**Priest Rapids Hydroelectric Project (P-2114)**

# 2018 SUMMARY RESULTS OF THE WATER QUALITY FIXED-SITE MONITORING PROGRAM WITHIN THE PRIEST RAPIDS HYDROELECTRIC PROJECT

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## Executive Summary

This annual fixed-site monitoring program (FSM program) water quality summary report (summary report) provides results of the FSM program efforts that the Public Utility District No. 2 of Grant County, Washington (Grant PUD) conducted in 2018 in accordance with conditions of the 401 Water Quality Certification (WQC; WDOE 2007) issued by the Washington Department of Ecology (WDOE) for the operation of the Priest Rapids Hydroelectric Project (Project) and the WDOE-approved Quality Assurance Project Plan (QAPP; Hendrick 2009).

Water quality parameters monitored in 2018 under the FSM program included:

1). total dissolved gas (TDG (millimeters of mercury) [mm Hg])),
2). water temperature (degrees Celsius [°C]),
3). dissolved oxygen (DO (milligrams per liter [mg/L])),
4). pH (units), and
5). turbidity (Nephelometric Turbidity Unit [NTU]).

Monitoring methods and quality assurance/quality control (QA/QC) procedures followed protocols outlined in the QAPP (Hendrick 2009). Section 6.7.3 of the 401 WQC (WDOE 2007) requires Grant PUD to provide the results of the monitoring efforts as well as a summary of the results by March 1 of the year following the monitoring activities. This deadline was extended to March 15, 2019 with an extension of time (EOT) request and approval by WDOE on February 21, 2019 (Appendix B).

Water quality monitoring conducted in 2018 occurred at Grant PUD's fixed-site water quality monitoring stations (FSM stations). The purpose of monitoring water quality parameters within the Project is to provide information on water quality conditions and to verify compliance with applicable water quality standards and conditions within the 401 WQC (WDOE 2007) and QAPP (Hendrick 2009).

In general during 2018, total dissolved gas (TDG) percent saturation (%SAT) was at its highest from mid-May through early June, with TDG values that were above 120 %SAT at all FSM stations for this time period. After early June TDG %SAT fell below 120 %SAT at all FSM stations, with the occasional rise above 120 %SAT, primarily at the Wanapum tailrace FSM station, throughout the remainder of 2018. Additionally, water temperatures peaked during late-August/early September, with some daily maximum values greater than 20°C at all FSM stations. Grant PUD's 2018 periodic grab-sampling efforts under the FSM program indicated DO between 9.8 and 12.4 mg/L, pH from 7.8 to 8.4 units, and turbidity between 0 and 5.0 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 2019, according to conditions contained in the 401 WQC (WDOE 2007) and the updated QAPP (Grant PUD 2018).

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**Terms and Abbreviations**

| | |
|---|---|
| 1-DMax | maximum daily temperature |
| 7-DADMax | 7-day average of the daily maximum temperatures |
| °C | degrees Celsius |
| DCP | data collection platform |
| DO | dissolved oxygen |
| EPA | Environmental Protection Agency |
| FERC | Federal Energy Regulatory Committee |
| FSM program | fixed-site monitoring program |
| FSM stations | fixed-site monitoring stations |
| Grant PUD | Public Utility District No. 2 of Grant County, Washington |
| kcfs | thousand cubic feet per second |
| MW | megawatt |
| mg/L | milligrams per liter |
| mm Hg | millimeters of mercury |
| multi-probe | multi-parameter water quality monitoring probe |
| NIST | National Institute of Standards and Technology |
| NMFS | National Marine Fisheries Service |
| NTU | Nephelometric Turbidity Unit |
| Project | Priest Rapids Hydroelectric Project |
| QAPP | Quality Assurance Project Plan |
| QA/QC | quality assurance/quality control |
| 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 on the Columbia River in central Washington State. The Project is authorized by the Federal Energy Regulatory Commission (FERC) under Project No. 2114[1] and includes the Wanapum and Priest Rapids developments.

A 401 Water Quality Certification (WQC) for the operation of the Project was issued by the Washington Department of Ecology (WDOE) on April 3, 2007 (WDOE 2007), amended on March 6, 2008, and directly incorporated into the FERC license to operate the Project in April of 2008 (FERC 2008). Various sections of the 401 WQC require Grant PUD to monitor total dissolved gas (TDG), water temperature, dissolved oxygen (DO), and pH throughout the Project (WDOE 2007). Section 6.7.3 of the 401 WQC (WDOE 2007) requires Grant PUD to provide WDOE with water quality monitoring results, along with a summary report, by March 1 of the year following the monitoring activities. This deadline was extended to March 15, 2019 with an extension of time (EOT) request and approval by WDOE on February 21, 2019 (Appendix B).

Water quality data were collected, analyzed, and reported for the year 2018. Additionally, instruments were maintained and calibrated as defined in Grant PUD's WDOE-approved Quality Assurance Project Plan (QAPP; Hendrick 2009), which contains elements of sampling frequency, procedures, equipment, analytical methods, quality control, data handling and assessment procedures, and reporting protocols designed to meet the conditions of the 401 WQC (WDOE 2007; see Section 2.0).

The following annual fixed-site monitoring program (FSM program) water quality summary report (summary report) provides the results of Grant PUD's FSM program in 2018 in accordance with Section 6.7.3 of the 401 WQC (WDOE 2007).

## 2.0 Quality Assurance Project Plan

The water quality data summarized in this summary report were collected in accordance with Grant PUD's QAPP, titled:

> *"Quality Assurance Project Plan for Monitoring Selected Water Quality Parameters within the Priest Rapids Hydroelectric Project"* (Hendrick 2009).

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. Water quality parameters that are monitored under the QAPP include:

1). TDG (millimeters of mercury [mm Hg]),
2). water temperature (degrees Celsius [°C]),
3). DO (milligrams per liter [mg/L]),
4). pH (units), and
5). turbidity ((Nephelometric Turbidity Units [NTU]).

Water quality monitoring conducted under the QAPP was performed via Grant PUD's FSM program.

[1] 123FERC ¶ 61,049 (2008).

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 provide information on water quality conditions within the Project, as well as verify compliance with applicable water quality standards and conditions within the 401 WQC. Implementation of the QAPP assures that water quality data collected by the FSM program are of sufficient quality to meet the objectives of the FSM program. Adaptive management provisions in the QAPP determine potential changes to monitoring methods, locations, etc. that may be warranted. Annual updates are made to the QAPP as necessary (subject to WDOE and FERC approval).

In 2018, Grant PUD submitted an updated QAPP (Grant PUD 2018) that begun implementation in 2019 and will replace the original 2009 QAPP (Hendrick 2009). The updated QAPP was approved by WDOE on February 21, 2019.

The current QAPP for Grant PUD's FSM program can be found at the following location:

https://www.grantpud.org/water-quality

### 2.1 Priest Rapids Hydroelectric Project Description

The downstream boundary of the Project is located approximately three miles below Priest Rapids Dam (river mile [RM] 397.1) and extends upriver to the Rock Island Dam tailrace at RM 453.5 (Figure 1).

The Wanapum development consists of a 14,680-acre reservoir and an 8,637-foot-long by 186.5-foot-high dam spanning the Columbia 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; a downstream fish passage structure (the Wanapum Fish Bypass (WFB)); and a powerhouse containing ten vertical shaft integrated Kaplan turbine/generator sets with a total authorized installed capacity (best gate) of 735 MW (Figure 2).

The Priest Rapids development consists of a 7,725-acre reservoir and a 10,103-foot-long by 179.5-foot-high dam spanning the Columbia 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; a downstream fish passage structure (the Priest Rapids Fish Bypass (PRFB)) and a powerhouse containing ten vertical shaft integrated Kaplan turbine/generator sets with a total authorized installed capacity (best gate) of 675 MW (Figure 3).

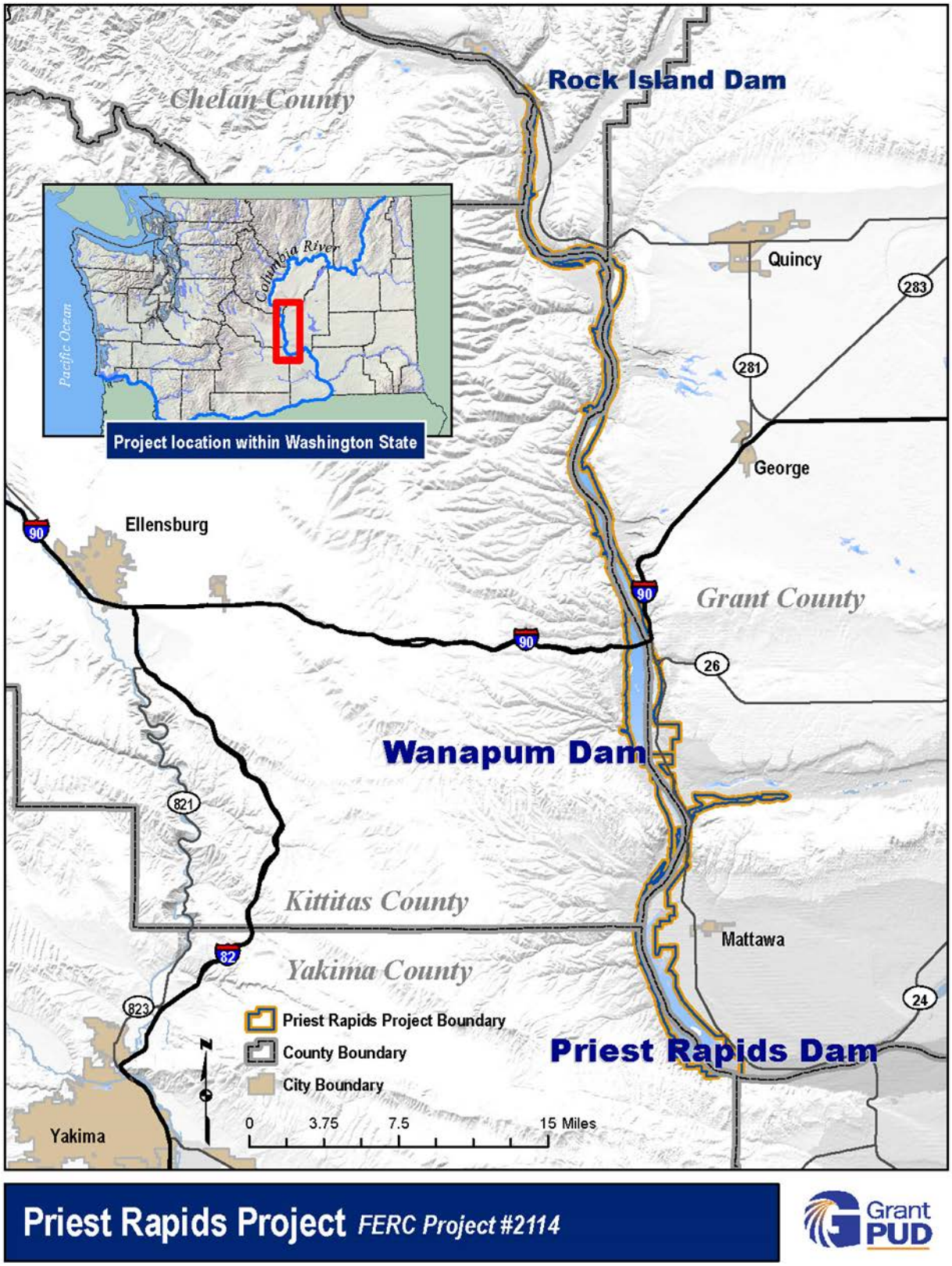


**Figure 1** **The Priest Rapids Project is located in central Washington State on the mid-Columbia River.**

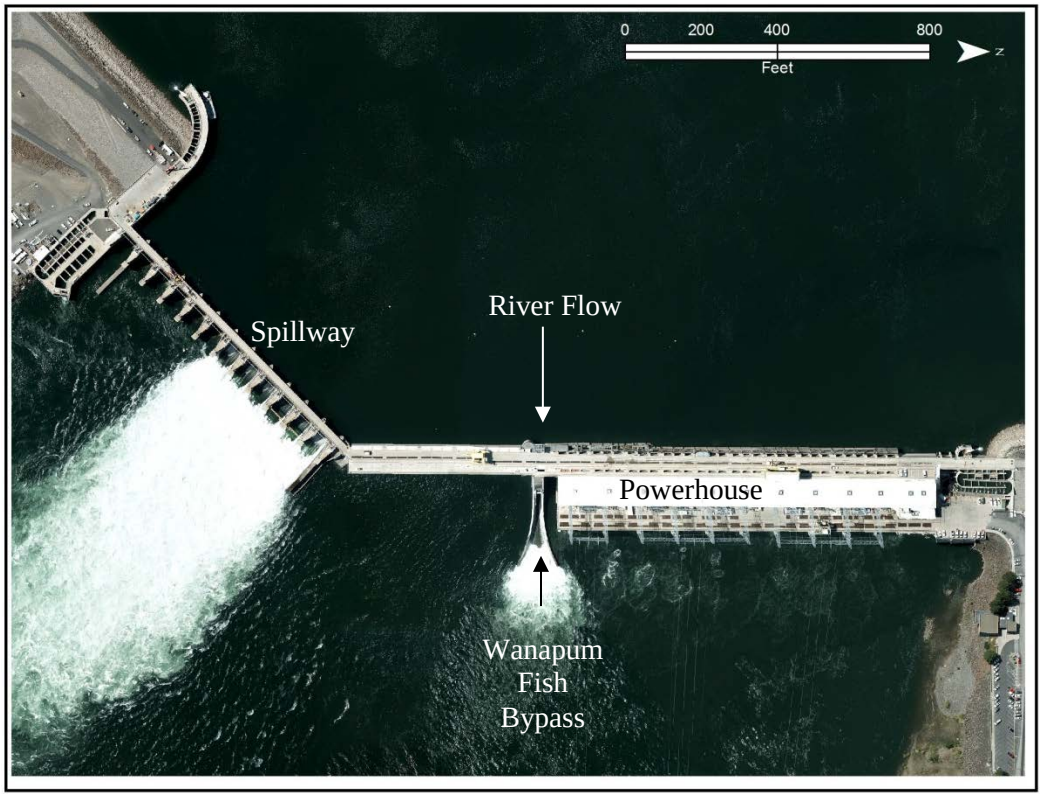


**Figure 2** **Aerial photograph of Wanapum Dam, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

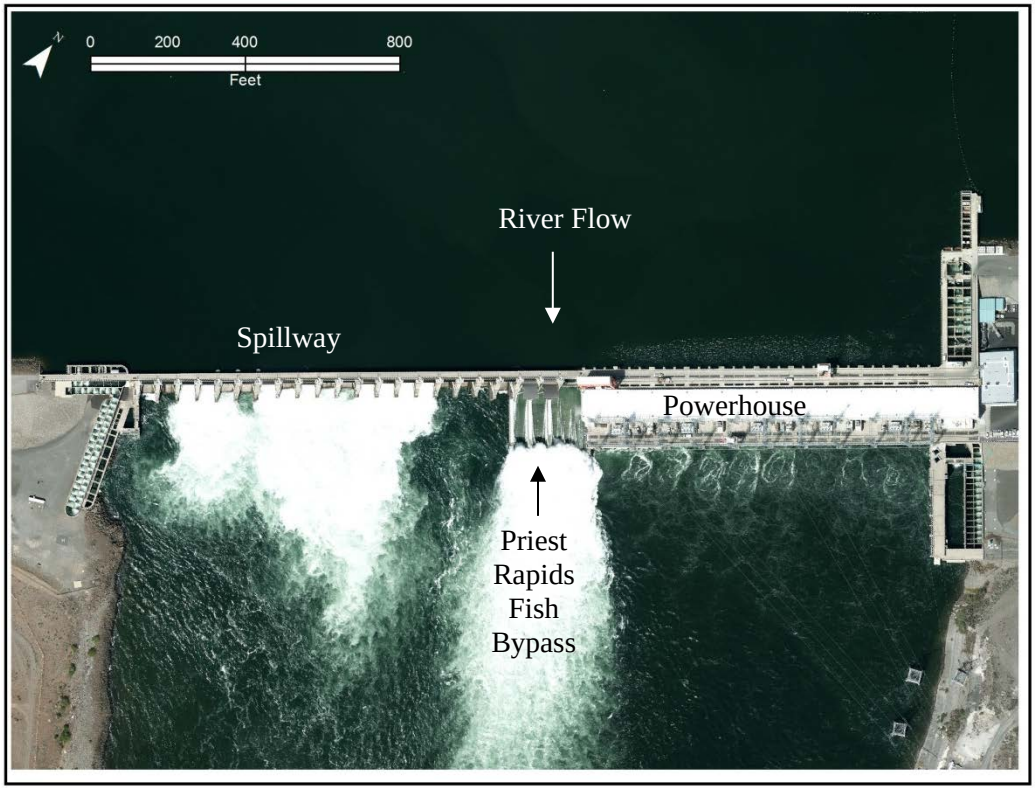


**Figure 3** **Aerial photograph of Priest Rapids Dam, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

## 2.2 Regulatory Framework

Section 6.0 of the 401 WQC (WDOE 2007) contains various water quality conditions that Grant PUD must comply with for the continued operation of the Project. These various conditions necessitate monitoring of TDG, water temperature, DO, and pH within the Project.

The following sections detail the water quality monitoring requirements and numeric standards for each parameter monitored within the Project under the 401 WQC (WDOE 2007).

### 2.2.1 Total Dissolved Gas

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

Section 6.4.10(d) of the 401 WQC (WDOE 2007) obligates Grant PUD to maintain a TDG monitoring program at its fixed-site monitoring stations (FSM stations) annually, and that the TDG measurements shall occur on an hourly basis. Additionally, Section 6.4.11(a) of the 401 WQC (WDOE 2007) states monitoring results shall be made available electronically to the public, "*…as close to the time of occurrence as technology will reasonable allow*."

Section 5.0(b) of the 401 WQC (WDOE 2007) and WAC 173-201A-200(f)(i) provides that the TDG water quality standard for both Wanapum and Priest Rapids dams shall not be applicable if flows exceed the "7Q10 flood flow", which is the highest seven consecutive day average flow with a ten-year recurrence frequency. The 7Q10 flood flow is calculated to be 264 kcfs for Wanapum and Priest Rapids dams.

According to Section 6.4.1(d) of the 401 WQC, Grant PUD may be deemed in compliance with water quality standards for TDG if both of the following apply:

- TDG levels in the dam's forebay exceed 110 %SAT during the non-fish spill season or 120 %SAT during the fish-spill season, and
- The dam does not further increase TDG levels in the tailrace.

In addition, in accordance with Washington water quality standards and compliance methods, Grant PUD is only responsible for TDG levels created by operation of Wanapum and/or Priest Rapids Dams. Specifically, Chapter 90.48.422 of the Revised Code of Washington (RCW) states:

> *With respect to federal energy regulatory commission licensed hydropower projects, the department may only require a person to mitigate or remedy a water quality violation or problem to the extent there is substantial evidence such person has caused such violation or problem.*

Section 6.4 of the Project's 401 WQC outlined a 10-year compliance schedule related to TDG (Section 6.4.2(b), Table 1; WDOE 2007), which began in 2008 with the issuance of the Project

license (FERC 2008). To date, Grant PUD has implemented all operational and structural TDG abatement measures, as well as completed annual monitoring and reporting requirements in accordance with Section 6.4 of the 401 WQC (WDOE 2007). Furthermore, based on the results of the TDG compliance analyses presented in Grant PUD's WDOE-approved *Final Summary of Total Dissolved Gas Monitoring with the Priest Rapids Hydroelectric Project – Year 10 Report* (Year 10 Report; Grant PUD 2018a), Grant PUD has achieved reasonable compliance of the current TDG water quality standards.

### 2.2.2 Water Temperature

WAC 173-201A-602 designates the segment of the Columbia River within the Project as salmonid spawning, rearing, and migration; 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 $t = 34/(T + 9)$.

Certain sections of the Columbia River within the Project are classified as impaired for temperature under Section 303(d) of the Clean Water Act. Portions of the Columbia River upstream of the Project are also 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).

In 2015, and in accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), Grant PUD conducted temperature modeling using a CE-QUAL-W2 model to determine Grant PUD's contribution, if any, to water temperature values recorded from 2003–2012 that were above WDOE water quality standards (NHC 2016). Final results from this modeling effort were sent to the WDOE on April 14, 2016.

### 2.2.3 Dissolved Oxygen and pH

The water quality criteria for DO within the Project require that DO be greater than 8.0 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) states 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.

## 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), water temperature (°C), DO (mg/L), pH (units), and turbidity (NTU). Barometric pressure, TDG, and water temperature are collected/reported on an hourly basis throughout the year, while DO, pH, and turbidity are noted once every two or three weeks throughout the year under Grant PUD's FSM program.

Each FSM station is equipped with a Hydrolab Corporation Model DS5X, DS5, DS4a, MS5, or MS4a multi-parameter water quality monitoring sonde (multi-probe) that is enclosed in a submerged perforated conduit pipe. The multi-probe contains individual TDG, water 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 (Hach Hydromet 2010). At the FSM stations, multi-probes are connected to an automated system that allows hourly monitoring of barometric pressure, TDG, and water temperature. A National Institute of Standards and Technology (NIST) certified barometer located at each FSM station provides the barometric pressure readings necessary to correct the partial pressure readings taken by the multi-probes (and convert TDG mm Hg to %SAT). 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 station.

The data logging system at each FSM station consists of the same basic equipment, which includes the multi-probe enclosed in a submerged perforated conduit or standpipe connected to a Sutron Corporation 9210 data collection platform (DCP). Multi-probes are interrogated by the DCPs every 15 minutes and the data are archived within the DCP. The DCPs 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 software). Replicas of the current year's data, along with archived data (back five years) are made available at Grant PUD's external water quality website (Grant PUD 2019).

For additional information regarding Grant PUD's FSM program/stations, see the QAPP (Hendrick 2009).

## 4.0 Results

The following sections provide results and summaries of Grant PUD's FSM program for 2018. The hourly data can be attained from Grant PUD's water quality website (Grant PUD 2019).

### 4.1 Description of 2018 Flow Characteristics

Mean daily discharges during 2018 were compared to the previous ten-year average (Figure 4), as measured at the U.S. Geological Survey (USGS) streamflow gage #12472800 located 2.6 RM downstream of Priest Rapids Dam.

In general, 2018 mean daily discharges were higher than the previous ten-year average with peak spring runoff well above the average (~51.1% higher on average from mid-April through early June and ~8.5% higher on average over the entire year). The early influx of water (starting early February; see Figure 4) was in response to Grand Coulee drafting for maintenance on its drum gates, which required a lower than normal operational water level. The peak flows coincided with flood control operations at Grand Coulee Dam and increased tributary flows from snowmelt and increased precipitation.

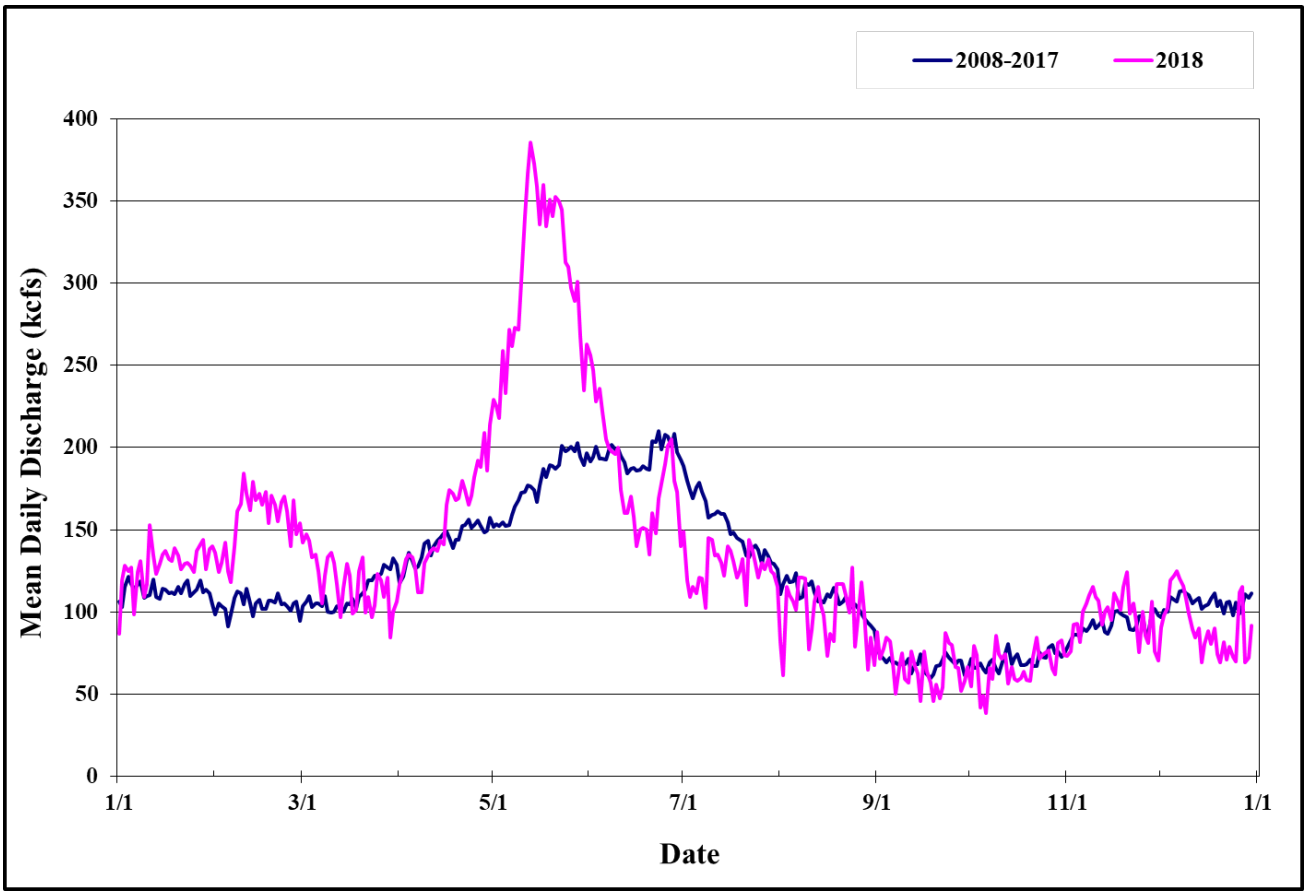


**Figure 4** **Comparison of 2018 vs. previous ten-year average of mean daily discharge values measured at the U.S. Geological Survey (USGS) streamflow gage #12472800 located 2.6 river miles below Priest Rapids Dam, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

### 4.2 Total Dissolved Gas

Hourly TDG data were collected, summarized, and reported from January 1 through December 31, 2018. Data collection, QA/QC measures, and analyses of TDG values mirrored those described in the QAPP (Hendrick 2009).

Suspect or erroneous TDG values were omitted from the analysis, but are included, as well as an explanation for omission, in Appendix A of this summary report.

The QA/QC issues during the 2018 FSM program monitoring year consisted of probe or sensor failures, or database errors. Of the 35,040 available hours from January 1 through December 31, 970 hours were omitted/lost (approximately 2.8%). A total data completeness of 97.2% for the 2018 FSM program monitoring year was well within the 90% data completeness objective as specified in the QAPP (Hendrick 2009). Table 1 displays the number of hourly TDG values that were omitted/lost from the dataset due to various QA/QC issues. See Appendix A of this summary report for an explanation for omission from the dataset.

**Table 1 Overview of Grant PUD's total dissolved gas data set during 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| Location[1] | Data Interval | Available data collection hours | Number of omitted/lost hourly readings[2] | % data loss |
|---|---|---|---|---|
| WANF | 1/1 – 12/31 | 8,760 | 50 | 0.6 |
| WANT | 1/1 – 12/31 | 8,760 | 613 | 7.0 |
| PRDF | 1/1 – 12/31 | 8,760 | 0 | 0 |
| PRDT | 1/1 – 12/31 | 8,760 | 305 | 3.5 |
| **Total** | **1/1 – 12/31** | **35,040** | **968** | **2.8** |

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

### 4.2.1 Total Dissolved Gas Summary

In general, TDG %SAT was at its highest during mid-May through early June, with TDG values that were above 120 %SAT at all FSM stations for this time period, the majority of which occurred during 7Q10 flows (flows above 264 kcfs). After early June TDG %SAT fell below 120 %SAT at all FSM stations, with the occasional rise above 120 %SAT, primarily at the Wanapum tailrace FSM station, throughout the remainder of 2018 FSM program monitoring season.

The summary values (mean, standard deviation, minimum, and maximum) for all hourly TDG measurements at each FSM station during 2018 are presented in Table 2. Figures 5 through 10 below present graphical displays of the TDG values recorded during the 2018 FSM program monitoring season including TDG values during 7Q10 flows.

**Table 2** **Summary of hourly total dissolved gas measurements from each fixed-site monitoring station (FSM station) during 2018 Non-Fish and Fish-Spill Seasons, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| Location[1] | Season | Mean[2] | Standard Deviation | Minimum[2] | Maximum[2] |
|---|---|---|---|---|---|
| WANF | Non-Fish | 99.3 | 3.4 | 92.4 | 111.4 |
| | Fish-Spill | 114.6 | 8.0 | 97.9 | 136.5 |
| WANT | Non-Fish | 100.2 | 3.8 | 94.7 | 125.3 |
| | Fish-Spill | 116.4 | 10.3 | 97.4 | 142.7 |
| PRDF | Non-Fish | 99.5 | 3.6 | 93.1 | 117.1 |
| | Fish-Spill | 115.0 | 9.2 | 100.9 | 140.4 |
| PRDT | Non-Fish | 100.5 | 4.4 | 93.5 | 120.1 |
| | Fish-Spill | 114.8 | 7.7 | 101.5 | 133.8 |
| PASCO[3] | Fish-Spill | 111.4 | 6.0 | 100.5 | 127.3 |

*Notes:*
[1]WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.
[2]All values represent %SAT.
[3]The PASCO site is owned and operated by the Army Corps and only operates during the fish-spill season.

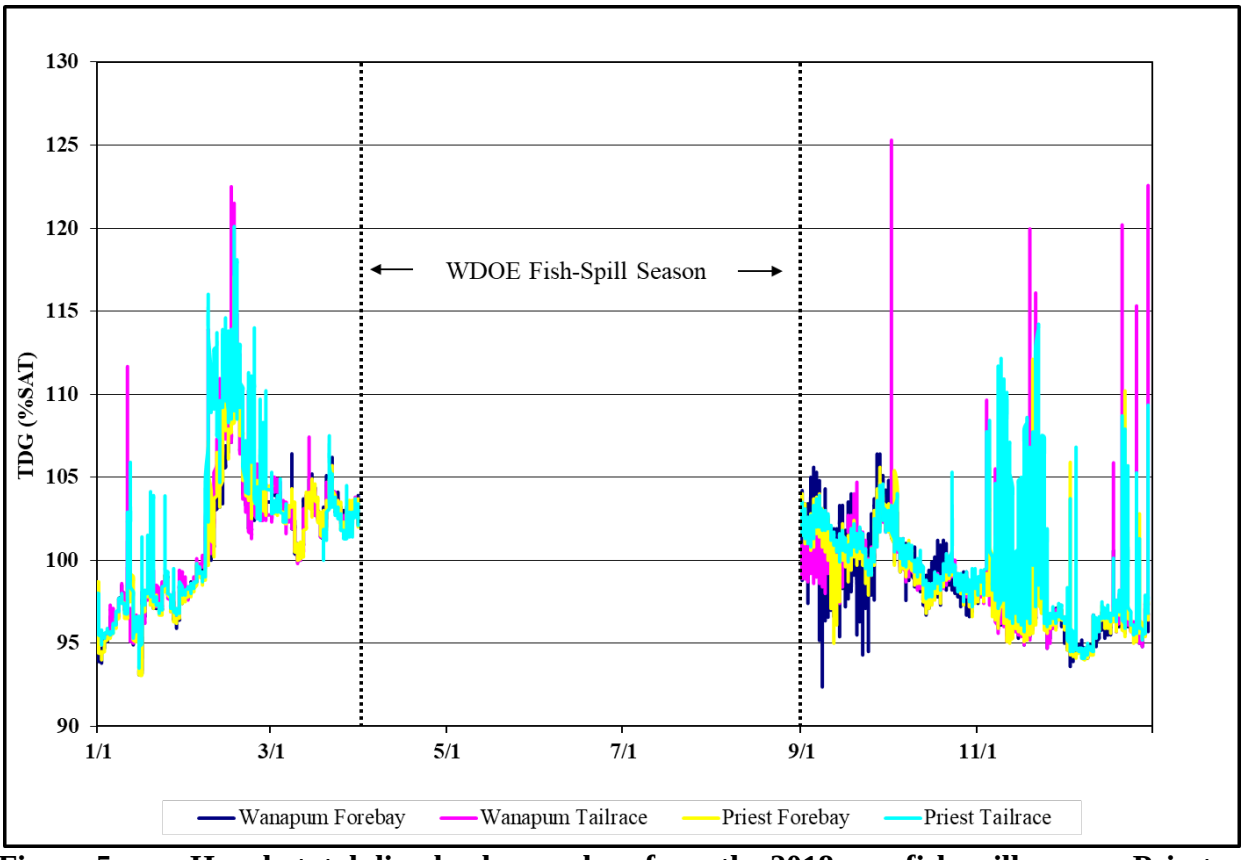


**Figure 5** **Hourly total dissolved gas values from the 2018 non-fish spill season, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

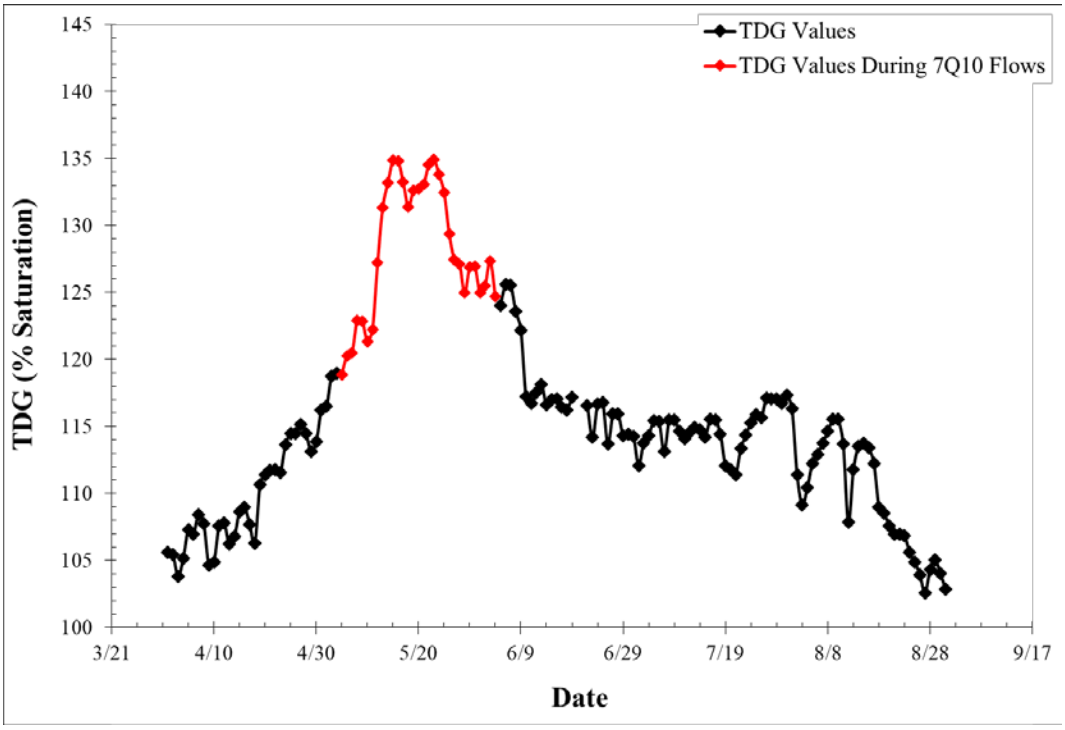


**Figure 6** **Total dissolved gas values (average of the 12-highest consecutive hourly TDG values in a 24-hour period) from the 2018 fish-spill season recorded at the Wanapum Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

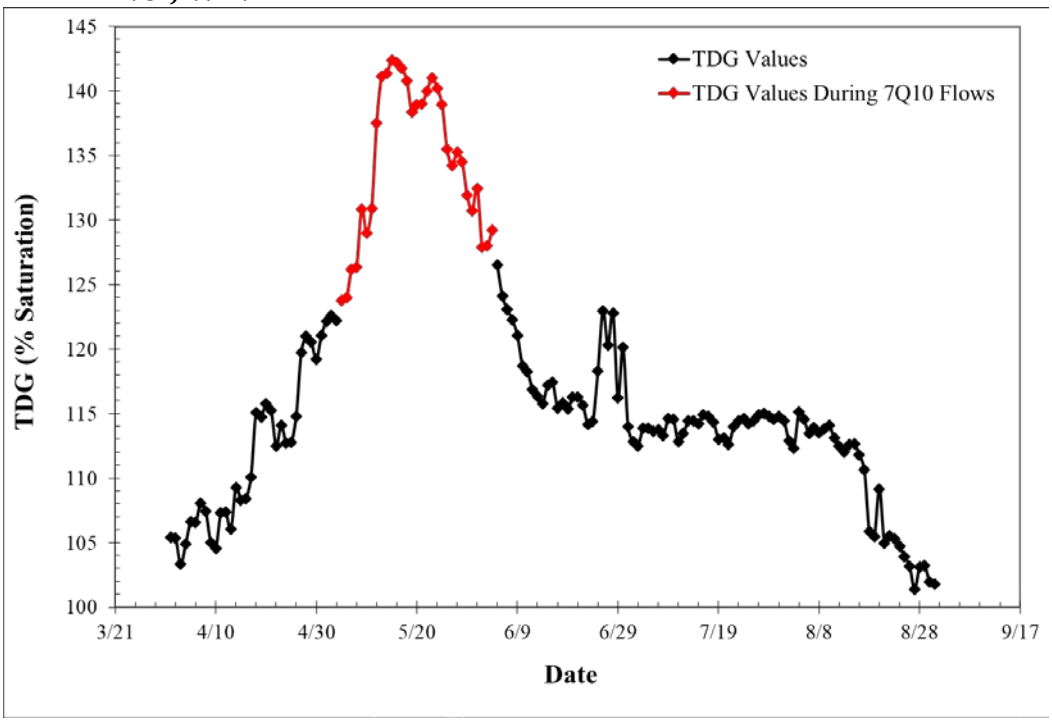


**Figure 7** **Total dissolved gas values (average of the 12-highest consecutive hourly TDG values in a 24-hour period) from the 2018 fish-spill season recorded at the Wanapum Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

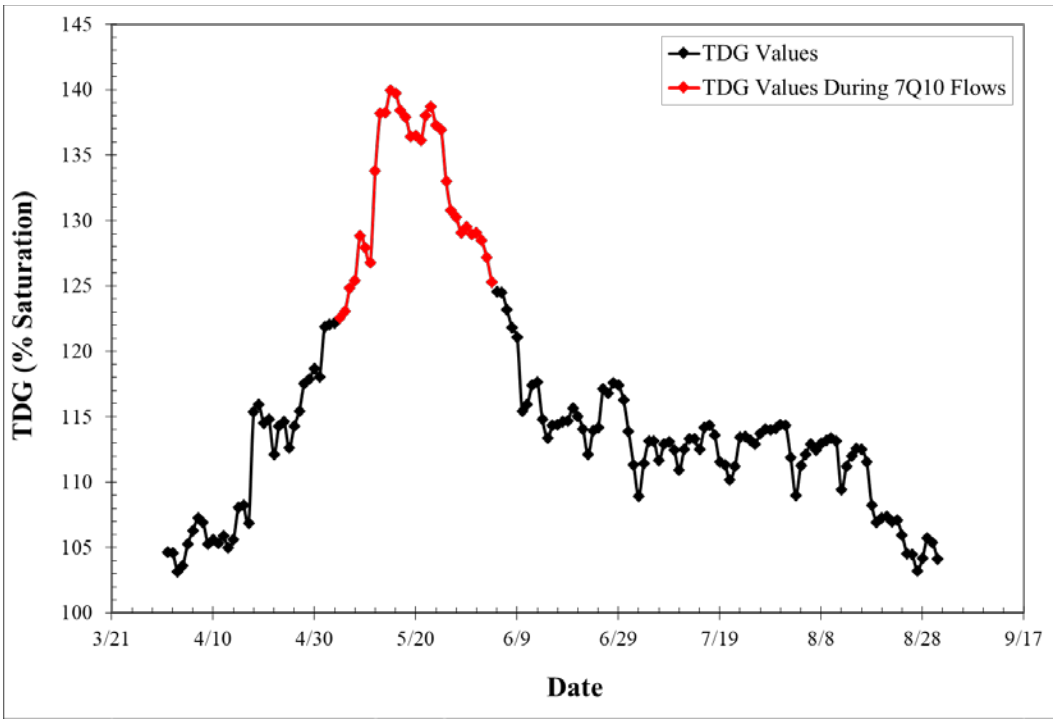


**Figure 8** **Total dissolved gas values (average of the 12-highest consecutive hourly TDG values in a 24-hour period) from the 2018 fish-spill season recorded at the Priest Rapids Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

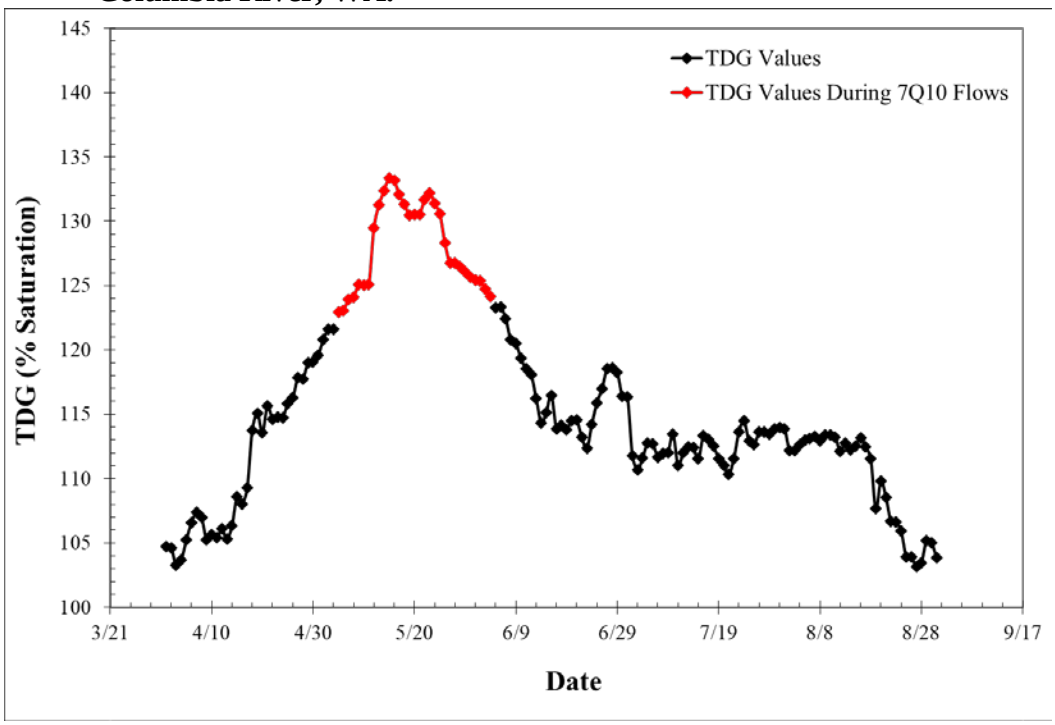


**Figure 9** **Total dissolved gas values (average of the 12-highest consecutive hourly TDG values in a 24-hour period) from the 2018 fish-spill season recorded at the Priest Rapids Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

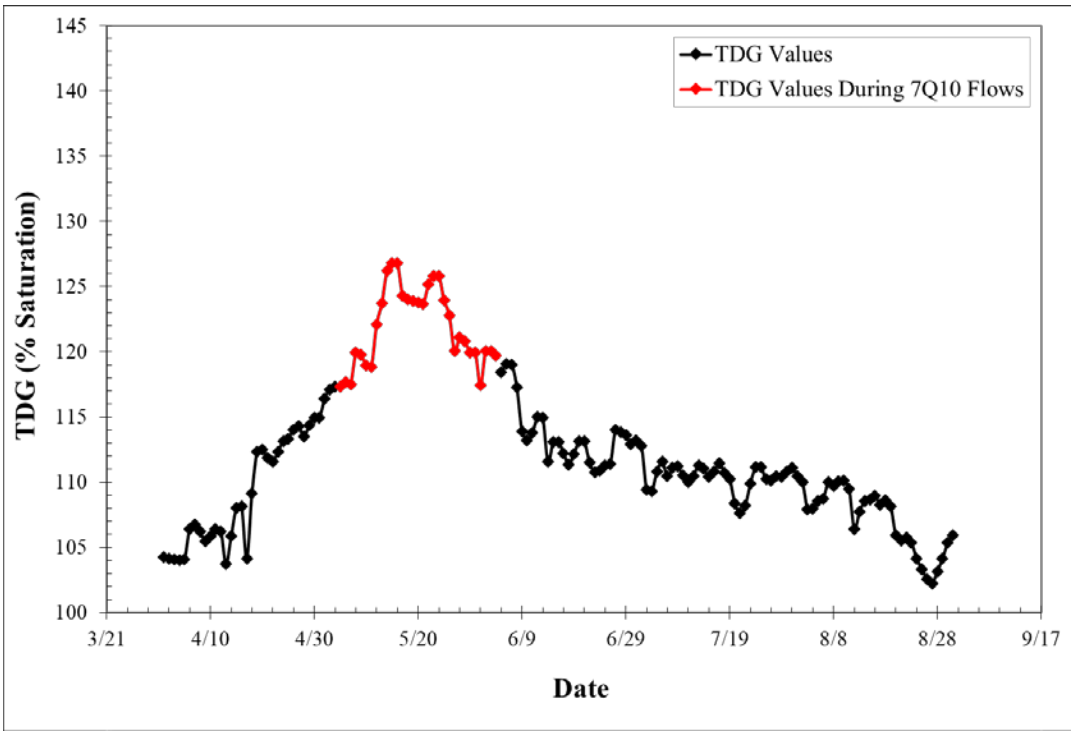


**Figure 10 Total dissolved gas values (average of the 12-highest consecutive hourly TDG values in a 24-hour period) from the 2018 fish-spill season recorded at the Pasco FSM station, mid-Columbia River, WA.**

The complete 2018 TDG hourly dataset can be found at Grant PUD's water quality website at: https://www.grantpud.org/water-quality.

### 4.2.2 Total Dissolved Gas Compliance Analyses

Grant PUD will continue to collect hourly TDG time-series data and, concurrent with each 5-Year update of its compliance gas abatement plan (GAP), perform a compliance analyses similar to the Year 10 Report (Grant PUD 2018a), using the previous 10 years of TDG data to ensure that Project operations continue to meet a similar level of compliance demonstrated in the Year 10 Report. The compliance analysis will include a descriptive characterization of the TDG data and an overall compliance assessment for the Project with respect to the TDG water quality standards.

## 4.3 Water Temperature

Water temperature data were collected on an hourly basis during the 2018 FSM program monitoring season at each FSM station within the Project. Data collection, QA/QC, and analyses of water temperature data followed those described in the QAPP (Hendrick 2009).

Overall data loss in 2018 was 983 of the combined 35,040 available hours, or approximately 2.8% data loss, which was within the 90% data completeness data quality objective as specified in the QAPP (Hendrick 2009).

Table 3 demonstrates the number of 1-DMax and 7-DADMax values that were omitted/lost from the dataset due to QA/QC issues compared to the total number of available hours.

**Table 3 Overview of the water temperature data set during 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| Location[1] | Available hours | Number of hours omitted/lost[2] | % data loss |
|---|---|---|---|
| WANF | 8,760 | 65 | 0.7 |
| WANT | 8,760 | 611 | 7.0 |
| PRDF | 8,760 | 0 | 0 |
| PRDT | 8,760 | 307 | 3.5 |
| **Total** | **35,040** | **983** | **2.8** |

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

### 4.3.1 Water Temperature Summary

In general, water temperatures were highest during mid-August to mid-September, with some daily maximum values greater than 20°C. The summary values (mean, standard deviation, minimum, and maximum) for all hourly temperature measurements taken from each FSM station are presented in Table 4; Figure 11 and Figure 12 present graphical displays of the 1-DMax and 7-DADMax values for the 2018 FSM program monitoring season.

**Table 4 Summary of hourly temperature measurements from each fixed-site monitor during 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| Location[1] | Data Interval | Mean[2] | Standard Deviation | Minimum[2] | Maximum[2] |
|---|---|---|---|---|---|
| WANF | 01/01 – 12/31 | 11.5 | 6.0 | 2.2 | 22.6 |
| WANT | 01/01 – 12/31 | 11.6 | 5.9 | 2.5 | 20.8 |
| PRDF | 01/01 – 12/31 | 11.5 | 5.8 | 2.3 | 21.3 |
| PRDT | 01/01 – 12/31 | 11.8 | 5.7 | 2.3 | 20.9 |

*Notes:*
[1]WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.
[2]All values represent degrees Celsius.

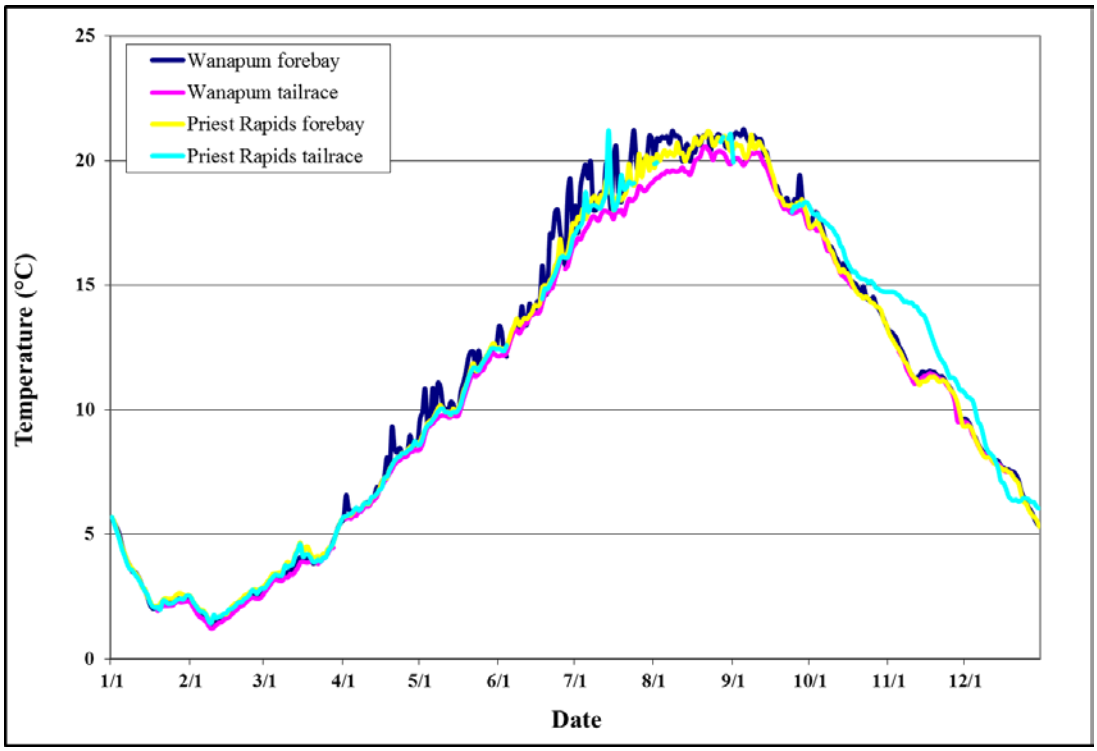


**Figure 11** **Daily maximum (1-DMax) water temperature values recorded at each fixed-site monitoring station (FSM station) in 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

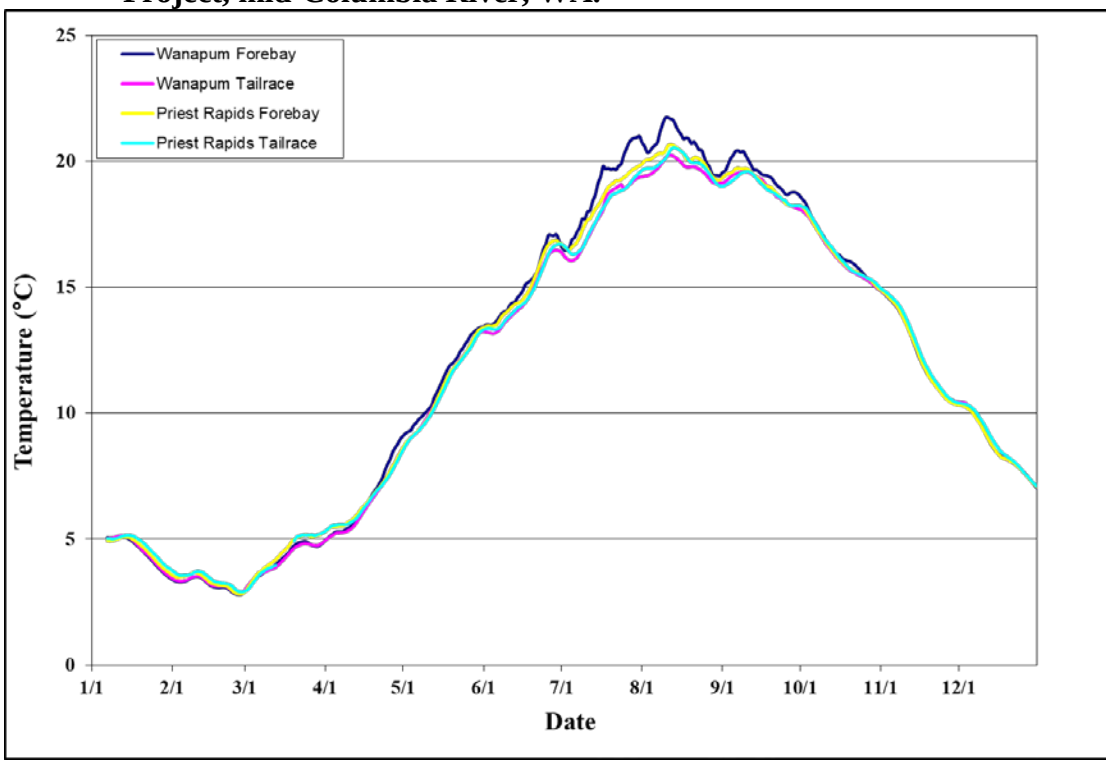


**Figure 12** **Seven-day rolling average of daily maximum temperatures (7-DADMax) recorded at each fixed-site monitoring station (FSM station) in 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

The complete 2018 water temperature hourly dataset can be found at Grant PUD's water quality website at: https://www.grantpud.org/water-quality.

### 4.3.2 Water Temperature Modeling

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 2015, and in accordance with Section 6.5.2 of the 401 WQC (WDOE 2007), Grant PUD conducted temperature modeling using a CE-QUAL-W2 model to determine Grant PUD's contribution, if any, to water temperature values recorded from 2003–2012 that were above WDOE water quality standards. Final results from this modeling effort were sent to WDOE on April 14, 2016.

### 4.3.3 Temperature QA/QC

Per the conditions of the QAPP (Hendrick 2009), Grant PUD performed QA/QC measurements of all currently operational Hydrolab® multi-probes against an NIST-certified thermometer. Multi-probes and the NIST-certified thermometer were placed into an ice bath to verify temperature accuracy and reliability. Data collected by the multi-probes during exposure to the ice bath were compared to the NIST-certified thermometer to ensure that the temperature sensor of each multi-probe were accurate and reliable. Results from this analysis are displayed in Table 5. As discussed in the QAPP, the accuracy/bias of the temperature sensor 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 by the QAPP (Hendrick 2009).

**Table 5 Temperature QA/QC data collected during 2018.**

| Date | Model | Serial # | Probe Temp[1] | Digital Thermometer[1] | Difference |
|---|---|---|---|---|---|
| 3/08/18 | DS5 | 46027 | 1.04 | 1.06 | **0.02** |
| 3/08/18 | DS4a | 37428 | 1.03 | 1.05 | **-0.02** |
| 3/08/18 | DS4a | 39420 | 1.01 | 1.03 | **-0.02** |
| 3/08/18 | MS4a | 40839 | 1.04 | 1.07 | **-0.03** |
| 3/08/18 | DS5x | 43947 | 1.09 | 1.05 | **0.04** |
| 3/08/18 | DS4a | 37535 | 1.04 | 1.07 | **0.03** |
| 3/08/18 | MS4a | 40928 | 1.06 | 1.05 | **0.01** |
| 3/08/18 | DS4a | 37517 | 1.08 | 1.06 | **0.02** |
| 3/08/18 | MS5 | 44768 | 1.11 | 1.07 | **0.04** |
| 3/08/18 | MS4a | 42195 | 1.07 | 1.06 | **0.01** |
| 3/08/18 | DS5 | 46021 | 1.04 | 1.05 | **-0.01** |
| 3/08/18 | MS4a | 42187 | 1.05 | 1.07 | **-0.02** |
| 3/08/18 | DS5 | 46043 | 1.03 | 1.06 | **-0.03** |

*Notes:*
[1]All values represent degrees Celsius.

## 4.4 Dissolved Oxygen, pH, and Turbidity

Summary results and values (mean, standard deviation, minimum, and maximum) from the periodic grab-sample monitoring of DO, pH, and turbidity values are presented in Table 6. Data

collection, QA/QC, and analyses of DO, pH, and turbidity followed those described in the QAPP (Hendrick 2009).

Of the data collected, no DO samples were below 9.8 mg/L, pH values were between 6.5 and 8.5 units, and turbidity ranged from 0.0 to 5.0 NTUs at all FSM stations within the Project during the 2018 water quality monitoring season.

**Table 6 Dissolved oxygen, pH, and turbidity grab-sample results in 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| | WANF[1] | | | WANT[1] | | | PRDF[1] | | | PRDT[1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **DO[2]** | **pH[3]** | **Turb[4]** | **DO[2]** | **pH[3]** | **Turb[4]** | **DO[2]** | **pH[3]** | **Turb[4]** | **DO[2]** | **pH[3]** | **Turb[4]** |
| 1/11/2018 | 12.1 | 8.0 | 1.0 | 12.2 | 8.0 | 1.1 | 12.3 | 8.1 | 0.9 | 12.2 | 8.0 | 1.0 |
| 2/15/2018 | 12.0 | 8.1 | 0.6 | 12.1 | 8.0 | 0.8 | 12.0 | 8.0 | 1.0 | 12.2 | 8.0 | 0.8 |
| 3/15/2018 | 12.4 | 8.3 | 5.0 | 12.4 | 8.2 | 4.8 | 12.2 | 8.2 | 4.6 | 12.2 | 8.2 | 4.4 |
| 4/19/2018 | 11.8 | 7.8 | 4.5 | 11.6 | 7.8 | 4.1 | 11.4 | 7.9 | 3.8 | 11.6 | 8.0 | 4.0 |
| 5/10/2018 | 11.9 | 7.8 | 5.0 | 11.8 | 8.2 | 4.8 | 11.5 | 8.1 | 5.0 | 11.4 | 8.2 | 4.8 |
| 5/24/2018 | 11.5 | 8.1 | 2.3 | 11.4 | 8.0 | 2.8 | 11.3 | 8.2 | 3.0 | 11.2 | 8.1 | 2.8 |
| 6/7/2018 | 10.8 | 8.1 | 1.8 | 10.8 | 7.9 | 1.4 | 10.6 | 7.9 | 2.0 | 11.0 | 8.0 | 1.5 |
| 6/21/2018 | 10.6 | 7.8 | 0.5 | 10.6 | 8.2 | 0.6 | 10.4 | 8.0 | 1.0 | 10.8 | 7.9 | 1.2 |
| 7/12/2018 | 9.8 | 7.9 | 0.4 | 9.9 | 8.0 | 0.3 | 10.0 | 8.1 | 0.4 | 10.0 | 7.9 | 0.6 |
| 7/26/2018 | 9.9 | 8.2 | 1.2 | 10.0 | 8.1 | 1.0 | 10.1 | 8.0 | 1.8 | 9.9 | 8.0 | 1.2 |
| 8/16/2018 | 10.2 | 8.3 | 0.8 | 10.4 | 8.1 | 0.4 | 10.1 | 7.9 | 1.0 | 10.2 | 7.8 | 0.9 |
| 8/30/2018 | 10.3 | 8.4 | 0.6 | 10.5 | 8.2 | 0.6 | 10.4 | 8.2 | 0.5 | 10.3 | 8.0 | 0.6 |
| 9/20/2018 | 10.9 | 7.9 | 0.4 | 11.0 | 8.0 | 0.3 | 10.8 | 8.0 | 0.4 | 10.9 | 8.0 | 0.6 |
| 10/18/2018 | 11.2 | 8.0 | 1.5 | 11.4 | 7.9 | 1.2 | 11.1 | 7.8 | 1.4 | 11.0 | 8.1 | 0.5 |
| 11/15/2018 | 11.5 | 8.0 | 0.5 | 11.2 | 8.0 | 1.0 | 11.4 | 8.0 | 1.2 | 11.1 | 7.9 | 0.7 |
| 12/13/2018 | 12.0 | 7.8 | 0.2 | 11.8 | 7.9 | 0.4 | 11.6 | 7.9 | 0.4 | 11.8 | 8.0 | 0.6 |
| **Mean** | 11.2 | 8.0 | 1.6 | 11.2 | 8.0 | 1.6 | 11.1 | 8.0 | 1.8 | 11.1 | 8.0 | 1.6 |
| **Min.** | 9.8 | 7.8 | 0.2 | 9.9 | 7.8 | 0.3 | 10.0 | 7.8 | 0.4 | 9.9 | 7.8 | 0.5 |
| **Max.** | 12.4 | 8.4 | 5.0 | 12.4 | 8.2 | 4.8 | 12.3 | 8.2 | 5.0 | 12.2 | 8.2 | 4.8 |
| **Stdev.** | 0.8 | 0.2 | 1.6 | 0.8 | 0.1 | 1.5 | 0.7 | 0.1 | 1.5 | 0.7 | 0.1 | 1.4 |

*Notes*:
[1]WANF = Wanapum Dam forebay, WANT = Wanapum Dam tailrace, PRDF = Priest Rapids Dam forebay, PRDT = Priest Rapids Dam tailrace.
[2]DO values represent mg/L, [3]pH values represent units, and [4]Turbidity values represent NTUs.

## 5.0 Conclusions

Water quality data collected in 2018 at Grant PUD's FSM stations included hourly TDG and water temperature data and periodic grab-samples of DO, pH, and turbidity. Grant PUD will continue its hourly TDG and water temperature monitoring as well as periodic grab-sampling of DO, pH, and turbidity at its FSM stations in 2019, in accordance with conditions contained in the 401 WQC (WDOE 2007) and the updated QAPP (Grant PUD 2018). Grant PUD will also continue its efforts in 2019 to assure minimal data loses at its FSM stations. These efforts include following the updated QAPP, which outlines standardized equipment calibration/maintenance, data collection, and data management procedures that are meant to achieve data completeness targets of greater than 90% (Grant PUD 2018).

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# Appendix A
# Omitted/Lost Data Explanations for 2018

**Table A-1 Hourly data points omitted/lost from the fixed-site monitoring (FSM) data set during 2018, Priest Rapids Hydroelectric Project, mid-Columbia River, WA.**

| Location[1] | Date(s) | hr.(s) | Total hr.(s) lost/omitted | Problem/reason for omission | Comments/action taken to correct problem |
|---|---|---|---|---|---|
| WANF | 6/19-6/21 | 9:00-10:00 | 50 | Probe failure | Replaced with new Probe |
| WANT | 1/01-1/04 | 01:00-11:00 | 83 | Probe failure | Replaced with new Probe/Unable to access site because of inclement weather |
| WANT | 1/15-1/16 | 01:00-00:00 | 24 | Database failure | Restarted server |
| WANT | 9/16-9/17 | 01:00-13:00 | 37 | Probe failure | Replaced with new Probe |
| WANT | 11/29-12/18 | 01:00-13:00 | 469 | Probe failure | Replaced with new Probe/Unable to access site because of inclement weather |
| PRDT | 2/19 | 11:00-15:00 | 5 | Database failure | Restarted server |
| PRDT | 3/6-3/19 | 23:00-10:00 | 300 | Lost Hard Power | Coordinated with local crew(s) to orchestrate power issue. Replaced breaker/fuse/and battery. |

*Notes*:
[1]WANF = Wanapum Dam forebay, WANT= Wanapum Dam tailrace, PRDT= Priest Rapids Dam tailrace

# Appendix B
# Extension of Time Approval for the 2018 Water Quality Summary

**Carson Keeler**

**From:** Zimmerman, Breean (ECY) <bzim461@ECY.WA.GOV>
**Sent:** Thursday, February 21, 2019 12:43 PM
**To:** Carson Keeler
**Cc:** NR Records; Debbie Firestone; Ross Hendrick; Tom Dresser; Peter Graf
**Subject:** RE: EOT for 2018 WQ Summary Report



Hi Carson,

Thank you for your call today and this follow up email. Your request for an extension of time for the subject report submittal from March 1, 2019 to March 15, 2019 is granted.

Breean Zimmerman | **Hydropower Projects Manager**
Water Quality Program | Central Regional Office
(509) 575-2808 (w) | (509) 406-5130 (c) | bzim461@ecy.wa.gov

**From:** Carson Keeler <Ckeeler@gcpud.org>
**Sent:** Thursday, February 21, 2019 12:37 PM
**To:** Zimmerman, Breean (ECY) <bzim461@ECY.WA.GOV>
**Cc:** NR Records <Nrrec@gcpud.org>; Debbie Firestone <Dfirest@gcpud.org>; Ross Hendrick <Rhendr1@gcpud.org>; Tom Dresser <TDresse@gcpud.org>; Peter Graf <Pgraf@gcpud.org>
**Subject:** EOT for 2018 WQ Summary Report

Good afternoon Breean,

Section 6.7.3 of the Priest Rapids Project's 401 WQC requires Grant PUD to provide to Ecology the results of its water quality monitoring efforts as well as a summary of the results by March 1 of each year (WQ Summary Report). Based upon the phone conversation we had early today and the justifications we discussed, we'd (Grant PUD) like to request an extension of time (EOT) for the submittal of the WQ Summary Report from March 1, 2019 to March 15, 2019. The additional couple of weeks will provide ample time for Grant PUD to provide a summary report that is consistent with the 10 Year TDG Report and 5 Year GAP. Please let me know if you have any questions.

Thanks,

Carson

Carson Keeler
Grant PUD
Office: (509) 754-5088 x2687
Cell: (509) 797-5176