SUMMARY OF 2013 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 2013 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).

Mean daily discharges during the 2013 fish-spill season were slightly higher than the 2002 – 2012 average (about 12% higher on average) over the entire fish-spill season (April 1 through August 31).

During the 2013 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 20 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 modified top-spill bulkhead, located at spillways 5 and 6, operated in conjunction with spillways 4 and 7 (both operated at 4 feet of bottom-spill). This fish-spill configuration passes up to 24 kcfs depending on forebay elevations. 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, 2013 (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 17, 2013 and concluded on August 22, 2013. The fish-spill season began at Priest Rapids Dam on April 18, 2013 and concluded on August 23, 2013. 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 17 and June 14, 2013 (FPC 2013). The combined spring and summer fish-spill periods from April 17 through August 23 encompassed greater than 99% of the entire 2013 outmigration (FPC 2013) and greater than 95% of the sub-yearling Chinook passed by August 12 (FPC 2013); fish-spill from August 12 through the 23 allowed fish to move downstream through the Wanapum and Priest Rapids developments.

Exceedances of TDG standard were minimal during the 2013 fish-spill season, with a total of 43 exceedances of the 115/120 %SAT standard (based on daily average of the 12-highest consecutive hourly readings). There were no exceedances of the 1-hour 125 %SAT standard. The Priest Rapids forebay fixed-site monitoring station (FSM station) accounted for the majority of TDG exceedances (30 of 43 or >69%), all of which can be attributed to river flow in excess of Wanapum Dam's current hydraulic capacity (~163 kcfs). When flows were above Wanapum Dam's hydraulic capacity, involuntary spill was required that contributed to elevated TDG levels, and because of the short distance between Wanapum and Priest Rapids dams (18 river miles (RM)), TDG levels did not have a chance to dissipate below the 115 %SAT by the time they reached the Priest Rapids Dam forebay FSM station. Additionally, of the 30 exceedances recorded at the Priest Rapids Dam forebay FSM station, 23 (77%) corresponded with incoming TDG levels 115 %SAT or above recorded during the same time period at the Wanapum Dam forebay FSM station. Finally, three of the exceedances were attributed to Grant PUD assisting the Grant County Sheriff's Department in the search of human remains in the Wanapum

Reservoir (which required Grant PUD to spill above its spill caps in order to maintain desired water elevations). Appendix D of this report provides comments and/or corrective action descriptions associated with exceedances that occurred during the 2013 fish-spill season.

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 2013, 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 construction of the Priest Rapids Fish Bypass (PRFB; started construction fall of 2011 with expected completion by fish-spill season of 2014). Grant PUD believes that by implementing these measures over the next four years (as part of the ten-year compliance schedule that began in 2008) it is implementing the most current reasonable and feasible measures to reduce elevated TDG values 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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List of Abbreviations

%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 2013 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 section; 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

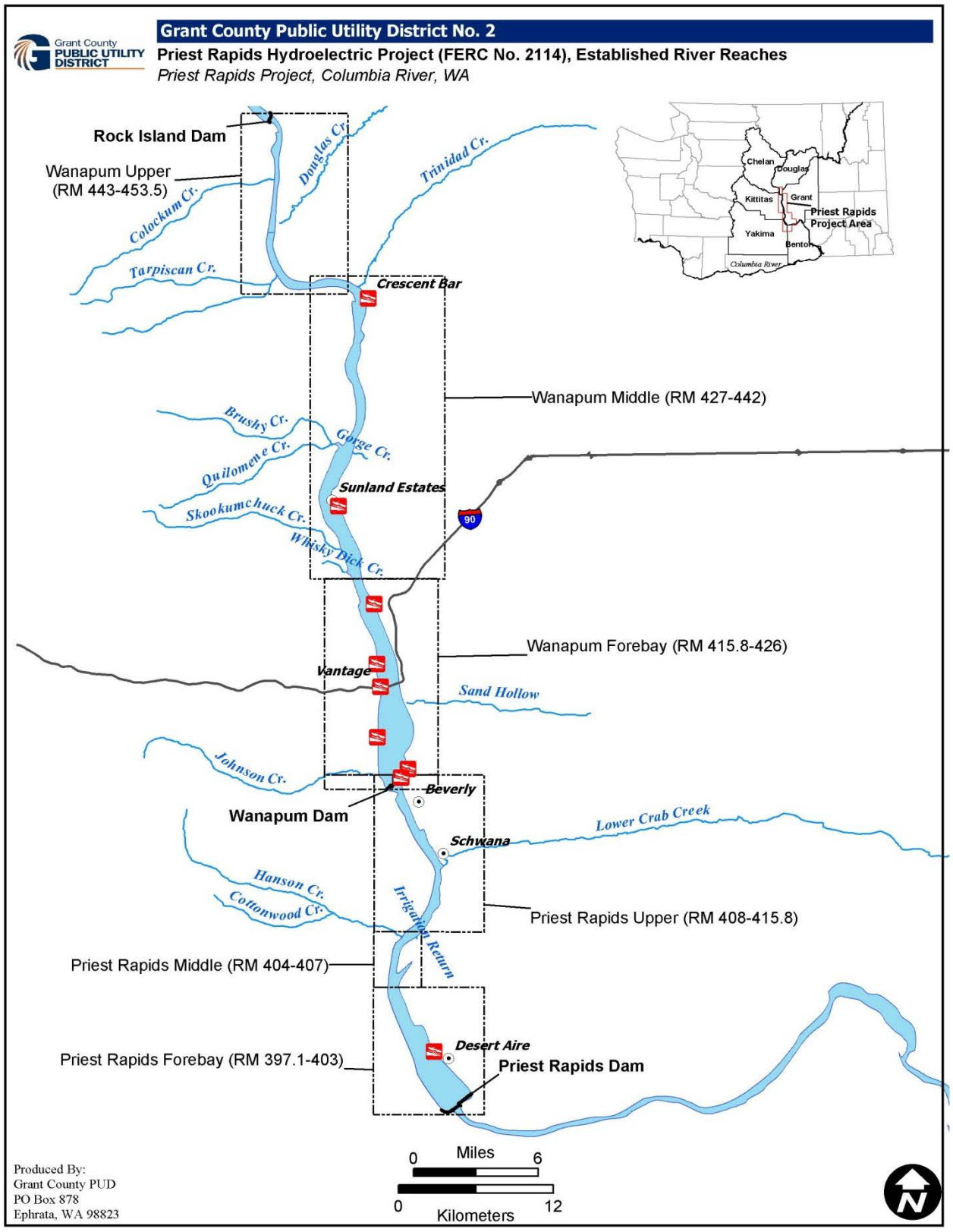

Figure 1 **The Priest Rapids Project and established river reaches presented by river mile (RM), mid-Columbia River, WA.**

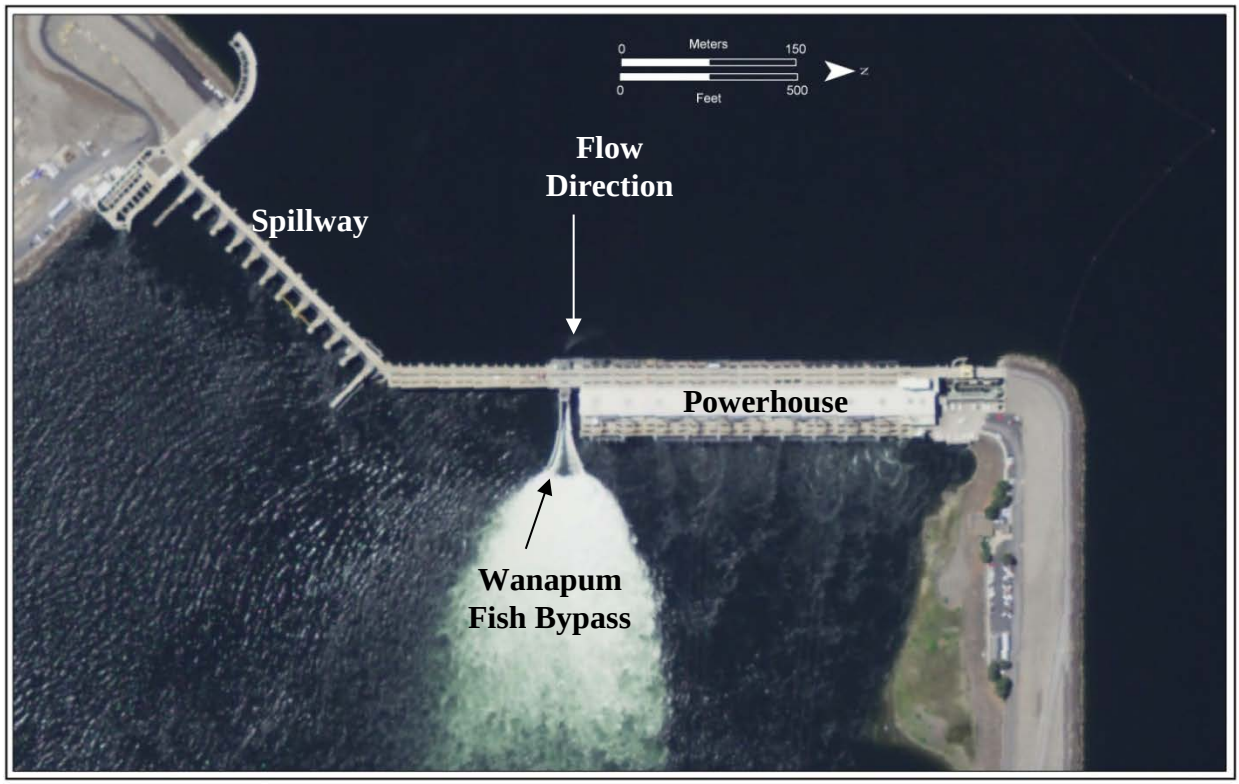

Figure 2 **Aerial photograph of Wanapum Dam, mid-Columbia River, WA.**

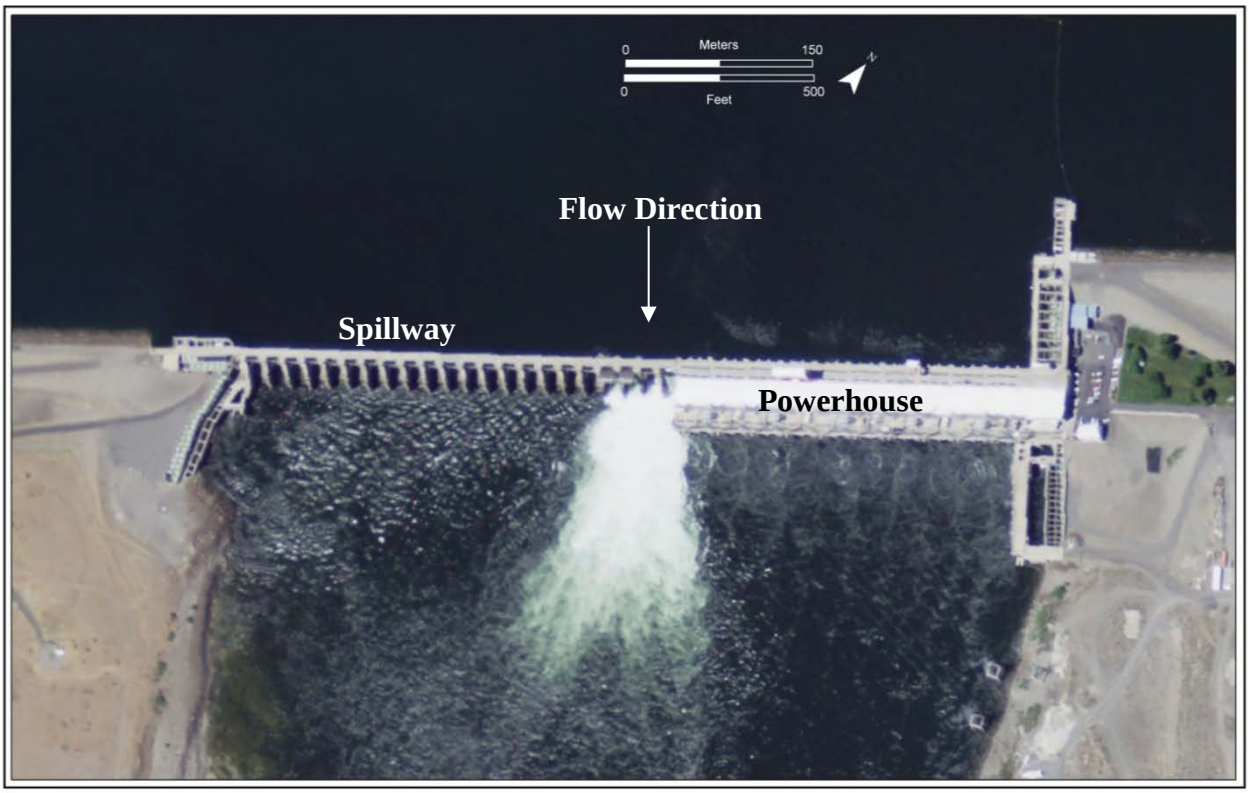

Figure 3 **Aerial photograph of Priest Rapids Dam, mid-Columbia River, WA.**

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.

Appendix A of this report provides an example of how the "rolling average" method created a TDG exceedance on two separate days based on the same grouping of hourly values during the 2013 fish-spill season, and Grant PUD's method for accounting for those occurrences. Additionally, Appendix A provides a table detailing all "double-counting" instances for the 2013 fish-spill season.

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 2013 fish-spill season were analyzed for apparent exceedances of current water quality standards.

All of the TDG sensors used during the 2013 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 B of this report.

The data QA/QC issues during the 2013 fish-spill season were related to either TDG membrane failures (at the Wanapum tailrace FSM Station) or spotty TDG data from multi-probe at the Wanapum Dam forebay FSM station. Overall data loss for Grant PUD operated FSM stations during the 2013 fish-spill season was 189 hourly readings (1.3% of the total available data collection hours), which was well within the 90% data completeness/quality objective as specified in the QAPP (Hendrick 2009).

Table 1 displays the number of TDG values that were omitted from the dataset due to QA/QC issues during the 2013 fish-spill season. Appendix B provides detailed information related to data that was omitted due to QA/QC issues.

Table 1 Overview of total dissolved gas data set during 2013 fish-spill season.

Location	Available data collection hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
WANF	3672	48	1.3
WANT	3672	141	3.8
PRDF	3672	0	0.0
PRDT	3672	0	0.0
Total	14688	189	1.3

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

Note that the Pasco FSM station, which is operated by the U.S. Army Corps of Engineers (Corps), also had some QA/QC issues (siltation in the standpipe at the Pasco site which resulted in faulty TDG values, resolved by blowing out the standpipe (Steve Juul, personal communication, October 2013). This resulted in 560 hours of data being omitted from the 2013 fish-spill season data-set.

3.0 Results

The following sections describe the 2013 fish-spill season flow characteristics compared to the previous ten-year average, the 2013 fish-spill season programs, the fish migration timing compared to fish-spill season durations, and the 2013 biological TDG monitoring results.

3.1 Description of 2013 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2013 fish-spill season was compared to the ten-year average of mean daily flows from 2002 to 2012 (Figure 4) as measured at the U.S. Geological Survey (USGS) streamflow gage #12472800 located 2.6 RMs downstream of Priest Rapids Dam (USGS 2013). In general, 2013 mean daily discharges were slightly higher than the 2002–2012 average (12% higher on average) during the fish-spill season (April 1 through August 31).

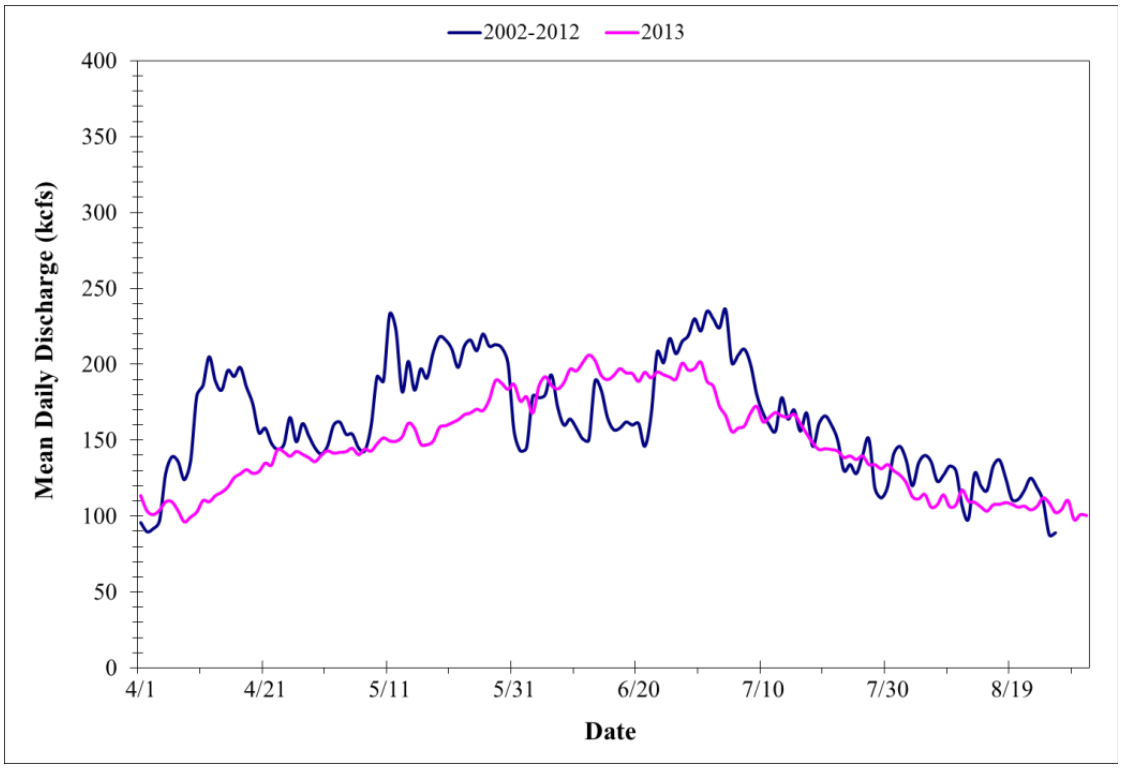

Figure 4 Comparison of 2013 vs. previous ten-year average of mean daily discharge values as measured at the USGS streamflow gage #12472800 located below Priest Rapids Dam, mid-Columbia River, WA.

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 2013 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 20 kcfs. The spillway at Wanapum Dam was operated on an as-needed basis to pass involuntary spill (76% of the time for the entire 2013 fish-spill season, see

Section 3.5.3), according to spill patterns designed for the optimal fish-passage safety and as approved by the PRCC.

3.2.2 Priest Rapids Dam

The terms and conditions of the Biological Opinion required Grant PUD to investigate alternative top-spill designs for a fish-bypass facility at Priest Rapids Dam in consultation with NMFS and the PRCC (NMFS 2008). Following completion of the Downstream Passage Alternatives Study (Jacobs et al. 2003), a process was initiated to develop a new fish passage facility for Priest Rapids Dam. In 2006 a prototype surface spill passage route (top-spill bulkhead located at spillways nineteen and twenty) was constructed to help evaluate fish behavior and survival under controlled operating conditions to address unknown aspects of fish passage at Priest Rapids Dam. Evaluations were undertaken in 2006, 2007 (Timko et al. 2007), 2008 (Sullivan et al. 2008), 2009 (Timko et al. 2009), and 2010 (Timko et al. 2010) under consultation with the PRCC. In the fall of 2011, construction began on the Priest Rapids Fish Bypass (PRFB) at spillbays 20-22. To allow for continued passage of downstream migrants during construction of the PRFB (expected completion is 2014), as approved by the PRCC the prototype top-spill bulkhead fish-spill method was relocated from spillbays nineteen and twenty to spillbays five and six (operated in conjunction with spillbay four and seven (both operated at four feet of bottom-spill)) for the 2013 fish-spill season. This fish-spill configuration passes up to 24 kcfs depending on forebay elevations. The other spillbay gates at Priest Rapids Dam were 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. Based on the above referenced studies of the prototype surface spill (top-spill bulkhead), construction of the Priest Rapids Fish Bypass (PRFB) began in September 2011, which will permanently modify spillbays twenty through twenty-two to create a surface spill fish-passage route at Priest Rapids Dam. Construction of the PRFB is expected to be completed by April of 2014.

3.3 Fish-Spill Quantities and Duration

Spring fish-spill began at Wanapum Dam on April 17, 2013 at 1300 hours and ended June 14, 2013 at 2359 hours, while spring fish-spill began at Priest Rapids Dam on April 18, 2013 at 1300 hours and ended June 14, 2013 at 2359 hours. Summer fish-spill began on June 15, 2013 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 22, 2013 at Wanapum Dam and 0800 hours on August 23, 2013 at Priest Rapids Dam (see Appendix C).

Table 2 provides a summary of the 2013 fish-spill for Wanapum and Priest Rapids dams. No adjustments in the fish-spill methods and levels were needed in 2013 for the purpose of maintaining compliance with water quality standards for TDG; however, involuntary spill due to high river flows in excess of powerhouse capacities did contribute to elevated TDG levels recorded during the 2013 fish-spill season in most instances (see Section 3.5).

Table 2 Summary of 2013 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 17, 2013	***Spring Spill Initiated***		
April 17-June 14	WFB (Open 24 Hours/Day)	Up to 20 kcfs	RPA 1 and terms and conditions of the Biological Opinion and as guided/approved by the PRCC
June 15, 2013	***End of Spring Spill/ Summer Spill Initiated***		
June 15-Aug 22	WFB (Open 24 Hours/Day)	Up to 20 kcfs	Priest Rapids Project Salmon and Steelhead Settlement Agreement and as guided/approved by the PRCC
August 22, 2013	***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 18, 2013	***Spring Spill Initiated***		
April 18-June 14	Prototype top-spill: spillways 5 and 6 (full open); spillways 4 and 7 open 4 ft.	Up to 24 kcfs	RPA 1 and terms and conditions of the Biological Opinion and as guided/approved by the PRCC
June 15, 2013	***End of Spring Spill/ Summer Spill Initiated***		
June 15-Aug 23	Prototype top-spill: spillbays 5 and 6 (full open); spillbays 4 and 7 open 4 ft.	Up to 24 kcfs	Priest Rapids Project Salmon and Steelhead Settlement Agreement and as guided/approved by the PRCC
August 23, 2013	***End of Summer Spill***		
[1]Actual quantity spilled is dependent on forebay and tailwater elevations.			

3.3.1 Involuntary Spill

At Wanapum Dam, involuntary spill occurred 95% of the time during the spring fish-spill season, 58% of the time during the summer fish-spill season, and 76% of the time over the entire fish-spill season.

At Priest Rapids Dam, involuntary spill occurred 49% of the time during the spring fish-spill season, 23% of the time during the summer fish-spill season, and 36% of the time over the entire fish-spill season. These percentages are based on the total number of hourly spill values greater than the designated fish-spill values vs. the total number of available hours during the fish-spill season (from April 1 through August 31).

For a more detailed description of 2013 fish-spill season duration, methods, and adjustments see Appendix C.

3.4 Biological Evaluations

The following sections provide a summary of fish passage timing results as they relate to the 2013 fish-spill season at Wanapum and Priest Rapids dams and results from gas bubble trauma (GBT) monitoring. Note that no fish passage studies were conducted in 2013.

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 2013)). Figure 5 illustrates that approximately 98% of the yearling spring outmigrants passed during the spring fish-spill period between April 17 and June 14 (FPC 2013). Figure 6 shows that the combined spring and summer fish-spill periods from April 17 through August 23 encompassed greater than 99% of the entire 2013 outmigration (FPC 2013), while Figure 7 shows that greater 95% of the sub-yearling Chinook passed by August 12 (FPC 2013); spill from August 12–23 allowed the remaining percentages of outmigrant fish to move downstream through the Wanapum and Priest Rapids developments.

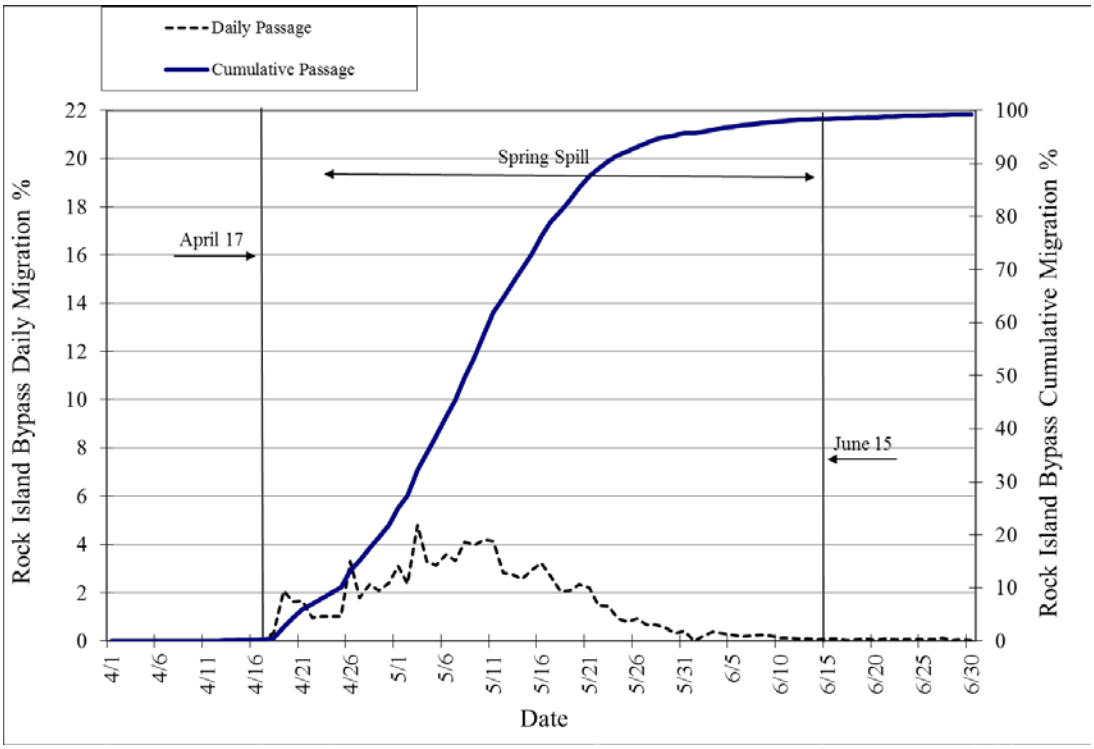

Figure 5 **Fish-spill and migration timing for yearling Chinook and steelhead, spring 2013. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2013).**

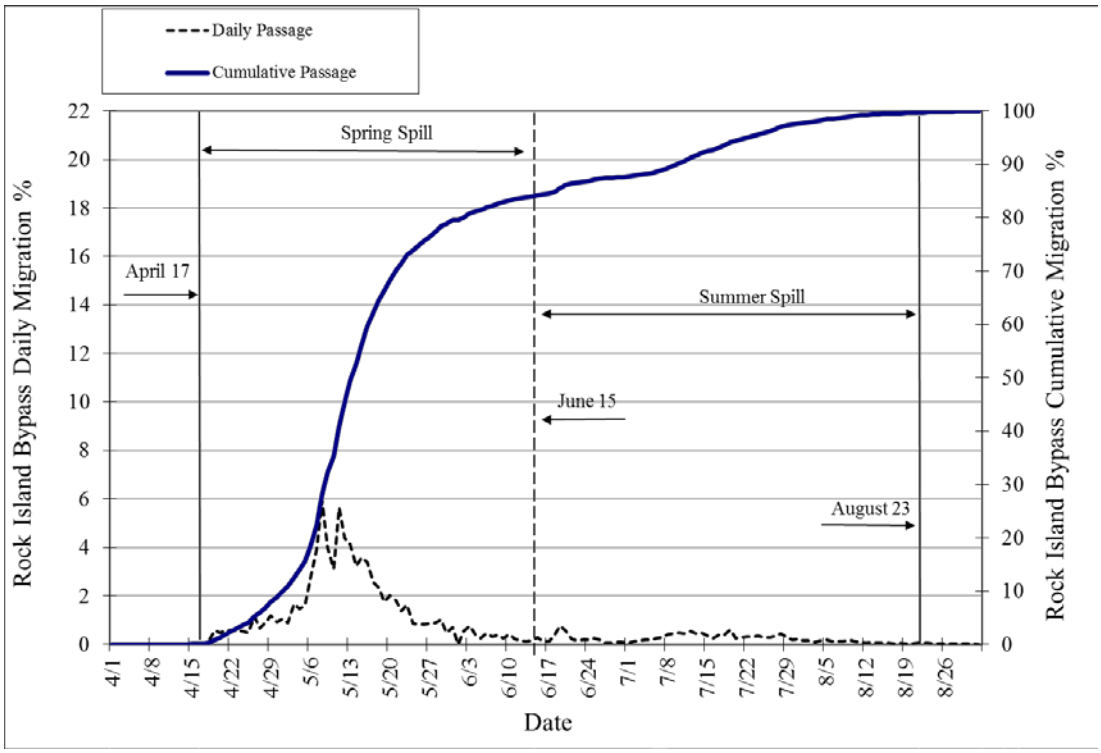

Figure 6 **Fish-spill and migration timing for all species, 2013. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2013).**

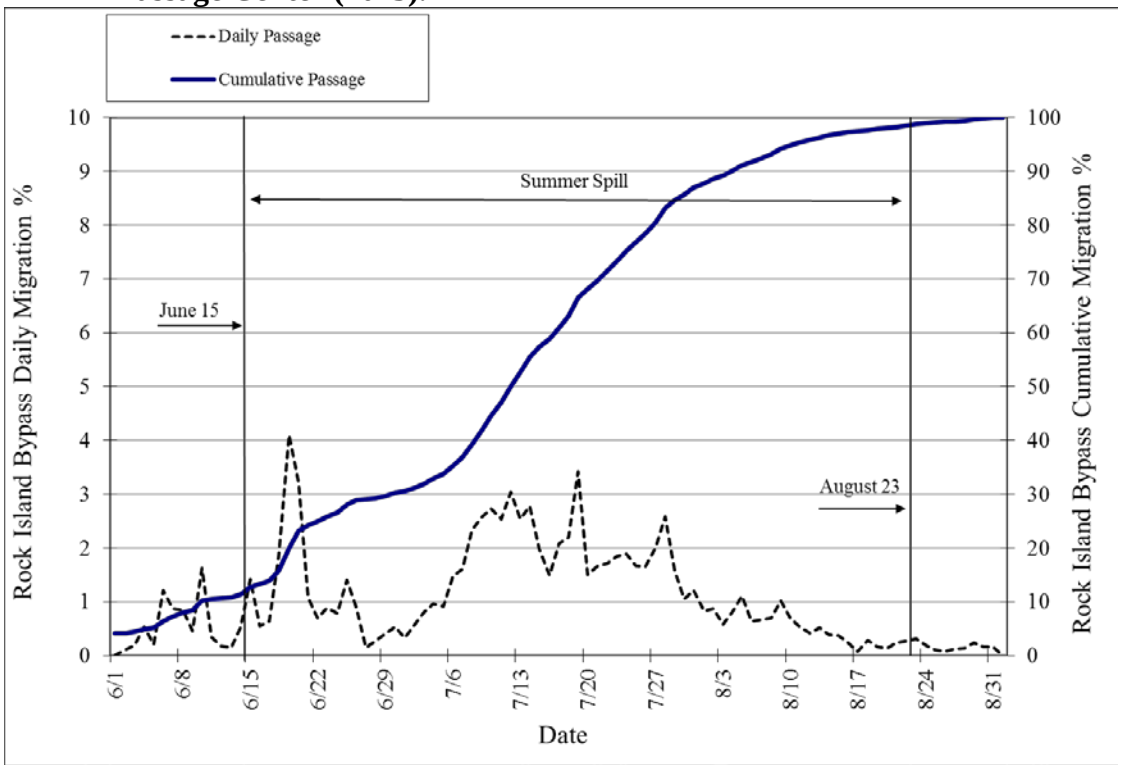

Figure 7 **Fish spill and migration timing for sub-yearling Chinook, summer 2013. Priest Rapids Project, mid-Columbia River, WA. Rock Island Bypass Index data courtesy of the Fish Passage Center (2013).**

3.4.2 Gas Bubble Trauma Monitoring

Grant PUD conducted GBT monitoring during the 2013 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 Priest Rapids Dam.

During the 2013 fish-spill season, 2,207 smolts were examined for GBT, with 12 exhibiting signs of GBT, or approximately 0.5% 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. All 12 of the smolts that had symptoms of GBT during the 2013 season were Chinook and received a rank of one. The total number of fish sampled for the 2013 fish-spill season was less than the number sampled during the 2012 (3,469) fish-spill season due to water temperatures exceeding the 20° Celsius sampling threshold and construction on Priest Rapids Dam that closed the intake deck, which restricted access for the gate-well dipping crew, preventing the collection of sample fish.

Table 3 below provides the summary results of GBT monitoring during the 2013 fish-spill season recorded at Priest Rapids Dam.

Table 3 Gas bubble trauma monitoring results from Priest Rapids Dam in 2013. 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	2,106	12	0	0	0	12
Steelhead	101	0	0	0	0	0
Total	***2,207***	***12***	0	0	0	***12***

3.5 Total Dissolved Gas Monitoring

The following sections discuss the results of TDG monitoring from the 2013 fish-spill season within the Project and at the Pasco compliance point location. Specific sections include TDG averages with associated figures for each FSM station/compliance point location, a breakdown of all TDG exceedances and possible explanations for those exceedances, and the connection between elevated TDG levels and involuntary spill during the 2013 fish-spill season.

Summary values for all hourly TDG measurements taken from each FSM station during the 2013 fish-spill season are presented in Table 4 below.

Table 4 **Summary of hourly total dissolved gas measurements from each fixed-site monitor station (FSM station) during the 2013 fish-spill season. Priest Rapids Project, mid-Columbia River, WA.**

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
WANF	04/1 – 08/31	111.0	3.3	101.6	120.7
WANT	04/1 – 08/31	112.7	3.5	103.9	122.9
PRDF	04/1 – 08/31	111.6	3.5	101.6	122.1
PRDT	04/1 – 08/31	114.1	3.7	103.3	122.2
PASCO	04/1 – 08/31	110.0	3.1	102.1	118.6

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

Figures 8 through 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 sensor membrane failure, or siltation issues at the Pasco compliance point (see Sections 1.2.1 and 2.0). The average of the 12-highest consecutive hourly TDG readings from each day during the spring and summer fish-spill seasons from each FSM station, including explanation of possible causes of TDG exceedances and corrective actions taken to reduce elevated TDG levels are presented in Appendix D of this report.

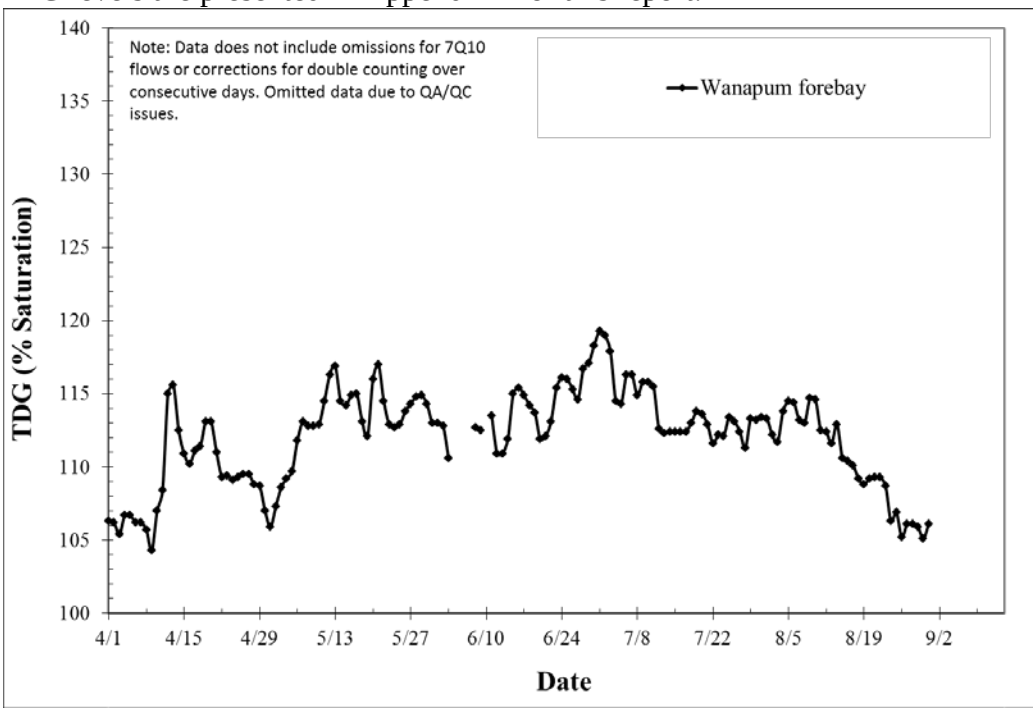

Figure 8 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Wanapum Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

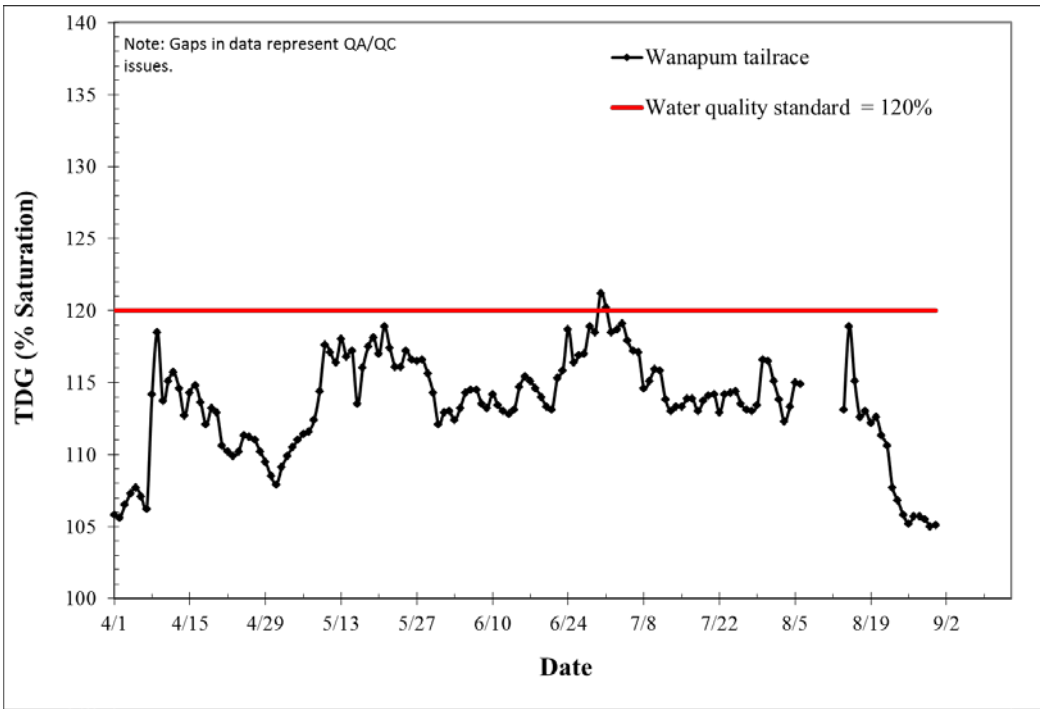

Figure 9 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Wanapum Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

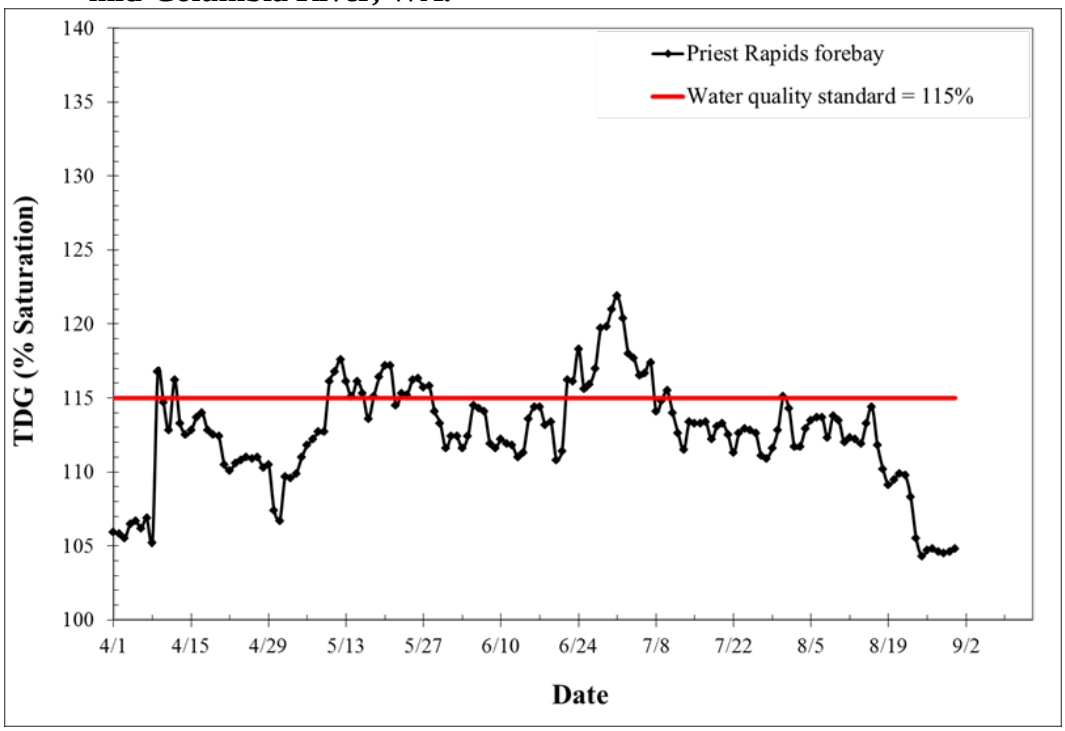

Figure 10 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Priest Rapids Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

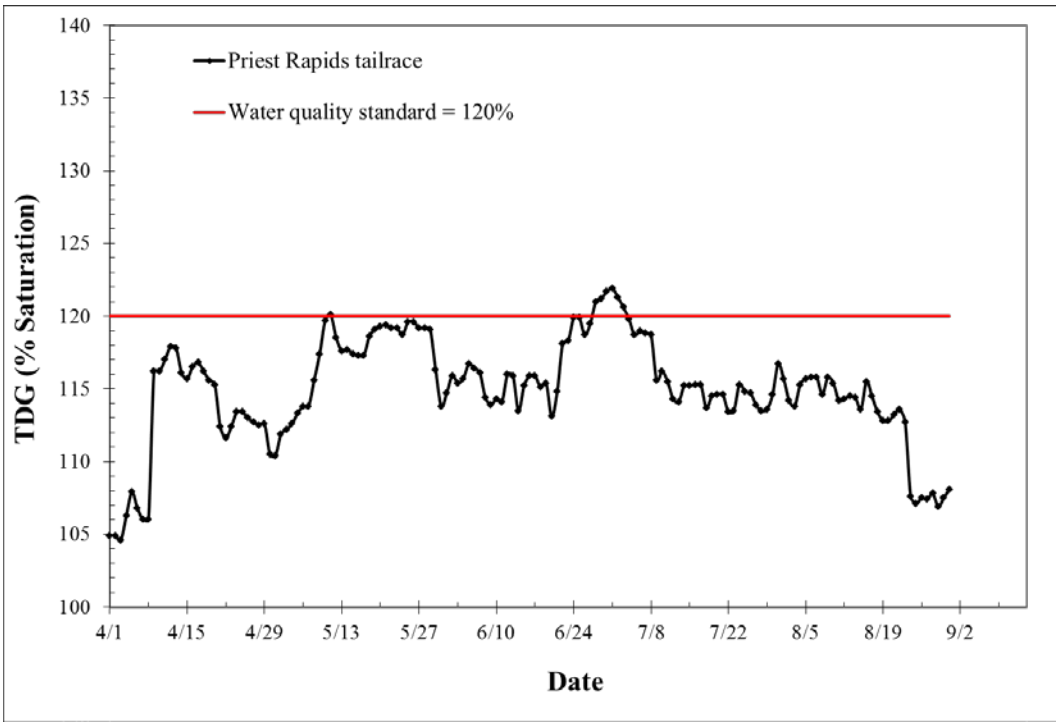

Figure 11 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Priest Rapids Dam tailrace FSM station. Priest Rapids Project, mid-Columbia River, WA.**

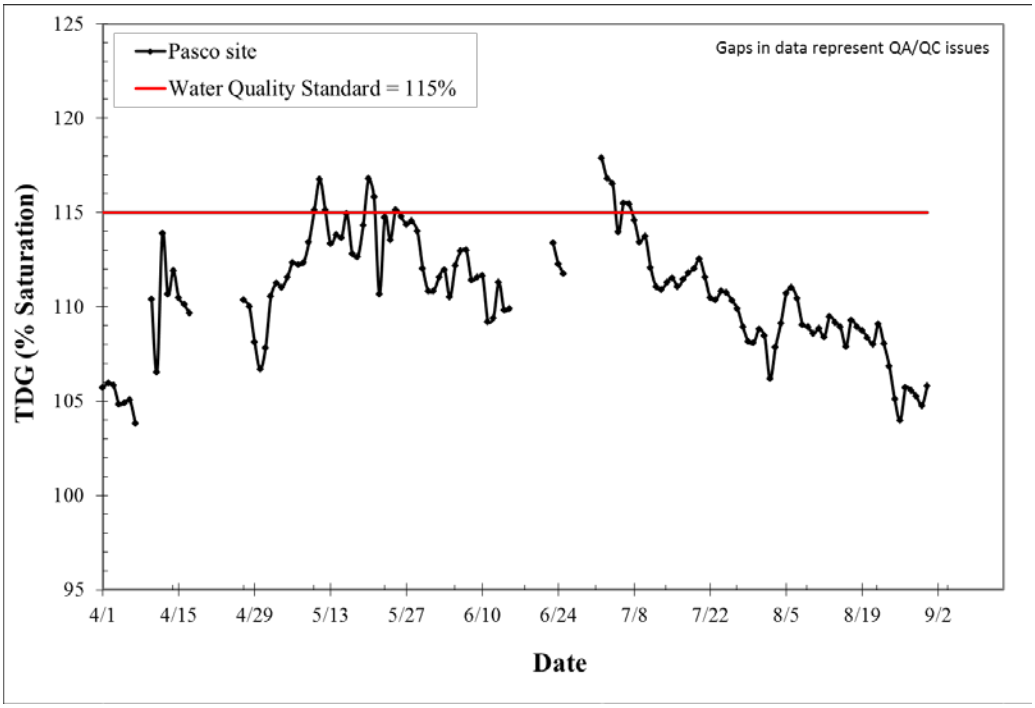

Figure 12 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the McNary forebay (Pasco site), mid-Columbia River, WA.**

3.5.2 Total Dissolved Gas Exceedances

Table 5 displays the total number of times TDG levels exceeded the current water quality standards during the 2013 fish-spill season as measured at each of Grant PUD's FSM stations along with the Pasco compliance point (owned/operated by the Corps). The total number of exceedances also reflects the omission of exceedances caused by the previous day's hourly values, if those same hourly values also created a 12-hour average TDG value above standards for the previous day (see Section 1.2.2 and Appendix A for explanation of how the WDOE 12-high consecutive calculation method and associated "double-counting" issues were addressed in 2013).

Appendix B within this report presents all omitted data with explanations of why they were omitted.

Table 5 Number of 2013 fish-spill season total dissolved gas exceedances. Priest Rapids Project, mid-Columbia River, WA.

	Number of 115 %SAT/120 %SAT exceedances					Number of 125 %SAT exceedances		
Location[1]	Spring Spill	Summer Spill	Total	Total # of days[2]	% above standard	Total	Total # of hrs[2]	% above standard
WANT	0	1	1	146	1%	0	3531	0%
PRDF	14	16	30	153	20%	0	3672	0%
PRDT	0	6	6	153	4%	0	3672	0%
PASCO	3	3	6	147	4%	0	3139	0%
Total	17	26	43	599	7%	0	14014	0%

[1]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.
[2]Based on total number of available days/hrs minus days/hrs omitted due to TDG membrane failures or other QA/QC issues.

Exceedances of TDG values standard were minimal during the 2013 fish-spill season, with a total of 43 exceedances of the 115/120 %SAT standard. There were no exceedances of the 1-hour 125 %SAT standard. The Priest Rapids forebay fixed-site monitoring station (FSM station) accounted for the majority of exceedances (30 of 43 or >69%), all of which can be attributed to river flow in excess of Wanapum Dam's current hydraulic capacity of 163 kcfs (see Section 3.5.3 for additional detail). When flows were above Wanapum Dam's hydraulic capacity, involuntary spill was required that contributed to elevated TDG levels, and because of the short distance between Wanapum and Priest Rapids dams (18 RM), TDG levels did not have a chance to dissipate below 115 %SAT by the time they reached the Priest Rapids Dam forebay FSM station. Additionally, of the 30 exceedances recorded at the Priest Rapids Dam forebay FSM station, 23 (77%) corresponded with incoming TDG levels 115 %SAT or above recorded during the same time period at the Wanapum Dam forebay FSM station (see Figure 13). Finally, three of the exceedances were attributed to Grant PUD assisting the Grant County Sheriff's Department in the search of human remains in the Wanapum Reservoir (which required Grant PUD to spill above its spill caps in order to maintain desired water elevations).

More specifics on exceedances and factors for the corresponding exceedance for the 2013 fish-spill season can be found in Appendix D of this report.

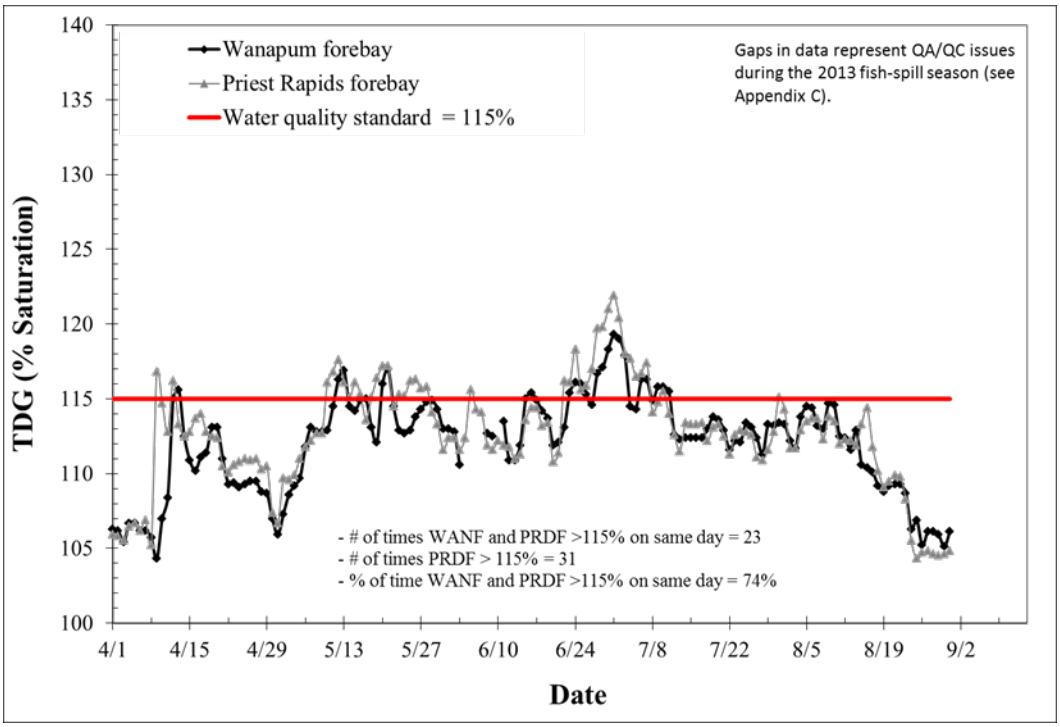

Figure 13 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in 24-hour period) from the 2013 fish-spill season recorded at the Wanapum Dam forebay FSM station and the Priest Rapids Dam forebay FSM station. Priest Rapids Project, mid-Columbia River, WA.**

3.5.3 Total Dissolved Gas and Involuntary Spill

Figures 14 and 15, and Table 6 show that mean daily flow values recorded at Wanapum Dam exceeded the current Wanapum Dam Powerhouse capacity of 141 kcfs 76% of the time over the entire fish-spill season. In addition, mean daily flow values recorded at Wanapum Dam were in excess of the current Wanapum Dam Powerhouse capacity plus voluntary (fish-spill) amounts (~163 kcfs) 52% of the time during the entire fish-spill season. As a result of these higher flows, involuntary spill was required for part of the fish-spill season, and all of the TDG exceedances occurred during periods of involuntary spill.

Table 6 **Amount of time mean daily flow values exceeded Wanapum Dam's powerhouse capacity and/or powerhouse capacity plus fish-spill amounts. Priest Rapids Project, mid-Columbia River, WA.**

Season (total # of days)	Number of days >141[1]	Percent of days >141	Number of days >163[2]	Percent of days >163
Spring Spill (75)	71	95%	48	64%
Summer Spill (78)	45	58%	32	41%
Entire Season (153)	116	76%	80	52%

Notes:
[1]The current powerhouse capacity at Wanapum Dam is limited to 141 kcfs during the fish spill season.
[2]Fish-spill amounts at Wanapum Dam during the 2012 fish-spill season were up to 22 kcfs, therefore powerhouse capacity plus fish-spill amounts were equal to ~163 kcfs.

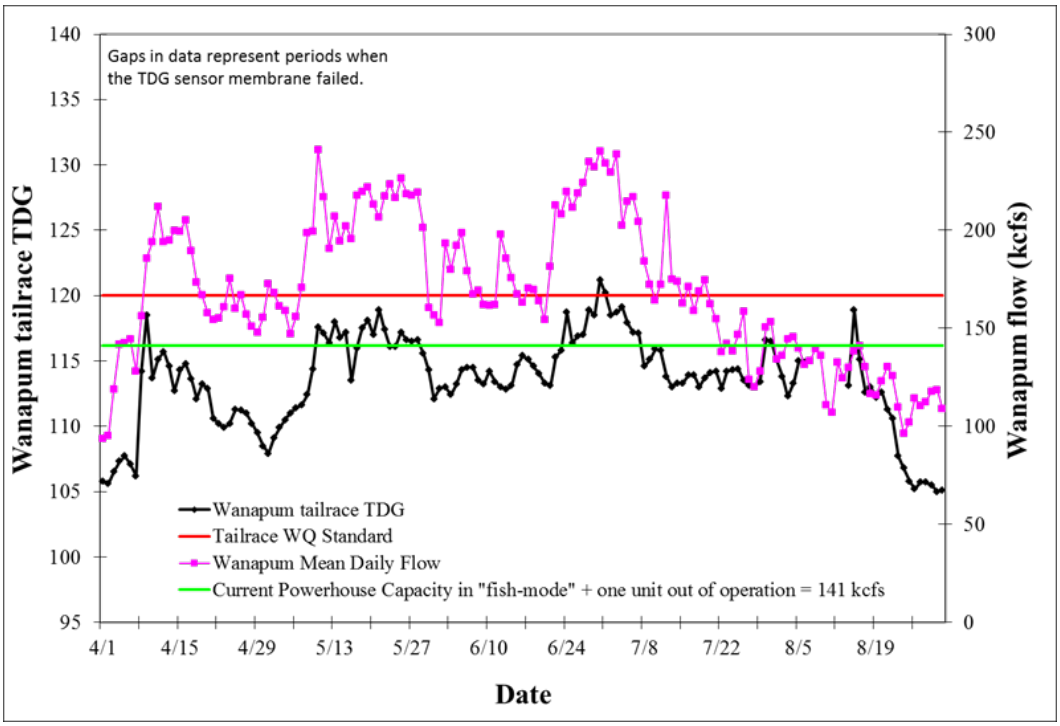

Figure 14 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Wanapum Dam tailrace FSM station vs. Wanapum Dam mean daily flow values. Priest Rapids Project, mid-Columbia River, WA.**

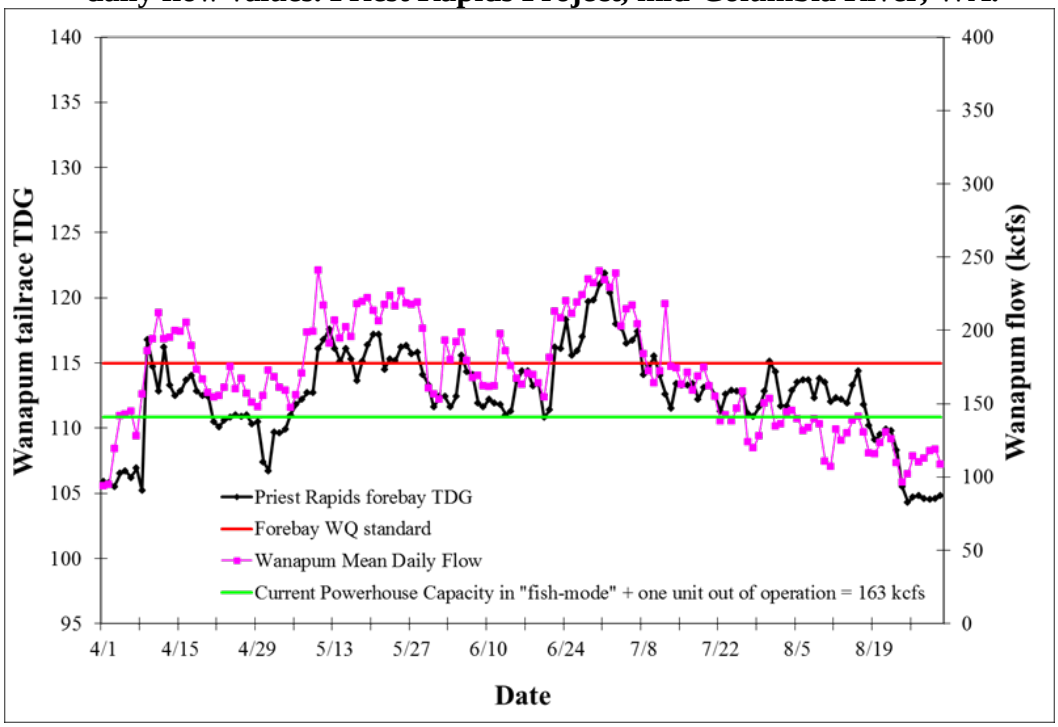

Figure 15 **Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2013 fish-spill season recorded at the Priest Rapids Dam forebay FSM station vs. Wanapum Dam mean daily flow values. Priest Rapids Project, mid-Columbia River, WA.**

Because all of the TDG exceedances during the 2013 fish-spill season occurred when mean daily flows from Wanapum Dam exceeded powerhouse capacities, modifications to the fish-spill program were not a feasible TDG reduction option. Note that Grant PUD is also limited to how "full" it can run its powerhouse due to regional and federal constraints, and thus in general the combination of both Wanapum and Priest Rapids dams are limited to 85% of their full capacity (Section 4.1 provides additional detail). When possible, Grant PUD attempted to maximize powerhouse discharge (up to the aforementioned 85% capacity) and minimize involuntary spill, and Section 4.1 below provides a summary of the TDG abatement measures taken during the 2013 fish-spill season.

The dates of each TDG exceedance and the corrective measures taken to reduce the elevated values are shown in Appendix D.

4.0 Total Dissolved Gas Abatement Measures

The following sections describe some of the TDG abatement measures that Grant PUD undertook during the 2013 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 2013a).

4.1 Total Dissolved Gas Abatement Measures in 2013

During the 2013 fish-spill season, Grant PUD continued to implement TDG abatement measures per its GAP (Keeler 2013), 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. Mandating a high level of turbine usage during periods of high flow was, at times during 2013, an effective means of limiting involuntary spill and TDG impacts; however, during periods of very high-sustained flows, there was not adequate turbine capacity to sufficiently limit spill.

  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 20, 2013. The purpose of this meeting was to discuss alternative actions to mitigate the expected high TDG values that were anticipated to accompany the high flow conditions. 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 2014 draft GAP provides a summary of the proposed operational and structural abatement measures that Grant PUD plans to implement for the 2014 fish-spill season (Keeler 2013b). 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 2013, 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 include the operation of the WFB, which is designed to safely pass outmigrating smolts while minimizing TDG uptake. The PRFB, which is designed to increase fish-passage while maintaining or reducing TDG levels at Priest Rapids Dam, is scheduled to be completed in 2014 (construction began in September of 2011). The installation of the advanced hydropower turbines at Wanapum is complete, with the final unit completed in September of 2013. As required under Sections 6.4.4(b) and 6.4.9 of the Project's 401 WQC (WDOE 2007), as well as Section II of the individual 401 WQC (WDOE 2004) for the advanced turbine installation project, Grant PUD conducted a field study to evaluate TDG levels with all ten of the advanced turbines operating to determine the effect, if any, the advanced turbines have on TDG below Wanapum Dam. Data for this evaluation was collected in early October (of 2013) and is currently being evaluated, with preliminary data and draft report scheduled to be submitted to WDOE by December 31, 2013 (see Keeler 2012b for additional detail on this study).

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

During the 2013 fish-spill season, all TDG exceedances occurred when flow volumes were greater than the current hydraulic capacity at Wanapum Dam (see Figure 15, and Table 7), which resulted in increased involuntary spill. Grant PUD implemented abatement measures intended to help moderate high TDG levels (see Section 4.1), including attempting to maximize powerhouse flows (up to its capacity that is available after accounting for regional and federal constraints) and reduce involuntary spill by selling power at reduced costs, participating in regional efforts to reduce TDG at each mid-Columbia River dam, and closely monitoring TDG and incoming flows.

As described in Section 4.0 and in the 2014 draft GAP (Keeler 2013), continuing and upcoming TDG abatement measures will be implemented by Grant PUD over the next five 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 of the PRFB (construction started in September 2011; planned to be operational in 2014), and installation of advanced hydropower turbines at Wanapum Dam (completed October 2013).

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, adjusting spill percentages as needed to comply with current TDG standards.

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Appendix A
Total dissolved gas compliance value calculation method

Table A-1, below, presents an example of when the Washington Department of Ecology (WDOE) TDG compliance value calculation method, which includes the last eleven hourly values from the previous day, created a double-counting instance during the 2013 fish-spill season.

On April 13, 2013, the WDOE compliance method would have created two TDG exceedances based on the same group of hours recorded at the Priest Rapids Dam forebay fixed-site monitoring station (FSM station). The red highlighted hours below indicate those which would have been counted on both days, which would have created the value of 116.2 percent saturation (%SAT) on April 12 ***and*** 115.9 %SAT on April 13 (yellow highlights), even though there was no hourly value above 115%SAT on April 13. To correct this issue during the 2013 fish-spill season, Grant PUD documented double-counting events. In the example below, the compliance value on April 13 of 115.9%SAT was replaced by the average of the highest 12 consecutive hourly values that did NOT include the previous days last eleven hourly values (which already created a TDG exceedance on April 12). This resulted in a TDG compliance value on April 13, 2013 of 113.3%SAT (green highlight).

In total, during the 2013 fish-spill season, there were six occurrences of the double-counting instances that lead to an apparent exceedance of TDG standards (see Table A-2). Grant PUD will continue to use this method for tracking and accounting for double-counting issues in future fish-spill seasons.

Table A-1 Example of double counting using "rolling average" method.

Date	Hour	Hourly TDG Value	Average of 12 previous hours	Highest 12-hr consecutive average for each day
4/12/2013	1500	**117.1**	**117.3**	
4/12/2013	1600	**116.8**	**117.4**	
4/12/2013	1700	**116.2**	**117.5**	
4/12/2013	1800	**115.8**	**117.7**	
4/12/2013	1900	**115.8**	**117.8**	
4/12/2013	2000	**115.6**	**117.9**	
4/12/2013	2100	**115.5**	**117.9**	
4/12/2013	2200	**115.5**	**117.9**	
4/12/2013	2300	**115.8**	**117.9**	
4/12/2013	2359	115.0	**117.8**	**116.2**
4/13/2013	0100	114.4	**115.9**	**115.9**
4/13/2013	0200	114.3	**115.7**	
4/13/2013	0300	114.2	115.4	
4/13/2013	0400	113.7	115.2	
4/13/2013	0500	113.4	114.9	
4/13/2013	0600	113.2	114.7	
4/13/2013	0700	113.1	114.5	
4/13/2013	0800	112.9	114.3	
4/13/2013	0900	112.8	114.0	
4/13/2013	1000	112.7	113.8	
4/13/2013	1100	112.6	113.5	
4/13/2013	1200	112.6	113.3	**113.3**
4/13/2013	1300	112.6	113.2	
4/13/2013	1400	112.6	113.0	
4/13/2013	1500	112.5	112.9	
4/13/2013	1600	112.4	112.8	
4/13/2013	1700	112.2	112.7	
4/13/2013	1800	112.0	112.6	
4/13/2013	1900	111.9	112.5	
4/13/2013	2000	111.7	112.4	
4/13/2013	2100	111.4	112.3	
4/13/2013	2200	111.3	112.2	
4/13/2013	2300	111.2	112.0	
4/13/2013	2359	111.3	111.9	

Table A-2 Exceedance events created by hourly values from the previous day (double counting instances).

Date	Location	12-high with previous day values	12-high without previous day values
4/13/13	PRDF	115.9	113.3
5/22/13	PRDF	116.4	114.5
5/29/13	PRDF	115.8	114.1
7/4/13	WANF	116.6	114.5
7/8/13	WANF	115.7	114.9
7/8/13	PRDF	116.8	114.1

Notes:
WANF = Wanapum forebay, PRDF = Priest Rapids forebay.

Appendix B
Data omitted from the 2013 fixed-site monitoring total dissolved gas dataset because of QA/QC issues (Table B-1)

Table B-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
PASCO	4/7-4/9	1700-1400	Siltation issues within the standpipe[1]	Removed the silt from within the standpipe
PASCO	4/18-4/26	0200-1400	Siltation issues within the standpipe[1]	Removed the silt from within the standpipe
WANF	6/4 6/5 6/6 6/10	1100-2100 1100-1900 1200-1900 1200-2300	Spotty TDG data from multi-probe	Replaced multi-probe with a new multi-probe
PASCO	6/16-6/22	1100-1200	Siltation issues within the standpipe[1]	Removed the silt from within the standpipe
PASCO	6/26-7/2	0400-1000	Siltation issues within the standpipe[1]	Removed the silt from within the standpipe
WANT	8/7-8/13	1200-0800	TDG spike, membrane failure	Replaced membrane with new TDG membrane

Note: WANF = Wanapum forebay, WANT = Wanapum tailrace, PRDF = Priest Rapids forebay, PRDT = Priest Rapids tailrace, PASCO = Pasco Fixed Site Monitoring Station, operated by the U.S. Army Corps of Engineers.

[1] Email response dated 10/29/2013 from Corps (Steve Juul) stating that they (the Corps) had some siltation issues at the Pasco station and had to blow-out the deployment pipe a couple of different times throughout the spill-season. The TDG data was deleted in the database from April 7 at 1700 hrs to April 9 at 1400 hrs., April 18at 0200 hrs to April 26 at 1400 hrs, June 16 at 1100 hrs to June 22 at 1200 hrs, and June 26 at 0400 hrs to July 2 at 1000 hrs (see Juul 2013).

Appendix C
2013 Fish-Spill Season Memoranda

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

MEMORANDUM April 16, 2013

TO: Dispatch
Wanapum Dam Control Room
Priest Rapids Dam Control Room
Bryan Bird, Hydro Operations Supervisor
Mark Beattie, Asst. Hydro Operations Supervisor,
Planning and Scheduling

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

FROM: Curt Dotson, Fisheries Program Supervisor – Anadromous Fish Passage & Operations Branch

Purpose: Start of 2013 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 1.13 states that the primary juvenile salmonid passage will be tainter gate spill of 61 percent of average daily total river flow, or total dissolved gas (TDG) limits, whichever is less. 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.

Action 1.12 of Section 2.9.6 allows Grant PUD to evaluate alternative top-spill concepts for juvenile fish passage at Priest Rapids Dam.

On April 16, 2013 the Priest Rapids Coordinating Committee (PRCC) spill representatives gave concurrence to Grant PUD to implement Section 2.9.6, Action 1.5 and Action 1.8, of the Biological Opinion as it pertains to juvenile salmonid downstream passage at Wanapum Dam. During this same communication, the spill representatives agreed that Grant PUD should proceed with Section 2.9.6, Actions 1.12 and Actions 1.16 for juvenile salmonid passage at Priest Rapids 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 17, 2013	1300 hrs.	WFB	24 hours/day
Priest Rapids Dam	April 18, 2013	1300 hrs.	TG-5 & 6 (full open). TG-4 & 7 open 4 ft.	24 hours/day

Wanapum Dam should follow the spill pattern titled, "2013 Wanapum Dam Spill Pattern During Fish Spill". In the case of any inadvertent spill (excess of powerhouse capacity), that spill shall be discharged through the spillbay(s) as indicated in the "2013 Wanapum Dam Spill Gate Operations for Inadvertent Spill During Fish Spill" spread sheet.

Priest Rapids Dam should follow the spill pattern titled "2013 Spill Pattern During Top-Spill Bulkhead Operations". In case of any inadvertent spill, please follow the inadvertent spill pattern give in latest version of the "2013 Priest Rapids Dam Inadvertent Spill Pattern".

Operation of the Wanapum and Priest Rapids turbines in "fish mode" will commence at the same date and 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.

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, 2013

TO: Dispatch
Wanapum Dam Control Room
Priest Rapids Dam Control Room
Bryan Bird, Hydro Operations Supervisor
Planning and Scheduling

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

FROM: Curt Dotson, Fisheries Program Supervisor

Purpose: Start of 2013 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, 2013 at which time Summer Fish Spill will begin. The 2013 Summer Fish Spill

program for Wanapum Dam will be the same as the 2013 Wanapum Spring Fish Spill program – operation of the Wanapum Fish Bypass (WFB) 24/7.

At Priest Rapids Dam, Spring Fish Spill will continue until 2359 hr. of June 14th, 2013 at which time Summer Fish Spill will begin. The 2013 Summer Fish Spill program for Priest Rapids Dam will be the same as the 2013 Priest Rapids Spring Fish Spill program – operation of TG-5 & 6 (top-spill bulkhead), TG-4 & TG-7 open 4 ft.

Fish Spill at Wanapum and Priest Rapids Dams:

Hydro Project	Start Date	Start Time	Spill Rate	Duration
Wanapum Dam	June 14, 2013	2359 hrs.	WFB	24 hours/day
Priest Rapids Dam	June 14, 2013	2359 hrs.	TG-5 & 6 (full open). TG-4 & TG-7 open 4 ft.	24 hours/day

Wanapum Dam should follow the spill pattern titled, "2013 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 2013 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 21, 2013

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 Program Supervisor

Purpose: 2013 Summer Fish Spill - Ending

Discussion: The 2013 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 2013 Summer Fish Spill program for Wanapum Dam was the same as the 2013 Wanapum Spring Fish Spill program – operation of the Wanapum Fish Bypass (WFB) 24/7. The 2013 Summer Fish Spill program for Priest Rapids Dam was the same as the 2013 Priest Rapids Spring Fish Spill program – operation of TG-5 & 6 (top-spill bulkhead), TG-4 and TG-7 open 4 ft. 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.*'

Table 1 provides the daily Rock Island Dam Index counts for sub-yearling Chinook since August 16, 2013 illustrating the decreasing in numbers of sub-yearling Chinook passing Rock Island Dam.

Table 1. Daily Sub-yearling Chinook Passage counts at Rock Island Dam

August:	6	12	14	16	17	18	19	20
Index Count:	170	172	93	41	47	73	40	38

Summer fish spill at Wanapum Dam will end on August 22, 2013 and at Priest Rapids Dam on August 23, 2013.

For adult fall-back, the ice/trash sluiceway at Wanapum will be opened and remain open to pass water 24/7, until further notice. For adult fall-back operations at Priest Rapids Dam, TG-6 is to be opened to the full-open position and pass water 24/7 over the top-spill bulkhead until further notice. 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 fish-spill", those turbines may return to standard turbine operations.

Conclusion: Based upon agreed criteria and in-season information presented above, Grant PUD 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 1400 hr. on August 20, 2013 at Wanapum Dam and at 0800 hr. on August 21, 2013 at Priest Rapids Dam (Table 2).

Table 2. Fish Spill at Wanapum and Priest Rapids Dams.

Hydro Project	Start Date	Start Time	Spill Rate	Duration
Wanapum Dam	August 22, 2013	0800 hr.	0% Sluice gate open	24 hours/day.
Priest Rapids Dam	August 23, 2013	0800 hr.	0% TG-6 gate full open (top-spill bulkhead)	24 hours/day

The Wanapum Dam sluice gate and Priest Rapids Dam TG-6 will remain fully opened until November 15, 2013 to provide a fall-back route for adult salmonids.

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

Appendix D
Daily averages of the 12-highest hourly total dissolved gas readings during the 2013 fish-spill season

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
1-Apr	106.3	105.8	105.9	104.9	105.7	
2-Apr	106.2	105.6	105.8	104.9	106.0	
3-Apr	105.4	106.5	105.5	104.6	105.8	
4-Apr	106.7	107.3	106.5	106.3	104.8	
5-Apr	106.7	107.7	106.7	107.9	104.9	
6-Apr	106.2	107.1	106.2	106.8	105.1	
7-Apr	106.2	106.2	106.9	106.0	103.8	
8-Apr	105.7	114.2	105.2	106.0	n/d	
9-Apr	104.3	118.5	**116.8**	116.2	n/d	High flows in the system (Grand Coulee Dam flood control preparation); powerhouse flows increased so that powerhouse was operating at 85% capacity.
10-Apr	107.0	113.7	114.7	116.2	110.4	
11-Apr	108.4	115.1	112.8	117.0	106.5	
12-Apr	115.0	115.7	**116.2**	117.9	113.9	High flows in the system (Grand Coulee Dam flood control preparation); powerhouse flows increased so that powerhouse was operating at 85% capacity.
13-Apr	**115.6**	114.6	113.3	117.8	110.7	
14-Apr	112.5	112.7	112.5	116.1	111.9	
15-Apr	110.9	114.3	112.8	115.7	110.5	
16-Apr	110.2	114.8	113.7	116.5	110.1	
17-Apr	111.1	113.6	114.0	116.8	109.7	
18-Apr	111.4	112.1	112.8	116.2	n/d	
19-Apr	113.1	113.2	112.5	115.6	n/d	
20-Apr	113.1	112.9	112.4	115.3	n/d	
21-Apr	111.0	110.6	110.5	112.4	n/d	
22-Apr	109.3	110.2	110.1	111.6	n/d	
23-Apr	109.4	109.9	110.6	112.4	n/d	
24-Apr	109.1	110.2	110.8	113.4	n/d	
25-Apr	109.3	111.3	111.0	113.4	n/d	
26-Apr	109.5	111.2	110.9	113.0	n/d	
27-Apr	109.5	111.0	111.0	112.7	110.4	
28-Apr	108.8	110.2	110.3	112.5	110.0	
29-Apr	108.7	109.5	110.5	112.6	108.1	
30-Apr	107.0	108.5	107.4	110.5	106.7	
1-May	105.9	107.9	106.7	110.4	107.8	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
2-May	107.3	109.1	109.7	111.9	110.6	
3-May	108.6	109.9	109.6	112.2	111.3	
4-May	109.2	110.5	109.9	112.6	111.0	
5-May	109.7	111.0	111.0	113.3	111.6	
6-May	111.8	111.4	111.8	113.8	112.3	
7-May	113.1	111.6	112.2	113.8	112.2	
8-May	112.8	112.4	112.7	115.6	112.3	
9-May	112.8	114.4	112.7	117.4	113.4	
10-May	112.9	117.6	**116.1**	119.7	115.1	Exceedances from 5/10-5/12 can be attributed to drafting the Wanapum forebay to assist the Grant County Sherriff's department in the recovery of human remains. Spill caps were exceeded in order to obtain the desired water elevations. Spill levels reduced and the body search was called off so that TDG levels could come back into compliance. Exceedance on 5/13 likely associated with high incoming TDG in WANF.
11-May	114.5	117.1	**116.8**	120.1	**116.7**	
12-May	**116.3**	116.4	**117.6**	118.5	115.1	
13-May	**116.9**	118.0	**116.1**	117.6	113.3	
14-May	114.5	116.8	115.1	117.7	113.8	
15-May	114.2	117.2	**116.1**	117.4	113.7	Powerhouse operating at 85% capacity; spill caps being met; cause of exceedance unknown.
16-May	114.9	113.5	115.3	117.3	114.9	
17-May	115.0	116.0	113.6	117.3	112.8	
18-May	113.1	117.5	115.1	118.6	112.6	
19-May	112.1	118.1	**116.4**	119.1	114.3	Attempted to preemptively spill in anticipation of high flows; reduced spill due to exceedance
20-May	**116.0**	117.0	**117.2**	119.3	**116.8**	TDG levels high throughout system and incoming TDG levels where greater than 115%; powerhouse operating at 85% capacity, but due to high flow, spill above spill caps required.
21-May	**117.0**	118.9	**117.2**	119.4	**115.8**	
22-May	114.5	117.4	114.5	119.2	110.7	
23-May	112.9	116.1	115.3	119.2	114.8	
24-May	112.7	116.1	115.2	118.7	113.6	
25-May	112.9	117.2	**116.2**	119.6	115.1	High flows in the system; powerhouse operating at 85% capacity
26-May	113.8	116.6	**116.3**	119.6	114.8	
27-May	114.3	116.5	**115.7**	119.2	114.4	Very little de-gassing occurring between WANF and PRDF; spill caps were reduced in an attempt to reduce TDG levels
28-May	114.8	116.6	**115.8**	119.2	114.5	
29-May	114.9	115.6	114.1	119.1	114.0	
30-May	114.3	114.3	113.3	116.3	112.0	
31-May	113.0	112.1	111.6	113.8	110.8	
1-Jun	113.0	112.9	112.4	114.7	110.8	
2-Jun	112.8	113.0	112.4	115.9	111.6	
3-Jun	110.6	112.4	111.6	115.4	112.0	
4-Jun	n/d	113.2	112.4	115.7	110.5	
5-Jun	n/d	114.3	114.5	116.7	112.2	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
6-Jun	n/d	114.5	114.3	116.4	112.9	
7-Jun	n/d	114.5	114.1	116.1	113.0	
8-Jun	112.7	113.5	111.9	114.4	111.4	
9-Jun	112.5	113.2	111.6	113.9	111.6	
10-Jun	n/d	114.2	112.2	114.3	111.7	
11-Jun	113.5	113.4	111.9	114.1	109.2	
12-Jun	110.9	113.0	111.8	116.0	109.4	
13-Jun	110.9	112.8	111.0	115.9	111.3	
14-Jun	111.9	113.1	111.3	113.5	109.8	
15-Jun	115.0	114.7	113.6	115.2	109.9	
16-Jun	115.4	115.4	114.4	115.9	n/d	
17-Jun	114.9	115.1	114.4	115.9	n/d	
18-Jun	114.2	114.6	113.2	115.1	n/d	
19-Jun	113.7	114.0	113.4	115.4	n/d	
20-Jun	111.9	113.3	110.8	113.1	n/d	
21-Jun	112.1	113.1	111.4	114.8	n/d	
22-Jun	113.1	115.3	**116.2**	118.1	n/d	During this time period, incoming high flows (due in part to rain event) exceeded powerhouse capacity and incoming TDG levels were elevated. Grant PUD operated its projects at 85% capacity the majority of the time (during other times, Grant PUD assumed additional spill at Priest Rapids Dam in an attempt to reduce spill at upstream projects (in order to help reduce high TDG levels within the Mid-C system).
23-Jun	115.4	115.8	**116.1**	118.3	113.4	
24-Jun	**116.1**	118.7	**118.3**	119.9	112.3	
25-Jun	**116.0**	116.4	**115.6**	119.9	111.8	
26-Jun	115.3	116.9	**115.9**	118.7	n/d	
27-Jun	114.6	117.0	**117.0**	119.5	n/d	
28-Jun	**116.7**	118.9	**119.7**	**121.0**	n/d	
29-Jun	**117.1**	118.5	**119.8**	**121.2**	n/d	
30-Jun	**118.3**	**121.2**	**121.0**	**121.7**	n/d	
1-Jul	**119.3**	120.2	**121.9**	**121.9**	n/d	
2-Jul	**119.0**	118.5	**120.4**	**121.3**	**117.9**	
3-Jul	**117.9**	118.7	**118.0**	**120.6**	**116.8**	
4-Jul	114.5	119.1	**117.7**	119.8	**116.5**	
5-Jul	114.3	117.9	**116.5**	118.7	114.0	
6-Jul	**116.3**	117.2	**116.7**	119.0	115.5	
7-Jul	**116.3**	117.1	**117.4**	118.8	115.4	
8-Jul	114.9	114.6	114.1	118.7	114.6	
9-Jul	**115.8**	115.1	114.8	115.6	113.4	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
10-Jul	**115.8**	115.9	115.5	116.2	113.7	
11-Jul	115.5	115.8	114.0	115.5	112.1	
12-Jul	112.6	113.8	112.6	114.3	111.1	
13-Jul	112.3	113.0	111.5	114.1	110.9	
14-Jul	112.4	113.3	113.4	115.2	111.3	
15-Jul	112.4	113.3	113.3	115.2	111.5	
16-Jul	112.4	113.9	113.3	115.3	111.1	
17-Jul	112.4	113.9	113.4	115.3	111.4	
18-Jul	113.0	113.0	112.2	113.7	111.8	
19-Jul	113.8	113.7	113.1	114.5	112.0	
20-Jul	113.6	114.1	113.3	114.6	112.5	
21-Jul	112.9	114.2	112.5	114.6	111.6	
22-Jul	111.6	112.9	111.3	113.4	110.5	
23-Jul	112.2	114.2	112.6	113.5	110.4	
24-Jul	112.1	114.3	112.9	115.3	110.8	
25-Jul	113.4	114.4	112.8	114.8	110.8	
26-Jul	113.1	113.5	112.6	114.7	110.3	
27-Jul	112.4	113.1	111.1	113.9	109.9	
28-Jul	111.3	113.0	110.9	113.5	108.9	
29-Jul	113.3	113.4	111.6	113.6	108.2	
30-Jul	113.2	116.6	112.8	114.6	108.1	
31-Jul	113.4	116.5	115.1	116.7	108.8	
1-Aug	113.3	115.1	114.3	115.7	108.5	
2-Aug	112.2	113.8	111.7	114.2	106.2	
3-Aug	111.7	112.3	111.7	113.8	107.8	
4-Aug	113.8	113.3	112.9	115.3	109.1	
5-Aug	114.5	115.0	113.5	115.7	110.7	
6-Aug	114.4	114.9	113.7	115.8	111.0	
7-Aug	113.2	n/d	113.7	115.8	110.4	
8-Aug	113.0	n/d	112.3	114.6	109.1	
9-Aug	114.7	n/d	113.8	115.8	108.9	
10-Aug	114.6	n/d	113.5	115.4	108.6	
11-Aug	112.5	n/d	112.0	114.2	108.8	
12-Aug	112.4	n/d	112.3	114.3	108.4	
13-Aug	111.6	n/d	112.2	114.5	109.5	

Date	WANF	WANT	PRDF	PRDT	Pasco	Comments/Corrective Action Taken
14-Aug	112.9	113.1	111.9	114.4	109.2	
15-Aug	110.6	118.9	113.3	113.6	108.9	
16-Aug	110.4	115.1	114.4	115.5	107.9	
17-Aug	110.1	112.6	111.8	114.5	109.3	
18-Aug	109.2	113.0	110.2	113.4	108.9	
19-Aug	108.8	112.2	109.1	112.8	108.8	
20-Aug	109.2	112.6	109.5	112.8	108.4	
21-Aug	109.3	111.3	109.9	113.2	108.0	
22-Aug	109.3	110.6	109.8	113.6	109.1	
23-Aug	108.7	107.7	108.3	112.7	108.0	
24-Aug	106.3	106.8	105.5	107.6	106.8	
25-Aug	106.9	105.8	104.3	107.1	105.1	
26-Aug	105.2	105.2	104.7	107.5	104.0	
27-Aug	106.1	105.7	104.8	107.4	105.7	
28-Aug	106.1	105.7	104.6	107.8	105.6	
29-Aug	105.9	105.5	104.5	106.9	105.3	
30-Aug	105.1	105.0	104.6	107.5	104.8	
31-Aug	106.1	105.1	104.8	108.1	105.8	

Notes:

1. WAND = Wanapum Dam; WANF = Wanapum forebay; WANT = Wanapum tailrace; PRD = Priest Rapids Dam; 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.
2. Orange highlighted values represent values that are above current water quality standards.
3. Both Wanapum and Priest Rapids dams are, in general, limited to 85% powerhouse capacity due to regional and federal constrains, which were described in Section 3.5.3 and 4.1 of the report.