SUMMARY OF 2015 ANNUAL FISH-SPILL SEASON AND TOTAL DISSOLVED GAS MONITORING

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for

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Executive Summary

This report summarizes the results of the 2015 fish-spill season and associated total dissolved gas (TDG) and biological monitoring within the Priest Rapids Hydroelectric Project (Project), owned and operated by the Public Utility District No. 2 of Grant County, Washington (Grant PUD).

During the 2015 fish-spill season, Grant PUD implemented spill programs as guided by the 2008 National Marine Fisheries Service (NMFS) Biological Opinion (Biological Opinion) and the Priest Rapids Coordinating Committee (PRCC). At Wanapum Dam fish-spill was through the Wanapum Fish Bypass (WFB), which is designed to safely bypass outmigrating smolts, while minimizing TDG uptake. Depending on forebay elevations, the WFB passes up to 22 thousand cubic feet per second (kcfs). The spillway at Wanapum Dam was operated on an as-needed basis to pass involuntary spill. At Priest Rapids Dam fish-spill was through the Priest Rapids Fish Bypass (PRFB). The PRFB was designed to safely bypass outmigrating smolts, while minimizing TDG uptake. Depending on forebay elevations, the PRFB passes up to 24 kcfs. The other spillway gates at Priest Rapids Dam were operated on an as-needed basis to pass involuntary spill.

In accordance with the Washington Department of Ecology's (WDOE's) water quality standards, the fish-spill season for TDG compliance purposes occurred from April 1 through August 31, 2015 (see Washington Administrative Code (WAC) 173-201A-200(1)(f)). In accordance with the Biological Opinion, the fish-spill season began at Wanapum Dam on April 19, 2015 and concluded on August 13, 2015. The fish-spill season began at Priest Rapids Dam on April 20, 2015 and concluded on August 14, 2015. The fish-spill periods were closely matched with the juvenile migration timing, with greater than 98% of the yearling spring outmigrants passing during the spring fish-spill period between April 19 and June 14, 2015 (FPC 2015). The combined spring and summer fish-spill periods from April 19 through August 14 encompassed greater than 99% of the entire 2015 outmigration (FPC 2015).

Mean daily discharges during the 2015 fish-spill season were moderately lower than the 2005 – 2014 (10-year) average (about 23% lower on average) over the entire fish-spill season (April 1 through August 31). This contributed immensely to the void in the exceedances of TDG levels observed during the 2015 fish-spill season.

There were no exceedances of TDG observed during the 2015 fish-spill season. The primary explanation for the absence of exceedances in TDG levels during the 2015 fish-spill season can likely be attributed to the fact that 2015 was a moderately low flow year overall compared to the last 10-years, and thus required minimal involuntary spill efforts within the Project and at upstream projects (which resulted in lower incoming TDG levels). Additionally, pre-emptive spill efforts undertaken by Grant PUD helped reduce or eliminate larger involuntary spill events. For example, if upstream flow predictions were anticipated to be higher than predicted power-load demand, which would lead to involuntary spill, pre-emptive spill was initiated several hours prior to the high flows, thus making room to store the excess water until it could be passed through the turbines (e.g. when power-load demand increased). This reduced the need to involuntarily spill larger amounts of water through the tainter-gates, which typically leads to higher TDG levels. The lower, longer sustained, pre-emptive spill did not lead to TDG levels in excess of TDG water quality standards. The pre-emptive spill events required close coordination with upstream project operators through Grant PUD's Power Marketing, dam Operators, and Natural Recourse departments.

Grant PUD strives to meet TDG standards, as well achieve juvenile and adult salmonid and steelhead fish passage and survival standards for the Project, all while meeting regional energy loads and demands. Grant PUD attempted to reduce TDG when feasible by implementing operational TDG abatement measures in 2015, including attempting to maximize turbine flows by setting involuntary spill caps and minimum generation requirements (and thus maximizing turbine flows and reducing involuntary spill), participation in regional spill/project operation meetings, implementation of the regional Spill Priority List, and continuing to preemptively spill based on anticipated high flow/low power load time periods. Examples of structural abatement measures include the construction of spillway deflectors at Wanapum Dam (2000), the construction of the WFB (2008), and the PRFB (2014). By implementing these measures over the next three years (as part of the ten-year compliance schedule that began in 2008), Gant PUD is implementing the most current reasonable and feasible measures to reduce elevated TDG levels that occur during the fish-spill season.

Grant PUD will continue to closely monitor TDG levels during the fish-spill season in accordance with its WDOE-approved Quality Assurance Project Plan (QAPP; Hendrick 2009), and will develop its spill programs in accordance with current TDG water quality criteria as set by WDOE, adjusting spill percentages as needed to comply with current TDG standards.

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%SAT	percent saturation
7Q10 flow	highest seven consecutive day average flow with a 10-year recurrence frequency
BPA	Bonneville Power Administration
Biological Opinion	National Marine Fisheries Service's Biological Opinion for the Priest Rapids Hydroelectric Project
Chelan PUD	Public Utility District No. 1 of Chelan County, Washington
Corps	U.S. Army Corps of Engineers
DO	dissolved oxygen
DS	DataSonde
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FSM station(s)	fixed-site monitoring station(s)
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County, Washington
kcfs	thousand cubic feet per second
mg/L	milligrams per liter
mm Hg	millimeters of mercury
MS	MiniSonde
MW	megawatt
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
PASCO	Pasco fixed-site monitoring station
PRDF	Priest Rapids forebay
PRDT	Priest Rapids tailrace
PRFB	Priest Rapids Fish Bypass
PRCC	Priest Rapids Coordinating Committee
Project	Priest Rapids Hydroelectric Project
QAPP	quality assurance project plan

QA/QC	quality assurance/quality control
RPA	Reasonable and Prudent Alternative
RM	river mile
TDG	total dissolved gas
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WANF	Wanapum forebay
WANT	Wanapum tailrace
WFB	Wanapum Fish Bypass
WDOE	Washington Department of Ecology
WQC	water quality certification

1.0 Introduction

The Public Utility District No. 2 of Grant County, Washington (Grant PUD) owns and operates the Priest Rapids Hydroelectric Project (Project; Figure 1). The Project is licensed as Project No. 2114[1] by the Federal Energy Regulatory Commission (FERC) and includes Wanapum and Priest Rapids dams. 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, amended on March 6, 2008, and effective on issuance of the FERC license to operate the Project on April 17, 2008 (FERC 2008). Section 6.4.11(c) of the 401 WQC (WDOE 2007) requires Grant PUD to submit an annual report on fish-spill and total dissolved gas (TDG) monitoring by October 31 annually. The following sections summarize the results of the 2015 fish-spill and TDG monitoring season.

1.1 Priest Rapids Project Description

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; 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).

The Wanapum and Priest Rapids dam spillways were initially designed to accommodate flows that exceeded turbine capacity and have more recently been used to spill water for the purpose of supplementing downstream smolt migrations. However, releasing flows over the spillways can also result in elevated TDG, which can be harmful to fish. To address this issue, Grant PUD coordinates its fish-spill program to address fish migrations and comply with current water quality standards for TDG and has implemented downstream bypass measures to safely pass salmonids and/or to reduce or minimize TDG.

[1] 123FERC¶61,049

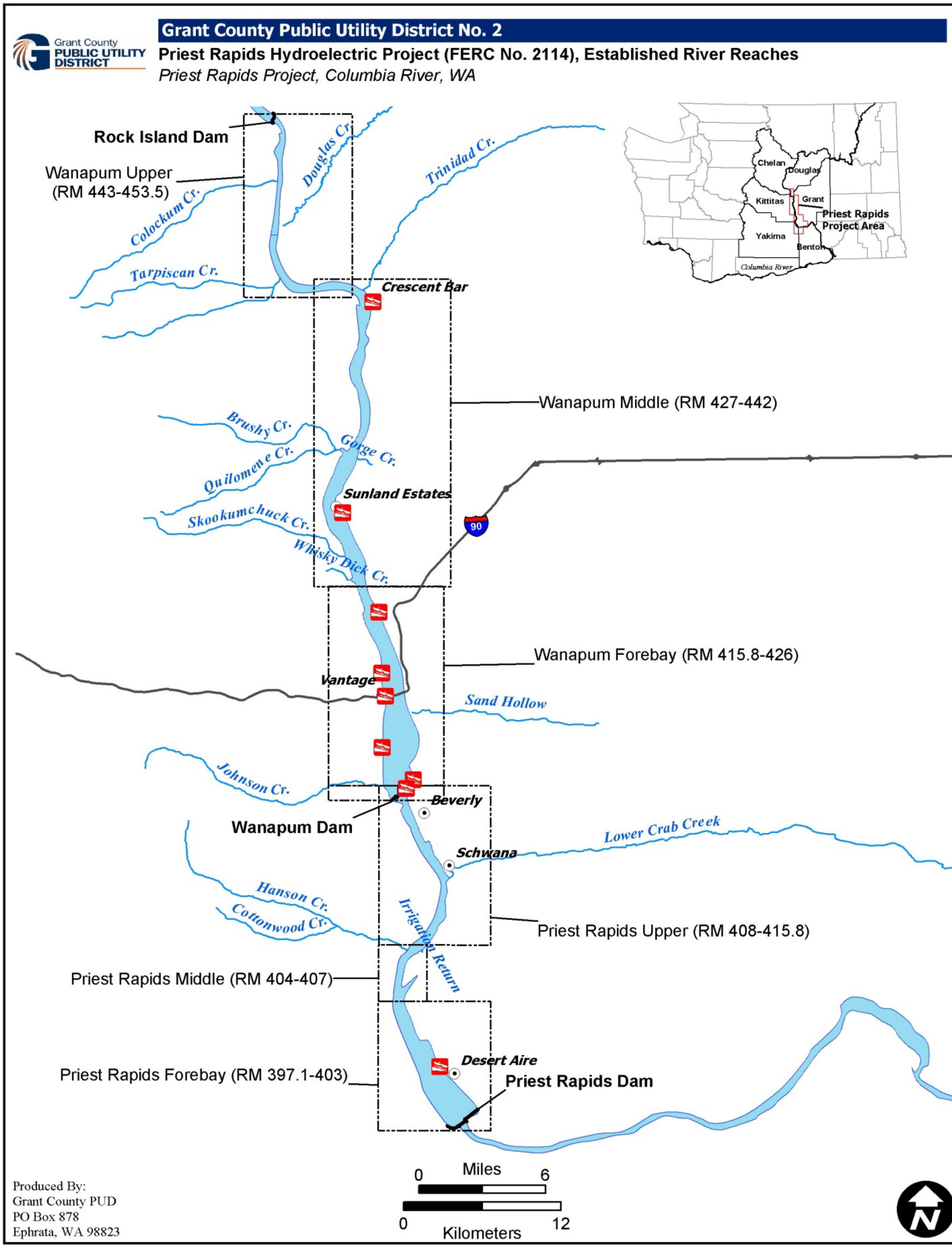

Figure 1 **The Priest Rapids Project and established river reaches presented by river mile (RM), mid-Columbia River, WA.**

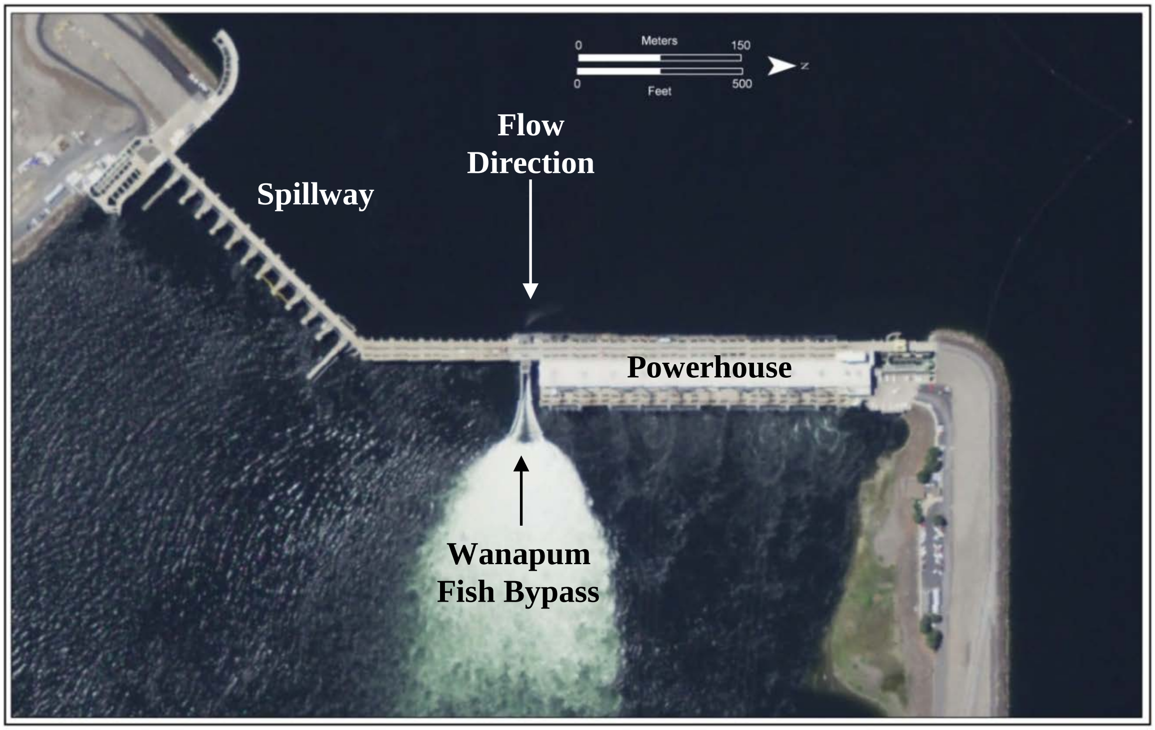

Figure 2 Aerial photograph of Wanapum Dam, mid-Columbia River, WA.

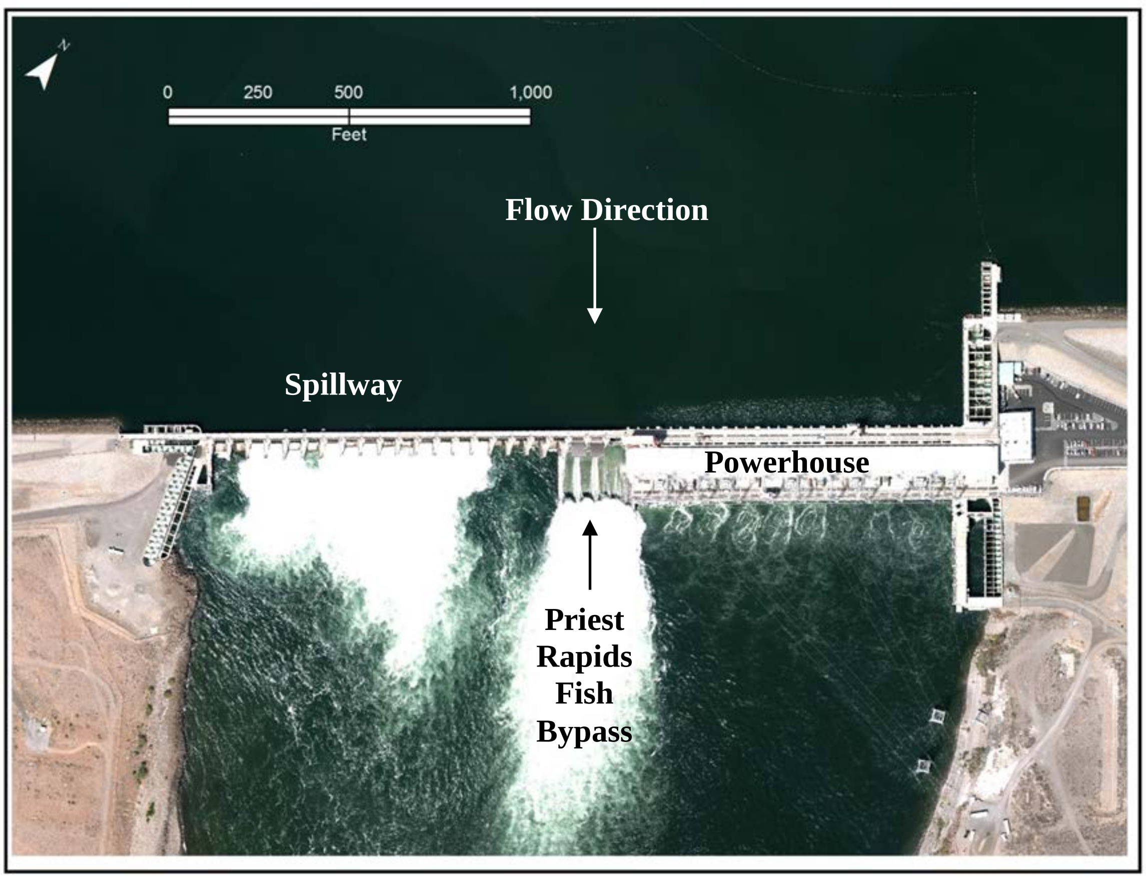

Figure 3 Aerial photograph of Priest Rapids Dam, mid-Columbia River, WA.

1.1.1 Fixed Site Water Quality Monitoring Stations

Grant PUD currently operates and maintains four fixed-site water quality monitoring stations (FSM stations) that record water depth (m), barometric pressure (millimeters of mercury (mm/hg)), TDG (mm/hg), temperature (°C), dissolved oxygen (DO; milligrams per liter (mg/L)), pH (units), and turbidity (Nephelometric Turbidity Unit (NTU)). Barometric pressure, TDG, and temperature are monitored on an hourly basis throughout the year, while depth, DO, pH, and turbidity grab-samples are collected every two to three weeks throughout the year in accordance with Grant PUD's WDOE-approved Quality Assurance Project Plan (QAPP; Hendrick 2009). Grant PUD's FSM stations are located midway across the river channel in the forebay and tailrace of each dam. The Public Utility District No. 1 of Chelan County (Chelan PUD) also operates and monitors a FSM station located in the Rock Island Dam tailrace, approximately 38 river miles (RMs) upstream of Wanapum Dam, during the fish-spill season. This allows Grant PUD to monitor upstream river conditions during the fish-spill season. The Pasco FSM station located at RM 329 and owned/operated by the U.S. Army Corps of Engineers (Corps), serves as the next downstream forebay TDG compliance point for Priest Rapids Dam. This location was chosen to measure mixed river gas conditions before dilution or concentration with the waters of the Snake River. This site allows Grant PUD to monitor downstream river conditions during the fish-spill season.

Each Grant PUD FSM station is equipped with a Hydrolab® Corporation DataSonde (DS) 5X, DS 5, DS4A, or MiniSonde (MS) 5 or MS4A multi-probe enclosed in a submerged conduit. 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 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-probe.

For a complete description of the FSM stations see the QAPP (Hendrick 2009).

1.2 Regulatory Framework

Washington state water quality standards are established by the WDOE for TDG during the non-fish and fish-spill seasons (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 115 %SAT in the forebay and 120 %SAT in the tailrace, based on the average of the twelve highest consecutive hourly readings in a twenty-four hour period. A one-hour, 125 %SAT maximum standard for TDG also applies throughout the Project.

1.2.1 7Q10 Flows

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 be waived 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.

1.2.2 Daily Total Dissolved Gas Compliance Value Calculation Method

Prior to 2008, the method used to calculate the daily TDG compliance value during the fish-spill season were based on the average of the twelve highest hourly values in a twenty-four hour period, starting at 0100 hours and ending at 2359 hours. This method was based on WDOE's 1997 water quality standards (WDOE 1997). In WDOE's 2006 revision to the water quality standards (which were not approved by the Environmental Protection Agency (EPA), and thus not effective, until 2008; WDOE 2008a) the method for calculating the TDG compliance value were changed. The new method provided that the TDG compliance value be determined by calculating the average of the twelve highest ***consecutive*** hourly values in a twenty-four hour period. Prior to the 2008 fish-spill season, there were discussion amongst the Columbia and Snake River dam operators on how to properly implement the "rolling average" method, especially as it related to what time the rolling average began. There were concerns related to the addition of the previous day's last eleven hours to the compliance value calculation on the next day.

On April 2, 2008 WDOE requested, via letter, that all Columbia and Snake River dam operators use a rolling average method for calculating the twelve highest consecutive hourly TDG readings in a twenty-four hour period, beginning at 0100 hours, based on WDOE's 2006 revised water quality standards (WDOE 2008b). Using a rolling average method that begins at 0100 hours results in counting the hours 1400 through 2359 twice: in the average calculations on the day they occur ***and*** on the next reporting day. As a result, a TDG water quality standard exceedance may be indicated on two separate days based on the same group of hours. On April 15, 2008 Grant PUD sent a letter to WDOE that expressed and provided an example of its concern regarding the rolling average method (Grant PUD 2008). Grant PUD also expressed its intention to monitor these "double-counting" problems and reported any instances in which the same block of hours create an exceedance on two different days in its annual report during two separate phone conversations with Mr. Chris Maynard and Ms. Marcie Mangold of WDOE on March 31, 2008.

Since the 2015 fish-spill season was void of TDG exceedances, there were no "double-counting" instances of TDG. Grant PUD will continue to track and report these "double-counting" occurrences in future fish-spill years.

2.0 Data Evaluation and Analyses

Data collection, quality assurance/quality controls (QA/QC), and analyses of TDG values were conducted in accordance with the QAPP for the FSM stations (Hendrick 2009). For this report, hourly TDG data recorded during the 2015 fish-spill season were analyzed for apparent exceedances of current water quality standards.

All of the TDG sensors used during the 2015 fish-spill season were calibrated and maintained in accordance with the methods and schedules described in the QAPP (Hendrick 2009). TDG sensors that did not pass calibration tests were sent back to the manufacture for repair and/or replaced prior to deployment. Suspect or erroneous TDG values were omitted from the analysis, but are included, as well as explanation for omission, in Appendix A of this report.

The data QA/QC issues during the 2015 fish-spill season were related to probe failures at the Wanapum Dam forebay/tailrace FSM stations. Overall data loss for Grant PUD operated FSM stations during the 2015 fish-spill season were 165 hourly readings (1.1% of the total available data collection hours), which were well within the 90% data completeness/quality objective as specified in the QAPP (Hendrick 2009).

Table 1 displays the total number of hourly TDG values that were omitted from the dataset due to QA/QC issues during the 2015 fish-spill season. Appendix A provides any detailed information related to data that was omitted due to QA/QC issues.

Table 1 Overview of total dissolved gas data set during 2015 fish-spill season.

Location	Available data collection hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
WANF	3672	21	0.6
WANT	3672	144	3.9
PRDF	3672	0	0.0
PRDT	3672	0	0.0
Total	14688	165	1.1

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

3.0 Results

The following sections describe the 2015 fish-spill season flow characteristics compared to the previous ten-year average (2005-2014), the 2015 fish-spill season programs, the fish migration timing compared to fish-spill season durations, and the 2015 biological TDG monitoring results.

3.1 Description of 2015 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2015 fish-spill season were compared to the ten-year average of mean daily flows from 2005 to 2014 (Figure 4) as measured at the U.S. Geological Survey (USGS) streamflow gage #12472800 located 2.6 RMs downstream of Priest Rapids Dam (USGS 2015). Overall the 2015 mean daily discharges were lower than the 2005–2014 average (~23% lower on average) during the fish-spill season (April 1 through August 31).

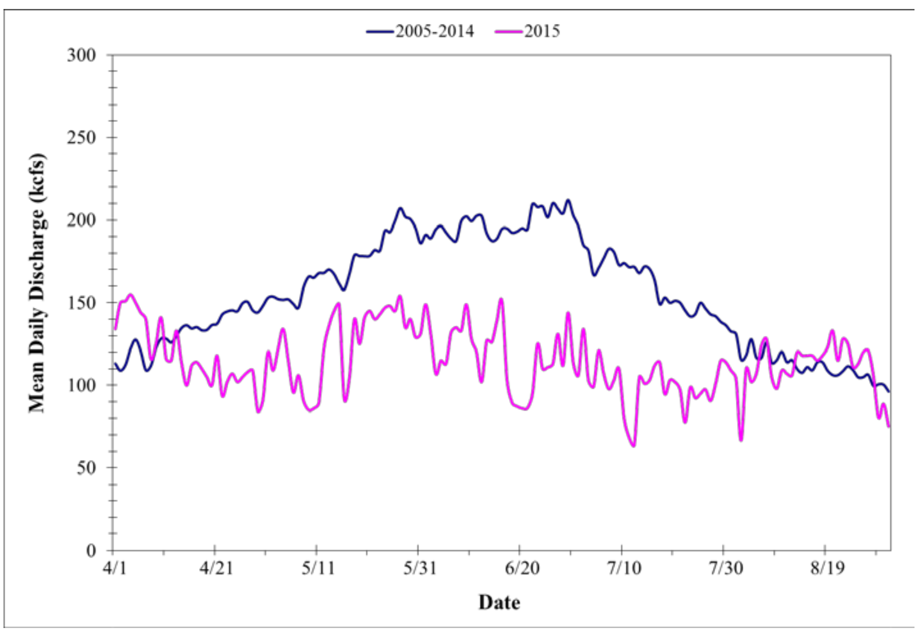

Figure 4 Comparison of 2015 vs. previous ten-year average of mean daily discharge values as measured at the USGS streamflow gage #12472800 located below Priest Rapids Dam, mid-Columbia River, WA.

3.2 Fish-Spill Programs

On February 1, 2008 the National Marine Fisheries Service (NMFS) issued a Biological Opinion (Biological Opinion) for the Project. The Biological Opinion includes terms and conditions related to Grant PUD's fish-spill program, and those terms and conditions are incorporated in the FERC license for operation of the Project (FERC 2008). Reasonable and Prudent Alternative (RPA) 1, and associated terms and conditions of the Biological Opinion (NMFS 2008) require Grant PUD to initiate its fish-spill programs before 2.5% of the spring migration period has passed, as documented by the smolt index counts at Rock Island Dam. The spring fish-spill program can conclude when 97.5% of the spring migration period is complete, or on June 15, whichever occurs first. The summer fish-spill program begins immediately after the end of the spring fish-spill season, as guided by the Priest Rapids Coordinating Committee (PRCC) and the fishway prescription set forth in the Priest Rapids Project Salmon and Steelhead Settlement Agreement (Grant PUD 2006), and continues until 95% of summer outmigrating smolts have passed. Grant PUD also provides limited spill (typically around 2 kcfs) for adult fall-back until November 15, annually.

3.2.1 Wanapum Dam

During the 2015 fish-spill season, Grant PUD implemented the Wanapum Dam spill program as guided by the Biological Opinion and the PRCC, which called for operation of the WFB, designed to safely pass outmigrating smolts, while minimizing TDG uptake. Depending on forebay elevations, the WFB passes up to 22 kcfs. The spillway at Wanapum Dam was operated on an as-needed basis to pass involuntary spill, according to spill patterns designed for the optimal fish-passage safety and as approved by the PRCC.

3.2.2 Priest Rapids Dam

During the 2015 fish-spill season, Grant PUD implemented the Priest Rapids Dam spill program as guided by the Biological Opinion and the PRCC, which called for operation of the PRFB, designed to safely pass outmigrating smolts, while minimizing TDG uptake. Depending on forebay elevations, the PRFB passes up to 24 kcfs. The spillway at Priest Rapids Dam was operated on an as-needed basis to pass involuntary spill, according to spill patterns designed for the optimal fish-passage safety and as approved by the PRCC.

3.3 Fish-Spill Quantities and Duration

Spring fish-spill began at Wanapum Dam on April 19, 2015 at 1000 hours and ended June 14, 2015 at 2359 hours, while spring fish-spill began at Priest Rapids Dam on April 20, 2015 at 1000 hours and ended June 14, 2014 at 2359 hours. Summer fish-spill began on June 15, 2015 at 0000 hours in accordance with the Priest Rapids Project Salmon and Steelhead Agreement (Grant PUD 2006), immediately following the end of the spring fish-spill season and continued through 0800 hours on August 13, 2015 at Wanapum Dam and 0800 hours on August 14, 2015 at Priest Rapids Dam (see Appendix B). Table 2 provides a summary of the 2015 fish-spill for Wanapum and Priest Rapids dams.

Table 2 Summary of 2015 fish-spill operations at Wanapum and Priest Rapids dams. Priest Rapids Project, mid-Columbia River, WA.

Wanapum Dam			
Date	**Spill Program**	**Quantity[1]**	**Purpose**
April 19, 2015	***Spring Spill Initiated***		
April 17-June 14	WFB (Open 24 Hours/Day)	Up to 22 kcfs	RPA 1 and terms and conditions of the Biological Opinion and as guided/approved by the PRCC.
June 15, 2015	***End of Spring Spill/ Summer Spill Initiated***		
June 15-Aug 13	WFB (Open 24 Hours/Day)	Up to 22 kcfs	Priest Rapids Project Salmon and Steelhead Settlement Agreement and as guided/approved by the PRCC.
August 13, 2015	***End of Summer Spill***		
[1]Actual quantity spilled is dependent on forebay and tailwater elevations.			

Priest Rapids Dam			
Date	**Spill Program**	**Quantity[1]**	**Purpose**
April 20, 2015	***Spring Spill Initiated***		
April 20-June 14	PRFB (Open 24 Hours/Day)	Up to 24 kcfs	RPA 1 and terms and conditions of the Biological Opinion and as guided/approved by the PRCC
June 15, 2015	***End of Spring Spill/ Summer Spill Initiated***		
June 15-Aug 14	PRFB (Open 24 Hours/Day)	Up to 24 kcfs	Priest Rapids Project Salmon and Steelhead Settlement Agreement and as guided/approved by the PRCC
August 14, 2015	***End of Summer Spill***		
[1]Actual quantity spilled is dependent on forebay and tailwater elevations.			

3.4 Biological Evaluations

The following sections provide a summary of fish passage timing results as they relate to the 2015 fish-spill season at Wanapum and Priest Rapids dams, a description of the fish passage studies conducted in 2015, and results from gas bubble trauma (GBT) monitoring.

3.4.1 Fish Passage Efficiencies

The fish-spill periods at the Project were very closely matched with the juvenile migration timing (as documented by smolt index counts at Rock Island Dam (FPC 2015)). Figure 5 illustrates that greater than 98% of the yearling spring outmigrants passed during the spring fish-spill period between April 19 and June 14 (FPC 2015). Figure 6 shows that the combined spring and summer fish-spill periods from April 19 through August 14 encompassed greater than 99% of the entire 2015 outmigration (FPC 2015), while Figure 7 shows that greater 99% of the sub-yearling Chinook passed by August 14 (FPC 2015).

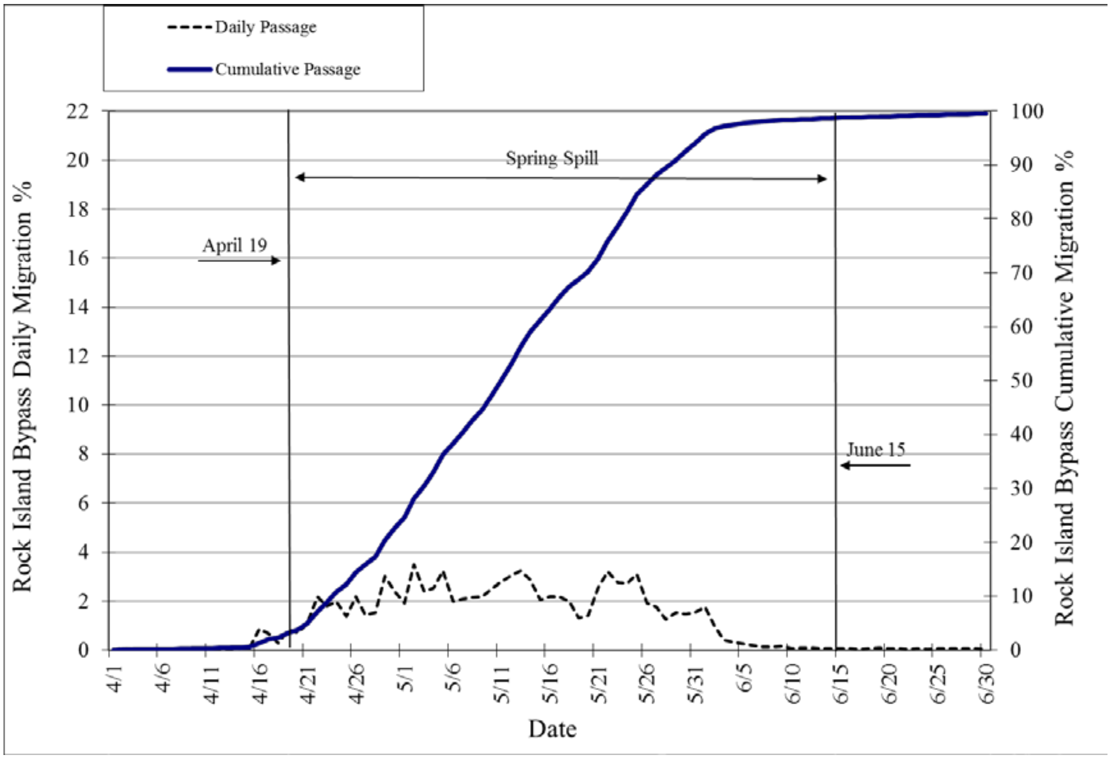

Figure 5 **Fish-spill and migration timing for yearling Chinook and steelhead, spring 2015. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2015).**

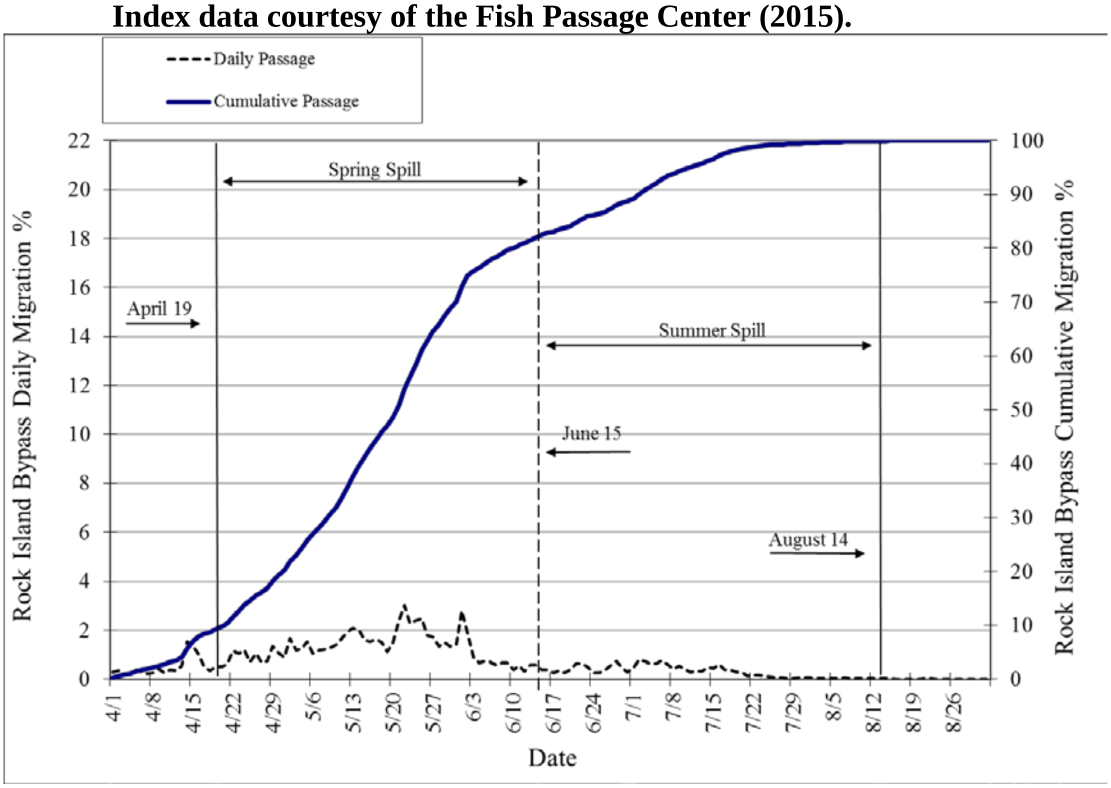

Figure 6 **Fish-spill and migration timing for all species, 2015. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2015).**

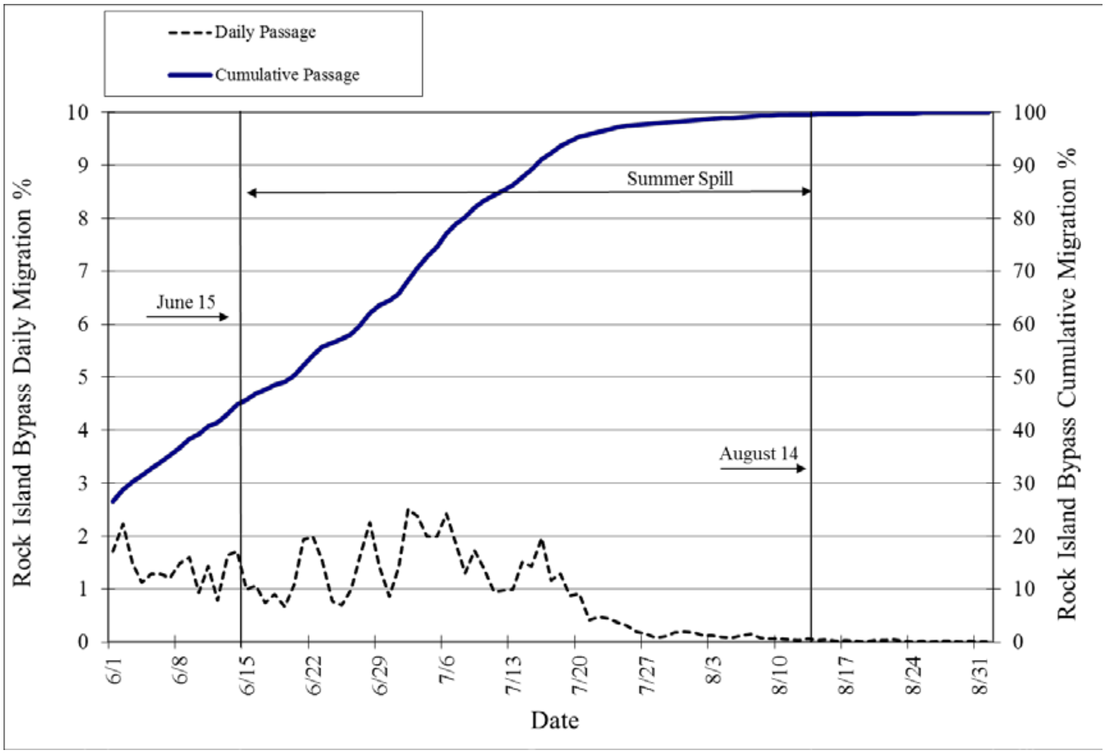

Figure 7 Fish spill and migration timing for sub-yearling Chinook, summer 2015. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2015).

3.4.2 Survival and Behavior Evaluation Studies

In 2015, in consultation and coordination with the PRCC, Grant PUD conducted a multi-species survival and behavior evaluation (juvenile steelhead and sockeye) within the Wanapum and Priest Rapids reservoir and at Wanapum and Priest Rapids dam to determine route specific survival (turbine, WFB and spillway) and fish passage efficiency (FPE) in relationship to each passage route.

Sockeye were released in the Rock Island Dam tailrace during the month of May with multi-day releases. It was found that 29.3% of the tagged sockeye passed Wanapum Dam via the powerhouse passage. Powerhouse survival for sockeye was 92.3%. Fish Passage Efficiency and survival for sockeye passing through the WFB was 63.1% and 98.0% survival, respectively. Spillway, used during times of inadvertent spill FPE was 5.3%, with an observed survival of 100%. Total estimated survival for sockeye passing Wanapum Dam was 95.8%, while estimated survival through the Wanapum Reservoir was 98.2%.

Juvenile steelhead were also released into the Rock Island Dam tailrace during 2015. FPE for juvenile steelhead passing through the powerhouse was 43.2%, with an observed estimated survival rate of 91.8%. At the WFB, the FPE was 48.0% and survival was estimated at 97.0%. Estimated survival through the Wanapum spillway was 100% with 0.9% of the juvenile steelhead passing via the spillway. Total estimated survival for juvenile steelhead passing through Wanapum Dam was 93.1%, while survival through the Wanapum Reservoir was 91.8%.

Survival estimates and fish passage efficiencies for sockeye and juvenile steelhead within the Priest Rapids Reservoir and at Priest Rapids Dam were as follows during the 2015 survival/behavior study conducted by Grant PUD. For sockeye the FPE/survival percentage (route dependent) were, for the PRFB, 64.6% and 99.5%, respectively; for the spillway, 0.2% and 100%, respectively; and for the powerhouse, 33.7% and 93.3%. For juvenile steelhead the FPE/survival percentage (route dependent) were, for the PRFB, 52.0% and 99.6%, respectively; for the spillway, 0.0%; and for the powerhouse, 39.9% and 95.5%, respectively.

All 2015 survival estimates for the Project are preliminary (draft) at the time of this 2016 TDG/Fish-Spill report.

3.4.1 Gas Bubble Trauma Monitoring

Blue Leaf Environmental (BLE) conducted GBT monitoring under contract of Grant PUD during the 2015 fish-spill season using the Smolt Gas Bubble Trauma Examination Protocol, developed by the Fish Passage Center (FPC; FPC 2009). This protocol has been used extensively throughout the Columbia and Snake River basins to standardize GBT examination practice by participating agencies within the Pacific Northwest. The principal objective was to administer smolt GBT examinations and record the presence of observed GBT-related tissue damage on salmonid smolt as a function of species, as they passed through the collection facilities at either Priest Rapids or Wanapum dams.

During the 2015 fish-spill season, 1,846 smolts were examined for GBT, with 2 exhibiting signs of GBT, or approximately 0.10% of the total smolts sampled. According to the FPC (FPC 2009), a rank is assigned based upon the percent area of the fin or eye covered with bubbles. A rank 0 is assigned if no bubbles occur; rank 1 is assigned if 1-5% of the fin or eye is covered with bubbles; rank 2 is assigned for 6-25% area covered; rank 3 for 25-50% area covered; and rank 4 for >50% area covered. Both of the smolts that had symptoms of GBT during the 2015 season were Chinook and received a rank of one.

Table 3 below provides the summary results of GBT monitoring during the 2015 fish-spill season recorded at either Priest Rapids or Wanapum dam.

Table 3 Gas bubble trauma monitoring results from either Priest Rapids or Wanapum dam in 2015. Priest Rapids Project, mid-Columbia River, WA.

		Number of fish with GBT Signs				
Species	Number of fish sampled	Rank 1	Rank 2	Rank 3	Rank 4	Total
Chinook	1,758	2	0	0	0	2
Steelhead	88	0	0	0	0	0
Total	***1,846***	***2***	0	0	0	***2***

3.5 Total Dissolved Gas Monitoring

The following sections discuss the results of TDG monitoring from the 2015 fish-spill season within the Project and at the Pasco compliance point location. Summary values for all hourly TDG measurements taken from each FSM station during the 2015 fish-spill season are presented in Table 4 below.

Table 4 **Summary of hourly total dissolved gas measurements from each fixed-site monitoring station (FSM station) during the 2015 fish-spill season. Priest Rapids Project, mid-Columbia River, WA.**

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
WANF	04/1 – 08/31	108.1	3.0	95.4	116.0
WANT	04/1 – 08/31	109.6	3.0	101.1	119.3
PRDF	04/1 – 08/31	108.1	3.0	98.2	114.9
PRDT	04/1 – 08/31	110.4	4.0	99.8	117.9
PASCO	04/1 – 08/31	107.1	2.7	99.0	112.9

Notes:
All values represent %SAT.
WANF = Wanapum forebay, WANT = Wanapum tailrace, PRDF = Priest Rapids forebay, PRDT = Priest Rapids tailrace, PASCO = Pasco Fixed-Site Monitoring Station located upstream of McNary Dam (next downstream forebay), operated by the US Army Corps of Engineers.

3.5.1 Total Dissolved Gas Averages during the Fish-Spill Season

Figure 8 through Figure 12 displays the average of the 12-highest consecutive hourly readings from each 24-hour period during the fish-spill season from each FSM station, except for days when there was no data available due to probe failure (see Sections 1.2.1 and 2.0).

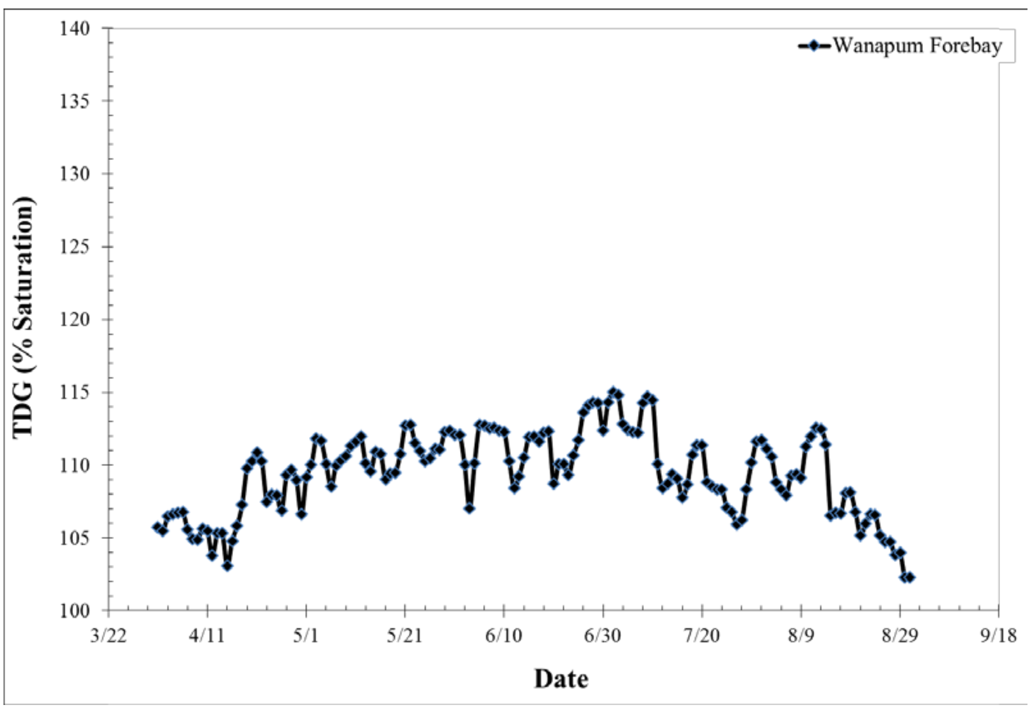

Figure 8 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Wanapum Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

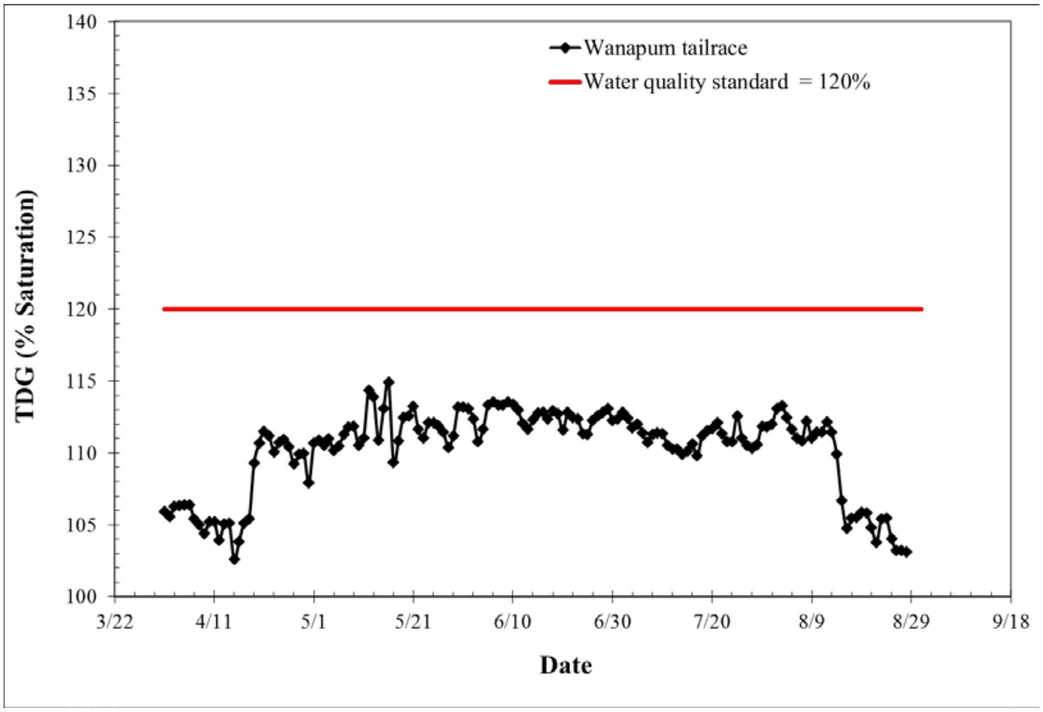

Figure 9 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Wanapum Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

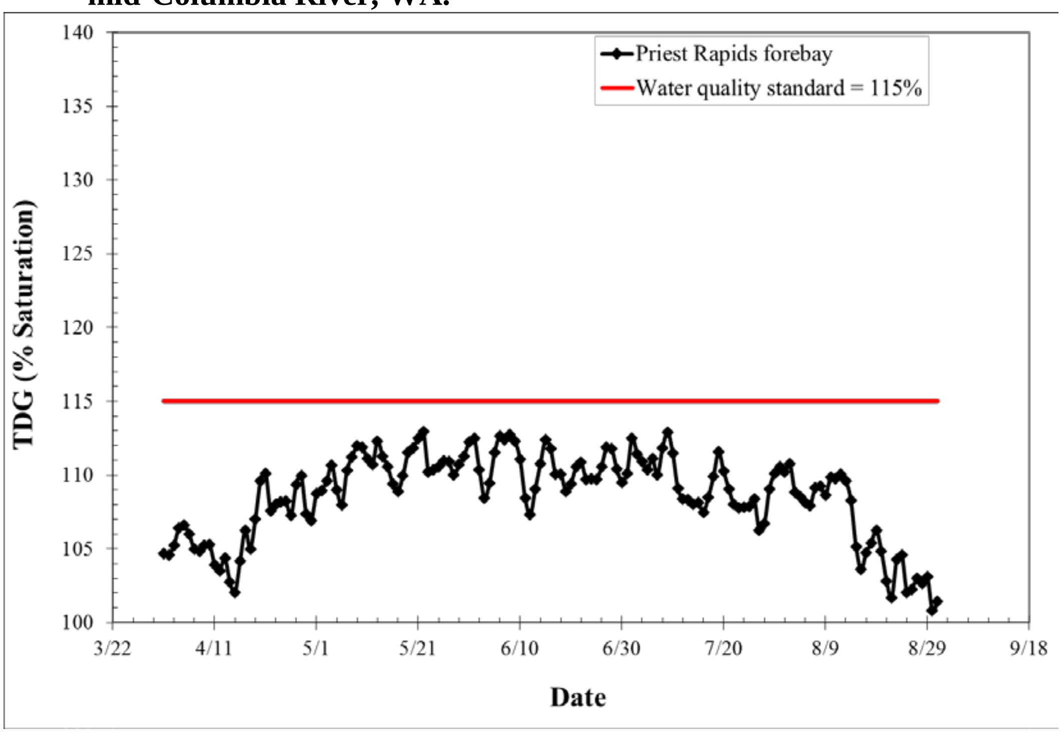

Figure 10 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Priest Rapids Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

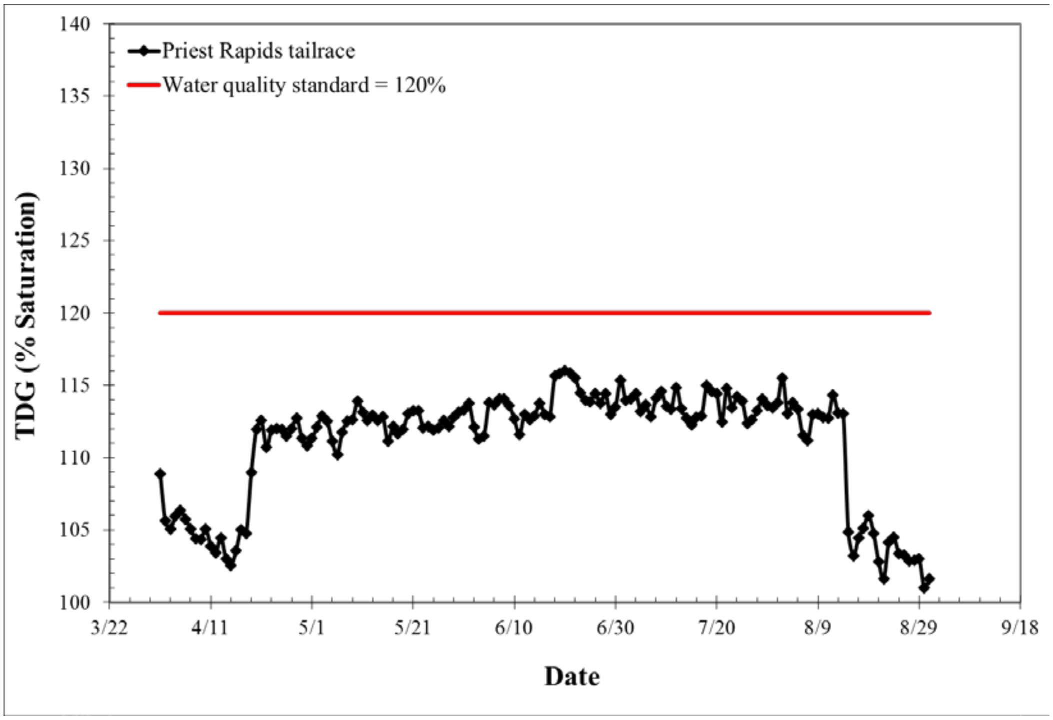

Figure 11 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Priest Rapids Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

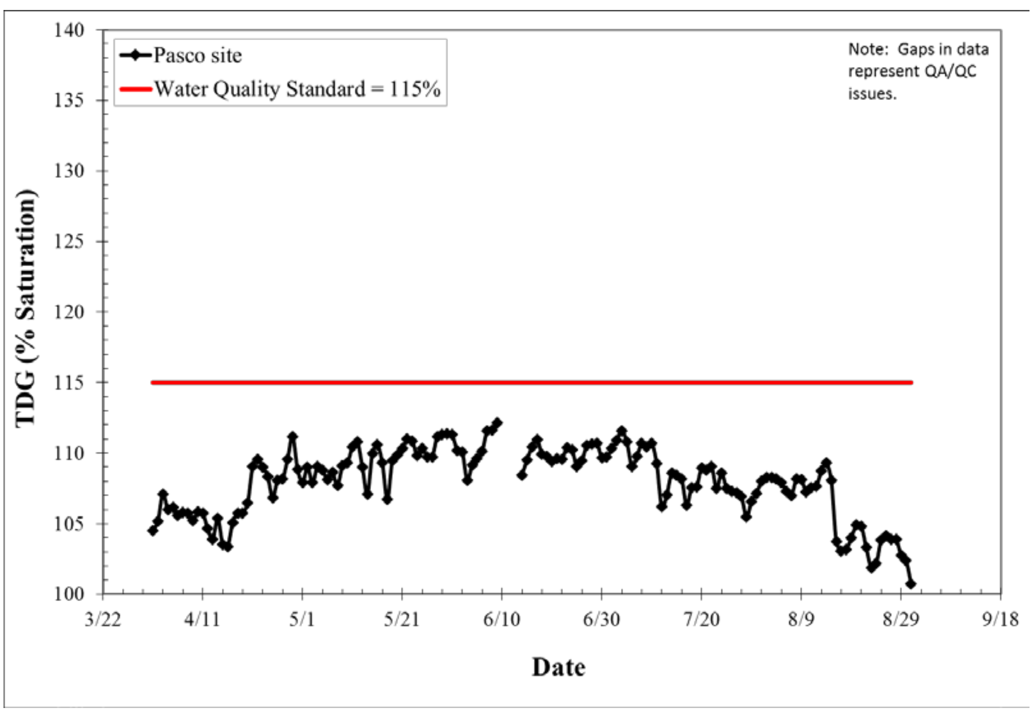

Figure 12 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the McNary forebay (Pasco site), mid-Columbia River, WA.**

3.5.2 Total Dissolved Gas Exceedances

There were no exceedances of TDG observed during the 2015 fish-spill season. The primary explanation for the absence of exceedances in TDG levels during the 2015 fish-spill season is attributed to 2015 being a lower than average flow year compared to the last ten-years, and thus required minimal involuntary spill efforts within the Project and at upstream projects (which resulted in lower incoming TDG levels).

4.0 Total Dissolved Gas Abatement Measures

The following sections describe some of the TDG abatement measures that Grant PUD undertook during the 2015 fish-spill season, as well as those it intends to take in the future as part of its WDOE-approved Gas Abatement Plan (GAP; Keeler 2016).

4.1 Total Dissolved Gas Abatement Measures in 2015

During the 2015 fish-spill season, Grant PUD continued to implement TDG abatement measures per its GAP (Keeler 2015), including the following:

Operational measures that were implemented, when feasible, to minimize involuntary spill and the TDG impacts associated with involuntary spill included:

- Attempting to maximize turbine flows by setting minimum generation requirements, this included establishing a common methodology for setting minimum generation requirements specific to Wanapum and Priest Rapids dam for the management of TDG. Each dam's minimum generation requirements were then allocated to power purchasers that receive a percentage of the projects' output.

  It is important to note that while attempting to maximize powerhouse flows, there are other regional constraints and considerations, as well as federal requirements that limit Grant PUD's ability to maximize powerhouse flows to 100% of its capacity. These constraints, considerations, and requirements include, but are not limited to:

  1. Variable market conditions, which can change rapidly and impact Grant PUD's ability to sell energy that will maximize powerhouse discharge.
  2. Variable incoming flow estimates (which is used, in part, to guide energy sales), which can change rapidly based on upstream project operational decisions and can impact Grant PUD's ability to maximize powerhouse discharge. For example if a given incoming flow estimate provided by upstream operators is changed, operators of projects below must attempt to account for the additional water that was not anticipated and based on the variable market conditions described above, can limit Grant PUD's ability to maximize powerhouse discharge.
  3. Regional renewable energy portfolio standards and federal tax incentives have stimulated investment in variable energy resources. The Pacific Northwest has the highest wind production capacity in the country, which tends to peak during the spring runoff (e.g. higher flow) and lower energy demand periods, which can lead to limited markets for hydroelectric energy, forcing negative pricing and/or involuntary spill.
  4. Requirements for Grant PUD to maintain "operating reserves", which requires that Grant PUD hold up to 7% of its powerhouse capacity in reserve to respond to

changes to system load and Northwest Power Pool reserve sharing group obligations.

Thus, in general both Wanapum and Priest Rapids dams are limited to 85% of their capacity based on the abovementioned regional constraints/considerations and federal requirements. Grant PUD attempted to operate its dams up to this capacity in order maximize powerhouse discharge and limit involuntary in order to help mitigate elevated TDG levels.

- Participation in regional spill/project operation meeting on March 12, 2015. This meeting brought together representatives from Natural Resources, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Association (BPA) and the Corps. Discussions included topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resources requirements (e.g. Hanford Reach fall Chinook flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.
- Grant PUD Natural Resources Department participation in Grant PUD operational and power management scheduling meetings, which allowed Grant PUD staff with expertise in TDG management to provide input to operational planning decisions (e.g. request for turbine outages, power and river flow forecasting and subsequent operational strategy decisions, etc.).
- Implementation of the Spill Priority List which included, for example, having the Mid-Columbia Project (i.e. Grant, Chelan, and Douglas PUDs) operators working to coordinate spill to reduce the overall TDG on the entire Columbia River system. The Columbia River Basin Projects Spill Priority List provided guidance to federal river operators when there was insufficient generation request available to pass the needed amount of water through the Federal Columbia River Power System. A mechanism through hourly coordination was used to shift load from the non-federal projects to the federal projects (by mutual agreement) to reduce the amount of spill (and TDG levels) that would otherwise occur at the federal projects using the Spill Priority List. Although this measure may not have resulted in direct decreases in TDG at Grant PUD's projects (and in some cases it may have increased TDG within Grant PUD's Project if spill was shifted to Wanapum or Priest Rapids dams in order to reduce spill at another project within the system), it was meant to help mitigate high TDG levels throughout the entire Columbia River system.
- Preemptive spill was used as feasible to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. For example, the spill rate could be stabilized if a project's storage was used to absorb flow fluctuations from upstream projects. Generally, a target operation of one foot from the allowed maximum at each project was used. When flows spike high, the storage could be used to lower the need for spill; when flows drop, the storage quantities could be reestablished by maintaining

spill rates. Allowing a greater amount of storage to absorb variations can be an effective method in stabilizing spill flows but it can also provide adequate time for adjusting spill to meet survival study objectives and TDG requirements.

4.2 Future Total Dissolved Gas Abatement Measures

Per requirements contained in the 401 WQC, Grant PUD's GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or new TDG abatement measures. The 2016 draft GAP provides a summary of the proposed operational and structural abatement measures that Grant PUD plans to implement for the 2016 fish-spill season (Keeler 2015). Operational abatement measures include minimizing involuntary spill by scheduling maintenance operations based on predicted flows and continuing to participate in the Hourly Coordination Agreement, which uses Automatic Control Logic to maintain preset reservoir levels at the mid-Columbia River dams in order to meet load requirements and prevent involuntary spill. In addition, Grant PUD plans to consult with WDOE on non-routine operational changes that may affect TDG, as well as manage fish-spill programs to meet TDG water quality standards through coordination with the PRCC. Grant PUD will also continue to conduct biological monitoring for GBT during the fish-spill season. Finally, Grant PUD plans to continue implementation of the TDG abatement measures described in Section 4.1 above that were conducted in 2015, including attempting to maximize turbine flows by setting minimum generation requirements, participation in regional spill/project operation meetings, implementation of the regional Spill Priority, and continuing to preemptively spill based on anticipated high flow/low power load time periods. Structural abatement measures have been completed and include the WFB, the PRFB, and the advanced hydropower turbines at Wanapum Dam.

TDG compliance monitoring will continue at Grant PUD's FSM stations. TDG and water temperature data will be collected on an hourly basis throughout the year and will be reported to Grant PUD's water quality web-site (http://www.grantpud.org/environment/water-quality/monitoring-data). An annual report to WDOE will summarize Grant PUD's TDG monitoring and fish-spill season results.

5.0 Conclusions

There were no TDG exceedances recorded during the 2015 fish-spill season which was greatly attributed to the lower than average (~23% lower on average) flow year (compared to the ten-year average) and preemptive spill efforts undertaken by Grant PUD to help reduce or eliminate larger involuntary spill events.

As described in Section 4.0 and in the 2015 GAP (Keeler 2015), continuing and upcoming TDG abatement measures will be implemented by Grant PUD over the next three years (as part of the ten-year compliance schedule that began in 2008) to mitigate for elevated TDG values that may occur during the fish-spill season. Examples of structural abatement measures include installation of spillway deflectors at Wanapum Dam, construction/use of the WFB, construction/use of the PRFB, and installation of advanced hydropower turbine systems at Wanapum Dam.

Grant PUD will continue to closely monitor TDG levels during the fish-spill season in accordance with the QAPP (Hendrick 2009), and will develop its spill programs in accordance with current TDG water quality criteria as set by WDOE.

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Appendix A

Table A-1 Hourly data points/sections omitted from the fixed site monitoring total dissolved monitoring dataset

Location	Date(s)	hr(s)	Problem/reason for omission	Comments/action taken to correct problem
WANT	5/3-5/4	2000-1400	Faulty Probe	Replaced with new probe/sent for repair
WANT	7/20-7/21	1300-0800	Faulty Probe	Replaced with new probe/sent for repair
WANF	8/17-8/18	1400-1000	Faulty Probe	Replaced with new probe/sent for repair
WANT	8/27-8/31	1500-2359	Faulty Probe	Replaced with new probe/sent for repair
Note: WANF = Wanapum forebay, WANT = Wanapum tailrace				

Appendix B
2015 Fish-Spill Season Memoranda

Grant County
PUBLIC UTILITY DISTRICT
Innovation & Excellence...Yesterday, Today and Tomorrow

MEMORANDUM April 17, 2015

TO: Dispatch
Wanapum Dam Control Room
Priest Rapids Dam Control Room
Planning and Scheduling

VIA: Tom Dresser, Fish, Wildlife, and Water Quality Manager

FROM: Curt Dotson

Purpose: Start of 2015 Spring Fish-Spill

Background: On April 17, 2008 FERC issued a new 44 year license to the Public Utility District No. 2 of Grant County (Grant PUD) for the operation of the Priest Rapids Project (Project No. 2114-116). Incorporated into this license are the fishway prescriptions set forth in the Biological Opinion that National Marine Fisheries Service (NOAA Fisheries) issued to Grant PUD on February 1, 2008.

Under Section 2.9.6 (Terms and Conditions) of the Biological Opinion, Action 1.5 states that the primary juvenile salmonid passage at Wanapum Dam will be 20 kcfs spill through the Wanapum Future Unit Fish Bypass (WFB) and that spill will commence before more than 2.5 percent of the spring migration have passed. Action 1.8, under that same Section, states that the Wanapum turbines will be operated in "fish mode" for 95 percent of the juvenile spring migration, and that turbine operation in "fish mode" will commence before 2.5 percent of the spring migrants have passed.

For juvenile fish passage at Priest Rapids Dam, Section 2.9.6, Action 1.12 states that the primary juvenile salmonid passage can be through an alternative top-spill facility; this is the Priest Rapids Fish Bypass (TG 20-22). This spill will also commence before 2.5 percent of the spring migrants have passed Priest Rapids Dam. Action 1.16 states that the Priest Rapids turbines will be operated in "fish mode" for 95 percent of the juvenile spring migration, and that turbine operation in "fish mode" will also commence before 2.5 percent of the spring migrants have passed the dam.

Discussion: The Rock Island Dam smolt index numbers indicate that the spring out-migration has begun. Based on the Biological Opinion, spring fish-spill at Wanapum and Priest Rapids dams will commence as indicated below and continue until further notice.

Fish Spill at Wanapum and Priest Rapids Dams:

Hydro Project	Start Date	Start Time	Spill Rate	Duration
Wanapum Dam	April 19, 2015	1000 hrs.	Wanapum Fish Bypass – 20 kcfs	24 hours/day
Priest Rapids Dam	April 20, 2015	1000 hrs.	PR Fish Bypass (Bays 20-22)	24 hours/day

In the case of any inadvertent spill (excess of powerhouse capacity) is needed at Wanapum Dam, that spill shall be discharged through the spill bay(s) as indicated in the "2015 Wanapum Dam Inadvertent Spill Pattern during Fish Spill" spread sheet.

In case of any inadvertent spill needed at Priest Rapids Dam, please follow the inadvertent spill pattern give in the "2015 Priest Rapids Dam Inadvertent Spill Pattern during Fish Spill".

Operation of the Wanapum and Priest Rapids turbines in "Fish-Mode" will commence on the same date and at the same time that "fish-spill" starts for each associated dam. For a listing of unit priority of turbine operations, please refer to the "First On / Last Off" List that was sent to each of the associated control rooms.

In the course of this year's juvenile salmonid survival/behavior studies (predominately during the month of May), there will be some alternating operational changes at both dams: At Wanapum Dam, there will be an alternating flow volume through the Wanapum Fish Bypass (WFB) of 72 hour blocks of time, alternating between 20 kcfs and 15 kcfs of flow. This change is flow amount (20 vs.15 kcfs) will be through the use of the bypass's pocket gate.

Alternating operational changes at Priest Rapids Dam (PRD) during the fish study will be with the control program of "Fish-Mode" being implemented at the PRD powerhouse. During the same alternating blocks (72 hours) of time for reduced flow through the WFB, the PRD powerhouse (all turbines) will be alternating between 72 hour blocks of time that the Fish-Mode restrictions (17.5 kcfs max. flow thru a turbine) are in place (Fish-Mode "ON") and then 72 hour block of time that the Fish-Mode restrictions have been removed (Fish-Mode "OFF").

An additional memo and schedule for these alternating blocks of time related to the operations of the WFB and PRD powerhouse during this year's fish studies will be coming out shortly.

The Fish-Spill Representatives will monitor TDG levels and make spill changes to ensure TDG levels remain within Washington Department of Ecology's water standards.

Please give Curt Dotson a call (509-750-1999) if you have any questions.

Grant County
PUBLIC UTILITY DISTRICT
Innovation & Excellence...Yesterday, Today and Tomorrow

MEMORANDUM June 10, 2015

TO: Dispatch
Wanapum Dam Control Room
Priest Rapids Dam Control Room
Planning and Scheduling

VIA: Tom Dresser, Fish, Wildlife, and Water Quality Manager

FROM: Curt Dotson, Fisheries Project Specialist

Purpose: Start of 2015 Summer Fish Spill

Background: On April 17, 2008 FERC issued a new 44 year license to the Public Utility District No. 2 of Grant County (Grant PUD) for the operation of the Priest Rapids Project (Project No. 2114-116). Incorporated into this license are the fishway prescriptions set forth in the Priest Rapids Salmon and Steelhead Settlement Agreement (SSA) that Grant PUD entered into with Governmental and Tribal (Fishery) Parties on February 10, 2006. This document addresses summer fish spill (Section 9.3) by establishing spill levels that are intended to pass 95% of the summer juvenile migrants (fall and summer Chinook). This calls for 49% summer spill at Wanapum Dam and 39% summer spill at Priest Rapids Dam. The summer migration season begins when summer/fall Chinook smolts are present in the river or June 15th, whichever occurs first. The Priest Rapids Salmon and Steelhead Settlement Agreement also provided the latitude for Grant PUD, in consultation with the PRCC, to implement operational measures for the Project to protect that portion of the run that passes the Project in order to improve downstream passage survival at the Project and contribute to achieving the overall no net impact (NNI) objective for summer/fall Chinook in the program area.

Action 9 & 18 of the SSA states that the Wanapum and Priest Rapids turbines will be operated in “fish mode” for the juvenile migration. Action 13 allows Grant PUD to evaluate alternative top-spill concepts for juvenile fish passage at Priest Rapids Dam.

Discussion: At Wanapum Dam, Spring Fish Spill will continue until 2359 hr. of June 14th, 2015 at which time Summer Fish Spill will begin. The 2015 Summer Fish Spill program for Wanapum Dam will be the same as the 2015 Wanapum Spring Fish Spill program – operation of the Wanapum Fish Bypass (WFB) and the Wanapum powerhouse operating within the Fish-Mode Program.

At Priest Rapids Dam, Spring Fish Spill will continue until 2359 hr. of June 15th, 2015 at which time Summer Fish Spill will begin. The 2015 Summer Fish Spill program for Priest Rapids Dam will be the same as the 2015 Priest Rapids Spring Fish Spill program – operation of the Priest Rapids Fish Bypass (TG 20-22), **but also include the operating of the Priest Rapid turbines within the Fish-Mode Program** (i.e. Fish-Mode "On").

Fish Spill at Wanapum and Priest Rapids Dams:

Hydro Project	Start Date	Start Time	Spill Rate	Duration
Wanapum Dam	June 14, 2015	2359 hrs.	WFB	24 hours/day
Priest Rapids Dam	June 15, 2015	2359 hrs.	PRFB (TG 20-22)	24 hours/day

Wanapum Dam should follow the spill pattern titled, "2015 Wanapum Dam Spill Gate Operations for Inadvertent Spill during Fish Spill" if inadvertent spill is needed.

Priest Rapids Dam should follow the spill pattern titled "Inadvertent Spill Pattern 2015 Priest Rapids Dam", if inadvertent spill is needed.

Operation of the Wanapum and Priest Rapids turbines in "Fish-Mode" will commence at the same date and time that summer "fish spill" starts for each associated dam.

The Fish Spill Representatives will monitor TDG levels and make spill changes to ensure TDG levels remain within Washington Department of Ecology's water standards.

Please give Curt Dotson a call (509-750-1999) if you have any questions.

Grant County
PUBLIC UTILITY DISTRICT
Innovation & Excellence... Yesterday, Today and Tomorrow

MEMORANDUM

August 12, 2015

TO: Grant Dispatch
Wanapum Dam Control Room
Priest Rapids Dam Control Room

VIA: Tom Dresser, Fish, Wildlife, and Water Quality Manager

FROM: Curt Dotson, Fisheries Project Specialist

Purpose: 2015 Summer Fish Spill - Ending

Discussion: The 2015 Summer Fish Spill Program began at Wanapum and Priest Rapids dams on June 14 (at 2359 hr), immediately following the end of spring fish spill. The 2015 Summer Fish Spill program for Wanapum Dam was the same as the 2015 Wanapum Spring Fish Spill program – operation of the Wanapum Fish Bypass (WFB). The 2015 Summer Fish Spill program for Priest Rapids Dam was the same as the 2015 Priest Rapids Spring Fish Spill program – operation of Priest Rapids Fish Bypass (bays 22, 21, & 20) 24/7.

The Priest Rapids Project Salmon and Steelhead Settlement Agreement states that '....*summer spill ends after 95% of the summer and fall Chinook juvenile migrants have passed Wanapum and Priest Rapids dams*.'

Summer fish-spill at Wanapum Dam will end on August 13, 2015 at 0800 hr. and at Priest Rapids Dam on August 14, 2015 at 0800 hr.

For adult fall-back, the ice/trash sluiceway at Wanapum will be opened and remain open to pass water 24/7, until November 15, 2015. For adult fall-back operations at Priest Rapids Dam, the ice/trash sluice gate at bay 22 will be opened to the full-open position and pass water 24/7 until November 15, 2015. Operation of the Wanapum and Priest Rapids turbines have been in "fish mode" for the duration of the summer fish-spill season, and upon reaching the respected date and time for each dam's "end of summer fish-spill", those turbines may return to standard turbine operations.

Conclusion: Based upon agreed criteria and in-season information, Grant PUD, in consultation with the PRCC fish-spill representatives, believes that the goal of assuring fish spill through 95% of the summer juvenile salmon out-migration through the Priest Rapids Project has been achieved. Therefore, Grant PUD will end summer fish spill at

0800 hr. on August 13, 2015 at Wanapum Dam and at 0800 hr. on August 14, 2015 at Priest Rapids Dam (Table 1).

Table 1. Fish Spill at Wanapum and Priest Rapids Dams.

Hydro Project	**Start Date**	**Start Time**	**Spill Rate**	**Duration**
Wanapum Dam	August 13, 2015	0800 hr.	Sluice gate open	24 hours/day.
Priest Rapids Dam	August 14, 2015	0800 hr.	Sluice gate open	24 hours/day

The Wanapum and the Priest Rapids dams' sluice gate will remain fully opened until November 15, 2015 to provide a fall-back route for adult salmonids.

Please call Curt Dotson if you have any questions (509-750-1999).

Appendix C
Daily averages of the 12-highest hourly total dissolved gas readings during the 2015 fish-spill season

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
1-Apr	105.8	105.9	104.7	108.9	104.5	
2-Apr	105.5	105.6	104.6	105.6	105.2	
3-Apr	106.5	106.3	105.2	105.0	107.1	
4-Apr	106.6	106.3	106.4	106.0	106.0	
5-Apr	106.7	106.4	106.6	106.4	106.2	
6-Apr	106.8	106.4	106.0	105.8	105.6	
7-Apr	105.6	105.4	105.0	105.1	105.8	
8-Apr	104.9	105.0	104.8	104.4	105.7	
9-Apr	104.9	104.4	105.2	104.3	105.2	
10-Apr	105.6	105.2	105.3	105.1	105.8	
11-Apr	105.5	105.2	103.9	103.9	105.7	
12-Apr	103.8	103.9	103.5	103.4	104.6	
13-Apr	105.3	105.1	104.4	104.5	103.9	
14-Apr	105.3	105.1	102.8	103.0	105.4	
15-Apr	103.1	102.6	102.1	102.5	103.5	
16-Apr	104.8	103.9	104.2	103.6	103.4	
17-Apr	105.8	105.1	106.3	105.0	105.1	
18-Apr	107.3	105.4	105.0	104.8	105.7	
19-Apr	109.8	109.3	107.0	109.0	105.8	
20-Apr	110.3	110.7	109.6	111.9	106.5	N/A
21-Apr	110.9	111.5	110.1	112.6	109.0	
22-Apr	110.3	111.2	107.6	110.7	109.6	
23-Apr	107.5	110.1	108.0	111.9	109.0	
24-Apr	108.0	110.7	108.2	112.0	108.3	
25-Apr	107.9	110.9	108.2	111.9	106.9	
26-Apr	106.9	110.4	107.3	111.5	108.1	
27-Apr	109.3	109.2	109.3	112.0	108.2	
28-Apr	109.7	109.9	109.9	112.7	109.6	
29-Apr	109.0	110.0	107.3	111.4	111.2	
30-Apr	106.6	107.9	106.9	110.8	108.8	
1-May	109.2	110.7	108.7	111.3	107.9	
2-May	110.0	110.9	109.0	112.1	109.0	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
3-May	111.8	110.5	109.6	112.9	107.9	N/A
4-May	111.7	111.0	110.7	112.5	109.1	
5-May	110.1	110.2	109.0	111.1	108.8	
6-May	108.5	110.5	108.0	110.2	108.1	
7-May	110.0	111.3	110.3	111.8	108.6	
8-May	110.3	111.8	111.2	112.5	107.7	
9-May	110.6	111.8	112.0	112.6	109.1	
10-May	111.3	110.5	111.9	113.9	109.3	
11-May	111.6	111.0	111.1	113.1	110.5	
12-May	112.0	114.4	110.7	112.6	110.8	
13-May	110.1	113.9	112.3	113.0	109.0	
14-May	109.6	110.9	111.3	112.6	107.1	
15-May	110.9	113.1	110.6	112.8	110.0	
16-May	110.8	114.9	109.4	111.1	110.6	
17-May	109.0	109.4	108.9	112.2	109.3	
18-May	109.4	110.8	109.9	111.7	106.7	
19-May	109.5	112.5	111.5	112.0	109.5	
20-May	110.8	112.6	111.9	113.0	109.9	
21-May	112.7	113.2	112.5	113.3	110.3	
22-May	112.8	111.6	113.0	113.2	111.0	
23-May	111.5	111.0	110.2	112.1	110.9	
24-May	111.0	112.1	110.4	112.2	109.8	
25-May	110.3	112.1	110.6	111.9	110.4	
26-May	110.5	111.9	111.0	112.1	109.7	
27-May	111.1	111.5	110.9	112.6	109.7	
28-May	111.1	110.4	110.0	112.2	111.2	
29-May	112.3	111.2	110.7	112.8	111.3	
30-May	112.4	113.2	111.3	113.2	111.4	
31-May	112.1	113.2	112.2	113.3	111.3	
1-Jun	112.1	113.1	112.5	113.8	110.2	
2-Jun	110.0	112.4	110.4	112.1	110.1	
3-Jun	107.0	110.8	108.5	111.3	108.1	
4-Jun	110.1	111.7	109.5	111.5	109.1	
5-Jun	112.8	113.3	111.5	113.8	109.6	
6-Jun	112.7	113.5	112.6	113.7	110.1	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
7-Jun	112.5	113.3	112.4	114.1	111.6	
8-Jun	112.6	113.4	112.8	114.1	111.6	
9-Jun	112.4	113.6	112.3	113.6	112.1	
10-Jun	112.3	113.4	111.1	112.7	n/d	
11-Jun	110.3	113.0	108.4	111.6	n/d	
12-Jun	108.4	112.0	107.3	113.0	n/d	
13-Jun	109.3	111.7	109.1	112.6	n/d	
14-Jun	110.5	112.3	110.8	112.9	108.4	
15-Jun	111.9	112.8	112.4	113.7	109.5	
16-Jun	112.0	112.8	111.8	113.0	110.5	
17-Jun	111.6	112.4	110.0	112.8	111.0	
18-Jun	112.2	113.0	110.1	115.7	109.9	
19-Jun	112.3	112.7	108.9	115.8	109.8	
20-Jun	108.7	111.6	109.4	116.0	109.4	
21-Jun	110.1	112.8	110.6	115.8	109.6	
22-Jun	110.1	112.5	110.8	115.5	109.6	
23-Jun	109.3	112.4	109.7	114.5	110.4	N/A
24-Jun	110.7	111.3	109.7	113.9	110.3	
25-Jun	111.7	111.3	109.7	113.9	109.1	
26-Jun	113.6	112.3	110.6	114.4	109.5	
27-Jun	114.1	112.6	111.9	113.8	110.6	
28-Jun	114.3	112.8	111.8	114.4	110.6	
29-Jun	114.3	113.1	110.4	113.0	110.7	
30-Jun	112.4	112.3	109.5	113.5	109.7	
1-Jul	114.3	112.4	110.1	115.3	109.7	
2-Jul	115.0	112.8	112.5	114.0	110.3	
3-Jul	114.8	112.4	111.5	114.1	110.9	
4-Jul	112.8	111.7	110.9	114.4	111.6	
5-Jul	112.4	112.0	110.3	113.2	110.8	
6-Jul	112.3	111.4	111.1	113.6	109.1	
7-Jul	112.2	110.7	110.0	112.8	109.8	
8-Jul	114.3	111.3	111.8	114.1	110.7	
9-Jul	114.7	111.4	112.9	114.6	110.4	
10-Jul	114.5	111.4	111.5	113.5	110.7	
11-Jul	110.1	110.6	109.1	113.4	109.2	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
12-Jul	108.4	110.3	108.4	114.9	106.2	
13-Jul	108.7	110.3	108.3	113.4	107.0	
14-Jul	109.4	109.9	108.0	112.7	108.6	
15-Jul	109.1	110.1	108.1	112.3	108.5	
16-Jul	107.8	110.6	107.5	112.8	108.2	
17-Jul	108.7	109.8	108.5	112.9	106.3	
18-Jul	110.7	111.2	109.9	115.0	107.6	
19-Jul	111.4	111.6	111.6	114.6	107.6	
20-Jul	111.4	111.7	110.3	114.4	109.0	
21-Jul	108.8	112.1	109.1	112.5	108.8	
22-Jul	108.5	111.3	108.0	114.8	109.0	
23-Jul	108.3	110.8	107.8	113.5	107.5	
24-Jul	108.3	110.8	107.8	114.2	108.6	
25-Jul	107.1	112.6	107.9	113.9	107.5	
26-Jul	106.8	111.0	108.4	112.4	107.3	
27-Jul	106.0	110.5	106.2	112.6	107.2	N/A
28-Jul	106.2	110.3	106.7	113.2	106.9	
29-Jul	108.3	110.6	109.1	114.1	105.5	
30-Jul	110.2	111.9	110.1	113.6	106.6	
31-Jul	111.6	111.8	110.6	113.4	107.1	
1-Aug	111.7	112.0	110.2	113.8	108.0	
2-Aug	111.1	113.1	110.8	115.5	108.3	
3-Aug	110.6	113.3	108.8	113.1	108.3	
4-Aug	108.8	112.5	108.5	113.8	108.2	
5-Aug	108.3	111.7	108.1	113.4	107.9	
6-Aug	107.9	111.0	107.9	111.5	107.3	
7-Aug	109.3	110.8	109.2	111.2	107.0	
8-Aug	109.4	112.2	109.2	113.0	108.2	
9-Aug	109.1	111.0	108.6	113.0	108.1	
10-Aug	111.3	111.4	109.8	112.8	107.2	
11-Aug	112.0	111.4	109.7	112.7	107.6	
12-Aug	112.6	112.2	110.1	114.3	107.7	
13-Aug	112.5	111.4	109.6	113.1	108.7	
14-Aug	111.4	109.9	108.3	113.0	109.3	
15-Aug	106.6	106.7	105.2	104.9	108.1	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
16-Aug	106.7	104.7	103.6	103.2	103.7	N/A
17-Aug	106.7	105.4	104.7	104.4	103.1	
18-Aug	108.1	105.5	105.4	105.1	103.2	
19-Aug	108.1	105.9	106.3	106.0	104.0	
20-Aug	106.8	105.8	104.8	104.8	104.9	
21-Aug	105.2	104.8	102.8	102.8	104.8	
22-Aug	106.0	103.8	101.7	101.6	103.3	
23-Aug	106.6	105.4	104.3	104.2	101.9	
24-Aug	106.6	105.5	104.6	104.5	102.2	
25-Aug	105.2	104.0	102.1	103.4	103.8	
26-Aug	104.7	103.2	102.3	103.3	104.1	
27-Aug	104.7	103.2	103.0	102.9	103.9	
28-Aug	103.9	103.1	102.7	102.9	103.9	
29-Aug	104.0	n/d	103.1	103.0	102.8	
30-Aug	102.3	n/d	100.8	101.0	102.4	
31-Aug	102.3	n/d	101.4	101.6	100.8	

Notes:
1. WANF = Wanapum forebay; WANT = Wanapum tailrace; PRDF = Priest Rapids forebay; PRDT = Priest Rapids tailrace; Pasco = Pasco Fixed Site Monitor located upstream of McNary Dam (next downstream forebay), operated by the US Army Corps of Engineers; n/d. = No data; see Appendix B for an explanation of why data was omitted, N/A = not applicable.