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Cc:	Sokolowski, Rosana; Bitterman, Deborah
Subject:	Final 2013 Gas Abatement Annual Report
Date:	Tuesday, December 24, 2013 10:21:52 AM
Attachments:	FINAL Gas Abatement Annual Rprt 2013.pdf

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY

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To: Pat Irle, Washington Department of Ecology

Chris Coffin, Washington Department of Ecology

Charlie McKinney, Washington Department of Ecology

From: Waikele Frantz, Environmental Permit Coordinator

Public Utility District No. 1 of Chelan County

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943

Final 2013 Gas Abatement Report

Please find attached the Final 2013 Gas Abatement Annual Report for Rocky Reach and Rock Island hydroelectric projects.

If you have any questions, please do not hesitate to contact me.

Happy holidays!

Thank you,

Waikele Frantz

509-661-4627

ROCKY REACH and ROCK ISLAND
HYDROELECTRIC PROJECTS
FERC No. 2145 AND 943

2013

GAS ABATEMENT ANNUAL REPORT

Prepared by:

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Public Utility District No. 1 of Chelan County
Wenatchee, WA 98801

December 2013

FINAL

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Annual Report is being submitted to the Washington State Department of Ecology (Ecology) as required by the 401 Water Quality Certification (401 Certification) for the Rocky Reach Hydroelectric Project (Project) and the Gas Abatement Plans (GAPs) for Rocky Reach and Rock Island hydroelectric projects that were approved by Ecology in April 2013.

Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual report to summarize the results of the operations and activities detailed in the 2013 GAPs. The intent of these actions was to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rocky Reach and Rock Island Habitat Conservation Plans (HCPs). Operations and activities detailed in the 2013 GAPs and reported on in this document include:

- Operations (spill configurations and fish spill plan)
- Fisheries Management (HCP)
- Biological Monitoring
- Involvement in water quality forums
- Physical Monitoring
- Gas abatement methods (operational and structural)

Mean daily flow discharges during the 2013 fish spill season were higher than the 2003-2012 average (about 113.1% of average at Rocky Reach, and 116.8% of average at Rock Island) over the entire fish spill season. Due to these above average flows, some involuntary spill occurred at both projects beginning in April and continued through July at both projects.

During the 2013 fish spill season, Chelan PUD implemented spill programs as guided by the Rocky Reach and Rock Island HCPs. At Rocky Reach, the Juvenile Fish Bypass (JFB) was operated exclusively with no spill for fish during the spring migration (April 1 – June 4). Approximately 10.3% of the daily average flow was spilled involuntarily during this time due to above average river flows. During the summer migration (June 5 – August 21), approximately 8.9% of the daily average flow was spilled voluntarily for fish, as required by the HCP. An additional 2.8% was spilled involuntarily during this same time due to above average river flows. To meet HCP fish passage requirements at Rock Island, 10% of the daily average flow was spilled voluntarily for fish during the spring migration (April 17 – June 4), while 20% of the daily

average flow was spilled voluntarily for during the summer migration (June 5 – August 18). An additional 2.5% was involuntarily spilled during the spring migration, due to above average river flows.

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria of 115% on 12 days. TDG exceeded the modified Washington State water quality TDG criteria on 8 days in the Rocky Reach tailrace (120%), 14 days in the Rock Island forebay (115%), and 3 days in Rock Island tailrace (120%) during this monitoring period. Numeric criteria were exceeded on 19 days in the Wanapum forebay (115%). These exceedances of the water quality criteria did not necessarily result in noncompliance, as many of the forebay exceedances occurred when the upstream dam's forebay exceeded 115%. After eliminating exceedances that occurred when the upstream forebay exceeded 115%, Project compliance with the modified water quality TDG criteria was as follows:

Compliance Monitoring Location	Percent Compliant
Rocky Reach Tailrace (125%)	100%
Rocky Reach Tailrace (120%)	94.8%
Rock Island Forebay (115%)	98.6%
Rock Island Tailrace (125%)	100%
Rock Island Tailrace (120%)	98%
Wanapum Forebay (115%)	93.4%

SECTION 1: . INTRODUCTION

1.1 Project Description

The Columbia River watershed lies east of the Cascade Mountains and west of the Rocky Mountains and encompasses parts of British Columbia, Idaho, Montana, Nevada, Oregon and Washington. Rocky Reach and Rock Island projects are located in mid-Washington State on the mainstem of the Columbia River (Figure 1). The study area involved 59 river miles (RM), from the forebay of Rocky Reach Project (RM 474) downstream to the forebay of Wanapum Project (RM 415). This included the 21 RM between Rocky Reach and Rock Island dams and 38 RM between Rock Island and Wanapum dams.

1.1.1 Rocky Reach

The powerhouse at Rocky Reach Project contains a total of 11 vertical axis-generating units and is situated on the west half of the river parallel to the flow (Figure 2). The spillway at Rocky Reach houses 12 individually opening 170-ton tainter gates arranged on the east half of the river, perpendicular to the river flow. The normal maximum reservoir water surface elevation is 707 ft. with an average tailrace water surface elevation of 618 ft., providing a gross head of 89 ft. The depth of the stilling basin immediately downstream of the project is approximately 40 ft. at average tailwater elevation.

In 2003, Chelan PUD began operation of the Juvenile Fish Bypass (JFB), which continues to be the primary juvenile fish survival tool at Rocky Reach Project. Testing completed during the first year of operation assisted Chelan PUD in determining the guidance efficiency of the JFB and estimate the level of spill necessary to meet the Rocky Reach Habitat Conservation Plan (RRHCP) survival standards. Voluntary spill is used at Rocky Reach to supplement the effectiveness of the JFB, when needed, to reach survival goals of the RRHCP (See Section 2.3 for details). Due to the success of the JFB, Chelan PUD has reduced spill levels used to supplement the JBS for juvenile salmonid passage since 2007. During the migration season for yearling Chinook and steelhead (generally mid-April to early-June), Chelan PUD has not needed to use spill to supplement the JFB. During the subyearling Chinook migration (generally mid-June to mid/late August) a spill level of 9 percent of daily flow (reduced from 15 percent) has been provided.

The 2013 fish spill program at Rocky Reach was managed to maximize fish passage, meet HCP requirements, minimize voluntary spill, and still stay within the terms of the State TDG fish spill water quality criteria. Voluntary spill levels were managed in real time as detailed in the TDG Operational Plan

(Appendix A) for the Rocky Reach Project. When Project operators observed instantaneous TDG levels that exceeded the criteria as set forth in the Plan, spill was reduced to the extent possible and TDG levels monitored.

Figure 1: Location of Rocky Reach and Rock Island Hydroelectric Projects on the Columbia River.

Figure 2: Location of forebay and tailrace fixed monitoring stations at Rocky Reach Project.

1.1.2 Rock Island

Rock Island Project consists of two separate powerhouses connected by a spillway. There are a total of 18 generating units; ten vertical axis Kaplan and Nagler turbines in the first powerhouse on the east shore, and eight horizontal axis bulb turbine generators in the second powerhouse on the west side of the river (Figure 3). The spillway is 1,184 ft. long and houses 31 spillgates divided by a center adult fishway. The east spillway contains a total of 14 gates, arranged perpendicularly to the river flow. The west spillway has 17 gates, situated at a slight angle to the river flow. Spillways are either 33 or 55 feet deep and have two or three spillgates stacked in the gate slot. Lifting one or more of these crest gates regulates spill volume. Each gate is 30 feet wide by 11 or 22 feet high. A total of nine gates have been modified or constructed to provide relatively low volume (1,850 or 2,500 cubic feet per second (cfs)) surface spill for fish bypass. The normal maximum reservoir elevation of Rock Island Project is 613 ft. with a tailrace elevation of 572 ft. and a head of 41 ft. Tailrace bathymetry below Rock Island is complex and ranges in elevation from approximately 580 ft. below bays 21-23 to approximately 520 ft. below Bay 1.

Chelan PUD has installed the following three TDG abatement structures at Rock Island:

1. Notched gates
   Gates 1, 16, 18, 24, 26, and 29 are equipped with notched gates that reduce TDG by reducing the volume of water necessary for voluntary fish passage.

2. Spill deflector in Bay 16
   The main objective for the design of this deflector was to reduce the uptake of TDG per total volume of water and to safely pass downstream migrants during the fish spill season. Studies conducted on the deflector have shown that it can reduce TDG by 2.7%.

3. Three Over/under gates
   The over/under gates are unique in that they pass water using the gate well as a water column. Water is released through a 6” gap at the bottom of the downstream gate slot below the surface of the tail water thus reducing total dissolved gas (TDG) when compared to water plunging through open spill gates. The gates are typically installed when fish spill begins in April and kept in place for the duration of the season. When in use the gates are installed at the south end of the spillway in slots 30, 31, and 32.

   Testing of the first gate installed indicated a reduction in TDG uptake by 8.5 - 13.5% points, as compared to the existing notched gate method, and by additional 2.5 - 4.5 % points as compared to deflectors. Fish passage survival tests performed indicated that overall survival was between 99% and 100%. Because the original Over/Under gate was successful at reducing TDG and maintaining fish survival, Chelan PUD made the decision to have three (gates 30, 31, 32) in place prior to the initiation of the 2007 spill season and have been utilized since.

Figure 3: Location of forebay fixed monitoring station at Rock Island Project.

Figure 4: Location of tailrace fixed monitoring station below Rock Island Project.

Operating under a spill regime of 20% of the daily average river flow through 2006, the Rock Island HCP (RIHCP) survival standards for spring plan species have been met at Rock Island and Chelan PUD began testing powerhouse optimization in 2007. This testing has resulted in Chelan PUD reducing spring fish spill at Rock Island from 20% of the daily average flow to just 10% of the daily average flow. Summer fish spill at Rock Island remains at 20% of the daily average flow.

The fish spill program at Rock Island was managed to maximize fish passage, meet HCP requirements, minimize voluntary spill, and still stay within the terms of the State TDG fish spill water quality criteria. Voluntary spill levels were managed in real time as detailed in the TDG Operational Plan (Appendix A) for the project. When Project operators observed instantaneous TDG levels that exceeded the criteria as set forth in the Plan, spill was reduced to the extent possible and TDG levels monitored.

1.2 Fixed Monitoring Station (FMS) Locations

At all sampling locations discussed below, TDG measurements were recorded throughout the monitoring season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to reduce the likelihood of exceeding the TDG criteria. These 15-minute intervals were averaged into hourly readings for use in compiling daily and 12-hour averages. All hourly data were forwarded to Chelan PUD headquarters building and then onto the US Army Corps of Engineers Reservoir Control Center and posted at their site on the World Wide Web.

Forebay FMS were located at fixed sites on the upstream face of Rocky Reach and Rock Island projects (Figures 2 and 3, respectively). A dissolved gas probe (Minisonde) developed by Hydrolab, Inc. was lowered down a conduit secured to the upstream face of each project and submerged to a depth of approximately 15 ft.

Tailrace monitoring stations were located downstream of both projects. The Rocky Reach monitoring station was located approximately one third of a mile downstream of the spillway on the juvenile fish bypass outfall (Figure 2), as required by the 401 Water Quality Certification (Ecology, April 4, 2006). This location was chosen because it was the most feasible location near the end of the aerated zone, which is the compliance point for the Mid-Columbia TDG TMDL. There is not a bridge or other structure downriver of Rock Island Project to which a monitoring station can be attached. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the project on the eastern

shoreline (Figure 4). Representativeness of the site is summarized in the Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt Submittal Report (2004):

> The representativeness of TDG readings at the tailwater FMS can vary according to spillway and powerhouse operations. Since spill flows tend to hug the east bank, the river is not fully mixed at the tailwater FMS. Operation of the Second Powerhouse will tend to push higher TDG flows into the east bank. However, First Powerhouse flows can have the opposite effect, pushing higher TDG flows towards the middle of the channel so that FMS readings reflect forebay TDG levels carried by powerhouse flows.

Unfortunately, there is no other feasible location for probe deployment at this time.

Either a Hydrolab Minisonde or Datasonde4 was deployed at each tailrace station. The units were submerged approximately 15 ft. below the surface using a 3/8-inch weighted wire cable.

1.3 Regulatory Framework

1.3.1 Washington State Department of Ecology Water Quality Numeric Criteria

The Washington State water quality numeric criteria for TDG (WAC 173-201A-200(1)(f)) address standards for the surface waters of Washington State. Under the water quality standards (WQS), TDG shall not exceed 110 percent at any point of measurement in any state water body. However, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. This plan must be accompanied by fisheries management and physical and biological monitoring plans. The elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. The following special fish passage exemptions for the Snake and Columbia rivers apply when spilling water at dams is necessary to aid fish passage:

- TDG must not exceed an average of one hundred fifteen percent as measured in the forebays of the next downstream dams and must not exceed an average of one hundred twenty percent as measured in the tailraces of each dam (these averages are measured as an average of the twelve highest consecutive hourly readings in any one day, relative to atmospheric pressure); and
- A maximum TDG one hour average of one hundred twenty-five percent must not be exceeded during spillage for fish passage.

Chelan PUD submitted the required Gas Abatement Plan for each Rocky Reach and Rock Island to Ecology in March 2013 and received approval for both plans in April 2013.

The amount of control that Chelan PUD has over TDG super saturation in the Columbia River is limited to control of spill at the Rocky Reach and Rock Island projects. In high flow years, river flows regularly exceed the hydroelectric capacity of projects located on the main stem Columbia, forcing large volumes of water to be spilled throughout the basin. Meekin and Allen (1974) noted that supersaturated waters do not completely equilibrate in transit through the downstream reservoirs. In many years, TDG levels arriving at the Rocky Reach forebay exceed the 110% TDG criteria and even the 115% fish passage exemption due to spill at upstream projects. When TDG levels arrive at the Rocky Reach forebay exceeding the 115% forebay criterion, the Chelan PUD projects may not be able to meet the TDG criteria for the tailrace or the forebay of the next project.

1.3.2 Daily TDG Compliance Value Calculation

Chelan PUD calculated TDG levels for compliance with the numeric criteria as per an April 2, 2008 memo from Chris Maynard (former Hydropower Coordinator with Ecology), which reads:

> "Beginning during the 2008 spill season, the operators should use the following method to average and report the 12 consecutive hourly highest (12-C high) TDG reading in a day:
>
> > Method: Use a rolling average to measure 12 consecutive hours. The highest 12 hour average in 24 hours is reported on the calendar day (ending at midnight) of the final measurement.
> >
> > - The first averaging period of each calendar day begins with the first hourly measurement at 0100 hrs. This hour is averaged with the previous day's last hourly measurements.
> > - Each subsequent hourly measure is averaged with the previous 11 hours until there are 24 averages for the day.
> > - From the 24 hour averages, the highest average is reported for the calendar day.
> > - Round the 12 hour average to nearest whole number."

Using this rolling average method that begins at 0100 hrs 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 criterion exceedance may be indicated on two separate days ("double counting") based on the same group of hours. Consider a spill event beginning at 1300 hrs on a Tuesday and continuing through 0100 hrs on Wednesday. Suppose TDG values during those hours of spill were 125% and 100% for all remaining hours. Under this situation, 12-C High values would be 125% for both days despite daily averages equaling 112% and 101%, respectively. In other words, Wednesday would be deemed to be an exceedance despite having only one hour above the standard (since the 0100 hrs moving average includes the 11 previous hours of high spill occurring on Tuesday).

Because there was no established methodology prior to the 2013 monitoring season to address this issue, Chelan PUD coupled the above rolling average methodology with the following to eliminate "double counting":

1. Calculate a moving average for each hour, including that hour and the previous eleven consecutive hours (which may or may not include the previous calendar day), resulting in a 12-hour moving average, with trailing values, associated with each daily hour.
2. Review the data to determine if there is an exceedance (12-C High > 120%).
3. When it appears an exceedance is a result of the influence of high hourly TDG levels from the previous day, filter the data set to exclude the first twelve 12-hr rolling averages of that day when an exceedance was noted.
4. Tabulate the resulting data set to reflect the maximum value observed on each specific calendar date. In other words, the greatest moving average value (including the previous eleven hours) observed through the last twelve hours of each day should be reported.
5. Count the total number of resulting values that exceed 120%. This should be reported as a number of days and as a proportion of total days observed (e.g., X days above 120% ÷ total number of days measured = XX.X % days of exceedance).

Use of the above methodology allowed for the monitoring of consecutive hours while eliminating "double counting". In the abovementioned example, only one day, not two, would have been reported as an exceedance under this method.

Chelan PUD understands and appreciates the need for consistency throughout the basin in regards to compliance monitoring and reporting and will modify or replace the methodology described above at such time as Ecology provides an approved method.

SECTION 2: OPERATIONS

2.1 Description of 2013 Fish Spill Season Flow Characteristics

Mean daily discharge during the 2013 fish spill season was compared to the 10-year average of mean daily flows from 2003-2012, as measured at the Rocky Reach Hydroelectric Project (Figure 5) and the Rock Island Hydroelectric Project (Figure 6). Mean daily flow discharges during the 2013 fish spill season were higher than the 2003-2012 average (about 113.1% of average at Rocky Reach, and 116.8% of average at Rock Island) over the entire fish spill season. Flow for all months during the spill season, with the exception of June, was higher than the monthly 10-year average at both projects. The maximum hourly flows observed at Rocky Reach and Rock Island during the spill season were 230 kcfs and 229 kcfs, respectively, on June 30. Of the 153 days during the spill season (April 1 – August 31), there were no instances where the daily average flows exceeded the 7Q10 value at Rocky Reach or Rock Island.

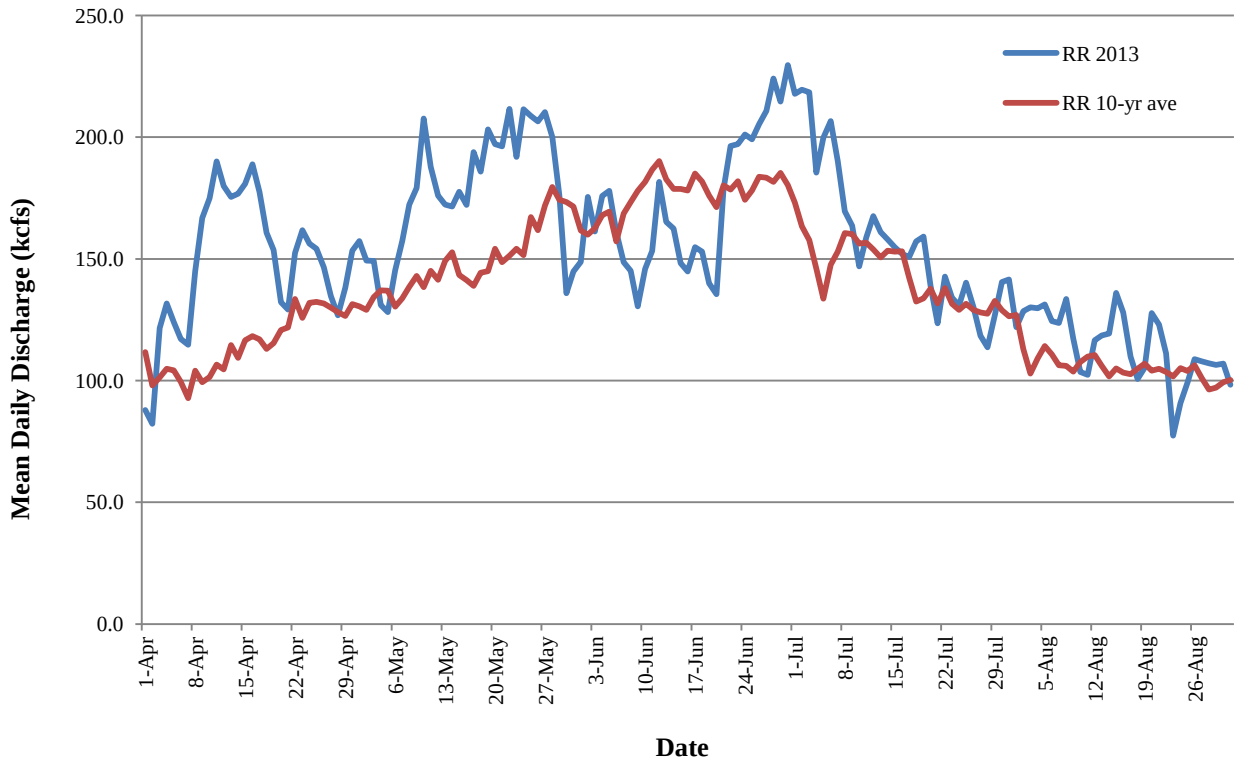

Figure 5: Comparison of 2013 vs previous 10-year average (2003-2012) of mean daily discharge at Rocky Reach.

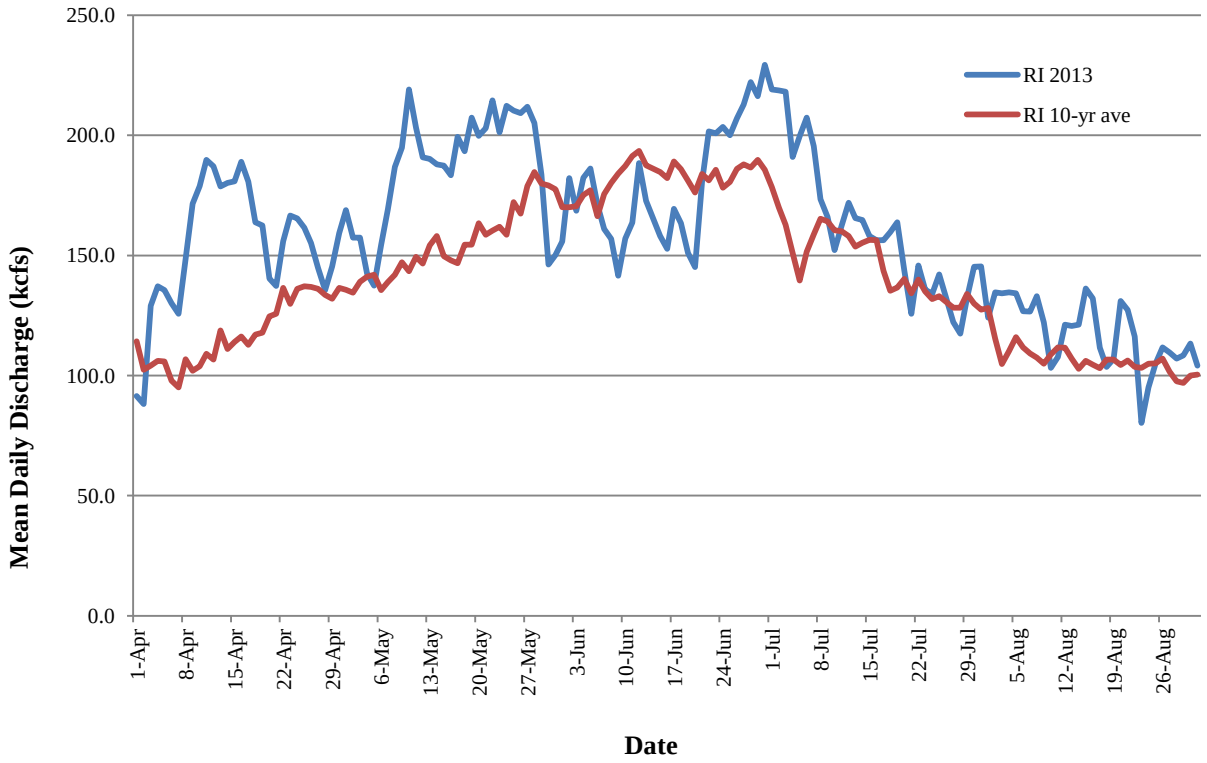

Figure 6: Comparison of 2013 vs previous 10-year average (2003-2012) of mean daily discharge at Rock Island.

2.2 Spill Configurations

The spill levels for fish passage set forth below are subject to real-time modification to meet TDG standards, in accordance with a real-time operational plan. The Project operators are instructed to monitor the tailrace TDG level and reduce spill if TDG levels specified in the TDG Operational Plan (Appendix A) are exceeded. The operators at the Rock Island Hydroelectric Project are also instructed to inform the operators at Rocky Reach when the Rock Island forebay TDG level exceeds 115%. Since implementation of this plan, TDG exceedances in the tailrace of each project have been reduced.

2.2.1 Rocky Reach

The standard spill configuration used at Rocky Reach uses gates 2-8 with a minimum discharge per spill bay of about 4 kcfs. The standard spill configuration was designed to create a crown-shaped pattern of turbulent flow below the spillway with decreasing velocities leading toward the fishway entrances.

This spill pattern provides favorable guidance conditions for adult migrant salmon and steelhead. The same pattern is used for juvenile fish passage spill. During spill operations, whether for juvenile fish passage, TDG management, or for other purposes, the gates are operated via a computer automated

system that follows the spill pattern. Gates 9-12 are used only in high flow conditions when gates 2-8 cannot pass enough water. The standard spill pattern was deviated from only when needed during high flow and spill events.

2.2.2 Rock Island

The standard spill pattern for fish spill at Rock Island first utilizes the three Over/Under gates (31, 32, 30), then with increased spill, followed by the notched gates (1, 26, 16, 18, 24, 29), and finally the full gates (20, 17, 19, 22, 25 and 21).

The standard spill pattern was deviated from in 2013 at Rock Island in an attempt to maintain TDG compliance during high flow and spill events. This deviation included the closing of notched gates and the addition of gates 6 and 27.

2.3 Fish Spill Program

As part of the HCPs for the Rocky Reach and Rock Island hydroelectric projects, Chelan PUD is required to meet survival standards for fish migrating through the projects. Juvenile dam passage survival is a key component of project survival. Chelan PUD uses a different combination of tools to facilitate fish passage at the Rocky Reach and Rock Island Projects because of each project's unique features. At Rocky Reach, passage is facilitated by the juvenile fish bypass (JFB), which is the primary method to increase juvenile dam passage survival. The efficiency of the JFB has allowed for a reduction in the amount and duration of spill at certain phases of the migration season, thereby reducing TDG levels. At Rock Island, spill is still the preferred method of moving fish past the project, with most of the spill being passed through the modified "notched" spill gates. Results of survival studies conducted at Rock Island have enabled Chelan PUD to reduce voluntary (fish) spill in the spring from 20% of the daily average flow to 10% of the daily average flow. Summer spill at Rock Island remains at 20% of the daily average flow.

The spill regimes implemented by Chelan PUD at each project are dictated by the timing of each species of fish migration. In the spring (generally mid-April to early- June), yearling Chinook, steelhead and sockeye migrate past the projects, while subyearling Chinook migrate during the summer (generally mid-June to mid/late-August).

2.3.1 Fish Spill Quantities and Duration

Spill scenarios can be divided into two categories: fish spill (voluntary) and non-fish spill (involuntary). Non-fish/involuntary spill scenarios include, but are not limited to:

- Flow in excess of hydraulic capacity
- Plant load rejection spill
- Immediate replacement spill
- Maintenance spill
- Error in communication spill
- Spill past unloaded units

Definitions of these spills can be found in the 2013 Rocky Reach and Rock Island Gas Abatement Plans.

In 2013, spill events at Rocky Reach were involuntary April 1 – June 4 (spring), and both voluntary and involuntary June 5 – August 21 (end of summer fish spill). Of the total volume of water spilled April 1 – June 4, 100% was involuntary. Between June 5 and the end of summer fish spill on August 21, 76% of the total volume spilled was voluntary, while 24% was involuntary.

Spill events at Rock Island were involuntary April 1 – April 16, voluntary and involuntary April 17 – June 4 (end of spring summer spill), and voluntary June 5 - August 18 (end of summer fish spill). Of the total volume of water spilled April 1 – April 16, 100% was involuntary. Of the total volume of water spilled April 17 – June 4, 64% was voluntary and 36% was involuntary. Between June 5 and August 18, 100% of the total volume of water spilled was voluntary.

Monthly average spills ranged from 7.5 to 21.38 thousand cubic feet per second (kcfs) (Table 1) at Rocky Reach, and from 13.85 to 33.86 kcfs at Rock Island (Table 2). Minimum and maximum daily average spills at Rocky Reach varied from 0 to 50.6 kcfs and from 0 to 52.3 kcfs at Rock Island.

Table 1: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach, April 1 - August 31, 2013.

			Spill Purpose					
			Fish Spill			Other		
	Average Flow Kcfs	Average Spill Kcfs	Spill Kcfs	% of flow	% of Total Spill	Spill Kcfs	% of flow	% of Total Spill
April	148.16	13.26	0	0.0	0.0	13.26	8.9	100.0
May	178.22	21.38	0	0.0	0.0	21.38	12.0	100.0
June	172.78	20.12	13.56	7.8	67.4	5.65	3.8	32.6
July	159.38	19.69	14.2	8.9	72.1	5.49	3.5	27.9
August	115.03	7.35	7.19	6.2	97.8	0.17	0.1	2.2

Table 2: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island, April 1 - August 31, 2013.

			Spill Purpose					
			Fish Spill			Other		
	Average Flow Kcfs	Average Spill Kcfs	Spill Kcfs	% of flow	% of Total Spill	Spill Kcfs	% of flow	% of Total Spill
April	153.39	17.62	7.38	4.80	41.9	10.24	6.7	58.1
May	186.06	23.85	18.60	10.0	78.0	5.25	2.8	22.0
June	178.80	33.86	33.30	18.6	98.3	0.56	0.3	1.7
July	161.92	32.73	32.72	20.2	100.0	0.01	0.0	0.0
August	117.69	13.85	13.84	11.8	100.0	0.01	0.0	0.0

The following sections describe in detail the voluntary fish spill quantities and durations at Rocky Reach and Rock Island.

2.3.1.1 **Rocky Reach**

During the spring of 2013, Chelan PUD operated the juvenile fish bypass system exclusively with no voluntary spill for yearling Chinook, steelhead, and sockeye passage. However, river flows required operation of the spillway during this time. Because these spill events were not required for fish passage, they are considered involuntary.

To meet RRHCP survival standards for subyearling (summer) Chinook, Chelan PUD had a target spill level of 9% of daily average river flow at Rocky Reach for a duration covering 95% of their outmigration during the summer of 2013. The summer spill program for subyearling Chinook began on June 5 and ended on August 21. Percent daily river flow spilled during the summer spill season amounted to 11.7%; however,

only 9% was spill for fish, while the remaining 2.7% was involuntary spill due to higher than average flows.

Table 3 below provides a summary of the Juvenile Fish Passage Operations at Rocky Reach in 2013.

Table 3: Summary of juvenile fish passage operations at Rocky Reach, April 1 - August 31, 2013.

Date	Juvenile Fish Passage Program	Quantity	Notes
1-Apr	Juvenile Fish Bypass (JFB) Operation Began		Operated exclusively with no fish spill during the spring (April 1 – June 4)
5-June	Summer Spill Initiated	9% of daily average river flow	Spill for sub-yearling (summer) Chinook
21-Aug	End of summer spill		
31-Aug	Juvenile Fish Bypass Operation Ended		

2.3.1.2 **Rock Island**

Spill through modified gates remains the primary fish passage measure used to meet RIHCP survival standards at Rock Island Project. Spring fish spill of 10% began on April 17 and was continued through June 4. Total spill during the spring fish spill season amounted to 12.5%; however, only 10% was spill for fish, while the remaining 2.5% was involuntary spill due to higher than average river flows.

Rock Island fish spill increased to 20% upon onset of the summer outmigration of subyearling Chinook. Summer spill commenced on June 5 and continued through August 18. Total spill during the summer fish spill season amounted to 20%; of which all but 0.1% was for fish.

Table 4 below provides a summary of the Juvenile Fish Passage Operations at Rock Island in 2013.

Table 4: Summary of juvenile fish passage operations at Rock Island, April 1 - August 31, 2013.

Date	Juvenile Fish Passage Program	Quantity
1-Apr	Fish Bypass Operation Began	
17-Apr	Spring Spill Initiated	10% daily average river flow
4-June	End of Spring Spill	
5-June	Start of Summer Spill	20% of daily average river flow
18-Aug	End of Summer Spill	
31-Aug	Fish Bypass Operation Ended	

SECTION 3: IMPLEMENTATION RESULTS

3.1 Fisheries Management

No survival studies on spring migrants (yearling Chinook, steelhead, sockeye) were conducted in 2013 as HCP survival standards have been achieved for all three species at both projects. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for summer/fall subyearling Chinook have been conducted since 2004.

3.2 Biological Monitoring (GBT)

Gas bubble trauma (GBT) monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach 401 Water Quality Certification requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. Chelan PUD is currently working with Ecology to determine if this study is necessary in light of work on resident GBT that has been accomplished by others since the writing of the 401 Cert.

As part of the Fish Passage Center's Smolt Monitoring Program at Rock Island, yearling and subyearling Chinook salmon and steelhead were examined for evidence of GBT between 15 April and 18 August 2013. Each week a random sample of up to 100 fish composed of both yearling Chinook salmon and steelhead were examined in April and May two days per week. In June, when the subyearling Chinook salmon collection exceeded the yearling Chinook collection, the sample was changed to subyearling Chinook. A random sample of up to 100 subyearling was examined two days per week. Examinations followed FPC standardized procedure as outlined by FPC (2004).

During 2013 monitoring, 2,413 smolts were examined for GBT. Of these, 8, or 0.33%, showed signs of GBT. Table 5 provides the summary results of 2012 GBT monitoring.

Table 5: Summary of Gas Bubble Trauma examinations at Rock Island in 2013.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		N	%	N	%	N	%
Chinook yearling	935	5	0.53%	5	0.53%	0	0.00%
Steelhead	454	2	0.44%	2	0.44%	0	0.00%
Chinook Sub-yearling	1024	1	0.10%	1	0.10%	0	0.00%
Total	2413	8	0.33%	8	0.33%	0	0.00%

3.3 Water Quality Forums

Chelan PUD has actively participated in regional water quality forums with Ecology, WDFW, NMFS, Tribal Agencies, the U.S. Fish and Wildlife Service, the USACE, and other Mid-Columbia PUDs. These meetings, ranging from Transboundary Gas Group to Columbia Basin meetings with USACE, allow for coordination for monitoring, measuring, and evaluating water quality in the Columbia Basin. Chelan PUD will continue its involvement in water quality meetings for further coordination with other regional water quality managers.

The Corps's year-end TDG Monitoring and Quality Assurance/Quality Control (QA/QC) meeting will be held on December 11 this year. Chelan PUD will be unable to attend, but will request meeting notes.

3.4 Physical Monitoring (TDG)

Chelan PUD conducted TDG monitoring at the four FMS discussed in Section 1.2 from April 1 through August 31, 2013. TDG levels from these four stations were obtained every fifteen minutes and the hourly averages of these readings were recorded in the head-quarters computer. The extensive nature of the hourly data makes presentation of the complete data set in this report impractical. Hourly data can be obtained upon request from Chelan PUD or can be accessed at the following internet site: http://www.nwd-wc.usace.army.mil/report/tdg.htm.

3.4.1 Data Evaluation and Analyses (QA/QC)

3.4.1.1 Data Completeness

A comparison was made to determine what percentage of all possible data (hourly readings at all FMS) was collected throughout the monitoring season (Table 6). Throughout the 2013 monitoring season (April 1 - August 31), 99.9% and 100% of all possible data were collected at the Rocky Reach forebay and tailrace FMS, respectively. At the Rock Island forebay FMS, 99.9% of all possible data was collected, while at the Rock Island tailrace FMS, 99.5% of all possible data was collected (Table 8).

Table 6: Overview of total dissolved gas data set during 2013 fish spill season

Location	Available data collection hours	Number of omitted/ lost hourly readings	Percent data completeness (%)
RRFB	3672	1	99.9%
RRTR	3672	0	100%
RIFB	3672	4	99.9%
RITR	3672	18	99.5%
Total	14,688	22	99.8%

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3.4.1.2 **Calibration and Maintenance**

Chelan PUD entered into a Professional Services Agreement with Columbia Basin Environmental to perform monthly calibrations and equipment maintenance. Quality Assurance/Quality Control measures were accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log was maintained for all work done on the monitoring equipment, including monthly maintenance, calibration, exchange of instruments, and any other pertinent information. Redundant measurements with a mobile instrument to verify the accuracy of the in-situ instruments were conducted during the monthly calibrations. Calibration reports are included as Appendix E.

3.4.2 **Fish Spill Season TDG Monitoring Results**

Hourly TDG data from Rocky Reach and Rock Island projects was averaged and the daily averages are presented in Appendix D. The summary values (mean, min, max) for all hourly TDG measurements taken from each FMS during the 2013 fish spill season are presented in Table 7 below.

Table 7: Average TDG levels (based on the 12-highest consecutive hours) in forebay and tailrace of Rocky Reach and Rock Island and forebay of Wanapum, April 1 – August 31, 2013.

Location	Mean	Minimum	Maximum
Rocky Reach Forebay	111	105	118
Rocky Reach Tailrace	115	104	122
Rock Island Forebay	111	104	117
Rock Island Tailrace	115	105	122
Wanapum Forebay	112	104	119

Figures 7 and 8 show the volume of spill and average of the 12 highest consecutive hourly readings from each 24-hr period during the fish spill season from each fixed monitoring station.

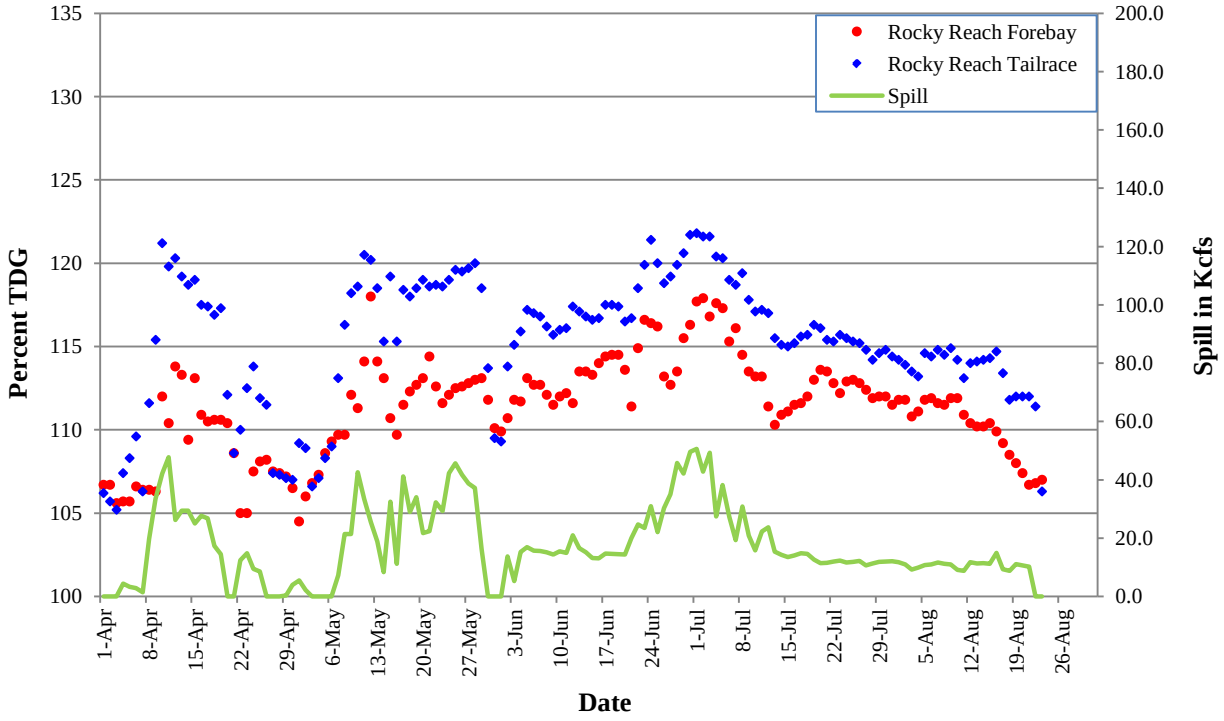

Figure 7: Spill and daily average TDG (basedon the 12 highest consecutive hours) in the forebay and tailrace of Rocky Reach Dam during the 2013 fish spill season.

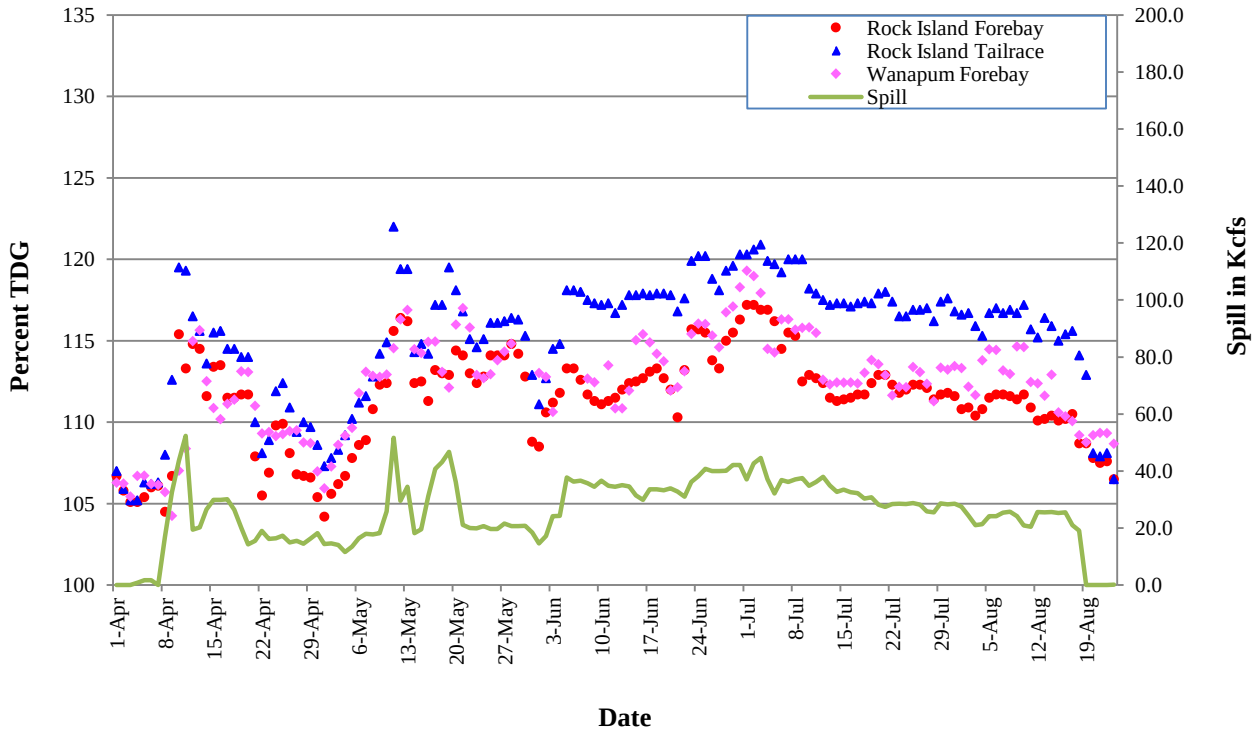

Figure 8: Spill and daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rock Island Dam and Wanapum forebay during the 2013 fish spill season.

Regression analysis was used to evaluate the relationship between the change in TDG levels from forebay to tailrace and the total volume spilled at both Rocky Reach and Rock Island projects. This analysis was not conducted for days of no spill (voluntary or involuntary). These results were examined to identify any correlation between project operations and spill related TDG fluctuations from the forebay to the tailrace.

3.4.2.1 **Rocky Reach**

The following TDG data represent the season as a whole, April 1 – August 31, regardless if there was spill (voluntary or involuntary) or not. The regression analysis includes only those days when spill occurred. **Data presented in the following are based on the daily average of the 12 highest consecutive hours.**

From April 1 to August 31, 2013, TDG levels in the Rocky Reach forebay averaged 111% and ranged from 105% to 118%. TDG levels in the tailrace averaged 115% and ranged from 104% to 122%. The average (based on the 12 highest consecutive hours) change in percent TDG from the forebay to the tailrace was an increase of 3.6%, ranging from a decrease of 1.0% to an increase of 9.4%. A summary of this data can be found in Tables 7 and 8.

Regression analysis showed a moderate relationship between the total volume spilled to percent change in TDG (r2=0.5481, Figure 9). Total volume of spilled to change in percent TDG for the season as a whole (April 1 – August 31) is also represented in Figure 10 below.

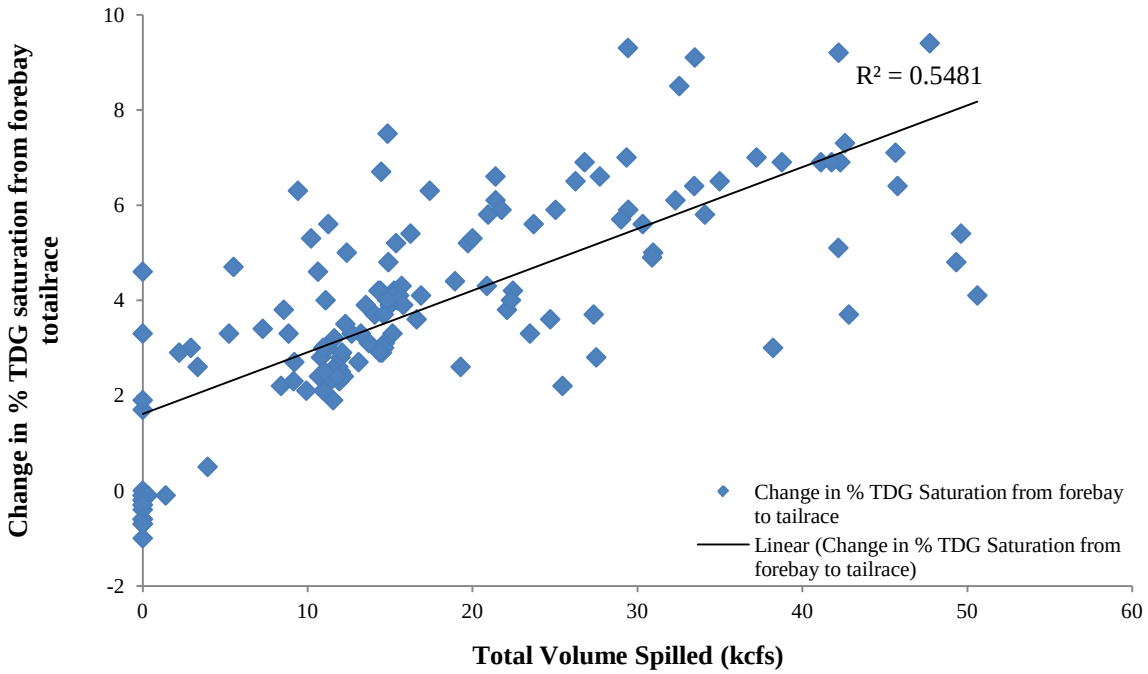

Figure 9: Total volume spilled to percent change in TDG from Rocky Reach forebay to Rocky Reach tailrace, April 1 – August 31, 2013.

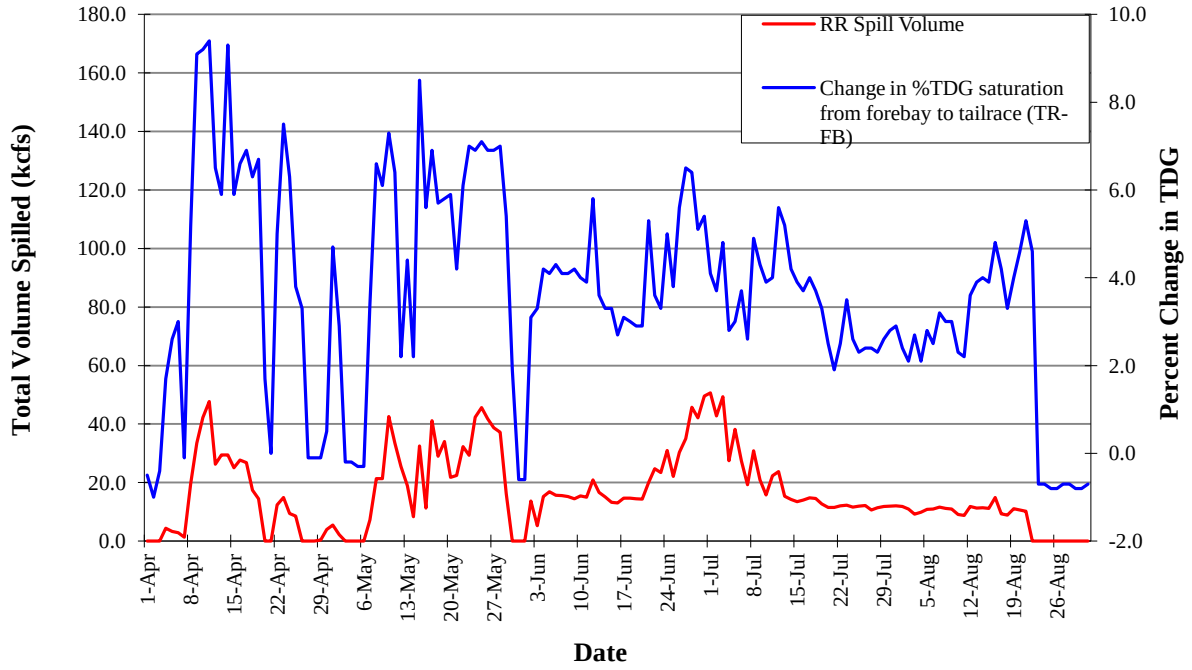

Figure 10: Total volume spilled to percent change in TDG from forebay to tailrace at Rocky Reach, April 1 – August 31, 2013.

3.4.2.2 **Rock Island**

The following TDG data represent the season as a whole, April 1 – August 31, regardless if there was spill (voluntary or involuntary) or not. The regression analysis includes only those days when spill occurred. Data presented in the following are based on the daily average of the 12 highest consecutive hours.

From April 1 to August 31, 2013, TDG levels in the Rock Island forebay averaged 111% and ranged from 104% to 117%. TDG levels in the tailrace averaged 115% and ranged from 105% to 122%. The average (based on the 12 highest consecutive hours) change in percent TDG from the forebay to the tailrace was an increase of 3.6%, ranging from zero change to an increase of 7.5%. A summary of this data can be found in Tables 7 and 8.

Regression analysis showed a moderate relationship between the total volume spilled to percent change in TDG (r2=0.4097, Figure 11). Total volume of spilled to change in percent TDG for the season as a whole (April 1 – August 31) is also represented in Figure 12 below.

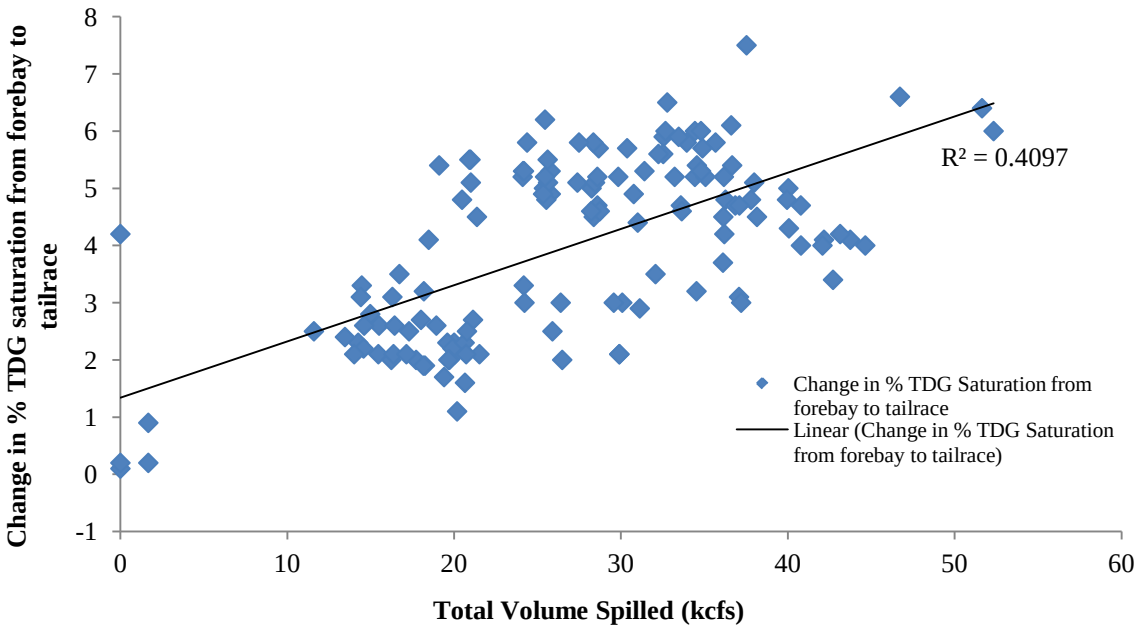

Figure 11: Total volume spilled to percent change in TDG from Rock Island forebay to Rock Island tailrace, April 1 – August 31, 2013.

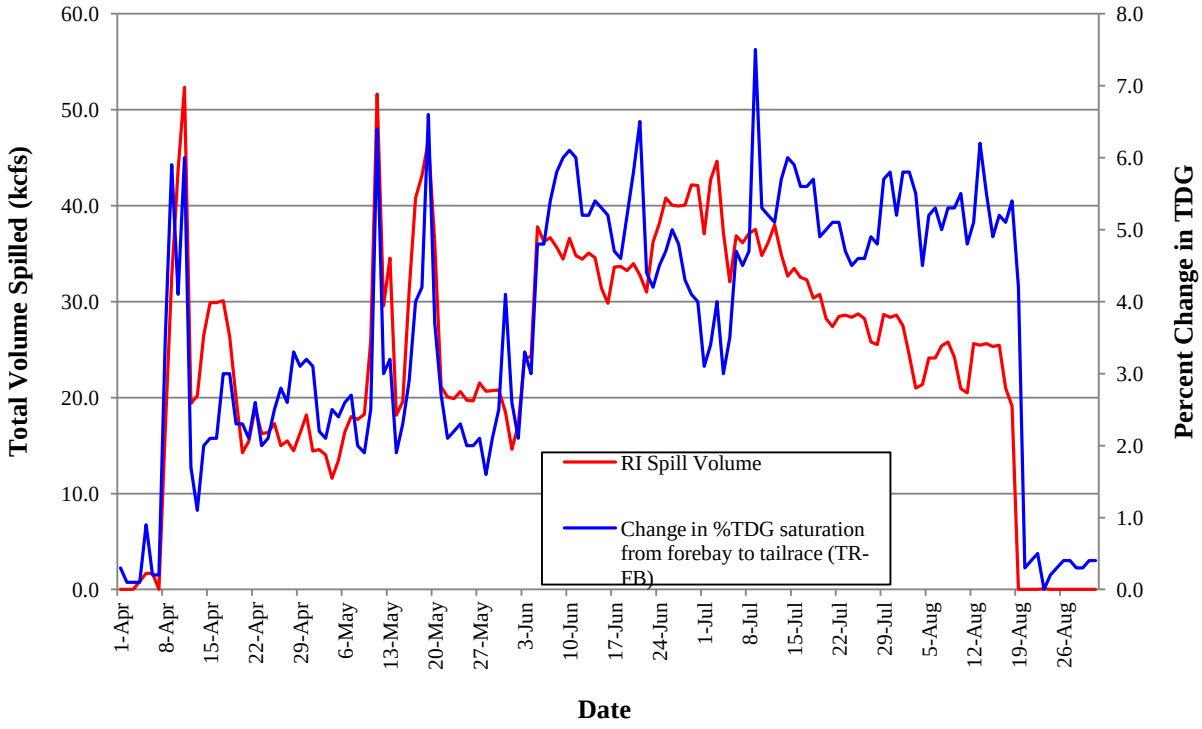

Figure 12: Total volume spilled to percent change in TDG from forebay to tailrace at Rock Island, April 1 – August 31, 2013.

Table 8 below provides a summary of total flow spilled, percent river flow spilled, and change in TDG from forebay to tailrace at Rocky Reach and Rock Island dams during the 2013 spill season.

Table 8: Rocky Reach and Rock Island projects: Average of total volume spilled (voluntary and involuntary), percent total river flow spilled, and change in percent TDG from forebay to tailrace, April 1 – August 31, 2013.

	Rocky Reach			Rock Island		
	Average Volume Spilled (Kcfs)	Percent Total River Flow Spilled	Change in Percent TDG	Average Volume Spilled (Kcfs)	Percent Total River Flow Spilled	Change in Percent TDG
April	13.4	7.6	4.0	17.7	10.6	2.2
May	21.4	10.9	4.6	23.8	12.7	2.8
June	20.1	11.2	4.0	33.8	19.1	4.8
July	19.6	11.8	3.4	32.6	20.6	4.9
August	7.3	6.7	2.2	13.8	12.7	3.3
Average*	16.35	9.6	3.6	24.3	15.1	3.6
(Range)	(0-50.61)	(0-25.4)	(-1-9.4)	(0-52.3)	(0-27.8)	(0-7.5)

*Averages and ranges shown here are of all daily 12-highest consecutive hours (for TDG) and all hours of the season (for volume and % spilled), not averages or ranges of the monthly averages.

3.4.2.3 **Wanapum Forebay**

From April 1 to August 31, 2013, TDG levels in the Wanapum forebay averaged 112% and ranged from 104% to 119%.

3.4.3 Discussion of Exceedances

At both Rocky Reach and Rock Island dams, there are three compliance criteria for the 2013 fish passage waiver that must be met in association with operation of the projects.: 1) average TDG in the tailrace cannot exceed 125% for one hour or 2) 120% for 12 continuous hours (12C-High), and 3) TDG in the next downstream forebay cannot exceed 115% 12C-High. These forebay and tailrace compliance criteria are waived when flows exceed the seven-day, 10-year frequency flood (7Q10) (252 kcfs at Rocky Reach and 264 kcfs at Rock Island). Additionally, the forebay criterion are also waived when the 12C-High exceeds 115% in the upstream dam's forebay.

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria on 12 days (7.8% of the total number of days observed). TDG exceeded the modified Washington State TDG fish spill water quality criteria on 8 days (5.2% of the total number of days observed) in the Rocky Reach tailrace, 14 days (9% of the total number of days observed) in the Rock Island forebay, and 3 days (2% of the total numbers of days observed) in the Rock

Island tailrace during this monitoring period. Numeric criteria were exceeded on 19 days (12.4% of the total number of days observed) in the Wanapum forebay (Grant County PUD). These exceedances of the water quality criteria did not necessarily result in noncompliance, as many of the forebay exceedances occurred when the upstream dam's forebay exceeded 115%.

When the upstream dam's forebay TDG exceeded 115%, TDG values for that 24-hour period were omitted from the data set used for determination of compliance.

Noncompliance at each FMS is further detailed in the following sections and Table 9.

3.4.3.1 **Rocky Reach**

Tailrace 125% Standard

Total hours of TDG data collected during the 2013 fish spill season in the Rocky Reach tailrace equaled 3,672. No hours were eliminated from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125% for 0 hours. Compliance with this standard was 100%.

Tailrace 120% Standard

TDG data was collected on 153 days during the 2013 fish spill season in the Rocky Reach tailrace. None of the data was omitted from the data set due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120% on 8 days. Compliance with this standard was 94.8%.

Downstream (Rock Island) Forebay 115% Standard

TDG data was collected on 153 days during the 2013 fish spill season in the Rock Island forebay. However, of those 153 days 12 were omitted from the data set used for determination of compliance due to upstream forebay 12C-High TDG exceeding 115%. Of the remaining 141 days when the upstream forebay 12C-High TDG was below 115%, the Rock Island forebay 12C-High TDG exceeded 115% on 2 days. Compliance with this standard was 98.6%

3.4.3.2 **Rock Island**

Tailrace 125% Standard

Total hours of TDG data collected during the 2013 fish spill season in the Rock Island tailrace equaled 3,654. No hours were omitted from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125% for 0 hours. Compliance with this standard was 100%.

Tailrace 120% Standard

TDG data was collected on 153 days during the 2013 fish spill season in the Rock Island tailrace. No days were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120% on 3 days. Compliance with this standard was 98%.

Downstream (Wanapum) Forebay 115% Standard

TDG data was collected on 148 days during the 2013 fish spill season in the Wanapum forebay. However, of those 148 days 10 were omitted from the data set used for determination of compliance due upstream forebay 12C-High TDG exceeding 115%. Of the remaining 138 days when flows were below the 7Q10 flow and the upstream forebay 12C-High TDG was below 115%, the Wanapum forebay 12C-High TDG exceeded 115% on 9 days. Compliance with this standard was 93.4%.

Table 9: Number of 2013 fish spill season TDG noncompliance* exceedances, Rocky Reach tailrace, Rock Island forebay and tailrace, and Wanapum forebay

Location	Number of Exceedances (based on 12C-High Criteria)**	Total # of Days Sampled***	% Days > Standard	Number of 1-hr Maximum (>125%)	Total # of Hours Sampled	% Hours >125% standard
RRTR	8	153	5.2	0	3672	0
RIFB	2	153	1.3			
RITR	3	153	2.0	0	3654	0
WANFB	9	148	6.1			
Total	21	760	2.3	0	7326	0

*A noncompliance exceedance is one that occurred while flows were below 7Q10 (applies to forebay and tailrace compliance) and the upstream forebay was <115% (applies to next downstream forebay).
**>115% in forebay (FB) and >120% in tailrace (TR)
*** Total days in sample, does not take into account those days that were eliminated due to upstream forebay 12C-High TDG >115%.

3.4.4 Non-Fish Spill TDG Monitoring Results

As per WAC 173-201A-200(1)(f), total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection (during the non-fish spill season).

Between January 1 and March 31, 2013, the 110% criterion was exceeded 7 hours in the Rocky Reach tailrace and no hours at the remaining sites. Overall compliance January 1 – March 31 was 99.9%.

Between September 1 and December 1, 2013, the 110% criterion was exceeded on four hours in the Rocky Reach tailrace and on no hours at any of the other FMS. The Rocky Reach tailrace FMS experienced a loss of 707 hours of TDG data during this time due to a failed instrument. Spill at Rocky Reach occurred during 33 of those hours, of which 18 had spill of less than 20 kcfs.

3.4.5 Corrective Actions

Actions taken to maintain/regain compliance with the TDG standards included:

- Implementation of the TDG Operational Plan.
- Chelan PUD adjusted spill, as possible, at both projects; and adjusted gate configurations at Rock Island to reduce TDG, when possible. These actions were consistent with the Operational Plans for TDG.
- Attempted to maximize turbine flows by setting minimum generation requirements, which included establishing a common methodology for setting minimum generation requirements specific to Rocky Reach and Rock Island dams 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 2012, 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.
- Participation in regional spill/project operation meeting in the spring. 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.
- 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 Chelan PUD's projects (and in some cases it may have increased TDG within Chelan PUD's Project if spill was shifted to Rocky Reach or Rock Island dam 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.

- Utilizing two of Rock Island's spill gates that discharge below the tailwater surface. Water passed by this method is classified as spilled energy. In certain conditions, this capability offers a better alternative than traditional spill placement for the management of system TDG. Prior to using this spill alternative, energy accounting system calculations needed to be changed to properly allocate energy spilled at Rock Island to those of the Mid-C collective that were responsible for spilling the energy.
- Preemptive spill can be used to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. 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 could be 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.

SECTION 4: TOTAL DISSOLVED GAS ABATEMENT MEASURES IMPLEMENTED IN 2013

4.1 Operational

Due to the success of the juvenile fish bypass system at Rocky Reach and survival studies at both projects, Chelan PUD has been able to reduce spill at both Rocky Reach and Rock Island for at least a portion of the spill season, thereby reducing the generation of total dissolved gas in the project waters.

4.1.1 Rocky Reach

Results of survival studies have allowed Chelan PUD to greatly reduce spill for fish at Rocky Reach Dam. The JFB is now operated exclusively, with no spill, for spring migrants; and spill during the summer migration has been reduced to 9% of the daily average flow. Spill levels from 2003 to 2013 are shown in Table 10 below. The JBS continues to be the most efficient non-turbine route for fish passage at the Rocky Reach Project and does not require spill for its operation.

The goal of the Rocky Reach Total Dissolved Gas Abatement Plan (GAP) approved by Ecology in April of 2013 is to implement measures to achieve compliance with the Washington state water quality standards for TDG in the Columbia River at the Project while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Fish Management Plan. To meet this goal, Chelan PUD implemented the following operational measures:

1. Minimized voluntary spill – no fish (voluntary) spill planned for the spring migration, 9% of the daily average river flow for the summer migration.
2. During fish passage, managed voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimized spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoided spill, to the extent practicable, by continuing to participate in the Hourly Coordination Agreement, to the extent it reduces TDG.
5. Maximized powerhouse discharge as appropriate up to 212 kcfs.
6. Continued the analysis of the three alternate spillway configurations that were tested in 2011 and 2012 to determine if any would be efficient at minimizing TDG. The report has been sent to Ecology for review and will be discussed in the March 1 Water Quality Annual Report.

Table 10: Rocky Reach fish spill comparison, 2003-2013.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	*Spill Level
2003	Spring	20-Apr	29-May	40	15% / 25%
2003	Summer	30-May	14-Aug	77	15%
Total				**117**	
2004	Spring	6-May	6-Jun	31.5	0% / 24%
2004	Summer	7-Jun	21-Aug	70	9%
Total				**101.5**	
2005	Spring	10-May	9-Jun	18.5	0% / 24% **
2005	Summer	10-Jun	15-Aug	67	9%
Total				**85.5**	
2006	Spring	2-May	1-Jun	19.0	0% / 24% **
2006	Summer	2-Jun	11-Aug	71	9%
Total				**90**	
2007	Spring	No Spill	No Spill	0	0%
2007	Summer	2-Jun	21-Aug	81	9%
Total				**81**	
2008	Spring	No Spill	No-Spill	0	0%
2008	Summer	8-Jun	31-Aug	81	9%
Total				**81**	
2009	Spring	No Spill	No Spill	**0**	0%
2009	Summer	10-Jun	31-Aug	78	9%
Total				**78**	
2010	Spring	No Spill	No Spill	**0**	0%
2010	Summer	9-Jun	20-Aug	**73**	9%
Total				**73**	
2011	Spring	No Spill	No Spill	**0**	0%
2011	Summer	4-Jun	12-Aug	**70**	9%
Total				**70**	
2012	Spring	No Spill	No Spill	**0**	0%
2012	Summer	26-May	9-Aug	**76**	9%
Total				**76**	
2013	Spring	No Spill	No Spill	**0**	0%
2013	Summer	5-June	21-August	**78**	9%
Total				**78**	

* Percentage of daily average river flow at Rocky Reach. Two values in this column represents two different spill levels during the season (first value is the spill level for yearling Chinook and steelhead, second value is the spill level for sockeye.)

** 24 days of on/off spill test for sockeye

4.1.2 Rock Island

After meeting the HCP juvenile survival standards for all spring migrating species under a 20% spring spill regime in 2006, Chelan PUD has implemented a spill reduction study resulting in spring (voluntary) fish spill being reduced to 10% of the daily average river flow. Spill levels from 2003 to 2012 are shown in Table 11 below.

Table 11: Rock Island fish spill comparison, 2003-2013.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	*Spill Level
2003	Spring	17-Apr	31-May	45	20%
2003	Summer	1-Jun	16-Aug	77	20%
Total				**122**	
2004	Spring	17-Apr	8-Jun	53	20%
2004	Summer	9-Jun	4-Aug	57	20%
Total				**110**	
2005	Spring	17-Apr	9-Jun	54	20%
2005	Summer	10-Jun	9-Aug	61	20%
Total				**115**	
2006	Spring	17-Apr	13-Jun	58	20%
2006	Summer	14-Jun	11-Aug	59	20%
Total				**117**	
2007	Spring	17-Apr	1-Jun	46	10%
2007	Summer	2-Jun	21-Aug	81	20%
Total				**127**	
2008	Spring	17-Apr	7-Jun	52	10%
2008	Summer	8-Jun	16-Aug	70	20%
Total				**122**	
2009	Spring	17-Apr	9-Jun	54	10%
2009	Summer	10-Jun	17-Aug	69	20%
Total				**123**	
2010	Spring	17-Apr	8-Jun	53	10%
2010	Summer	9-Jun	20-Aug	73	20%
Total				**126**	
2011	Spring	17-Apr	3-Jun	48	10%
2011	Summer	4-Jun	24-Aug	82	20%
Total				**130**	
2012	Spring	17-Apr	27-May	41	10%
2012	Summer	28-May	18-Aug	83	20%
Total				**124**	
2013	Spring	17-Apr	4-June	49	10%
2013	Summer	5-June	18-Aug	75	20%
				124	

* Percentage of daily average river flow at Rock Island

The goal of the Rock Island Total Dissolved Gas Abatement Plan (GAP) approved by Ecology in April of 2013 is to implement measures to achieve compliance with the Washington state water quality standards for TDG in the Columbia River at the Project while continuing to meet the fish passage and survival standards set forth in the Rock Island HCP and Fish Management Plan. To meet this goal, Chelan PUD implemented the following operational measures:

1. Minimized voluntary spill – due to the success thus far of the HCP survival studies, Chelan PUD has been able to reduce spring fish (voluntary) spill from 20% to 10% of the daily average river flow.
2. During fish passage, managed voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimized spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoided spill, to the extent practicable, by continuing to participate in the Hourly Coordination Agreement, to the extent it reduces TDG.

4.2 Structural

No structural modifications were made or utilized at Rocky Reach Dam in 2013.

At Rock Island Dam, Chelan PUD utilized the notched gates, the spill deflector, and the Over/Under spill gates during 2013 fish spill operations. Before additional Over/Under gates are constructed, or other structural changes are made, Chelan PUD will operate under the existing structural configuration over the course of the next several years (to include the remainder of Phase I survival testing) to determine the impact on TDG abatement resulting from the three existing Over/Under gates.

SECTION 5: CONCLUSIONS

TDG values were slightly elevated throughout the mid-Columbia River for a portion of the 2013 fish-spill season due to a slightly higher than normal flows and the resultant spill. Spill upstream of each project resulted in occasionally high incoming TDG levels in the Rocky Reach, Rock Island, and Wanapum forebays. During the 2013 fish spill season, 69% of TDG exceedances in the Rock Island and Wanapum forebays occurred when incoming TDG levels exceeded numeric criteria. After eliminating these exceedances, Project compliance with the modified water quality TDG criteria was as follows:

Compliance Monitoring Location	Percent Compliant
Rocky Reach Tailrace (125%)	100%
Rocky Reach Tailrace (120%)	94.8%
Rock Island Forebay (115%)	98.6%
Rock Island Tailrace (125%)	100%
Rock Island Tailrace (120%)	98%
Wanapum Forebay (115%)	93.4%

Flows did not exceed the 7Q10 flows established for Rocky Reach or Rock Island in 2013.

Chelan PUD undertook reasonable and feasible abatement measures to moderate high TDG levels (see Section 3.4.5 and Section 4), including attempting to maximize powerhouse flows 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.

Chelan PUD will continue to closely monitor TDG levels during the fish spill season in accordance with Ecology approved GAPs, the Rocky Reach 401 Water Quality Certification, and the Rocky Reach QAPP.

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APPENDIX A: TDG OPERATIONAL PLANS ROCKY REACH AND ROCK ISLAND

2013 Rocky Reach Operational Plan
for Total Dissolved Gas During Fish Spill Season
April 1 – August 31
(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

1. If tailrace TDG average is greater than **120% for the 6-hour average**
   - reduce spill by 3 kcfs
   - monitor for 1 hour
   - if the 6-hr average TDG >120%, reduce spill by another 2 kcfs
   - monitor for 1 hour
   - continue reducing spill by 2 kcfs until 6-hr average TDG is less than 120% for one full hour
   - **if after reducing spill to control TDG levels, TDG drops below 118% for one full hour, increase spill by 2 kcfs and monitor ****

2. If tailrace TDG is greater than **125% for 1 hr**
   - follow protocol outlined above, but instead, use **one-hour TDG levels of 125%** as the metric
   - continue until TDG is less than 125% for 1 hr and until the 6-hr average TDG <120%

If you receive a call from RI advising that the RI forebay is out of compliance (greater than 115%) and the RR forebay is 115% or less, reduce spill by 3 kcfs. Two hours after reducing spill, call RI to determine what the RI forebay gas levels are. If still above 115%, reduce spill another 2 kcfs. If after reducing spill for this reason, the Rock Island forebay drops to less than 113%, Rock Island will call again and advise. At this point, increase back to the hourly spill volume target by increasing spill in the reverse order it was decreased. For example, if to bring the RI forebay back into compliance, it was necessary to reduce spill by a total of 5 kcfs, begin by increasing spill by 2 kcfs, wait two hours, and call RI to determine what the forebay TDG levels are. If TDG is still below 115%, increase spill by 3 kcfs (back to the target volume in this case). This will allow for a ramping effect, rather than an open/shut effect which could bump the Rock Island forebay TDG levels back out of compliance (>115%).

**** Note**: It will not be necessary to monitor for one full hour after re-opening gates if it appears that TDG is approaching the upper threshold, rather, the procedure will repeat upon reaching the threshold. It is anticipated that in time, the operators will "get a feel" for how much change in TDG will occur as a result of opening or closing gates and it will be possible to hold the TDG around 118% or 119% or so. Once the operators have this down, instead of closing a gate entirely, it may only be necessary to close partially, and vice versa for the opening process.

2013 Rock Island Operational Plan
for Total Dissolved Gas During Fish Spill Season
(Applies only when not spilling for headwater control)

Protocol

1. If tailrace TDG average is greater than **120% for the 6-hour average**
   - monitor for 2 hours, re-check 6-hour average
   - if TDG >120% for 6-hr average, shift spill from gate 17 to 27
   - monitor for 2 hours, re-check 6-hour average
   - if TDG >120% for 6-hr average, open gate 17 and close 2 notched gates (closure order is listed below)
   - monitor for 2 hrs; re-check 6-hour average
   - if TDG >120% for 6-hr average, close two more notched gates
   - **if after closing gates to control TDG levels, the TDG 1-hr average drops below 118%, re-open notched gates in the reverse order of closure****

   Order of notched gate closure: 29, 24, 18, 16

2. If tailrace TDG is greater than **125% for 1 hr**
   - follow protocol outlined above, but instead, use **one-hour TDG levels of 125%** as the metric
   - continue until TDG is less than 125% for 1 hr and until the 6-hr average TDG <120%

3. If forebay TDG exceeds 115% for greater than one hour, call Rocky Reach and advise that the RI forebay is out of compliance. Rocky Reach will then reduce spill, but only if the RR forebay TDG is 115% or less. Once RI forebay TDG levels reduce to 113% call RR again so that they may return to previous spill operations.

4. If it becomes necessary to implement any further actions to attain TDG compliance, please contact Steve Hemstrom and Waikele Hampton immediately so they can determine the next steps to take.

**** Note**: It will not be necessary to monitor for one full hour after re-opening if it appears that TDG is approaching the upper threshold again, rather, the procedure will repeat upon reaching the threshold. It is anticipated that in time, the operators will "get a feel" for how much change in TDG will occur as a result of opening or closing gates and it will be possible to hold the TDG around 118% or 119% or so. Once the operators have this down, instead of closing a gate entirely, it may only be necessary to close partially, and vice versa for the opening process.

APPENDIX B: 2013 TOTAL DISSOLVED GAS ABATEMENT PLANS

Rocky Reach Hydroelectric Project

and

Rock Island Hydroelectric Project

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/40364.pdf

APPENDIX C: DISSOLVED GAS LEVELS

Rocky Reach, Rock Island, and Wanapum Projects, 2013

April 2013. Numbers in bold exceed the water quality criteria.

All TDG values are rounded to the nearest whole number, as specified in the April 2, 2008 memo from Chris Maynard.

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2013	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-Apr	107	106	107	106	106	106	107	106	107	107	106	107	106	0.0	0.0	88.0	91.5	0.0	0.0	0	100	0	100
2-Apr	107	106	106	106	105	105	106	105	105	106	105	106	106	0.0	0.0	82.3	88.1	0.0	0.0	0	100	0	100
3-Apr	106	105	106	105	105	105	105	105	105	105	105	105	105	0.0	0.0	121.5	129.1	0.0	0.0	0	100	0	100
4-Apr	106	106	106	107	106	113	105	105	105	105	105	105	107	4.4	0.8	131.7	137.1	2.8	0.5	0	100	0	100
5-Apr	106	105	106	108	106	113	105	105	106	106	105	108	107	3.3	1.7	124.0	135.5	2.2	1.1	0	100	0	100
6-Apr	107	106	107	110	107	113	106	105	106	106	106	108	106	2.9	1.7	117.1	130.1	2.3	1.0	0	100	0	100
7-Apr	106	106	107	106	106	108	106	105	106	106	105	107	106	1.4	0.0	114.8	125.6	0.9	0.0	0	100	0	100
8-Apr	106	104	106	112	108	116	105	104	105	108	106	112	106	19.7	16.7	145.0	148.5	10.4	9.1	0	100	0	100
9-Apr	106	104	114	115	114	123	107	106	107	113	111	114	104	33.5	32.6	166.7	171.5	19.8	19.0	0	100	0	100
10-Apr	112	110	113	**121**	119	123	115	112	116	120	118	122	107	42.2	43.7	174.9	178.9	24.1	24.5	0	100	0	100
11-Apr	110	110	110	120	119	121	113	112	114	119	118	120	108	47.7	52.3	190.1	189.8	25.4	27.8	0	100	0	100
12-Apr	114	113	114	120	119	122	115	114	116	117	115	117	115	26.2	19.4	179.9	187.1	14.4	10.4	0	100	0	100
13-Apr	113	111	113	119	119	120	115	112	113	116	113	115	**116**	29.4	20.2	175.5	178.7	16.7	11.3	0	100	0	100
14-Apr	109	109	109	119	117	119	112	110	112	114	113	114	113	29.4	26.5	176.8	180.2	16.3	15.1	0	100	0	100
15-Apr	113	111	114	119	118	122	113	111	115	116	114	117	111	25.0	29.9	180.8	180.9	13.7	16.6	0	100	0	100
16-Apr	111	108	109	118	116	117	114	110	112	116	112	114	110	27.7	29.9	188.9	188.9	14.6	15.9	0	100	0	100
17-Apr	111	110	111	117	117	118	112	110	112	115	114	115	111	26.8	30.1	177.5	180.8	15.1	16.7	0	100	53	47
18-Apr	111	110	111	117	115	116	112	111	112	115	114	115	111	17.4	26.4	160.8	163.8	10.7	16.1	0	100	69	31
19-Apr	111	110	111	117	115	118	112	111	112	114	113	115	113	14.5	20.0	153.7	162.4	8.8	12.4	0	100	80	20
20-Apr	110	109	109	112	109	110	112	108	110	114	110	113	113	0.0	14.3	132.2	140.4	0.0	10.2	0	100	100	0
21-Apr	109	106	108	109	106	108	108	106	108	110	109	111	111	0.0	15.5	129.2	137.3	0.0	11.2	0	100	100	0
22-Apr	105	104	105	110	109	110	106	104	106	108	107	109	109	12.4	18.9	152.4	155.9	8.2	12.3	0	100	83	17
23-Apr	105	105	105	113	112	114	107	106	108	109	108	110	109	14.8	16.2	161.8	166.6	9.1	9.9	0	100	100	0
24-Apr	108	107	108	114	112	116	110	108	111	112	110	114	109	9.4	16.4	156.2	165.4	5.6	10.1	0	100	100	0
25-Apr	108	107	109	112	110	114	110	107	109	112	109	113	109	8.6	17.3	154.1	161.6	5.2	10.7	0	100	93	7
26-Apr	108	107	108	112	107	109	108	107	109	111	109	112	109	0.0	15.0	146.6	155.1	0.0	9.9	0	100	100	0
27-Apr	108	107	108	107	107	108	107	106	107	109	109	111	110	0.0	15.5	134.7	144.8	0.0	11.1	0	100	100	0
28-Apr	107	107	107	107	107	107	107	106	107	110	109	111	109	0.0	14.5	126.8	135.6	0.0	10.9	0	100	100	0
29-Apr	107	107	107	107	107	107	107	106	107	110	109	111	109	0.3	16.3	138.2	145.4	0.2	11.7	0	100	100	0
30-Apr	107	105	106	107	106	113	105	105	105	109	108	110	107	3.9	18.2	153.3	159.3	2.1	11.5	0	100	88	12

May 2013. Numbers in bold exceed the water quality criteria.

All TDG values are rounded to the nearest whole number, as specified in the April 2, 2008 memo from Chris Maynard.

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2013	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-May	105	104	104	109	107	111	104	104	105	107	106	107	106	5.5	14.4	157.4	168.8	3.4	8.5	0	100	100	0
2-May	106	105	106	109	106	109	106	105	106	108	107	109	107	2.2	14.6	149.3	157.4	1.4	9.3	0	100	100	0
3-May	107	106	107	107	106	108	106	106	107	108	108	109	109	0.0	14.0	149.2	157.4	0.0	8.8	0	100	100	0
4-May	107	107	108	107	106	108	107	106	107	109	108	109	109	0.0	11.6	131.0	142.5	0.0	8.3	0	100	100	0
5-May	109	108	109	108	108	109	108	107	108	110	109	111	110	0.0	13.5	128.2	137.4	0.0	10.1	0	100	100	0
6-May	109	109	110	109	109	109	109	108	109	111	111	112	112	0.0	16.4	145.4	154.3	0.0	10.6	0	100	100	0
7-May	110	109	110	113	111	115	109	108	109	112	111	112	113	7.3	18.0	157.3	169.1	4.1	10.7	0	100	100	0
8-May	110	109	110	116	115	118	111	110	111	113	112	113	113	21.4	17.7	172.3	186.8	12.6	9.7	0	100	100	0
9-May	112	111	113	118	116	119	112	110	113	114	113	115	113	21.4	18.3	179.2	194.8	11.7	9.4	0	100	100	0
10-May	111	110	112	119	118	120	112	112	113	115	114	116	113	42.6	25.9	207.6	219.1	20.4	11.8	0	100	75	25
11-May	114	114	114	**121**	119	123	**116**	114	117	**122**	120	123	115	33.4	51.6	187.8	203.2	17.2	25.0	0	100	38	62
12-May	**118**	116	119	120	119	121	**116**	114	117	119	117	120	**116**	25.5	29.6	176.0	190.8	14.4	15.5	0	100	63	37
13-May	114	111	112	119	115	119	**116**	111	113	119	117	121	**117**	18.9	34.5	172.3	190.2	10.2	17.8	0	100	55	45
14-May	113	112	114	115	114	116	112	110	114	114	113	115	114	8.4	18.2	171.5	187.9	4.7	9.7	0	100	100	0
15-May	111	109	109	119	116	123	113	111	114	115	113	116	114	32.5	19.6	177.5	187.4	17.6	10.6	0	100	100	0
16-May	110	109	110	115	113	116	111	109	111	114	113	115	115	11.3	31.1	172.2	183.4	6.6	17.0	0	100	66	34
17-May	112	111	112	118	118	119	113	111	114	117	116	118	115	41.1	40.8	193.8	199.4	21.2	20.5	0	100	47	53
18-May	112	112	112	118	118	119	113	112	113	117	116	117	113	29.0	43.1	185.8	193.3	15.7	22.4	0	100	43	57
19-May	113	112	113	119	118	119	113	112	114	120	118	121	112	34.1	46.7	203.2	207.3	16.8	22.5	0	100	47	53
20-May	113	113	113	119	118	119	114	113	115	118	117	118	**116**	21.8	36.1	197.1	199.7	10.6	18.0	0	100	61	39
21-May	114	114	115	119	118	119	114	113	114	117	115	116	**117**	22.4	21.1	196.2	203.0	11.4	10.4	0	100	99	1
22-May	113	111	112	119	118	119	113	112	112	115	114	115	**116**	32.3	20.0	211.6	214.5	15.2	9.3	0	100	100	0
23-May	112	111	112	119	118	119	112	112	113	115	114	115	113	29.3	19.9	191.9	201.2	15.2	9.9	0	100	100	0
24-May	112	111	112	119	119	119	113	112	113	115	114	116	113	42.3	20.6	211.4	212.3	19.7	9.7	0	100	95	5
25-May	113	112	113	120	119	120	114	113	115	116	115	116	113	45.6	19.7	208.7	210.2	22.0	9.4	0	100	100	0
26-May	113	112	113	120	119	120	114	114	114	116	115	116	114	41.8	19.7	206.5	209.3	20.2	9.4	0	100	100	0
27-May	113	113	113	120	120	120	114	114	114	116	116	116	114	38.8	21.5	210.3	211.9	18.5	10.2	0	100	100	0
28-May	113	113	113	120	119	121	115	114	115	116	116	117	115	37.2	20.7	200.0	205.1	18.3	10.1	0	100	100	0
29-May	113	112	113	119	116	119	114	113	113	116	115	116	115	16.2	20.7	176.1	183.6	8.6	11.5	0	100	100	0
30-May	112	110	111	114	110	110	113	109	112	115	112	115	114	0.0	20.8	135.9	146.2	0.0	14.3	0	100	100	0
31-May	110	108	109	110	108	108	109	108	108	113	111	113	113	0.0	18.5	144.8	150.2	0.0	12.8	0	100	100	0

June 2013. Number in bold exceed the water quality criteria.

All TDG values are rounded to the nearest whole number, as specified in the April 2, 2008 memo from Chris Maynard.

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2013	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-Jun	110	109	110	109	108	110	109	108	109	111	110	112	113	0.0	14.6	148.7	155.8	0.0	9.6	0	100	100	0
2-Jun	111	110	111	114	114	116	111	110	112	113	112	114	113	13.7	17.1	175.4	182.2	7.6	9.3	0	100	83	17
3-Jun	112	111	112	115	112	115	111	111	112	115	114	115	111	5.2	24.2	161.2	168.6	3.1	14.4	0	100	76	24
4-Jun	112	111	112	116	115	116	112	111	112	115	114	115	N/A	15.2	24.2	175.8	182.3	8.7	13.4	0	100	77	23
5-Jun	113	113	113	117	117	117	113	112	114	118	117	119	N/A	16.9	37.8	177.9	186.2	9.5	20.3	89	11	100	0
6-Jun	113	112	113	117	116	117	113	112	113	118	117	118	N/A	15.7	36.3	161.0	171.1	9.9	21.3	100	0	100	0
7-Jun	113	112	113	117	116	117	113	112	112	118	117	118	N/A	15.6	36.7	148.7	161.0	10.8	23.3	100	0	100	0
8-Jun	112	111	112	116	115	116	112	111	112	118	116	118	113	15.2	35.7	145.0	156.9	10.5	22.8	100	0	100	0
9-Jun	112	111	112	116	115	116	111	110	111	117	116	117	112	14.4	34.4	130.5	141.6	11.1	24.4	100	0	100	0
10-Jun	112	111	113	116	115	116	111	110	112	117	116	118	N/A	15.4	36.6	145.8	157.0	10.5	23.3	100	0	100	0
11-Jun	112	112	112	116	115	117	111	110	111	117	116	117	113	15.0	34.8	153.2	163.6	9.8	21.3	100	0	100	0
12-Jun	112	111	112	117	116	118	112	111	112	117	116	117	111	20.9	34.4	181.6	188.4	11.2	18.2	76	24	100	0
13-Jun	114	113	114	117	116	117	112	111	112	117	116	117	111	16.6	35.1	165.2	172.8	10.1	20.3	91	9	100	0
14-Jun	114	113	113	117	116	117	112	112	113	118	117	118	112	15.1	34.5	162.5	169.7	9.5	20.4	100	0	100	0
15-Jun	113	113	114	117	116	117	113	112	113	118	117	119	115	13.2	31.4	148.2	158.1	8.9	19.8	100	0	100	0
16-Jun	114	113	114	117	116	117	113	112	113	118	117	118	115	13.1	29.8	144.9	152.7	9.1	19.7	100	0	100	0
17-Jun	114	114	115	118	116	118	113	113	114	118	117	120	115	14.7	33.6	154.8	169.4	9.4	19.7	100	0	100	0
18-Jun	115	114	115	118	117	118	113	113	113	118	117	118	114	14.6	33.6	152.9	163.4	9.8	20.8	100	0	100	0
19-Jun	115	114	115	117	116	117	113	112	113	118	117	118	114	14.5	33.2	139.9	151.0	10.4	22.0	100	0	100	0
20-Jun	114	112	113	117	115	116	112	111	112	118	117	123	112	14.4	33.9	135.5	145.1	10.8	23.7	100	0	100	0
21-Jun	111	111	111	117	115	118	110	110	111	117	116	119	112	20.0	32.8	178.6	180.7	10.8	18.2	74	26	100	0
22-Jun	115	113	116	119	118	119	113	112	113	118	117	118	113	24.7	31.0	196.3	201.6	12.5	15.4	56	44	100	0
23-Jun	**117**	116	117	120	120	121	**116**	115	116	120	119	120	115	23.5	36.2	197.2	200.8	11.9	17.9	67	33	100	0
24-Jun	**116**	116	116	**121**	121	122	**116**	115	116	120	120	122	**116**	30.9	38.2	201.2	203.5	15.3	18.9	55	45	100	0
25-Jun	**116**	115	116	120	119	119	**116**	114	115	120	119	120	**116**	22.1	40.8	199.1	200.1	11.1	20.4	84	16	100	0
26-Jun	113	112	113	119	118	119	114	112	113	119	117	118	115	30.3	40.0	205.3	207.1	14.7	19.2	58	42	100	0
27-Jun	113	112	113	119	119	119	113	113	114	118	117	119	115	35.0	40.0	210.8	212.9	16.6	18.7	50	50	100	0
28-Jun	114	113	114	120	120	120	115	114	115	119	118	120	**117**	45.8	40.1	224.1	222.1	20.3	18.1	38	62	100	0
29-Jun	**116**	115	116	**121**	120	122	**116**	115	116	120	119	120	**117**	42.2	42.2	214.7	216.3	19.7	19.5	44	56	100	0
30-Jun	**116**	116	117	**122**	121	122	**116**	115	117	120	119	120	**118**	49.6	42.1	229.6	229.4	21.6	18.3	37	63	100	0

July 2013. Number in bold exceed the water quality criteria.

All TDG values are rounded to the nearest whole number, as specified in the April 2, 2008 memo from Chris Maynard.

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill) Rocky Reach		Rock Island	
2013	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	24-hr	High	12-hr	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-Jul	118	117	118	**122**	122	122	**117**	117	118	120	120	121	**119**	50.6	37.1	217.7	219.1	23.3	16.9	35	65	100	0
2-Jul	118	117	118	**122**	121	121	**117**	117	117	**121**	120	121	**119**	42.8	42.7	219.5	218.6	19.5	19.5	43	57	100	0
3-Jul	117	117	117	**122**	121	122	**117**	116	117	**121**	120	121	**118**	49.3	44.6	218.5	218.1	22.6	20.5	40	60	100	0
4-Jul	118	117	118	120	119	122	**117**	116	117	120	119	120	115	27.5	37.2	185.5	191.0	14.6	19.9	58	42	100	0
5-Jul	117	115	117	120	119	122	**116**	115	117	120	118	121	114	38.2	32.1	199.8	199.6	19.4	16.1	41	59	100	0
6-Jul	115	114	116	119	118	120	115	113	115	119	118	120	**116**	27.3	36.9	206.6	207.4	13.1	17.7	60	40	100	0
7-Jul	116	116	116	119	118	118	**116**	115	116	120	119	120	**116**	19.3	36.1	190.1	195.5	10.1	18.5	85	15	100	0
8-Jul	115	114	115	119	118	121	115	114	116	120	118	121	**116**	30.9	37.1	169.5	173.4	18.0	21.5	53	47	100	0
9-Jul	114	112	113	118	116	118	113	112	115	120	118	120	**116**	20.9	37.5	163.7	166.0	12.6	22.6	81	19	100	0
10-Jul	113	113	114	117	116	118	113	112	113	118	117	118	**116**	15.8	34.8	146.9	152.3	10.7	22.8	100	0	100	0
11-Jul	113	111	112	117	116	119	113	112	114	118	117	118	115	22.3	36.2	158.7	162.4	14.0	22.4	72	28	100	0
12-Jul	111	110	111	117	116	118	112	111	113	118	116	118	113	23.7	38.0	167.6	171.9	14.2	22.1	70	30	100	0
13-Jul	110	110	111	116	114	116	112	110	111	117	116	117	112	15.4	34.9	161.0	165.5	9.5	21.0	100	0	100	0
14-Jul	111	110	111	115	114	116	111	110	112	117	116	118	112	14.3	32.7	157.9	164.7	9.0	19.9	100	0	100	0
15-Jul	111	111	112	115	114	115	111	111	112	117	116	118	112	13.5	33.5	154.8	158.1	8.7	21.1	99	1	100	0
16-Jul	112	111	112	115	114	116	112	111	112	117	116	117	112	14.1	32.5	152.0	156.3	9.4	21.0	94	6	100	0
17-Jul	112	111	112	116	115	116	112	111	112	117	116	118	112	14.8	32.2	150.8	156.3	9.8	20.5	95	5	100	0
18-Jul	112	111	113	116	115	117	112	111	112	117	116	118	113	14.6	30.4	157.2	159.6	9.2	19.1	92	8	100	0
19-Jul	113	112	113	116	115	117	112	112	113	117	117	118	114	12.7	30.8	159.1	163.7	7.9	18.7	98	2	100	0
20-Jul	114	113	114	116	115	117	113	112	114	118	117	118	114	11.5	28.2	138.9	143.7	8.2	19.6	100	0	100	0
21-Jul	114	113	113	115	114	115	113	112	113	118	117	118	113	11.5	27.4	123.5	125.7	9.4	22.0	100	0	100	0
22-Jul	113	112	112	115	114	116	112	111	112	117	116	117	112	12.0	28.4	142.8	145.9	8.6	19.9	100	0	100	0
23-Jul	112	112	113	116	114	116	112	111	112	117	116	117	112	12.3	28.6	134.0	135.9	10.5	24.3	100	0	100	0
24-Jul	113	112	113	116	114	116	112	111	112	117	116	118	112	11.7	28.4	130.9	134.0	9.4	22.4	100	0	100	0
25-Jul	113	112	113	115	114	116	112	112	113	117	116	118	113	11.9	28.7	140.3	142.0	8.6	20.8	100	0	100	0
26-Jul	113	112	113	115	114	116	112	112	113	117	116	118	113	12.2	28.2	130.2	132.4	9.4	21.7	100	0	100	0
27-Jul	112	112	112	115	113	115	112	111	112	117	116	117	112	10.7	25.8	118.4	122.3	9.0	21.1	100	0	100	0
28-Jul	112	112	113	114	113	115	111	111	112	116	116	117	111	11.4	25.5	113.6	117.4	10.4	22.7	100	0	100	0
29-Jul	112	112	112	115	114	116	112	111	112	117	116	118	113	11.9	28.7	126.9	132.3	9.4	21.8	100	0	100	0
30-Jul	112	111	112	115	114	116	112	111	112	118	116	118	113	12.0	28.3	140.5	145.2	8.6	19.8	100	0	100	0
31-Jul	112	111	111	114	114	115	112	110	111	117	116	117	113	12.1	28.6	141.5	145.4	8.5	19.8	100	0	100	0

August 2013. Numbers in bold exceed the water quality criteria.

All TDG values are rounded to the nearest whole number, as specified in the April 2, 2008 memo from Chris Maynard.

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill) Rocky Reach		Rock Island	
2013	12 ave	24 hr	High	12 hr	24 hr	High	12 hr	24 hr	High	12 hr	24 hr	High	12 hr	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-Aug	112	111	112	114	113	115	111	110	111	117	116	118	113	11.8	27.5	122.0	124.1	9.8	23.0	100	0	100	0
2-Aug	112	111	112	114	113	115	111	110	111	117	115	117	112	11.0	24.4	128.5	134.7	9.3	19.8	100	0	100	0
3-Aug	111	110	111	114	112	114	110	110	111	116	114	116	112	9.2	21.0	130.2	134.2	7.0	15.7	100	0	100	0
4-Aug	111	111	111	113	113	114	111	110	111	115	114	116	114	9.9	21.4	129.7	134.7	7.8	16.1	93	7	100	0
5-Aug	112	111	112	115	114	116	112	111	112	117	115	118	114	10.8	24.1	131.3	134.3	8.3	18.5	100	0	100	0
6-Aug	112	112	112	114	113	115	112	111	112	117	116	118	114	11.0	24.1	124.5	126.8	9.2	20.3	100	0	100	0
7-Aug	112	111	112	115	114	116	112	111	112	117	116	118	113	11.6	25.4	123.6	126.6	10.1	22.0	100	0	100	0
8-Aug	112	111	112	115	114	116	112	111	111	117	116	118	113	11.2	25.8	133.5	133.0	9.0	20.5	100	0	100	0
9-Aug	112	112	112	115	114	116	111	111	112	117	116	119	115	10.9	24.2	117.2	122.0	10.7	22.9	100	0	100	0
10-Aug	112	111	112	114	113	114	112	111	112	117	115	118	115	9.1	20.9	103.5	103.2	9.2	22.3	100	0	100	0
11-Aug	111	110	111	113	112	113	111	110	111	116	114	116	112	8.8	20.5	102.4	107.7	9.1	20.1	100	0	100	0
12-Aug	110	110	110	114	113	115	110	110	111	115	115	117	112	11.8	25.6	116.6	121.2	11.2	23.0	100	0	100	0
13-Aug	110	110	110	114	113	115	110	110	111	116	115	117	112	11.3	25.4	118.5	120.6	10.6	24.7	100	0	100	0
14-Aug	110	110	110	114	113	115	110	110	111	116	115	118	113	11.4	25.6	119.4	121.1	10.7	24.8	100	0	100	0
15-Aug	110	110	110	114	113	115	110	110	110	115	114	116	111	11.2	25.3	136.0	136.2	8.5	19.7	100	0	100	0
16-Aug	110	109	110	115	113	118	110	110	112	115	115	118	110	14.9	25.5	127.9	132.1	11.2	19.5	72	28	100	0
17-Aug	109	109	109	113	112	114	111	109	110	116	113	116	110	9.3	21.0	109.8	111.6	8.6	19.4	100	0	100	0
18-Aug	109	108	108	112	111	113	109	108	109	114	113	116	109	8.8	19.1	100.7	103.6	9.6	22.5	100	0	100	0
19-Aug	108	107	108	112	111	113	109	108	109	113	108	112	109	11.1	0.0	105.2	106.9	11.1	0.0	100	0	0	100
20-Aug	107	107	107	112	111	113	108	107	108	108	107	109	109	10.6	0.0	127.7	131.1	19.6	19.7	100	0	0	100
21-Aug	107	107	107	112	111	113	108	107	108	108	107	109	109	10.2	0.0	123.0	127.3	8.3	0.0	100	0	0	100
22-Aug	107	107	107	111	106	109	108	107	108	108	107	108	109	0.0	0.0	111.1	116.2	0.0	0.0	0	100	0	100
23-Aug	107	107	107	106	106	106	107	106	106	107	106	106	109	0.0	0.1	77.3	80.3	0.0	0.1	0	100	0	100
24-Aug	107	107	107	106	106	106	106	106	106	106	106	106	106	0.0	0.0	90.8	95.1	0.0	0.0	0	100	0	100
25-Aug	107	106	107	106	105	106	106	105	106	106	106	106	107	0.0	0.0	99.2	104.9	0.0	0.0	0	100	0	100
26-Aug	106	106	106	106	105	105	105	105	105	106	105	106	105	0.0	0.0	108.8	111.7	0.0	0.0	0	100	0	100
27-Aug	106	106	106	105	105	105	105	105	106	106	105	106	106	0.0	0.0	107.9	109.6	0.0	0.0	0	100	0	100
28-Aug	106	106	106	105	105	105	105	105	105	106	105	106	106	0.0	0.0	107.0	107.1	0.0	0.0	0	100	0	100
29-Aug	106	105	105	105	104	105	105	104	105	105	105	105	106	0.0	0.0	106.4	108.4	0.0	0.0	0	100	0	100
30-Aug	105	105	105	104	104	104	104	104	105	105	104	105	105	0.0	0.0	107.0	113.3	0.0	0.0	0	100	0	100
31-Aug	105	105	105	104	104	104	105	104	105	105	104	105	106	0.0	0.0	98.2	104.2	0.0	0.0	0	100	0	100

APPENDIX D: MONTHLY CALIBRATION LOGS

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Jan-13
Arrival Time: 14:20
Departure Time: 14:55

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 15-Jan-13 **Time:** 14:30

BP Station:
759.7 mmHg

	Std	Initial	Final
Temperature	3.50	3.5	N / C
TDG 100%	759.7	761	760
TDG 113%	859.7	861	860
TDG 126%	959.7	961	960
TDG 139%	1059.7	1062	1060

Comments:

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Jan-13
Arrival Time: 13:35
Departure Time: 14:15

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 15-Jan-13 **Time:** 13:50

BP Station:
761.4 mmHg

	Std	Initial	Final
Temperature	3.33	-1.2	N / C
TDG 100%	761.4	763	761
TDG 113%	861.4	863	861
TDG 126%	961.4	964	961
TDG 139%	1061.4	1064	1061

Comments: 1092

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Jan-13
Arrival Time: 12:00
Departure Time: 12:50

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 15-Jan-13 **Time:** 12:25

BP Station:
762.3 mmHg

	Std	Initial	Final
Temperature	3.59	3.4	N / C
TDG 100%	762.3	763	762
TDG 113%	862.3	864	862
TDG 126%	962.3	964	962
TDG 139%	1062.3	1065	1062

Comments:

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Jan-13
Arrival Time: 10:30
Departure Time: 11:35

Site: RIGW
Probe ID: 32545

Calibration Type: Field

Date: 15-Jan-13 **Time:** 10:55

BP Station:
764.1 mmHg

	Std	Initial	Final
Temperature	3.73	3.5	N / C
TDG 100%	764.1	765	764
TDG 113%	864.1	866	864
TDG 126%	964.1	966	964
TDG 139%	1064.1	1066	1064

Comments: 960

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Mar-13
Arrival Time: 10:00
Departure Time: 10:35

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 19-Mar-13 **Time:** 10:10

BP Station:
750.4 mmHg

	Std	Initial	Final
Temperature	4.89	4.8	N / C
TDG 100%	750.4	751	N / C
TDG 113%	850.4	850	N / C
TDG 126%	950.4	950	N / C
TDG 139%	1050.4	1050	N / C

Comments: 949
New membrane

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Mar-13
Arrival Time: 10:40
Departure Time: 11:25

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 19-Mar-13 **Time:** 10:55

BP Station:
752.0 mmHg

	Std	Initial	Final
Temperature	4.86	4.6	N / C
TDG 100%	752	750	752
TDG 113%	852	850	852
TDG 126%	952	950	951
TDG 139%	1052	1050	1052

Comments: 1097
New membrane

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Mar-13
Arrival Time: 12:00
Departure Time: 12:40

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 19-Mar-13 **Time:** 12:15

BP Station:
752.0 mmHg

	Std	Initial	Final
Temperature	5.03	4.9	N / C
TDG 100%	752	751	N / C
TDG 113%	852	851	N / C
TDG 126%	952	951	N / C
TDG 139%	1052	1051	N / C

Comments: 973
New membrane

Report created March 27, 2013

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Mar-13
Arrival Time: 13:00
Departure Time: 14:25

Site: RIGW
Probe ID: 32545

Calibration Type: Field

Date: 19-Mar-13 **Time:** 13:20

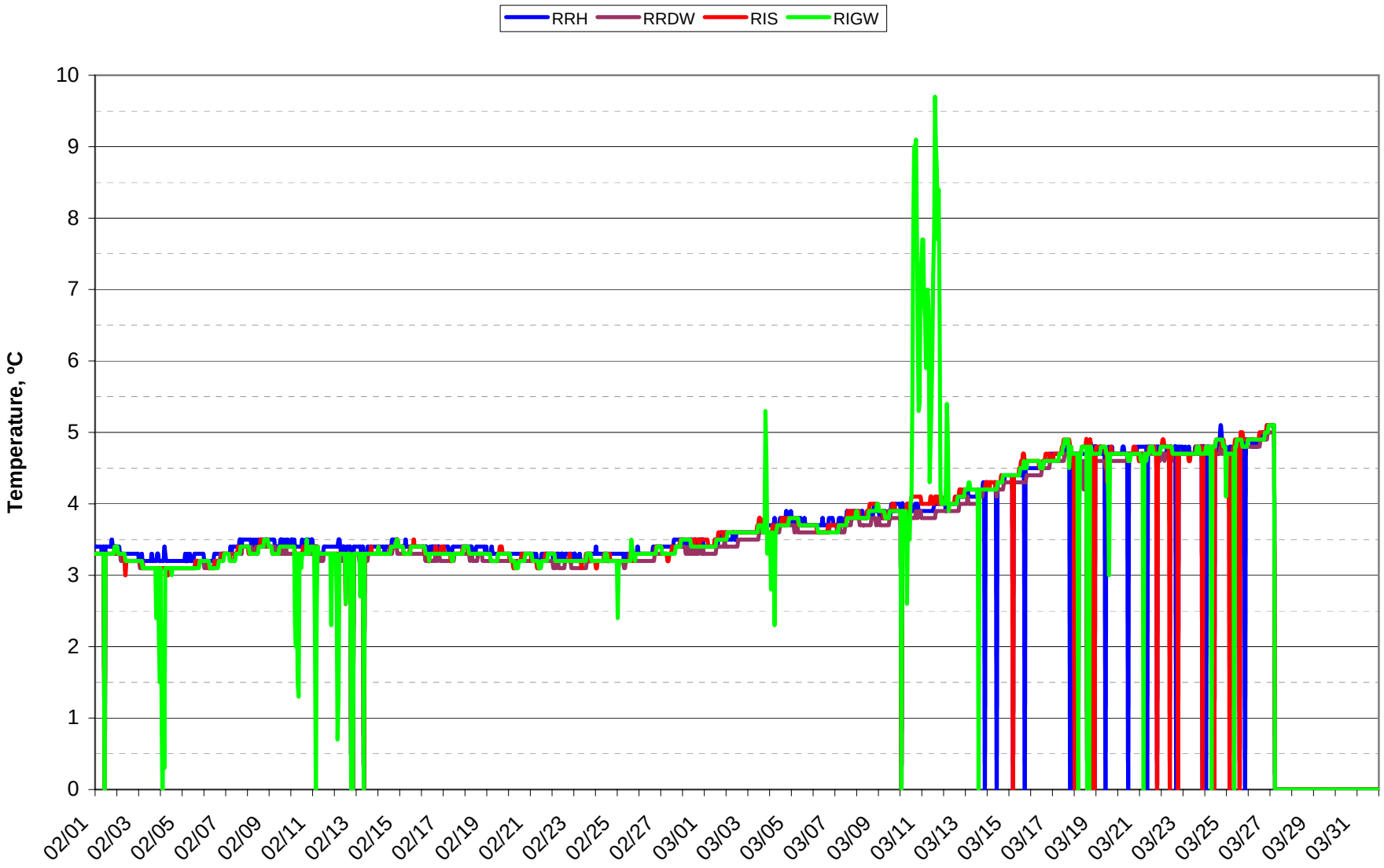
BP Station:
751.9 mmHg

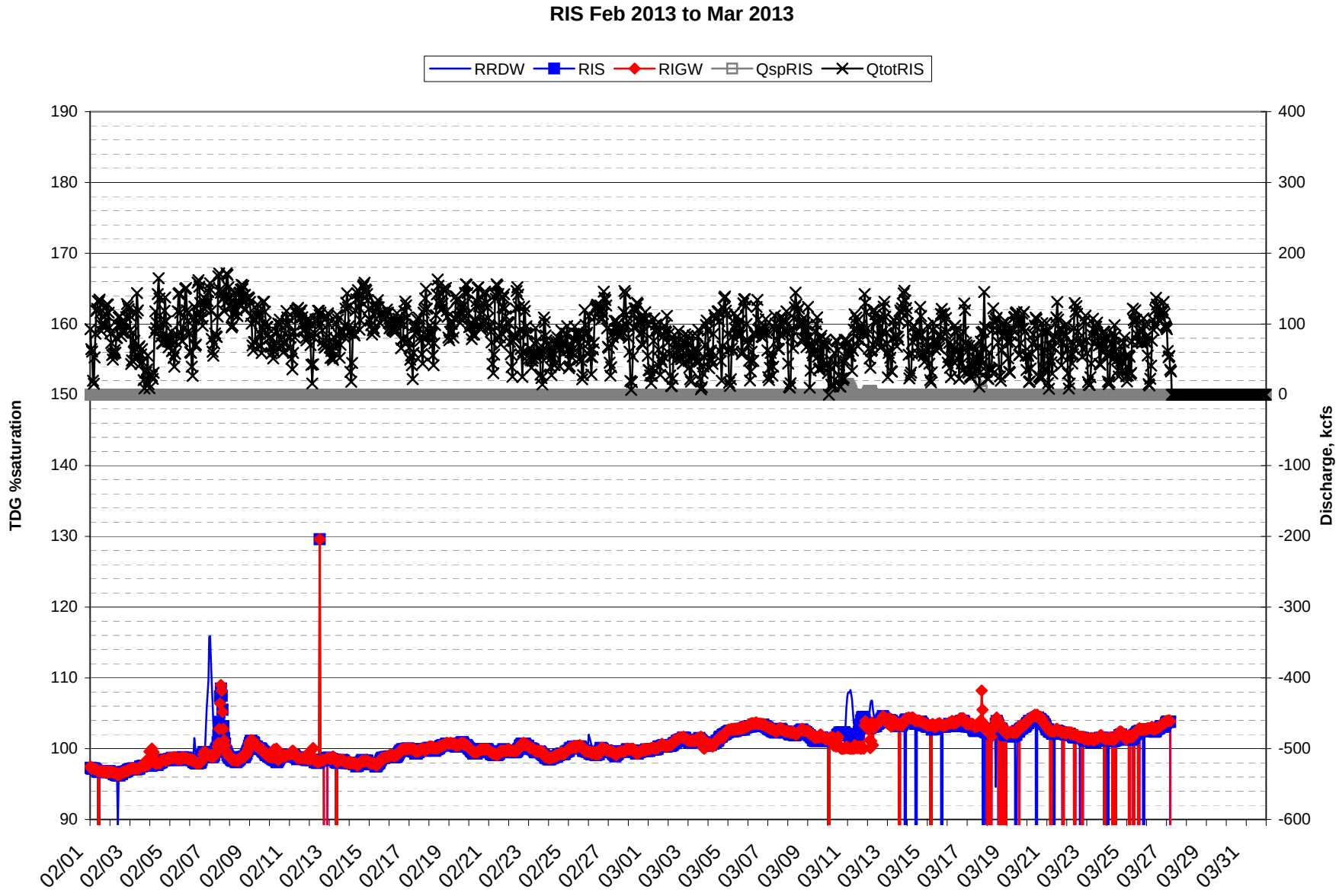
	Std	Initial	Final
Temperature	5.46	5.2	N / C
TDG 100%	751.9	752	N / C
TDG 113%	851.9	852	N / C
TDG 126%	951.9	952	N / C
TDG 139%	1051.9	1052	N / C

Comments: 955
New membrane

Report created March 27, 2013

RIS and RRH Feb 2013 to Mar 2013




RIS Feb 2013 to Mar 2013
RRDW
RIS
RIGW
QspRIS
QtotRIS
TDG %saturation
Discharge, kcfs
190
180
170
160
150
140
130
120
110
100
90
400
300
200
100
0
-100
-200
-300
-400
-500
-600
02/01
02/03
02/05
02/07
02/09
02/11
02/13
02/15
02/17
02/19
02/21
02/23
02/25
02/27
03/01
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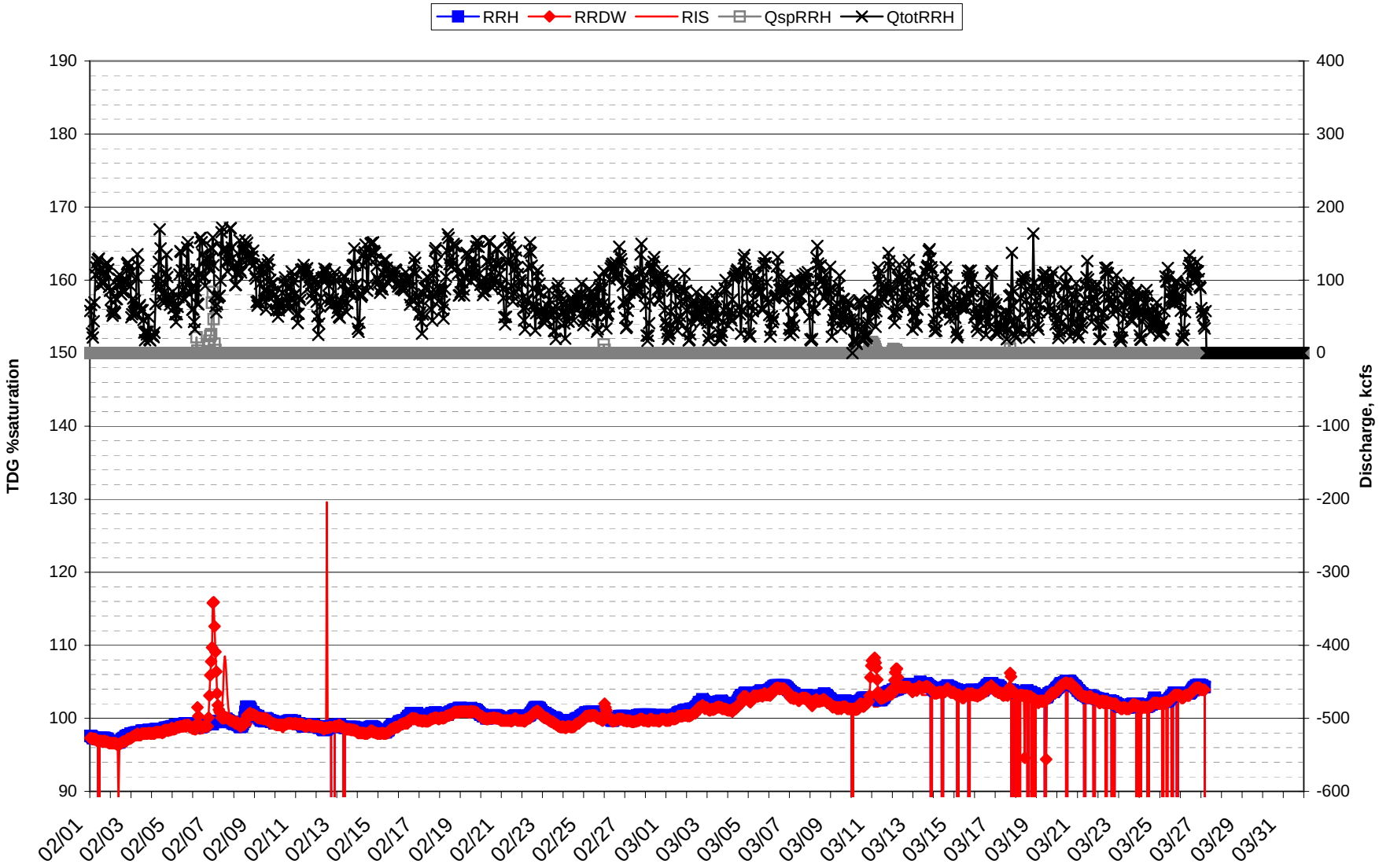
03/07
03/09
03/11
03/13
03/15
03/17
03/19
03/21
03/23
03/25
03/27
03/29
03/31

RRH Feb 2013 to Mar 2013



Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 18-Apr-13
Arrival Time: 9:55
Departure Time: 10:30

Site:
RRH

FMS ID	37607		37607	
Time	10:05		10:25	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	751.3	750.0	751.0	750.0
Temp ºC		6.4		6.4
TDGsat		109.7		108.7
TDG mmHg		823.0		815.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 18-Apr-13
BP Station: 751.3 mmHg
Time: 10:10

	Std	Initial	Final
Temperature ºC	7.65	7.6	N / C
TDG 100%	751.3	753	751
TDG 113%	851.3	853	851
TDG 126%	951.3	953	951
TDG 139%	1051.3	1053	1051
Depth m	0		N / C

Comments: 941, New membrane

Report created April 21, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 18-Apr-13
Arrival Time: 10:40
Departure Time: 11:15

Site:
RRDW

FMS ID	38865		38865	
Time	10:50		11:10	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	752.5	749.0	752.5	749.0
Temp ºC		6.4		6.4
TDGsat		116.3		117.2
TDG mmHg		871.0		878.0

Comments:

Calibration Type: Field
Probe ID: 38865
Date: 18-Apr-13
BP Station: 752.5 mmHg
Time: 10:55

	Std	Initial	Final
Temperature ºC	7.13	7	N / C
TDG 100%	752.5	754	N / C
TDG 113%	852.5	854	N / C
TDG 126%	952.5	953	N / C
TDG 139%	1052.5	1054	N / C
Depth m	0		N / C

Comments: 1115, New membrane

Report created April 21, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 18-Apr-13
Arrival Time: 11:50
Departure Time: 12:25

Site:
RIS

FMS ID	37606		37606	
Time	12:05		12:20	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	753.1	755.0	751.9	755.0
Temp ºC		6.5		6.5
TDGsat		110.9		111.3
TDG mmHg		837.0		840.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 18-Apr-13
BP Station: 752.7 mmHg
Time: 12:05

	Std	Initial	Final
Temperature ºC	7.66	7.5	N / C
TDG 100%	752.7	753	N / C
TDG 113%	852.7	853	N / C
TDG 126%	952.7	952	N / C
TDG 139%	1052.7	1053	N / C
Depth m	0		N / C

Comments: 985, New membrane

Report created April 21, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 18-Apr-13
Arrival Time: 12:50
Departure Time: 14:00

Site:
RIGW

FMS ID	32545		32545	
Time	13:10		13:55	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	752.8	754.0	752.8	753.0
Temp ºC		6.5		6.5
TDGsat		114.1		114.9
TDG mmHg		860.0		865.0

Comments:

Calibration Type: Field
Probe ID: 32545
Date: 18-Apr-13
BP Station: 752.8 mmHg
Time: 13:15

	Std	Initial	Final
Temperature ºC	7.7	7.5	N / C
TDG 100%	752.8	754	N / C
TDG 113%	852.8	854	N / C
TDG 126%	952.8	954	N / C
TDG 139%	1052.8	1054	N / C
Depth m	0		N / C

Comments: 954, New membrane

Report created April 21, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-May-13
Arrival Time: 11:05
Departure Time: 11:45

Site:
RRH

	FMS ID	37607		37607	
	Time	11:10		11:35	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		741.5	740.0	740.9	740.0
Temp °C			10.3		10.3
TDGsat			109.3		109.2
TDG mmHg			809.0		808.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 16-May-13
BP Station: 741.5 mmHg
Time: 11:15

	Std	Initial	Final
Temperature °C	11.46	11.4	N / C
TDG 100%	741.5	741	N / C
TDG 113%	841.5	841	N / C
TDG 126%	941.5	941	N / C
TDG 139%	1041.5	1041	N / C
Depth m	N/A		

Comments: 933

Report created May 28, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-May-13
Arrival Time: 10:25
Departure Time: 11:00

Site:
RRDW

	FMS ID	38865		38865	
	Time	10:35		10:55	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		744.0	741.0	744.0	741.0
Temp °C			10.2		10.2
TDGsat			112.8		114.4
TDG mmHg			836.0		848.0

Comments:

Calibration Type: Field
Date: 16-May-13
Time: 10:40

Probe ID: 38865
BP Station: 744 mmHg

	Std	Initial	Final
Temperature °C	11.03	10.9	N / C
TDG 100%	744	746	744
TDG 113%	844	845	843
TDG 126%	944	945	944
TDG 139%	1044	1045	1044
Depth m	N/A		

Comments: 1120

Report created May 28, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-May-13
Arrival Time: 12:15
Departure Time: 12:50

Site:
RIS

FMS ID	37606		37606	
Time	12:20		12:45	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	743.2	745.0	742.6	745.0
Temp ºC		10.1		10.2
TDGsat		109.8		110.2
TDG mmHg		818.0		821.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 16-May-13
BP Station: 743.2 mmHg
Time: 12:25

	Std	Initial	Final
Temperature ºC	11.51	11.4	N / C
TDG 100%	743.2	744	743
TDG 113%	843.2	843	843
TDG 126%	943.2	943	943
TDG 139%	1043.2	1042	1043
Depth m	N/A		

Comments: 961

Report created May 28, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-May-13
Arrival Time: 13:15
Departure Time: 14:00

Site:
RIGW

FMS ID	32545		32545	
Time	13:20		13:50	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	743.7	745.0	743.7	745.0
Temp °C		10.1		10.1
TDGsat		114.6		113.8
TDG mmHg		854.0		848.0

Comments:

Calibration Type: Field
Date: 16-May-13
Time: 13:30

Probe ID: 32545
BP Station: 743.8 mmHg

	Std	**Initial**	**Final**
Temperature °C	11.41	11.3	N / C
TDG 100%	743.8	745	744
TDG 113%	843.8	844	844
TDG 126%	943.8	944	944
TDG 139%	1043.8	1044	1044
Depth m	N/A		

Comments: 946

Report created May 28, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Jun-13
Arrival Time: 9:30
Departure Time: 10:00

Site:
RRH

FMS ID	37607		37607	
Time	9:35		9:55	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	744.2	743.0	744.2	743.0
Temp ºC		13.3		13.4
TDGsat		112.0		111.3
TDG mmHg		832.0		827.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 13-Jun-13
BP Station: 744.2 mmHg
Time: 9:45

	Std	**Initial**	**Final**
Temperature ºC	13.81	13.8	N / C
TDG 100%	744.2	743	744
TDG 113%	844.2	842	844
TDG 126%	944.2	942	944
TDG 139%	1044.2	1042	1044
Depth m	N/A		

Comments: 942

Report created July 01, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Jun-13
Arrival Time: 8:45
Departure Time: 9:25

Site:
RRDW

FMS ID	38865		38865	
Time	9:00		9:20	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	746.3	743.0	746.3	743.0
Temp ºC		13.3		13.2
TDGsat		115.9		117.2
TDG mmHg		861.0		871.0

Comments:

Calibration Type: Field
Probe ID: 38865
Date: 13-Jun-13
BP Station: 746.3 mmHg
Time: 9:05

	Std	Initial	Final
Temperature ºC	13.63	13.5	N / C
TDG 100%	746.3	745	N / C
TDG 113%	846.3	845	N / C
TDG 126%	946.3	945	N / C
TDG 139%	1046.3	1045	N / C
Depth m	N/A		

Comments: 1098

Report created July 01, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Jun-13
Arrival Time: 10:35
Departure Time: 11:10

Site:
RIS

FMS ID	37606		37606	
Time	10:45		11:05	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	746.6	748.0	746.6	748.0
Temp ºC		13.3		13.3
TDGsat		110.6		111.1
TDG mmHg		827.0		831.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 13-Jun-13
BP Station: 746.6 mmHg
Time: 10:50

	Std	Initial	Final
Temperature ºC	13.59	13.5	N / C
TDG 100%	746.6	747	N / C
TDG 113%	846.6	846	N / C
TDG 126%	946.6	946	N / C
TDG 139%	1046.6	1047	N / C
Depth m	N/A		

Comments: 981

Report created July 01, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Jun-13
Arrival Time: 11:35
Departure Time: 12:30

Site:
RIGW

FMS ID	32545		32545	
Time	11:45		12:25	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	747.1	748.0	747.3	748.0
Temp ºC		13.2		13.3
TDGsat		116.3		116.0
TDG mmHg		870.0		868.0

Comments:

Calibration Type: Field
Probe ID: 32545
Date: 13-Jun-13
BP Station: 747.3 mmHg
Time: 11:55

	Std	Initial	Final
Temperature ºC	13.62	13.4	N / C
TDG 100%	747.3	748	N / C
TDG 113%	847.3	848	N / C
TDG 126%	947.3	948	N / C
TDG 139%	1047.3	1048	N / C
Depth m	N/A		

Comments: 946

Report created July 01, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jul-13
Arrival Time: 9:45
Departure Time: 10:10

Site:
RRH

	FMS ID	37607		37607	
	Time	9:50		10:05	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		739.7	738.0	739.7	738.0
Temp ºC			16.7		16.7
TDGsat			112.5		112.7
TDG mmHg			830.0		832.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 10-Jul-13
BP Station: 739.7 mmHg
Time: 9:55

	Std	Initial	Final
Temperature ºC	17.26	17.2	N / C
TDG 100%	739.7	741	740
TDG 113%	839.7	841	840
TDG 126%	939.7	941	940
TDG 139%	1039.7	1042	1040
Depth m	N/A		

Comments: 924

Report created July 29, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jul-13
Arrival Time: 9:00
Departure Time: 9:35

Site:
RRDW

	FMS ID	38865		38865	
	Time	9:15		9:30	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		741.9	739.0	741.9	739.0
Temp ºC			6.2		16.6
TDGsat			114.9		116.6
TDG mmHg			849.0		862.0

Comments:

Calibration Type: Field
Probe ID: 38865
Date: 10-Jul-13
BP Station: 741.9 mmHg
Time: 9:20

	Std	Initial	Final
Temperature ºC	17.36	17.2	N / C
TDG 100%	741.9	741	N / C
TDG 113%	841.9	840	N / C
TDG 126%	941.9	940	N / C
TDG 139%	1041.9	1041	N / C
Depth m	N/A		

Comments: 1039

Report created July 29, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jul-13
Arrival Time: 11:00
Departure Time: 11:30

Site:
RIS

FMS ID	37606		37606	
Time	11:05		11:25	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	741.3	743.0	741.3	743.0
Temp ºC		16.6		16.6
TDGsat		111.7		113.9
TDG mmHg		830.0		846.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 10-Jul-13
BP Station: 741.3 mmHg
Time: 11:10

	Std	Initial	Final
Temperature ºC	17.19	17.1	N / C
TDG 100%	741.3	742	N / C
TDG 113%	841.3	841	N / C
TDG 126%	941.3	941	N / C
TDG 139%	1041.3	1041	N / C
Depth m	N/A		

Comments: 966

Report created July 29, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jul-13
Arrival Time: 11:50
Departure Time: 12:30

Site:
RIGW

FMS ID	32545		32545	
Time	12:00		12:25	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	742.3	743.0	742.3	743.0
Temp ºC		16.6		16.6
TDGsat		116.8		115.6
TDG mmHg		868.0		859.0

Comments:

Calibration Type: Field
Probe ID: 32545
Date: 10-Jul-13
BP Station: 742.3 mmHg
Time: 12:10

	Std	Initial	Final
Temperature ºC	18.31	18.2	N / C
TDG 100%	742.3	743	N / C
TDG 113%	842.3	843	N / C
TDG 126%	942.3	943	N / C
TDG 139%	1042.3	1043	N / C
Depth m	N/A		

Comments: 940

Report created July 29, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Aug-13
Arrival Time: 9:00
Departure Time: 9:35

Site:
RRH

	FMS ID	37607		37607	
	Time	9:05		9:30	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		741.7	740.0	741.7	740.0
Temp °C			18.9		18.9
TDGsat			110.9		109.7
TDG mmHg			821.0		812.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 07-Aug-13
BP Station: 741.7 mmHg
Time: 9:10

	Std	Initial	Final
Temperature °C	19.12	19.1	N / C
TDG 100%	741.7	741	N / C
TDG 113%	841.7	841	N / C
TDG 126%	941.7	941	N / C
TDG 139%	1041.7	1041	N / C
Depth m	N/A		

Comments: 932

Report created September 04, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Aug-13
Arrival Time: 8:20
Departure Time: 8:50

Site:
RRDW

FMS ID	38865		38865	
Time	8:30		8:45	
	2°std	FMS	2°std	FMS
Depth m				
BP mmHg	743.4	740.0	743.4	740.0
Temp ºC		18.9		18.9
TDGsat		113.9		113.9
TDG mmHg		843.0		843.0

Comments:

Calibration Type: Field
Probe ID: 38865
Date: 07-Aug-13
BP Station: 743.4 mmHg
Time: 8:35

	Std	Initial	Final
Temperature ºC	19	18.9	N / C
TDG 100%	743.4	741	743
TDG 113%	843.4	841	843
TDG 126%	943.4	941	943
TDG 139%	1043.4	1041	1043
Depth m	N/A		

Comments: 1102

Report created September 04, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Aug-13
Arrival Time: 10:10
Departure Time: 10:40

Site:
RIS

	FMS ID	37606		37606	
	Time	10:15		10:35	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		743.5	745.0	743.5	745.0
Temp ºC			18.9		18.9
TDGsat			109.9		109.4
TDG mmHg			819.0		815.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 07-Aug-13
BP Station: 743.5 mmHg
Time: 10:20

	Std	Initial	Final
Temperature ºC	19.27	19.2	N / C
TDG 100%	743.5	743	N / C
TDG 113%	843.5	843	N / C
TDG 126%	943.5	943	N / C
TDG 139%	1043.5	1043	N / C
Depth m	N/A		

Comments:

Report created September 04, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Aug-13
Arrival Time: 11:30
Departure Time: 12:30

Site:
RIGW

	FMS ID	32545		32545	
	Time	11:45		12:20	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		743.9	744.0	743.5	744.0
Temp °C			18.9		19.0
TDGsat			116.3		116.9
TDG mmHg			865.0		870.0

Comments:

Calibration Type: Field
Probe ID: 32545
Date: 07-Aug-13
BP Station: 743.9 mmHg
Time: 12:00

	Std	Initial	Final
Temperature °C	19.28	19.2	N / C
TDG 100%	743.9	745	N / C
TDG 113%	843.9	845	N / C
TDG 126%	943.9	945	N / C
TDG 139%	1043.9	1045	N / C
Depth m	N/A		

Comments: 945

Report created September 04, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Sep-13
Arrival Time: 11:55
Departure Time: 12:35

Site:
RRH

FMS ID	37607		37607	
Time	12:05		12:30	
	2°std	FMS	2°std	FMS
Depth m				
BP mmHg	744.9	744.0	744.7	744.0
Temp ºC		19.8		19.8
TDGsat		102.0		102.8
TDG mmHg		759.0		765.0

Comments:

Calibration Type: Field
Probe ID: 37607
Date: 19-Sep-13
BP Station: 744.8 mmHg
Time: 12:10

	Std	Initial	Final
Temperature ºC	20.51	20.5	N / C
TDG 100%	744.8	744	N / C
TDG 113%	844.8	844	N / C
TDG 126%	944.8	944	N / C
TDG 139%	1044.8	1044	N / C
Depth m	N/A		

Comments: 934

Report created October 07, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Sep-13
Arrival Time: 11:15
Departure Time: 11:50

Site:
RRDW

FMS ID	38865		38865	
Time	11:25		11:45	
	2°std	**FMS**	**2°std**	**FMS**
Depth m				
BP mmHg	747.6	744.0	747.6	744.0
Temp ºC		19.8		19.8
TDGsat		101.3		103.4
TDG mmHg		754.0		769.0

Comments:

Calibration Type: Field
Probe ID: 38865
Date: 19-Sep-13
BP Station: 747.6 mmHg
Time: 11:30

	Std	Initial	Final
Temperature ºC	19.78	19.7	N / C
TDG 100%	747.6	747	N / C
TDG 113%	847.6	847	N / C
TDG 126%	947.6	947	N / C
TDG 139%	1047.6	1047	N / C
Depth m	N/A		

Comments: 1090

Report created October 07, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Sep-13
Arrival Time: 13:05
Departure Time: 13:40

Site:
RIS

FMS ID	37606		37606	
Time	13:10		13:35	
	2°std	FMS	2°std	FMS
Depth m				
BP mmHg	746.9	748.0	746.0	748.0
Temp ºC		19.8		19.8
TDGsat		101.6		102.9
TDG mmHg		760.0		770.0

Comments:

Calibration Type: Field
Probe ID: 37606
Date: 19-Sep-13
BP Station: 746.2 mmHg
Time: 13:15

	Std	Initial	Final
Temperature ºC	20.09	20	N / C
TDG 100%	746.2	745	746
TDG 113%	846.2	845	846
TDG 126%	946.2	945	946
TDG 139%	1046.2	1046	1046
Depth m	N/A		

Comments: 972

Report created October 07, 2013

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Sep-13
Arrival Time: 14:05
Departure Time: 14:50

Site:
RIGW

	FMS ID	32545		32545	
	Time	14:15		14:45	
		2°std	FMS	2°std	FMS
Depth m					
BP mmHg		747.2	748.0	746.9	747.0
Temp ºC			19.8		19.8
TDGsat			102.1		104.0
TDG mmHg			764.0		777.0

Comments:

Calibration Type: Field
Date: 19-Sep-13
Time: 14:20

Probe ID: 32545
BP Station: 747 mmHg

	Std	Initial	Final
Temperature ºC	20.81	20.6	N / C
TDG 100%	747	747	747
TDG 113%	847	847	846
TDG 126%	947	947	947
TDG 139%	1047	1048	1047
Depth m	N/A		

Comments: 951

Report created October 07, 2013

APPENDIX E: RESPONSE TO COMMENTS

Agency Comment	Chelan PUD Response
As we agreed, you will provide the spill analysis plan and the results (described under 4.1.1 No. 6 on the list of operational measures) for review and comment at a later time, but no later than within the March draft water quality report.	Agreed. The language in 4.1.1 has been revised to reflect this.
Could you identify the gates that were notched and the three over/under gates?	Gate numbers for each of these have been added.