Priest Rapids Hydroelectric Project (P-2114)

SUMMARY OF 2009 WATER QUALITY MONITORING RESULTS WITHIN THE PRIEST RAPIDS HYDROELECTRIC PROJECT

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Executive Summary

This report provides results and summaries of water quality monitoring efforts that Public Utility District No. 2 of Grant County, Washington (Grant PUD) conducted in 2009 in accordance with conditions of the 401 Water Quality Certification (WQC) issued by the Washington Department of Ecology (WDOE) and the approved Quality Assurance Project Plan (QAPP) for the Priest Rapids Hydroelectric Project (Project). Water quality parameters monitored in 2009 included total dissolved gas (TDG; mm Hg), water temperature (°C), dissolved oxygen (DO; mg/L), pH (units), and turbidity (NTU). Monitoring methods and quality assurance/quality control procedures followed protocol described in the QAPP (Hendrick 2009a). Section 6.8.3 of the 401 WQC requires Grant PUD to provide the results of the monitoring efforts as well as a summary of those results by March 1 of the year following the monitoring activities.

Water quality monitoring conducted in 2009 was done at Grant PUD's Fixed Site Water Quality Monitoring (FSM) stations. The purpose of monitoring water quality parameters within the Project was to continue to provide information on water quality conditions and to verify compliance with applicable water quality standards and conditions within the WDOE 401 WQC and QAPP.

Results of Grant PUD's 2009 water quality monitoring effort indicated 19 exceedances of the 110% TDG standard during the non-fish spill season. In general, water temperatures peaked during the months of July through September with some daily maximum values greater than 20°C. In 2013 and in accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), Grant PUD will conduct temperature modeling to determine Grant PUD's contribution, if any, to water temperature values recorded from 2008–2012 that were above WDOE water quality standards. Grant PUD's 2009 water quality periodic monitoring efforts at each FSM station indicated DO between 9.4 and 13.8 mg/L, pH from 6.8 to 8.5 units, and turbidity between 0.0 and 6.8 NTUs. Grant PUD will continue its hourly TDG and water temperature monitoring as well as periodic DO, pH, and turbidity monitoring at its FSM stations in 2010, according to conditions contained in the 401 WQC (WDOE 2007) and QAPP (Hendrick 2009a).

Table of Contents

List of Figures

List of Tables

List of Appendices

Terms and Abbreviations

7-DADMax	7-day average of the daily maximum temperatures
Corps	U.S. Army Corps of Engineers
DCP	data collection platform
DO	dissolved oxygen
EPA	Environmental Protection Agency
Grant PUD	Public Utility District No. 2 of Grant County, Washington
FERC	Federal Energy Regulatory Committee
FSM	fixed-site monitoring
kcfs	thousand cubic feet per second
MW	megawatt
mg/L	milligrams per liter
mm Hg	millimeters of mercury
NTU	Nephelometric Turbidity Unit
Project	Priest Rapids Hydroelectric Project
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
Stdev	Standard deviation
TDG	total dissolved gas
TMDL	total maximum daily load
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology
WQC	water quality certification

1.0 Introduction

Public Utility District No. 2 of Grant County, Washington (Grant PUD) owns and operates the Priest Rapids Hydroelectric Project (Project), located along the Columbia River in central Washington. The Project is authorized by the Federal Energy Regulatory Commission (FERC) under Project No. 2114 and includes Wanapum and Priest Rapids dams. A 401 Water Quality Certification (WQC) for the operation of the Project was issued by the Washington State Department of Ecology (WDOE) on April 3, 2007 and amended on March 6, 2008. The WQC's terms and conditions were directly incorporated into the FERC license (license) to operate the Project on April 17, 2008. Various sections of the 401 WQC require Grant PUD to monitor total dissolved gas (TDG, mm Hg), water temperature (°C), dissolved oxygen (DO, mg/L), pH (units), and turbidity (NTU) throughout the Project (WDOE 2007). Section 6.7.3 of the WQC requires Grant PUD to provide WDOE with water quality monitoring results, along with a summary report, by March 1 of each year.

The following report provides the results of Grant PUD's water quality monitoring efforts in 2009, including a summary of those results, according to Section 6.7.3 of the 401 WQC. Water quality data was collected, analyzed, reported, and instruments maintained as defined in Grant PUD's WDOE approved Quality Assurance Project Plan (Hendrick 2009a), which contains elements of sampling frequency, procedures, equipment, analytical methods, quality control, data handling and assessment procedures, and reporting protocols (see Section 2).

2.0 Quality Assurance Project Plan

The water quality data summarized in this report was collected in accordance with a Quality Assurance Project Plan (QAPP), titled *"Quality Assurance Project Plan for Monitoring Selected Water Quality Parameters within the Priest Rapids Hydroelectric Project"*(Hendrick 2009a). The QAPP was approved by WDOE on January 30, 2009 and FERC on July 16, 2009. The QAPP provides details on water quality monitoring methods that Grant PUD plans to implement to meet conditions of the 401 WQC issued by WDOE. Water quality parameters that are being monitored under the QAPP include TDG, water temperature, DO, pH, and turbidity. Water quality monitoring conducted under the QAPP will be done via Grant PUD's Fixed Site Water Quality Monitoring (FSM) program. Information provided in the QAPP includes the following:

- Purpose and objectives of the FSM program
- List of parameters to be monitored
- Organization and schedule
- Data quality objectives
- Descriptions and maps of the monitoring locations
- Monitoring methods, procedures, and equipment
- Analytical methods
- Quality control procedures, including descriptions of calibration, maintenance, and data handling and assessment procedures
- Reporting protocols

- Provisions for adaptive management

The purpose of Grant PUD's FSM program is to continue to provide information on water quality conditions within the Project, as well as verify compliance with applicable water quality standards and conditions within the WDOE 401 WQC. Implementation of the QAPP helps assure that water quality data collected by the FSM program is of sufficient quality. Adaptive management provisions in the QAPP helps determine potential changes to monitoring methods, locations, etc. that may be needed, and annual updates will be made to the QAPP as necessary, subject to WDOE and FERC approval. The current QAPP for the FSM program can be found at: http://www.gcpud.org/resources/resLandWater/waterQuality.htm.

2.1 Priest Rapids Project Description

The Project is located on the Columbia River in central Washington state (Figure 1). From its headwaters in Canada, the Columbia River extends for 1,214 miles, with 460 miles in Canada and 754 miles in the United States. The Columbia River watershed drains an area of approximately 258,500 square miles in the Pacific Northwest. The following states and provinces comprise the majority of the Columbia River Basin: Washington, Oregon, and Idaho, the western portion of Montana, the southeastern portion of British Columbia, and small areas of Wyoming, Nevada, and Utah. For additional information regarding the Project, see the QAPP (Hendrick 2009a).

2.1.1 Wanapum Development

Wanapum Dam consists of a 14,680-acre reservoir and an 8,637-foot-long by 186.5-foot-high dam spanning the river. The dam consists of left and right embankment sections; left and right concrete gravity dam sections; a left and right fish passage structure, each with an upstream fish ladder; a gated spillway; an intake section for future generating units; a downstream fish passage structure in one of the unused intake sections (unit No. 11); and a powerhouse containing 10 vertical shaft integrated Kaplan turbine/generator sets with a total authorized capacity of 1,258 MW (Figure 2).

2.1.2 Priest Rapids Development

Priest Rapids Dam consists of a 7,725-acre reservoir and a 10,103-foot-long by 179.5-foot-high dam spanning the river. The dam consists of left and right embankment sections; left and right concrete gravity dam sections; a left and right fish passage structure each with an upstream fish ladder; a gated spillway section; and a powerhouse containing 10 vertical shaft integrated Kaplan turbine/generator sets with a total authorized capacity of 855 MW (Figure 3).

Figure 1 **Priest Rapids Hydroelectric Project Boundary and associated Transmission Line Right-of-Way, mid-Columbia River, WA.**

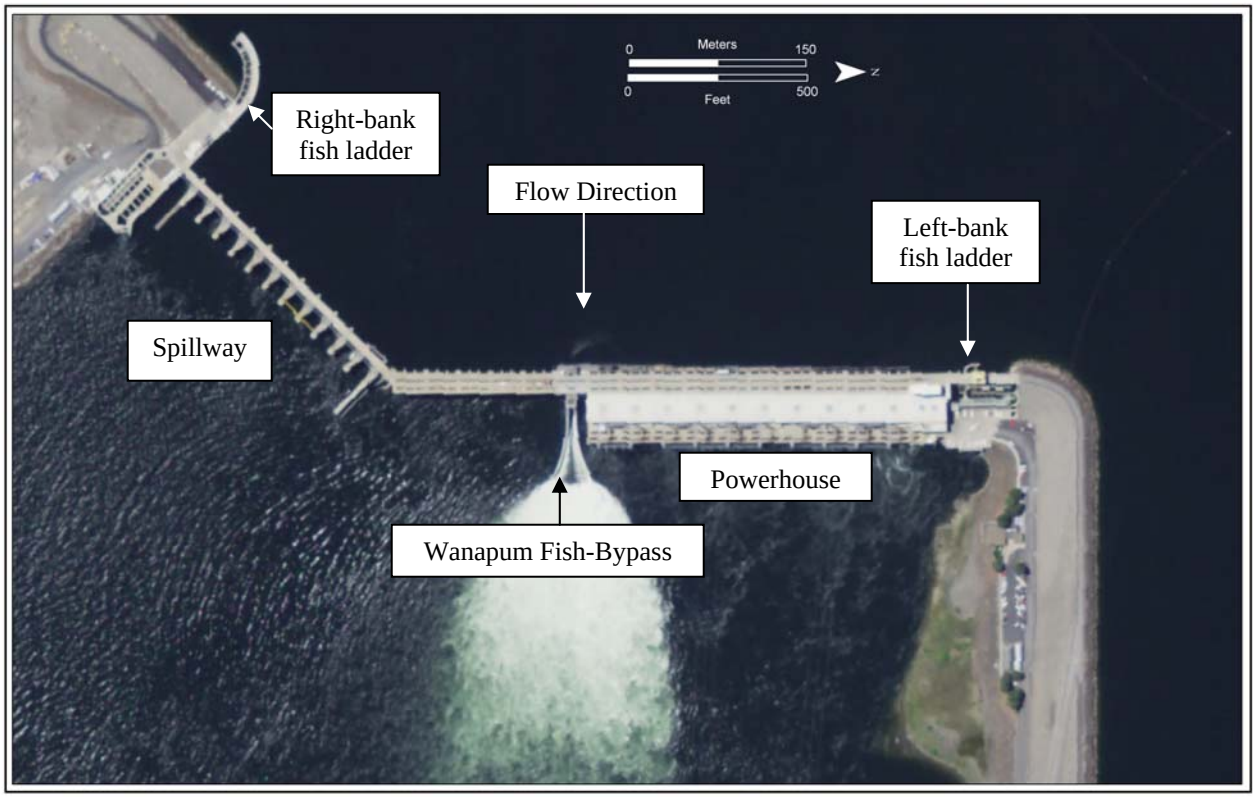

Figure 2 Aerial photograph of Wanapum Dam, mid-Columbia River, WA.

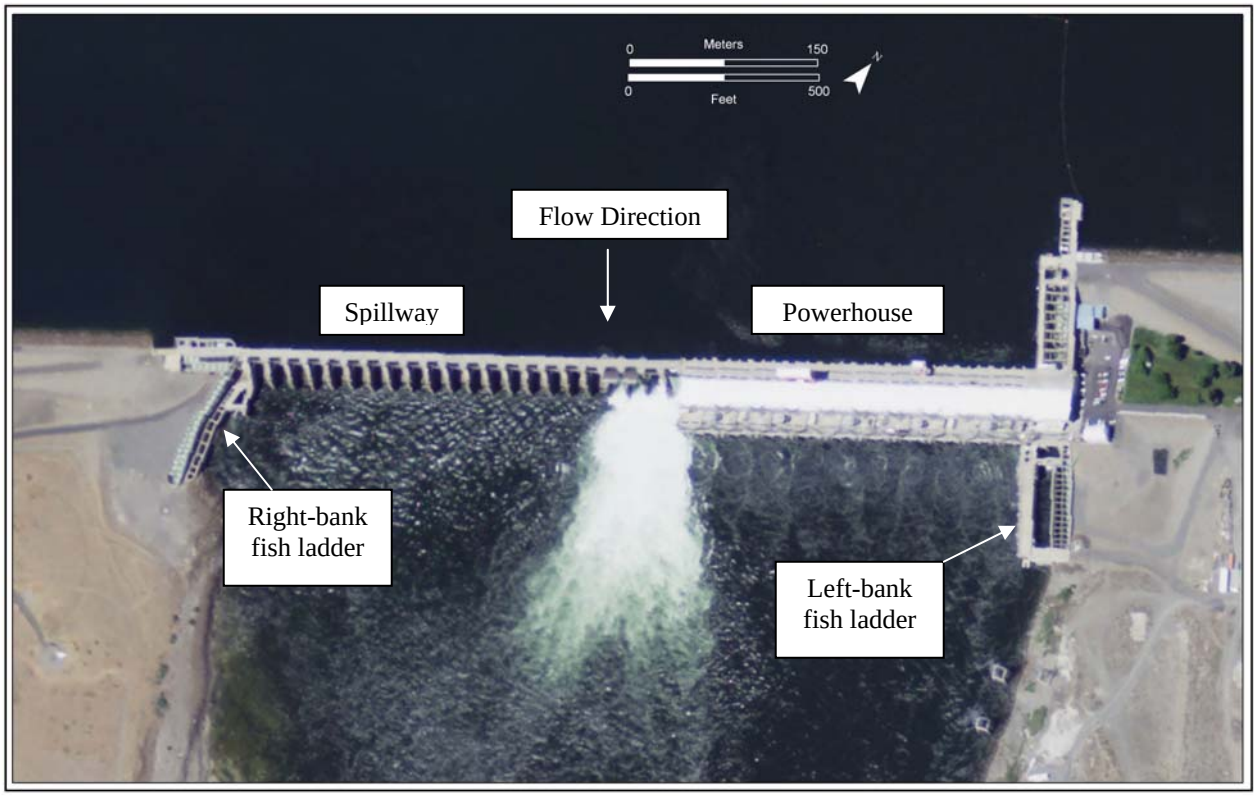

Figure 3 Aerial photograph of Priest Rapids Dam, mid-Columbia River, WA.

2.2 Regulatory Framework

Section 6.0 of the 401 WQC (WDOE 2007) contains water quality conditions that Grant PUD must follow, many of which require regular monitoring of TDG, temperature, DO, pH, and turbidity. The following sections detail the water quality monitoring requirements and numeric standards for each parameter monitored.

2.2.1 Total Dissolved Gas

Washington state water quality standards for TDG during the non-fish and fish-spill seasons are established by WDOE (see Washington Administrative Code (WAC) 173-201A-200(1)(f)). The current standard for TDG (in percent saturation) during the non-fish spill season (September 1 through March 31) is 110 percent for any hourly measurement. The current standard for TDG (in percent saturation) during the fish-spill season (April 1 through August 31) is 120 percent in the tailrace of the dam spilling water for fish and 115 percent in the forebay of the next downstream dam, based on the average of the 12 highest consecutive hourly readings in a 24-hour period. A 1-hour, 125 percent maximum standard for TDG also applies throughout the Project during the fish-spill season.

Section 6.4.10 of the 401 WQC requires Grant PUD to maintain a TDG monitoring program at its FSM's throughout the year, and that TDG measurements shall occur on an hourly basis. Monitoring results shall be made available electronically to the public "…as close to the time of occurrence as technology will reasonable allow" (WDOE 2007). In addition, Grant PUD shall provide WDOE with an annual TDG and fish-spill summary report.

2.2.2 Water Temperature

WAC 173-201A-602 designates the section of the Columbia River within the Project as salmonid spawning, rearing, and migration, and therefore water temperature must remain below 17.5°C, as measured by the 7-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. In addition, WAC 173-201A-602 provides that temperatures below Priest Rapids Dam shall not exceed a maximum daily (1-DMax) of 20.0°C due to human activities. When natural conditions exceed a 1-DMax of 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed $t = 34/(T + 9)$. In 2013 and in accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), Grant PUD will conduct temperature modeling to determine Grant PUD's contribution, if any, to water temperature values recorded from 2008–2012 that were above WDOE water quality standards. Portions of the Columbia River within the Project are currently classified as impaired for temperature under Section 303(d) of the Clean Water Act. Portions of the Columbia River upstream of the Project also are currently classified as impaired for temperature. WDOE has indicated that a Total Maximum Daily Load (TMDL) for temperature is expected to be developed by the Environmental Protection Agency (EPA) that will establish a final wasteload and load allocation for temperature (WDOE 2007).

2.2.3 Dissolved Oxygen, pH, and Turbidity

The water quality criteria for DO within the Project require that DO be greater than 8.0 milligrams per liter (mg/L). When DO is lower than the criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(d)).

WAC 173-201A-200(1)(g) provides that pH shall be within the range of 6.5 to 8.5 units with a human-caused variation within the above range of less than 0.5 units.

WAC 173-201A-200(1)(e) provides that turbidity levels shall not be >5 Nephelometric Turbidity Unit (NTU) over background turbidity when the background is 50 NTU or less.

3.0 Fixed Site Monitoring Program

Grant PUD currently operates and maintains four water quality FSM stations that record water depth (m), barometric pressure (mm Hg), TDG (mm Hg), temperature (°C), DO (mg/L), pH (units), and turbidity (NTU). Barometric pressure, TDG, and temperature are monitored on an hourly basis throughout the year, while DO, pH, and turbidity are monitored once every two or three weeks throughout the year. Each Grant PUD FSM station is equipped with a Hydrolab® Corporation Model DS5X, DS5, DS4a, MS5, or MS4a multi-parameter water quality probe that is enclosed in a submerged perforated conduit pipe. The multi-parameter probes (multi-probes) contain individual TDG, temperature, DO, pH, and turbidity sensors that are connected to a central housing system that allows for single connections, readouts, downloads, and power supplies for up to 15 water quality sensors. At Grant PUD's FSM stations, the multi-probes are connected to an automated system that allows Grant PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. A certified barometer located at each FSM provides the barometric pressure readings necessary to correct the partial pressure readings taken by the multi-probes (and convert TDG mm Hg to percent saturation). The multi-probes are also used to conduct periodic grab sampling of DO, pH, and turbidity and to collect quality assurance/quality controls (QA/QC) measurements at each FSM.

The data logging system at each of Grant PUD's FSM stations consist of the same basic equipment. This includes the multi-probe enclosed in a submerged perforated conduit or standpipe, which is connected to a Sutron® Corporation 9210 data collection platform (DCP). Multi-probes are interrogated hourly (at the top of the hour) and data is archived within the DCP. The DCPs data are then interrogated via radio transmission into Grant PUD's fiber-optic network, which then transfers the data into a secure database (using Sutron's XConnect® database software). Duplicates of the raw data are made available to Grant PUD's water quality web-site at http://www.gcpud.org/resources/resLandWater/waterQuality.htm (Grant PUD 2009). For additional information regarding the FSM program, see the QAPP (Hendrick 2009a).

4.0 Results

The following sections provide a summary of water quality monitoring results for 2009. The hourly data can be obtained from Grant PUD's water quality web-site (Grant PUD 2009). Note that a summary of TDG data collected during the 2009 fish-spill season were presented in

Hendrick (2009b), as required in Section 6.4.11 of the 401 WQC; therefore, those summary results are not presented in this report.

4.1 Description of 2009 Flow Characteristics

Mean daily discharge during 2009 was compared to the 10-year average (Figure 4), as measured at the U.S. Geological Survey (USGS) Streamflow gage #12472800 located 2.6 river miles downstream of Priest Rapids Dam. In general, 2009 mean daily discharges were lower than the 1998–2008 average (about 11 percent lower on average).

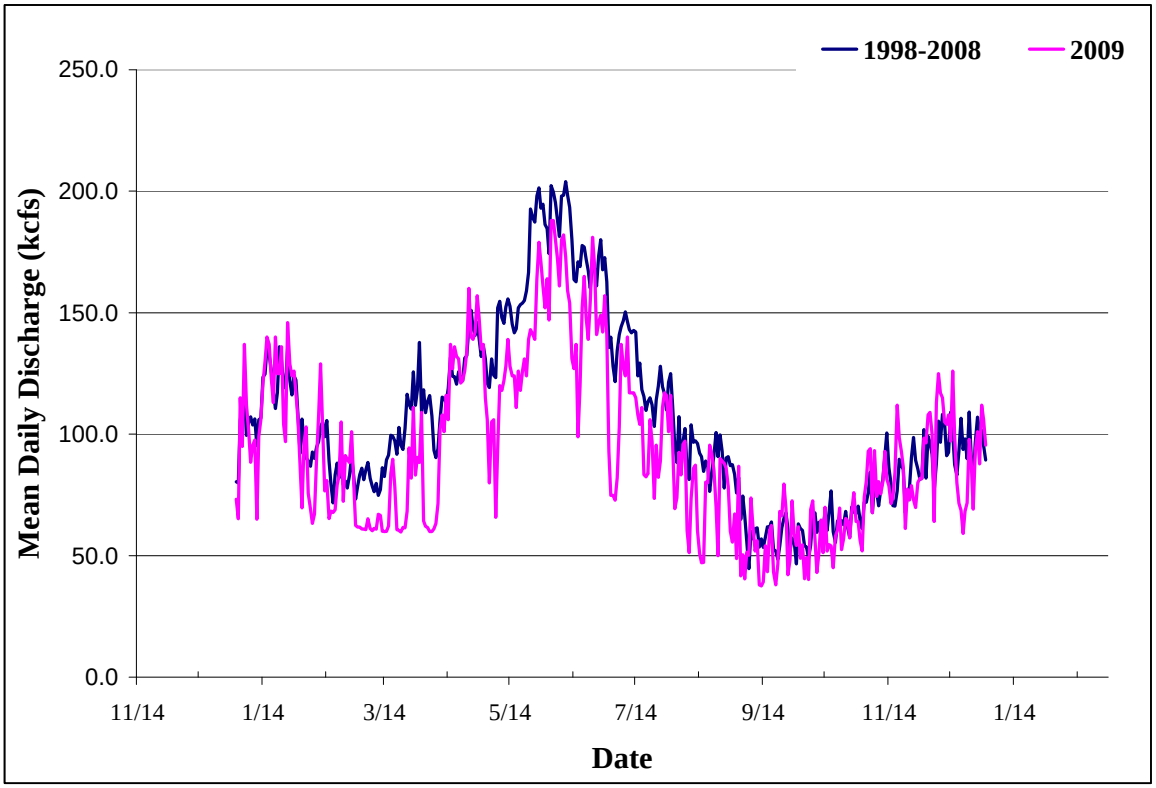

Figure 4 Comparison of 2009 vs. previous 10-year average of mean daily discharge values as measured at the U.S. Geological Survey streamflow gage #12472800 located below Priest Rapids Dam, mid-Columbia River, WA.

4.2 Total Dissolved Gas

As explained in Section 1.2.1, a modification to the WDOE water quality standards for TDG takes place during the fish-spill season, and therefore TDG monitoring results are broken into two different periods: the non-fish spill and fish-spill seasons.

4.2.1 Fish-Spill Season

Section 6.4.11 of the 401 WQC requires Grant PUD to submit a separate report related to TDG and fish-spill data collected during the fish-spill season (WDOE 2007). The 2009 TDG/fish-spill report was sent to WDOE on October 31, 2009 (Hendrick 2009b), and covers TDG monitoring results collected during the fish-spill season (April 1 - August 31).

4.2.2 Non-Fish Spill Season

As described in Section 1.2.1, for the purposes of compliance, the fish-spill season is defined by WDOE to occur from April 1 through August 31 of each year (WDOE 2007; Section 6.4.1.1(b)). Hourly TDG was collected from January 1 through December 31, 2009. Data collection, QA/QC measures, and analyses of TDG values mirrored those described in the QAPP (Hendrick 2009a). For this report, data recorded during 2009 were analyzed for apparent variances from current water quality standards. Suspect or erroneous values were omitted from the analysis, but are included, as well as an explanation for omission, in Appendix A of this report. Table 1 shows the number of TDG values that were omitted from the dataset due to QA/QC issues. Some of data QA/QC problems during the 2009 monitoring year were related to sensor failures, data transmission errors, and/or electrical issues that resulted in communication errors. Overall data loss from January 1 through March 31 was 234 of the combined 8,636 available hrs (less than 3 percent) compared to only 141 of the 11,712 available hrs (just over 1 percent) from September 1 through December 31. Total data loss for 2009 was well within the 90 percent data completeness data quality objective as specified in the QAPP (Hendrick 2009a).

Table 1 Overview of Grant PUD's water quality data set during 2009 non-fish spill season.

Location	Data Interval	Available data collection hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
WANF	01/01 – 03/31	2,159	24	1.1
	09/01 – 12/31	2,928	39	1.3
WANT	01/01 – 03/31	2,159	25	1.2
	09/01 – 12/31	2,928	39	1.3
PRDF	01/01 – 03/31	2,159	26	1.2
	09/01 – 12/31	2,928	24	0.8
PRDT	01/01 – 03/31	2,159	159	7.4
	09/01 – 12/31	2,928	39	1.3
Total	01/01 – 03/31	8, 636	234	2.7
	09/01 – 12/31	11,712	141	1.2
All	01/01 03/31; 9/01 12/31	20,348	375	1.8

Note: **WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.**

[1]See Appendix A for dates, times, and circumstances relating to omitted/lost data.

The summary values (mean, standard deviation, and minimum/maximum) for all hourly TDG measurements taken from each FSM during the non-fish spill season are presented in Table 2.

Table 2 Summary of hourly total dissolved gas measurements from each fixed-site monitor during the 2009 non-fish-spill season, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
WANF	01/01 – 03/31	98.1	2.9	93.0	104.0
	09/01 – 12/31	98.1	3.3	93.2	109.4
WANT	01/01 – 03/31	98.8	2.9	91.9	114.3
	09/01 – 12/31	98.4	3.2	93.3	118.4
PRDF	01/01 – 03/31	99.0	2.8	93.6	109.0
	09/01 – 12/31	98.1	3.0	93.3	107.4
PRDT	01/01 – 03/31	99.2	2.7	94.1	108.4
	09/01 – 12/31	99.4	3.5	93.7	116.3

Notes:
All values represent percent saturation.
WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.

Table 3 shows the number of TDG variances from current water quality standards, as measured at each FSM station in the Wanapum forebay, Wanapum tailrace, Priest Rapids forebay, and Priest Rapids tailrace. All of the TDG variances were related to involuntary spill events at either Wanapum or Priest Rapids dams, due to flow volumes that were higher than the capacity of the dams and/or higher than the market conditions would allow to be passed through the turbines. Figure 5 shows the daily maximum TDG readings from each 24 hour period during the non-fish spill season from each FSM. The hourly TDG readings from each day during the non-fish-spill seasons from each FSM can be found on Grant PUD's water quality web-site (Grant PUD 2009).

Table 3 Number of 2009 non-fish spill season total dissolved gas variances, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.

Location	From 01/01 to 3/31	From 09/01 to 12/31	Number of variances – Total	Total number of points	Percent above standard
WANF	0	0	0	5,025	0.0
WANT	6	3	9	5,024	0.2
PRDF	0	0	0	5,038	0.0
PRDT	0	10	10	4,891	0.2
Total	6	13	19	19,974	0.1

Note:
WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.

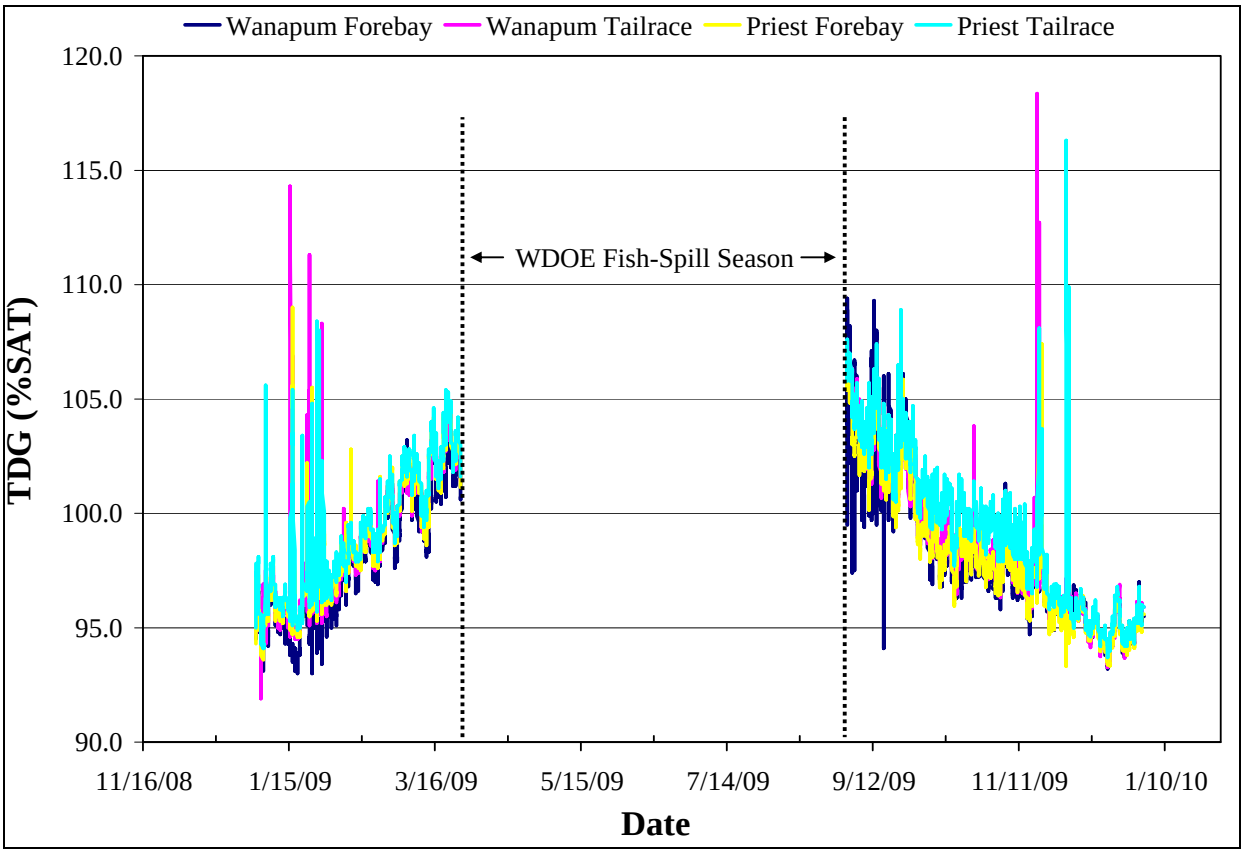

Figure 5 **Daily maximum total dissolved gas values from the 2009 non-fish spill season, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

4.3 Temperature

Water temperature data was collected on an hourly basis during 2009 at each of the FSM stations within the Project. Data collection, QA/QC, and analyses of water temperature followed those described in the QAPP (Hendrick 2009a). Suspect or erroneous values were omitted from the analysis, but are included, as well as an explanation for omission, in Appendix A of this report. Table 4 shows the number of 1-DMax and 7-DADMax values that were omitted from the dataset due to QA/QC issues compared to the total number of available hours. Some of the data QA/QC problems during the 2009 monitoring year were related to sensor failures, data transmission errors, and/or electrical issues that resulted in communication issues. Overall data loss in 2009 was 606 of the combined 35,040 available hours (less than 2 percent), which was well within the 90 percent data completeness data quality objective as specified in the QAPP (Hendrick 2009a).

Table 4 Overview of water temperature data set during 2009.

Location	Available hours	Number of hours omitted/lost[1]	Percent data loss (%)
WANF	8,760	133	1.5
WANT	8,760	156	1.8
PRDF	8,760	186	2.1
PRDT	8,760	131	1.5
Total	35,040	606	1.7

Notes:
WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.
[1]See Appendix A for dates, times, and circumstances relating to omitted/lost data.

The summary values (mean, standard deviation, and minimum/maximum) for all hourly temperature measurements taken from each FSM are presented in Table 5; Figures 6 and 7 present graphical displays of the 1-DMax and 7-DADMax values. In general, water temperatures peaked during the months of July through September. In 2002, Grant PUD funded a water temperature simulation study that examined the effects of the Project on water temperatures using the MASS1 model (Perkins et al. 2002). Results from this study found that the Project does not negatively impact water temperatures, and that the Columbia River temperatures are naturally greater than WDOE water quality standards and the Project does not create increases greater than 0.3°C (Perkins et al. 2002). In accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), in 2013 Grant PUD will again use the MASS1 model to evaluate the Project compliance with temperature standards with the data collected from 2008 through 2012.

Table 5 Summary of hourly temperature measurements from each fixed-site monitor during 2009, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
WANF	01/01 – 12/31	11.0	6.4	1.2	23.4
WANT	01/01 – 12/31	10.7	6.2	1.5	19.9
PRDF	01/01 – 12/31	10.8	6.2	1.3	21.3
PRDT	01/01 – 12/31	10.9	6.0	1.9	20.1

Notes:
All values shown in degrees Celsius.
WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.

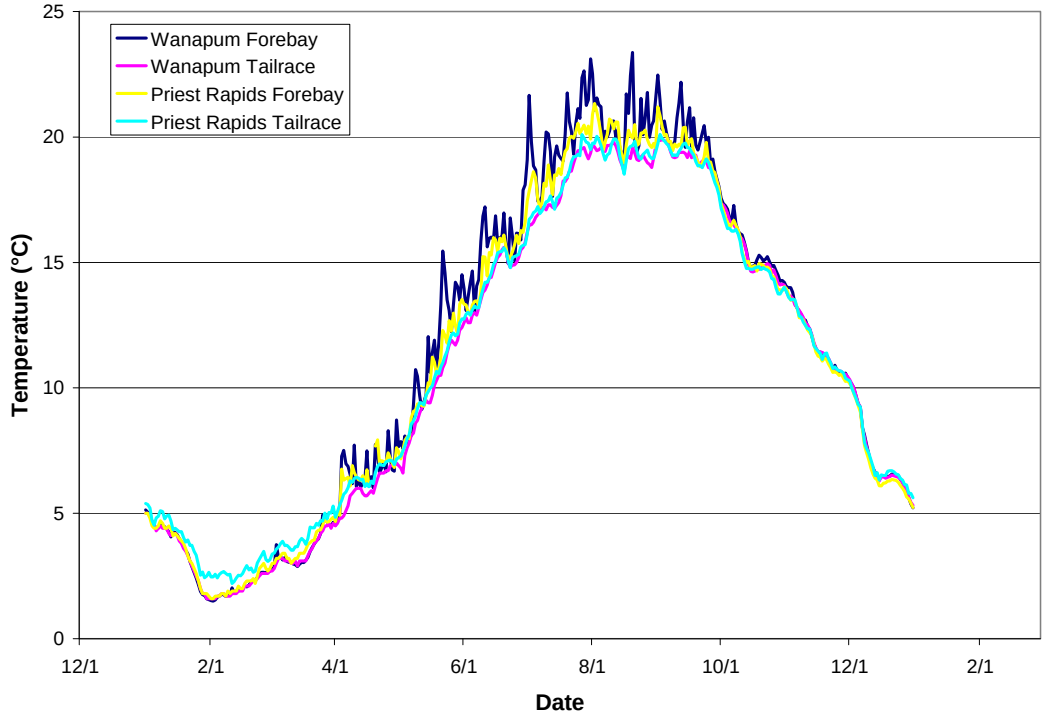

Figure 6 **Daily maximum water temperature values recorded at each fixed-site monitoring station in 2009, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

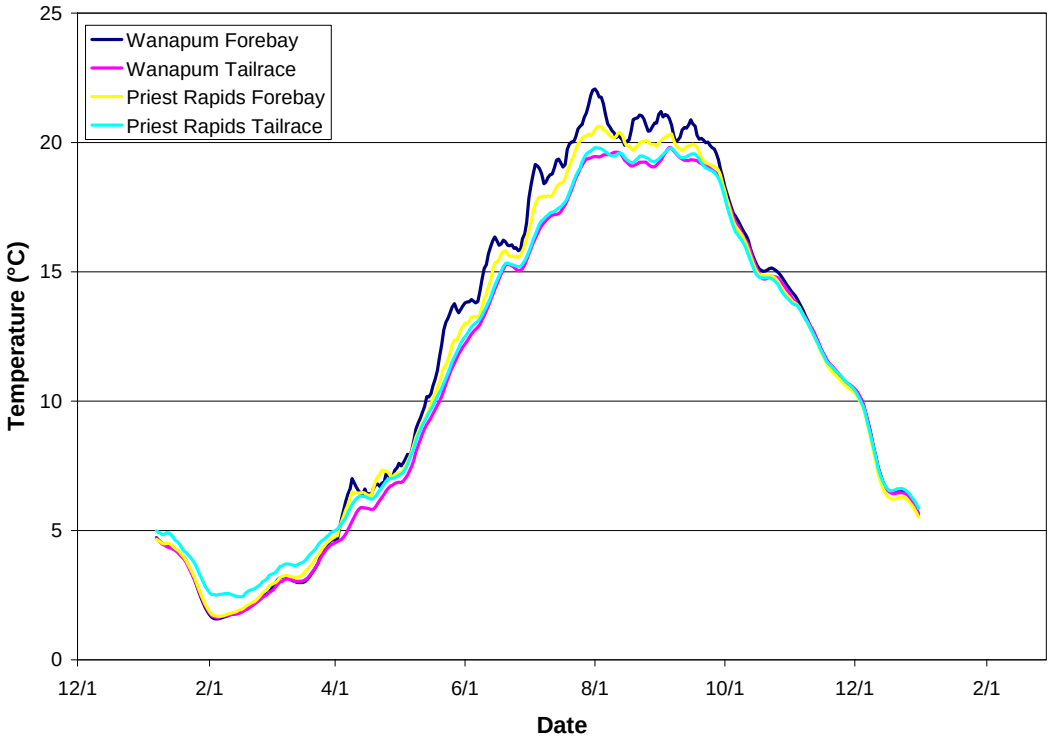

Figure 7 **Seven-day rolling average of daily maximum temperatures recorded at each fixed-site monitoring station in 2009, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

4.3.1 Temperature QA/QC

Per the conditions of the QAPP (Hendrick 2009a), Grant PUD performed QA/QC measures of all currently deployed Hydrolab® multi-probes against an NIST certified thermometer on April 20 and 23, 2009 respectively. Multi-probes and the NIST thermometer were placed into an ice bath to verify temperature accuracy. Data collected during exposure to the ice bath was compared to the certified thermometer to ensure that the temperature sensors of each multi-probe were performing properly. Results from this analysis are shown in Table 6. As discussed in the QAPP, the accuracy/bias of the temperature sensors is ±0.1°C, and thus the results of the ice-bath test suggests that all the sensors were within measurement quality objectives as defined in the QAPP (Hendrick 2009a).

Table 6 Temperature QA/QC data collection.

Date	Probe Model	Serial	Probe Temp	Digital Thermometer	Difference
4/20/09	DS5	46027	0.19	0.06	0.13
4/20/09	DS4a	37428	0.33	0.45	-0.12
4/20/09	DS4a	39420	0.42	0.39	0.03
4/20/09	MS4a	40839	0.85	0.87	-0.02
4/20/09	DS5x	43947	0.99	0.95	0.04
4/23/09	DS4a	37535	1.02	1.18	-0.16
4/23/09	MS4a	40928	1.06	0.98	0.08
4/23/09	DS4a	37517	1.08	1.16	-0.08
4/23/09	MS5	44768	1.11	1.08	0.03
4/23/09	MS4a	42195	1.18	1.29	-0.11
4/23/09	DS5	46021	1.25	1.20	0.05
4/23/09	MS4a	42187	1.65	1.69	-0.04
4/23/09	DS5	46043	2.31	2.36	-0.05

4.4 Dissolved Oxygen, pH, and Turbidity

Summary results and values (mean, standard deviation, and minimum/maximum) from the periodic monitoring of DO, pH, and turbidity values are presented in Table 7. Data collection, QA/QC, and analyses of DO, pH, and turbidity followed those described in detail the QAPP (Hendrick 2009a).

Of the data collected, no DO samples were below 8.0 mg/L at the Project FSMs. All pH values were between 6.5 and 8.5 units. Turbidity grab samples ranged from 0.0 to 6.8 for all FSM's.

Table 7 Dissolved oxygen, pH, and turbidity grab-sample results in 2009, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.

	WANF			WANT			PRDF			PRDT		
Date	DO (mg/L)	pH (units)	Turb (NTU)	DO (mg/L)	pH (units)	Turb (NTU)	DO (mg/L)	pH (units)	Turb (NTU)	DO (mg/L)	pH (units)	Turb (NTU)
1/21	9.8	7.1	0.0				10.6	7.2	0.0	11.0	6.8	4.4
2/11	11.8	7.1	0.6	11.23	7.0	4.2	11.3	7.1	4.0	11.4	6.9	6.8
3/4	13.3	7.8	0.0	13.8	7.3	0.0	13.1	8.2	0.0	13.8	8.1	0.0
3/26	12.3	7.3	0.0	13.3	7.3	0.0	13.3	7.9	0.0	13.1	7.9	0.0
4/20	12.0	8.1	0.0	12.3	8.1	0.1	12.1	8.3	0.0	12.2	8.1	0.0
5/13	13.4	8.4	0.0	13.4	8.3	0.2	13.5	8.5	0.0	13.4	8.4	0.3
5/29	12.8	7.9	5.0	12.7	8.0	0.0	12.7	8.1	0.0	12.6	8.1	1.0
6/10	11.0	7.8	3.0	11.0	7.8	1.0	10.9	7.8	0.2	11.2	7.8	1.1
6/24	11.2	8.2	5.5	11.0	8.2	0.0	11.0	8.3	1.5	11.0	8.3	2.6
7/8	10.6	8.2	0.6	10.8	8.2	0.2	10.4	8.2	0.0	10.6	8.3	0.3
7/22	10.8	8.1	0.4	10.5	8.0	0.5	10.8	8.1	0.6	10.7	8.0	0.6
8/5	9.6	7.5	0.6	10.0	8.0	0.1	10.2	8.1	2.4	10.1	8.0	2.2
8/20	10.6	8.3	2.0	10.4	8.0	0.4	10.3	8.4	2.0	10.6	8.0	2.2
9/16	10.1	8.4	1.0	10.0	8.4	0.3	10.1	8.1	1.2	10.0	8.1	0.8
10/14	9.5	7.3	0.0	10.1	8.0	0.0	9.5	8.0	0.0	9.4	8.0	0.0
11/5	10.1	8.0	0.0	10.3	8.1	0.0	9.6	8.2	1.0	10.1	8.0	0.0
12/3	10.0	7.9	0.0	10.0	7.7	0.0	10.0	7.9	0.0	10.0	8.0	0.0
12/30	12.1	7.8	0.0	12.7	8.0	0.0	12.8	8.0	0.0	12.4	7.9	0.0
Mean	11.2	7.8	1.0	11.4	7.9	0.4	11.2	8.0	0.7	11.3	7.9	1.2
Min.	9.5	7.1	0.0	10.0	7.0	0.0	9.5	7.1	0.0	9.4	6.8	0.0
Max.	13.4	8.4	5.5	13.8	8.4	4.2	13.5	8.5	4.0	13.8	8.4	6.8
Stdev.	1.3	0.4	1.7	1.3	0.4	1.0	1.3	0.4	1.1	1.3	0.4	1.8

***Notes*:**
WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.

5.0 Conclusions

Water quality data collected in 2009 at Grant PUD's FSM stations included hourly TDG and water temperature data and periodic grab-samples of DO and pH. Results indicated 19 exceedances of the 110% TDG standard during the non-fish spill season (see Hendrick (2009b) for information related to TDG monitoring during fish-spill season). There were two 1-DMax temperature values greater than 20°C recorded below Priest Rapids Dam and 342 7DADMax values greater than 17.5°C recorded at Grant PUD's four FSM stations. However, in 2013 and in accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), Grant PUD will conduct temperature modeling to determine Grant PUD's contribution, if any, to water temperature values recorded from 2008–2012 that were above WDOE water quality standards. Periodic grab-sample monitoring of DO and pH indicated no exceedances of the 8.0 mg/L DO or 6.5-8.5 pH standards. Grant PUD will continue its hourly TDG and water temperature monitoring as well as periodic DO and pH monitoring at its FSM stations in 2010, according to conditions contained in the 401 WQC (WDOE 2007) and FSM station QAPP (Hendrick 2009a).

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Appendix A
Data sections omitted from the 2009 fixed-site monitoring data set

Location	Date(s)	hr(s)	Problem/reason for omission	Comments/action taken to correct problem
WANT	1/21/09	14:00	TDG rose sharply (more than 10% saturation) without corresponding spill event or increases at other FSM sites	Deleted data, single event
All	2/22-2/23/09	3:00-2:00 (2/23)	No data; communication/transmission error	Rebooted system, data lost
PRDF	3/18/09	13:00-14:00	Missed two hours due to Sutron 9210 install	Rebooted system, data lost
PRDT	3/26-4/1/09	8:00-23:00	Probe failure	Replaced probe, data lost; large spill event on 3/31 may have cause failure
PRDF	4/17-4/20/09	12:00 – 12:00	Connection failure due to cable failure	Replaced cable, data lost
All	4/19-4/20/09	3:00 – 2:00	FSM database server failed	Rebooted system, data lost
WANT	7/6/09	19:00-20:00	Data transmission error due to SDS device error	Technicians troubleshoot, attempted to re-program/re-boot SDS device; research begins on potential to replace SDS device
WANT	7/7/09	16:00-20:00	Data transmission error due to SDS device error	Technicians continue to troubleshoot; research continues on potential to replace SDS device
WANT	7/10/09	17:00-19:00	Data transmission error due to SDS device error	Technicians continue to troubleshoot; research continues on potential to replace SDS device
WANT	7/11/09	15:00-22:00	Data transmission error due to SDS device error	Technicians continue to troubleshoot; research continues on potential to replace SDS device
WANT	7/12/09	16:00-19:00	Data transmission error due to SDS device error	Technicians continue to troubleshoot, based on continued issue (see above) Sutron Data Collection Platform, transmission radio, and SDS device replaced; fixed problem
All	7/26-7/27/09	3:00-2:00 (7/27)	FSM database server failed	Rebooted system, data lost
PRDF	8/5-8/6-09	15:00-8:00 (8/6)	Probe failure	Replaced probe, data lost
All	8/16/09	4:00-0:00 (8/17)	FSM database server failure	Rebooted system, data lost
All	10/25-10/26/09	3:00-2:00 (10/26)	FSM database server failed	Rebooted system, data lost
WANF, WANT, PRDT	12/13/09	3:00-17:00	FSM database server failure	Rebooted system, data lost
***Note*: WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.**				