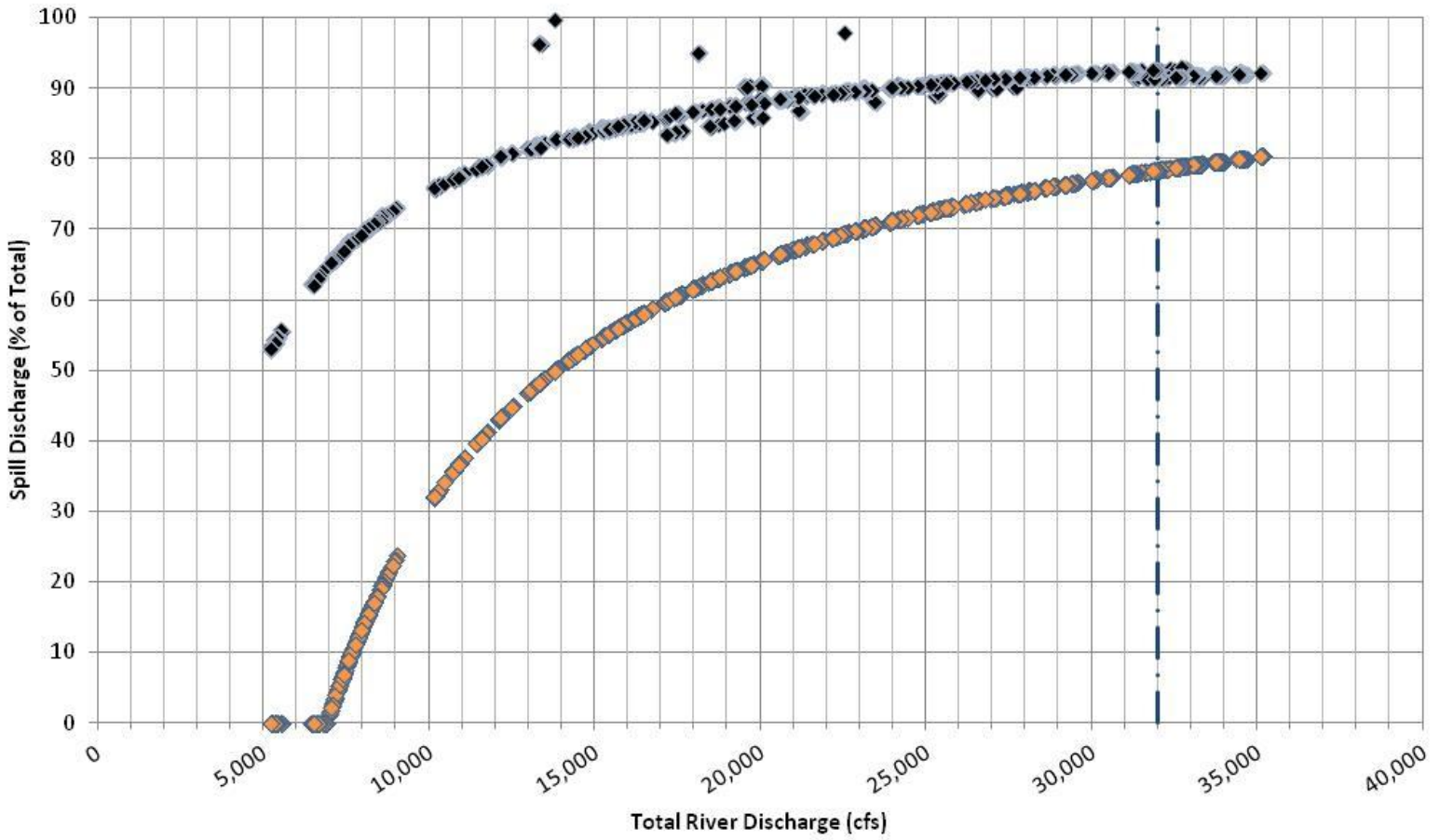
FIGURE 2-5



Golder Associates

Title	Actual and Hypothetical Spill Discharge and HED Operations		
Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 16, 2012

FIGURE 2-6



Golder Associates

Title	Actual and Hypothetical Spill Percent versus Total River Discharge		
Project Name	NM TDG Monitoring	Project No.	073-93081-02.412
Client Name	Avista	Date	February 17, 2012
			FIGURE 2-7

APPENDIX A
DATA QUALITY ANALYSIS

DATA QUALITY OBJECTIVES

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 mm Hg	±0.1 % of span	1.0 mm Hg
MS5 Dissolved Oxygen	0 to 30 mg/L	± 0.01 mg/L for 0 to 8 mg/L ± 0.02 mg/L for >8mg/L	0.01 mg/L
MS5 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 [3]

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 Washington TDG Monitoring Plan along with the same MQO for dissolved oxygen as used for the Long Lake HED tailrace DO monitoring plan.[4] 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.

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

[4] Golder Associates, Inc. 2010. Detailed Dissolved Oxygen Phase II Feasibility and Implementation Plan, Washington 401 Certification, Section 5.6(B), Spokane River Hydroelectric Project FERC Project No, 2545. Prepared for Avista Corporation. June 11, 2010.

Table A-2: Measurement Quality Objectives (MQOs)

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

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

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

	RMSE [1]			MQO			RMSE - MQO		
Meter IDs and Locations	BAR[2] (mm Hg)	Total Pressure[3] (%)	TDG[4] (%)	BAR (mm Hg)	Total Pressure (%)	TDG (%)	BAR (mm Hg)	Total Pressure (%)	TDG (%)
48762	4.10	0.58	0.59	2	1	1	2.10	-0.42	-0.41
48763	7.11	1.01	1.02	2	1	1	5.11	0.01	0.02
48764	1.04	0.15	0.15	2	1	1	-0.96	-0.85	-0.85
48765 (NMTR)	3.17	0.45	0.45	2	1	1	1.17	-0.55	-0.55
60375 (NMFB)	3.77	0.53	0.54	2	1	1	1.77	-0.47	-0.46
Overall RMSE	3.58	0.51	0.51	2	1	1	1.58	-0.49	-0.49

Notes:
Shaded values indicate exceedance of MQO.
[1] Pooled RMSE calculated at each station during service period and removal.

[2] Pooled RMSE calculated from BAR record at station during service period and removal as compared to the TDG in air uncorrected reading.

[3] Pooled RMSE calculated as the difference in TDG in air uncorrected minus the BAR, then divided by the TDG and multiplied by 100%.

[4] Pooled RMSE calculated at each station during service period and removal. TDG calculated as TDG in air uncorrected divided by the BAR and multiplied by 100%.
N/A - Not available, measurement not taken.

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

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

Part 2: Temperature and Dissolved Oxygen (DO)

	RMSE		MQO		RMSE - MQO	
Meter IDs and Locations	**Temp[1] (°C)**	**DO[2] (mg/L)**	**Temp (°C)**	**DO (mg/L)**	**Temp[1] (°C)**	**DO[2] (mg/L)**
48762	0.17	1.13	0.5	0.5	-0.33	0.63
48763	0.24	0.01	0.5	0.5	-0.26	-0.49
48764	0.20	1.23	0.5	0.5	-0.30	0.73
48765 (NMTR)	0.22	0.56	0.5	0.5	-0.28	0.06
60375 (NMFB)	0.19	0.43	0.5	0.5	-0.31	-0.07
Overall RMSE	0.20	0.82	0.5	0.5	-0.30	0.32

Notes:
Shaded values indicate exceedance of MQO.
[1] Pooled RMSE calculated from temperature record at station during service period and removal. Temperature calibration based on the difference between the meter and calibration thermometer in a water bath.
[2] Calculated RMSE as difference of the pre-calibration measurement and 100% saturation. Initial factory calibration included in analysis.

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. During the pre-deployment MS5 mass verification calibration event,[5] the TDG sensor in air was calibrated using barometric pressure that was incorrectly adjusted for altitude. Following this event, a spreadsheet was prepared and used to ensure correct calculation of BAR from weather station and barologger data. Before use for this monitoring study, all MS5s were recalibrated using the correct local barometric pressure.

Precision

Precision refers to the degree of variability in replicate measurements. Instrument precision was evaluated through the calibration and maintenance activities. MQOs for total pressure and TDG% were met for both meters used for long-term deployments and all but one of the MS5s used for spot measurements. MS5 48763, which slightly exceeded the MQO for both TDG and TDG%, was only used for spot measurements on March 23. However, BAR, the difference between the local barometric pressure and TDG sensor in air, did not meet the MQO of 2 mm Hg for any of the MS5s, due to using an incorrect barometric pressure for the first calibration event. TDG pressure data were corrected by adding the difference between the local barometric pressure and the corresponding value used to calibrate the TDG sensor, and data quality code assigned to track this situation.

The 0.5°C water temperature MQO was met by all MS5s; whereas, only two MS5s met the 0.5-mg/L DO MQO. The DO MQO was met by the long-term MS5 for NMFB, was slightly exceeded by the long-term MS5 for NMTR, and had greater exceedances for the MS5s used for spot measurements.

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

[5] The Pre-deployment MS5 mass verification calibration event was conducted at Post Falls HED.

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 TDG monitoring study, the MS5s underwent verification procedures. All differences between TDG pressure, dissolved oxygen, 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 TDG 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 long-term monitoring stations (NMFB and NMTR) that have been monitored in the past. Establishing a new spot monitoring station further downstream (NM3) will increase the comparability of data collected in 2011 with data collected for this study in future years.

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 TDG data collection period consisted of 11,320 15-minute periods. Data completeness met the goal of at least 90 percent for both NMFB and NMTR.

Table A-5 summarizes the number of specific DQCodes applied to NMFB and NMTR data.

Table A-4: Project Completeness

	NMFB		NMTR	
	Count	**Completeness (%)**	**Count**	**Completeness (%)**
Monitoring Period	11,320	--	11,320	--
Water Temperature (°C)	11,299	100%	10,439	92%
DO (mg/L)	11,293	100%	10,437	92%
BAR (mm Hg)	11,307	100%	used NMFB BAR	
TDG (mm Hg)	11,281	100%	10,407	92%
TDG (% saturation)	11,272	100%	10,389	92%

Table A-5: Number of Specific DQCodes During Monitoring Period

DQ Code	DQ Code Description	NMFB							NMTR				
		Temp (°C)	TDG (mmHg)	Depth (m)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)	Temp (°C)	TDG (mmHg)	Depth (m)	DO (mg/L)	Batt (volts)
-105	Data appear representative, although battery less than "minimum operating voltage" (<9 volts)	542	542	542	540	542	--	--	--	--	--	--	--
104	Zero recorded for unknown reason	--	--	--	--	--	--	--	--	--	--	1	--
301	Unrealistic DO value, suspect bad sensor or water under the cap	--	--	--	2		--	--	--	--	--	--	--
599	Suspect out of water based on depth	--	--	--	--	--	--	--	1	1	1	1	--
992	Out of water/moved for downloading data	1	1	1	1	1	2	8	--	--	--	--	--
993	Out of water for calibration/servicing	16	16	16	16	16	--	--	22	22	22	22	22
996	No data reported by instrument even though programmed correctly	--	--	--	--	--	7	7	846	846	846	846	846
997	Suspect not yet equilibrated after deployment	1	19	1	5	--	3	7	3	35	3	4	--
998	Out of water after recovery	--	--	--	--	--	--	--	1	1	1	1	1

Table A-5: Number of Specific DQCodes During Monitoring Period

DQ Code	DQ Code Description	NMFB							NMTR				
		Temp (°C)	TDG (mmHg)	Depth (m)	DO (mg/L)	Batt (volts)	Level (m H2O)	ATemp (°C)	Temp (°C)	TDG (mmHg)	Depth (m)	DO (mg/L)	Batt (volts)
999	Out of water before deployment	3	3	3	3	3	--	--	--	--	--	--	--
No DQ Code		10,757	10,739	10,757	10,753	10,758	11,308	11,298	10,447	10,415	10,447	10,445	10,451
Monitoring Period[1]		11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320

Notes:

[1] Monitoring period for NMFB was from 3/23/2011 14:30 to 7/19/2011 12:15. Monitoring period for NMTR was from 3/23/2011 16:45 to 7/19/2011 14:30.

APPENDIX B
CONSULTATION RECORD

2/8/2012

Marcie Mangold
Department of Ecology
4601 N Monroe St.
Spokane, WA 99205-1295

RE: TDG at Nine Mile HED

Dear Ms. Mangold,

Based on our telephone conversation with you and Chad Brown on February 6, 2012 I am following up with this written request. As we discussed, Nine Mile Hydroelectric Development (HED) had numerous equipment issues in 2011. These included damaged thrust bearings on turbine units 1 and 2, a cracked runner on unit 4, and a plugged sediment by-pass tube. This resulted in lost generation and abnormally high spills at the HED. Although the runner on unit 4 has been repaired and it now is operational, the other conditions will persist through 2012.

Under our current Spokane River Project License Amendment we expect to replace turbine units 1 and 2 within the next few years, although the exact schedule has yet to be fully defined. The new turbines will pass more water than the current ones do and when coupled with an operational sediment by-pass tube will reduce the amount of spilled water, thereby reducing Total Dissolved Gas (TDG) levels to those of a more normal operational year.

The enclosed graph illustrates the effect of higher than normal spill volumes on TDG production that we experienced at the Nine Mile HED during 2011. As we discussed, this data is not representative of normal plant operations with all four turbines and the sediment by-pass tube operational. Given that abnormal conditions may persist for several more years, Avista is requesting that TDG monitoring, as required by the Spokane River Project License, Appendix B, Section 5.4.C of the Washington 401 Water Quality Certification be suspended until plant operations return to normal. This request would also suspend the associated requirement for producing a TDG water quality attainment plan for the HED until representative data can be collected.

Avista expects to fully meet the HED's TDG requirements and once the plant operations return to normal two years of data will be collected at flows of 25,400 cfs or higher in accordance with Appendix B, Section 5.4.C of the License. At that time we will work with Ecology to best determine how to proceed with a TDG water quality attainment plan.

Thank you for considering this request. If you have any questions please feel free to call me at (509) 495-4613.

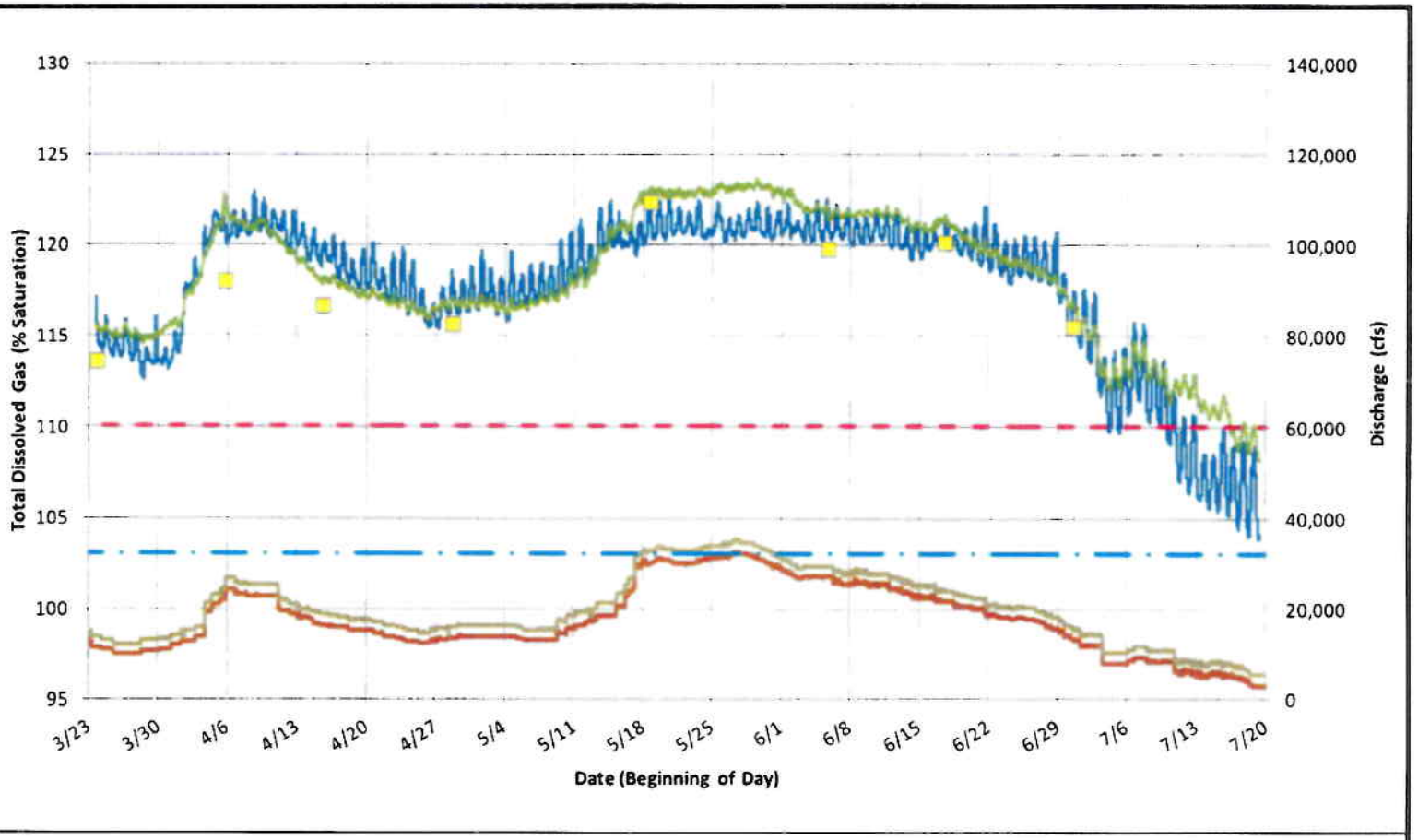
Sincerely,

Hank Nelson

Hank Nelson
Environmental Coordinator

Enclosure

C: Speed Fitzhugh, Avista



Golder Associates

Title: Total Dissolved Gas Percent of Saturation and HED Operations			
Project Name: NM TDG Monitoring		Project No: 073-93081-02.412	FIGURE 2-4
Client Name: Avista		Date: October 20, 2011	

FEB 20 2012

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

February 17, 2012

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

RE: Request for delay in Total Dissolved Gas monitoring – Spokane River Hydroelectric Project No. 2545 Nine Mile Falls Hydroelectric Development Total Dissolved Gas Monitoring – Washington 401 Certification, Section 5.4(C)

Dear Mr. Fitzhugh:

We have received Mr. Hank Nelson's letter dated February 8, 2011, regarding a request for a delay in total dissolved gas (TDG) monitoring at your Nine Mile Hydroelectric Development. We thank you for your time and for meeting with us regarding this matter.

Upon reviewing the TDG data presented to the Department of Ecology (Ecology) for the 2011 monitoring season, and Avista's Spokane River Hydroelectric Project Federal Energy Regulatory Commission (FERC) License Amendment issued September 16, 2011; Ecology is delaying the Total Dissolved Gas (TDG) monitoring requirement under Section 5.4(C) under the 401 Certification.

The TDG monitoring requirement under Section 5.4(C) of the 401 Certification will resume the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine/generator Units 1 and 2, as required in your amended FERC License. These actions will insure that Nine Mile is operating under normal Project operations prior to resuming TDG monitoring.

The current schedule in the amended FERC Order directs you to begin construction within two years or by September 16, 2013, and complete construction within four years or by September 16, 2015. With this schedule, Ecology requests that Avista provide a written update on the progress of turbine removal and replacement by September 1, 2014, and to resume TGD monitoring at the Nine Mile Hydroelectric Development during the first season following completion of the turbine/generator replacement project.

Again, we thank you for your time and coordination with this matter. Please feel free to contact me 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
Hank Nelson, Avista
James M. Bellatty, Ecology/WQP
David Moore, Ecology/WQP

AVISTA

2/17/2012

Marcie Mangold
Department of Ecology
4601 N Monroe Street
Spokane, WA 99205

In accordance with Avista's Federal Energy Regulatory Commission (FERC) June 18, 2009 Spokane River Project (FERC No. 2545) License Avista is submitting the following reports for your review and comment.

Annual Total Dissolved Gas Attainment and Monitoring Report for the Long Lake Development. There are two related components to this report.

A. *Annual Total Dissolved Gas Monitoring Report for 2011, Golder Associates, Dec. 2011.* As required by the Total Dissolved Gas (TDG) Water Quality Attainment Plan (WQAP) and the Washington TDG Monitoring Plan, this report provides the results of monitoring TDG at Long Lake HED and Nine Mile HED during 2011. Avista proposes to continue implementing the same monitoring plan at Long Lake HED in 2012. However, during 2011 the Nine Mile HED was plagued with numerous equipment issues which resulted in lost generation and increased spill. As a result, Avista proposed to delay monitoring until operations at the plant return to normal. Ecology agreed with this proposal and in their correspondence dated February 17, 2012 suspended TDG monitoring until the first season following completion of the Unit 1 and 2 turbine/generator replacement project and the sediment by-pass tube is again fully operational. This correspondence is attached.
B. *Long Lake Dam TDG Abatement Feasibility Phase III, Physical Model Study, 2011 Interim Report. Northwest Hydraulic Consultants, Jan. 2012.* This report documents the progress of building the physical model and hydraulic testing deflectors on the modeled Long Lake Dam spillway. Avista proposes to continue the modeling of the stepped weir alternative identified in the Phase II study during 2012. In addition, a third alternative termed the Noxon Concept (dentated spillway) will be developed including preliminary hydraulic design calculations, civil engineering, drawings, and cost estimates. Once these items are completed, Avista will be able to determine if the design should be modeled. Avista believes this effort could also be completed in 2012.

Annual Long Lake Tailrace Dissolved Oxygen Monitoring Report. This is the first annual report required under the FERC approved Dissolved Oxygen (DO) Feasibility and Implementation Plan. Monitoring DO took place from July 1st through October 31, 2011. The report illustrates the seasonal changes in DO just downstream of the dam during the low flow period of the year. In order to boost DO levels in the river, Avista installed manual aeration equipment on turbine Units 3 and 4. The results of aerating the turbine discharge water with the aeration equipment during generation are included in this report. This was Avista's first effort to implement the system, which had been tested in 2010. The results were encouraging. Avista proposes to automate the components of the system in 2012, which will allow for a more thorough, and effective aeration effort and assessment.

Avista would appreciate your review of the attached reports by March 21, 2012. This 30 day review period should allow Avista enough time to address your comments prior to submitting the reports to

FERC for their review and approval. Please feel free to call me anytime if you have questions or concerns.

Sincerely,

Hank Nelson

Hank Nelson
Environmental Coordinator

Enclosures

CC: Brian Crossley, Spokane Tribe

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

March 21, 2012

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
Nine Mile Falls Hydroelectric Development Total Dissolved Gas Monitoring Report
Washington 401 Certification, Section 5.4(C).

Dear Mr. Fitzhugh:

The Department of Ecology (Ecology) has reviewed the Nine Mile Falls Hydroelectric Development Total Dissolved Gas Monitoring Report mailed to us on February 22, 2012 and would like to provide the following comments:

Avista requested a delay in their TDG monitoring requirement until the Nine Mile HED is fully operational, which was approved by Ecology on February 17, 2012. The data that Avista collected in 2010, however, does help establish representative data for when the HED was only operating around 38 percent of its normal hydraulic capacity.

We currently do not have any comments on monitoring protocol or collection methods.

The TDG monitoring requirement under Section 5.4(C) of the 401 Certification will resume the first season following the removal of sediment in front of the sediment bypass intake and the replacement of turbine/generator Units 1 and 2, as required in your amended FERC License. These actions will insure that Nine Mile is operating under normal Project operations prior to resuming TDG monitoring.

We look forward to reviewing the reports and data once Nine Mile HED is once again up and running under normal operations. Thank you for the opportunity to comment. Please feel free to contact me by phone at (509) 329-3450 or 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
Hank Nelson, Avista
David Moore, Ecology/WQP

Nelson, Hank

From: Brian Crossley [crossley@spokanetribe.com]
Sent: Wednesday, March 21, 2012 4:23 PM
To: Nelson, Hank
Subject: TDG Long Lake and 9 mile and TDG abatement Phase III

9 mile TDG report- I agree- the data was not collected under "normal" conditions . Are the gates working good this year?

Phase III TDG abatement feasibility - I liked the idea that they constructed multiple level flip-lip that allows Avista some flexibility in managing flows and also that they are constructed across the entire spillway.

I presume the stepped model will be presented after they are done....

I have not read the DO report yet; I will get you comments on that tomorrow if I have any.

Brian