Bitterman, Deborah

From: Frantz, Waikele M.
Sent: Monday, March 11, 2013 2:20 PM
To: Bitterman, Deborah
Subject: FW: Final 2012 Gas Abatement Annual Report
Attachments: FINAL 2012 Gas Abatement Annual Report.pdf

From: Frantz, Waikele M.
Sent: Thursday, December 27, 2012 12:50 PM
To: 'Irle, Pat (ECY)'; Charlie McKinney
Cc: Smith, Michelle
Subject: Final 2012 Gas Abatement Annual Report

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

To: Pat Irle, 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 2012 Gas Abatement Report

Please find attached the Final 2012 Gas Abatement Report for Rocky Reach and Rock Island hydroelectric projects.

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

Thank you,
Waikele Frantz
509-661-4627

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

2012 GAS ABATEMENT ANNUAL REPORT

Prepared by:

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

December 2012

FINAL

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

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 2012.

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 2012 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 2012 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 2012 fish spill season were higher than the 2002-2011 average (about 166% of average at Rocky Reach, and 163% of average at Rock Island) over the entire fish spill season. Due to these above average flows, high levels of involuntary spill occurred at both projects beginning in April and continuing through July at both projects.

During the 2012 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 – May 25). However, due to high river flows, approximately 16.3% of the daily average flow was spilled involuntarily during this time. During the summer migration (May 26 – August 9), approximately 9% of the daily average flow was spilled voluntarily for fish, as required by the HCP. An additional 22.86% was spilled involuntarily during this same time due to high 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 1 – May 27), while 20% of the daily average flow was spilled voluntarily for during the summer migration (May 28 – August 18). An additional 6.39% and 5.88% were involuntarily spilled during the spring and summer migration, respectively, due to high river flows.

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria of 115% on 94 days. TDG exceeded the modified Washington State water quality TDG criteria on 58 days in the Rocky Reach tailrace (120%), 92 days in the Rock Island forebay (115%), and 66 days in Rock Island tailrace (120%) during this monitoring period. Numeric criteria were exceeded on 113 days in the Wanapum forebay (115%). These exceedances of the water quality criteria did not necessarily result in noncompliance, as many occurred during river flows that exceeded 7Q10 or when forebay TDG levels were above the numeric criteria. For instance some exceedances in the Rocky Reach tailrace, Rock Island forebay, Rock Island tailrace, and Wanapum forebay occurred when flows exceeded 7Q10. Additionally, some exceedances observed in the Rock Island and Wanapum forebays occurred when the upstream dam's forebay exceeded 115%. After eliminating exceedances that occurred when flows exceeded 7Q10 or 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%)	99.9%
Rocky Reach Tailrace (120%)	76%
Rock Island Forebay (115%)	89%
Rock Island Tailrace (125%)	93.6%
Rock Island Tailrace (120%)	66%
Wanapum Forebay (115%)	62%

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 2012 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
   These gates 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
   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 an 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 in place prior to the initiation of the 2007 spill season and these were utilized in 2008 - 2011, and again in 2012.

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 (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 February 2012 and received approval for both plans in April 2012.

The amount of control that Chelan PUD has over TDG supersaturation 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 mainstem 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 2012 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.

2. OPERATIONS

2.1 Description of 2012 Fish Spill Season Flow Characteristics

Mean daily discharge during the 2012 fish spill season was compared to the 10-year average of mean daily flows from 2002-2011, as measured at the Rocky Reach Hydroelectric Project (Figure 5) and the Rock Island Hydroelectric Project (Figure 6). Mean daily flow discharges during the 2012 fish spill season were higher than the 2002-2011 average (about 166% of average at Rocky Reach, and 163% of average at Rock Island) over the entire fish spill season. Flow for all months during the spill season 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 327 kcfs and 323 kcfs, respectively, on July 5. Of the 153 days during the spill season (April 1 – August 31), there were 35 and 30 instances where the daily average flows exceeded the 7Q10 value at Rocky Reach and Rock Island, respectively.

Figure 5. Comparison of 2012 vs previous 10-year average (2002-2011) of mean daily discharge at Rocky Reach Hydroelectric Project.

Figure 6. Comparison of 2012 vs previous 10-year average (2002-2011) of mean daily discharge at Rock Island Hydroelectric Project.

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.

Section 5.4(1)(b) of the 401 Water Quality Certification requires Chelan PUD to implement alternative spillway operations, using any of gates 2 through 12, to determine, in consultation with the Rocky Reach Fish Forum (RRFF) and HCP Coordinating Committee, whether TDG levels can be reduced without adverse effects on fish passage. Chelan PUD continued a test initiated in 2011 (see below for description) to determine if any of three established spillway configurations could be used to reduce TDG.

In 2011, high flow volumes and high levels of TDG in the Columbia River provided an opportunity for Chelan PUD to implement a test of spillway operations not previously tested under the high-flow conditions. The purpose was to evaluate the effectiveness of alternative operations using gates 2-12, to determine whether TDG levels could be reduced without adverse effects on fish passage. The testing utilized four spill configurations: standard (also referred to as "fish spill"), TDG Spill Pattern, Shallow Arc Spill, and Flattened Spill Pattern. This testing did not require any modifications to the TDG monitoring conducted on an annual basis.

The study was conducted from early June to the end of July while river flows were high. The testing schedule established that each configuration was to be run for 24 hours at a time (midnight to midnight, until the end of June; and 0700 -0700 until the end of the study). Upon the completion of one scenario, another would begin.

The data from this first year of testing showed some promise, but not enough data was collected to make a determination as to which, if any, of the three alternate configurations would be effective at minimizing TDG without adversely affecting fish passage. For this reason, Chelan PUD conducted another round of testing in 2012.

The same three alternate configurations were tested, along with the Standard ("fish spill") configuration in 2012. However, the testing schedule was revised such that the alternate (not Standard) spill configurations were tested for 12 hrs from 0710 hrs to 1910 hrs Monday – Friday during the course of the

study. The Standard Spill pattern was utilized between 1910 hrs and 0710 hrs Monday-Friday and all day Saturday and Sunday.

Chelan PUD is currently working with a consultant to analyze the two years' of data in hopes of establishing one of the alternate configurations as being effective at minimizing TDG and will provide Ecology a status update on the analysis when it becomes available.

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 2012 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. Due to the level of incoming gas levels and flows, these changes in spill pattern were not as successful at maintaining gas levels below 120% as they have been in previous years.

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 2012 Rocky Reach and Rock Island Gas Abatement Plans.

In 2012, spill events at Rocky Reach were involuntary April 1 – May 25 (spring), both voluntary and involuntary May 26 – early-August, and voluntary through August 9 (end of summer fish spill). Of the total volume of water spilled at Rocky Reach April 1 – May 25, 100% was involuntary. Between May 26 and August 9 (summer), 28.2% of the total volume spilled was voluntary, while 71.8% was involuntary. Spill events at Rock Island were involuntary April 1 – April 16, voluntary April 17 – May 27, both voluntary and involuntary May 28 – late-July, and voluntary July 27 – August 18 (end of summer fish spill). Of the total volume of water spilled at Rock Island April 1 – April 16, 100% was involuntary. Of the total volume of water spilled at Rock Island April 17 – May 27 , 61% was voluntary and 39% was involuntary. Between May 28 and August 18, 77.3% of the total volume of water spilled was voluntary, while 22.7% was involuntary at Rock Island. All involuntary spill was a result of high river flows.

Monthly average spills ranged from 7.75 to 104.85 thousand cubic feet per second (kcfs) (Table 1) at Rocky Reach, and from 16.81 to 69.87 kcfs at Rock Island (Table 2). Minimum and maximum daily average spills at Rocky Reach varied from 0 to 139.6 kcfs and from 0 to 121.9 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, 2012.

				Spill Purpose					
				Fish Spill			Other		
	Average Flow Kcfs	Average Spill Kcfs	Misc Flow	Spill Kcfs	% of flow	% of Total Spill	Spill Kcfs	% of flow	% of Total Spill
April	170.01	20.82	0.43	0	0	0	20.83	12.3	100
May	212.67	39.95	0.43	3.08	1.4	7.7	36.87	17.34	92.3
June	234.91	69.07	0.43	21.18	9	30.7	47.88	20.4	69.3
July	257.28	104.85	0.43	23.19	9.1	22	81.67	32.1	78
August	158.37	7.75	0.43	4.88	3.1	63	2.87	1.8	37

Table 2. Average monthly total flow, spill, and percent of total flow spilled for different purposes at

Rock Island, April 1 - August 31, 2012.

	Average Flow Kcfs	Average Spill Kcfs	Misc Flow	Spill Purpose					
				Fish Spill			Other		
				Spill Kcfs	% of flow	% of Total Spill	Spill Kcfs	% of flow	% of Total Spill
April	173.36	16.81	1.5	8.85	5.1	52.6	7.96	4.6	47.4
May	216.21	37.68	1.5	24.41	11.3	64.8	13.27	6.1	35.2
June	238.47	66.15	1.5	48.36	20.3	73	17.79	7.5	27
July	256.84	69.87	1.5	52.56	20.5	75	17.31	6.7	25
August	160.76	19.91	1.5	19.87	12.4	99.8	0.04	.02	0.2

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 2012, Chelan PUD operated the juvenile fish bypass system exclusively with no voluntary spill for yearling Chinook, steelhead, and sockeye passage. However, high 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 2012. The summer spill program for subyearling Chinook began on May 26 and ended on August 9. Percent daily river flow spilled during the summer spill season amounted to 31.86%; however, only 9% was spill for fish, while the remaining 22.86% 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 2012.

Table 3. Summary of juvenile fish passage operations at Rocky Reach, April 1 - August 31, 2012.

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 – May 25)
26-May	Summer Spill Initiated	9% of daily average river flow	Spill for sub-yearling (summer) Chinook
9-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 May 27. Total spill during the spring fish spill season amounted to 16.39%; however, only 10% was spill for fish, while the remaining 6.39% was involuntary spill due to high river flows.

Rock Island fish spill increased to 20% upon onset of the summer outmigration of subyearling Chinook. Summer spill commenced on May 28 and continued through August 18. Total spill during the summer fish spill season amounted to 25.88%; however, only 20% was spill for fish, while the remaining 5.88% was involuntary spill due to high river flows.

Table 4 below provides a summary of the Juvenile Fish Passage Operations at Rock Island in 2012.

Table 4. Summary of juvenile fish passage operations at Rock Island, April 1 - August 31, 2012.

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

3. IMPLEMENTATION RESULTS

3.1 Fisheries Management

No survival studies were conducted in 2012 on spring migrants (yearling Chinook, steelhead, and sockeye), 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, as required by Section 5.4(1)(c) of the Rocky Reach 401 Water Quality Certification, Chelan PUD is developing a plan to study GBT below Rocky Reach Dam. Implementation of this study is not expected to occur before 2013.

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 18 April and 14 August 2012. 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 2012 monitoring, 2,687 smolts were examined for GBT. Of these, 49, or 1.82%, showed signs of GBT. Elevated signs and levels of GBT can be attributed to higher than normal flows throughout the system causing involuntary spill and elevating the levels of TDG in the Columbia River from Grand Coulee Dam to Priest Rapids Dam. Table 5 provides the summary results of 2012 GBT monitoring.

Table 5. Summary of Gas Bubble Trauma examinations at Rock Island in 2012.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		N	%	N	%	N	%
Chinook yearling	818	9	1.10%	9	1.10%	0	0.00%
Steelhead	586	10	1.71%	8	1.37%	2	0.34%
Chinook Sub-yearling	1283	30	2.34%	29	2.26%	1	0.08%
Total	2687	49	1.82%	46	1.71%	3	0.11%

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 November 15 this year and this section will be updated after that time.

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, 2012. 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 2012 monitoring season (April 1 - August 31), 98% and 99.9% of all possible data were collected at the Rocky Reach forebay and tailrace FMS, respectively. At the Rock Island forebay FMS, 99.1% of all possible data was collected, while at the Rock Island tailrace FMS, 96.4% of all possible data was collected (Table 8).

The causes of the data losses include a blown TDG membrane in the Rock Island forebay instrument, failure of infrastructure in the Rock Island tailrace, and unknown causes in the Rocky Reach forebay and tailrace.

Table 6. Overview of total dissolved gas data set during 2012 fish spill season.

Location	Available data collection hours	Number of omitted/ lost hourly readings	Percent data completeness (%)
RRFB	3672	72	98%
RRTR	3672	3	99.9%
RIFB	3672	32	99.1%
RITR	3672	132	96.4%
Total	14,688	239	98.4%

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 2012 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, 2012.

Location	Mean	Minimum	Maximum
Rocky Reach Forebay	119	105	131
Rocky Reach Tailrace	118	106	130
Rock Island Forebay	118	106	130
Rock Island Tailrace	120	105	133
Wanapum Forebay	118	106	130

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.

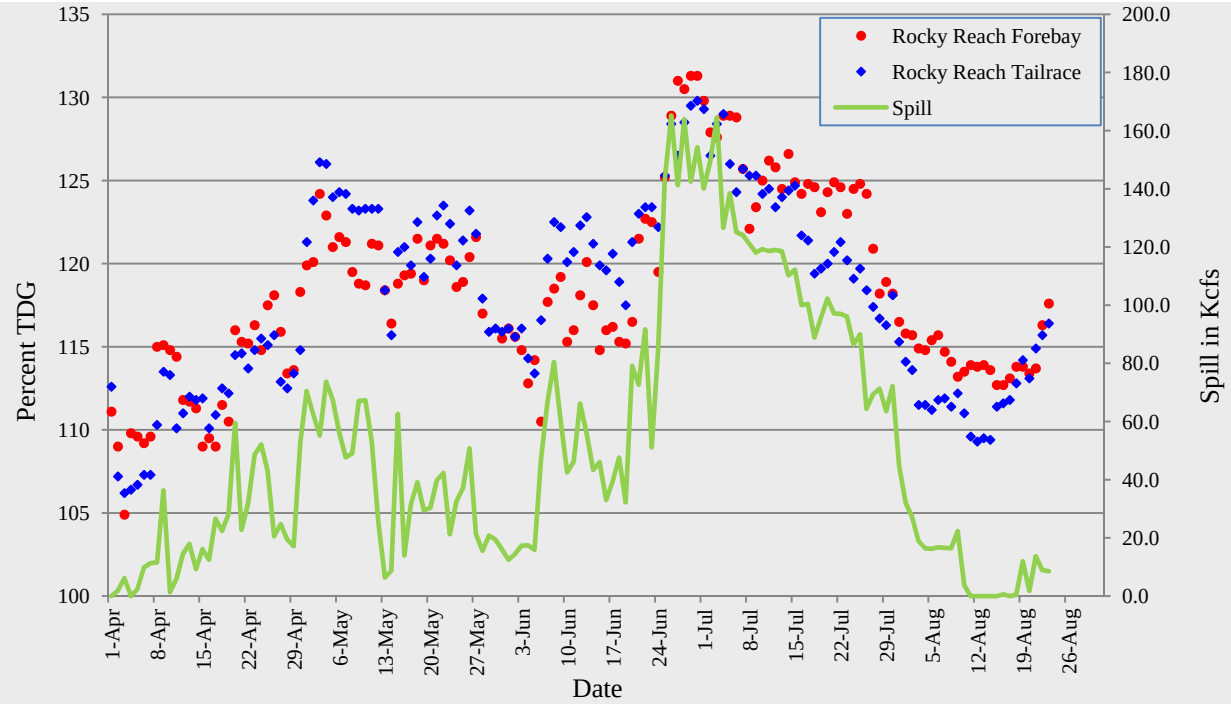

Figure 7. Spill and daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rocky Reach Dam during the 2012 fish spill season.

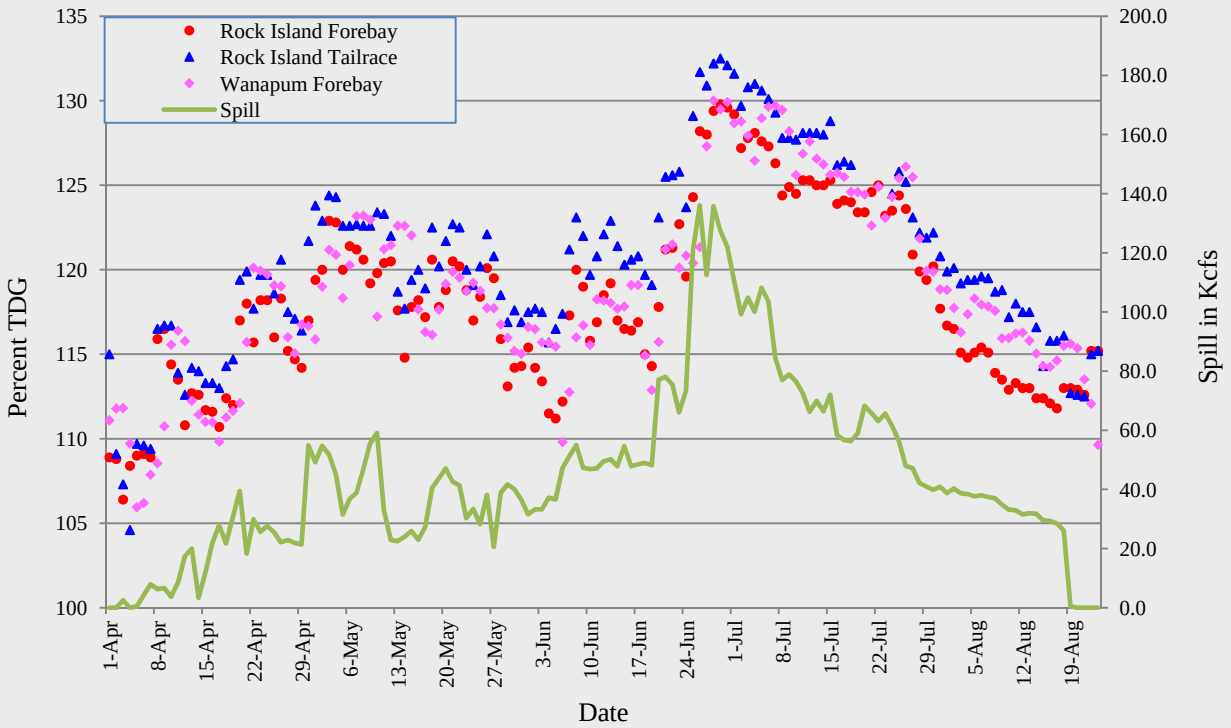

Figure 8. Spill and daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rock Island Dam and Wanapum forebay during the 2012 fish spill season.

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, 2012, TDG levels in the Rocky Reach forebay averaged 118% and ranged from 105% to 131%. TDG levels in the tailrace averaged 118% and ranged from 106% to 130%. The average (based on the 12 highest consecutive hours) change in percent TDG from the forebay to the tailrace was a decrease of 0.3%, ranging from a decrease of 5.8% to an increase of 6.1%. A summary of this data can be found in Tables 7 and 8.

Regression analysis showed a weak relationship between the total volume spilled to percent change in TDG (r^2=0.01, Figure 9). This compares well to previous years, with the exception of 2007, when the relationship was strong. 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.

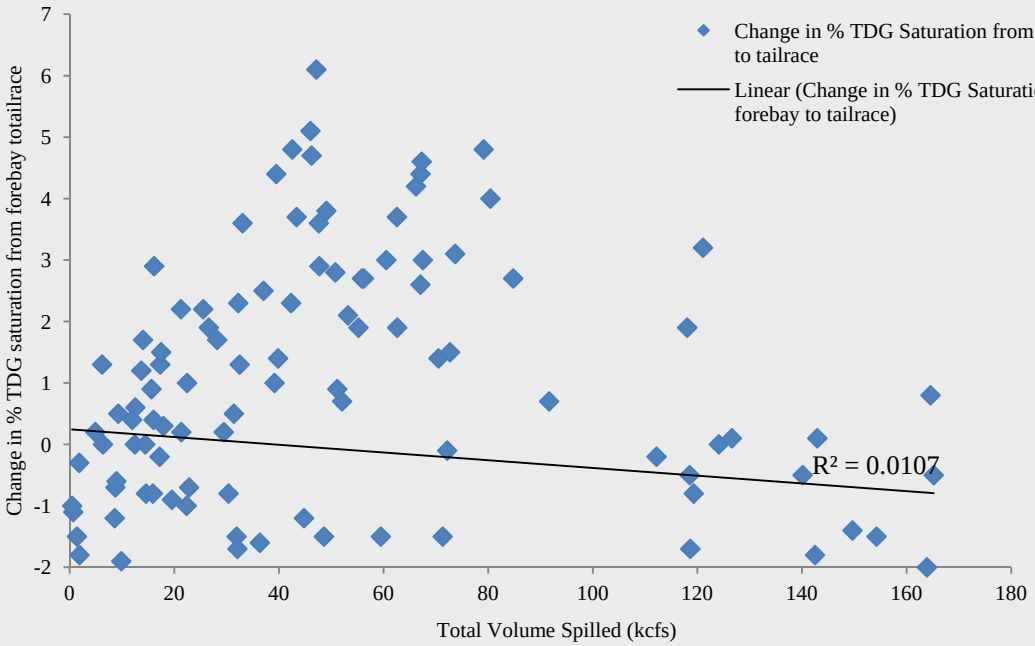

Figure 9. Total volume spilled to percent change in TDG from Rocky Reach forebay to Rocky tailrace, April 1 - August 31, 2012..

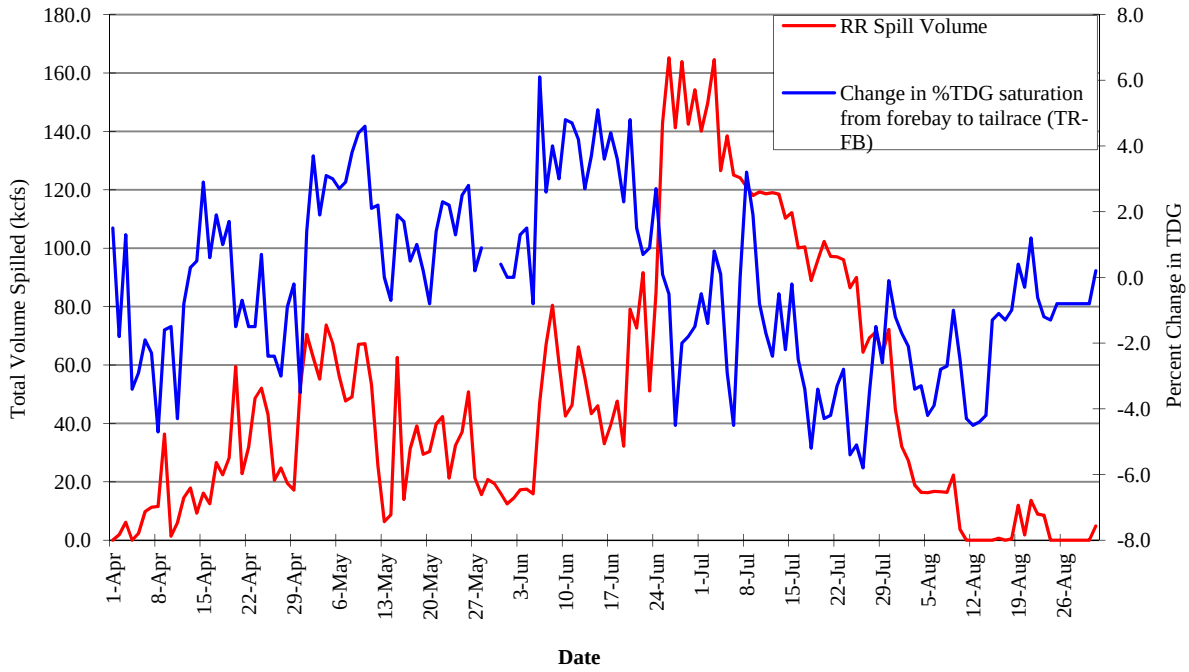

Figure 10. Total volume spilled to percent change in TDG from forebay to tailrace at Rocky Reach Project, April 1 - Aug 31, 2012.

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, 2012, TDG levels in the Rock Island forebay averaged 118% and ranged from 106% to 130%. TDG levels in the tailrace averaged 120% and ranged from 105% to 133%. 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 3.8% to an increase 6.1%. A summary of this data can be found in Tables 7 and 8.

Regression analysis showed a weak relationship between the total volume spilled to percent change in TDG (r^2=.0123, Figure 11). This compares well to previous years, with the exception of 2007 when the relationship was strong. 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.

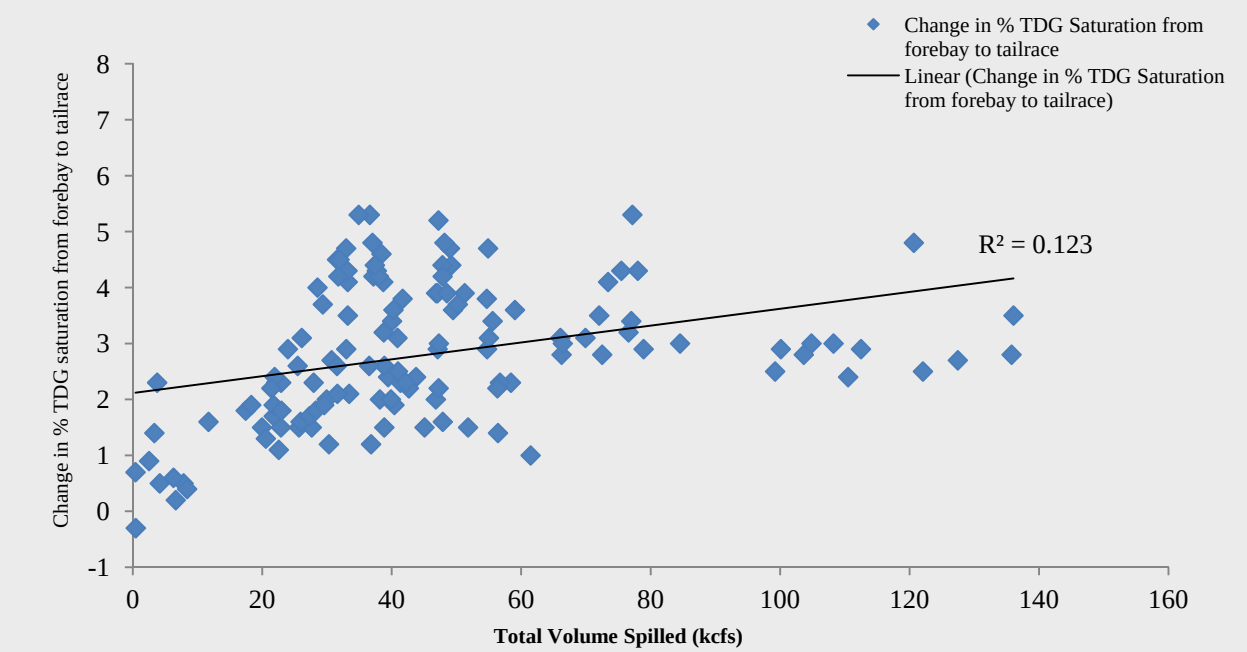

Figure 11. Total volume spilled to percent change in TDG from Rock Island forebay to Rock Island tailrace, April 1 - August 31, 2012.

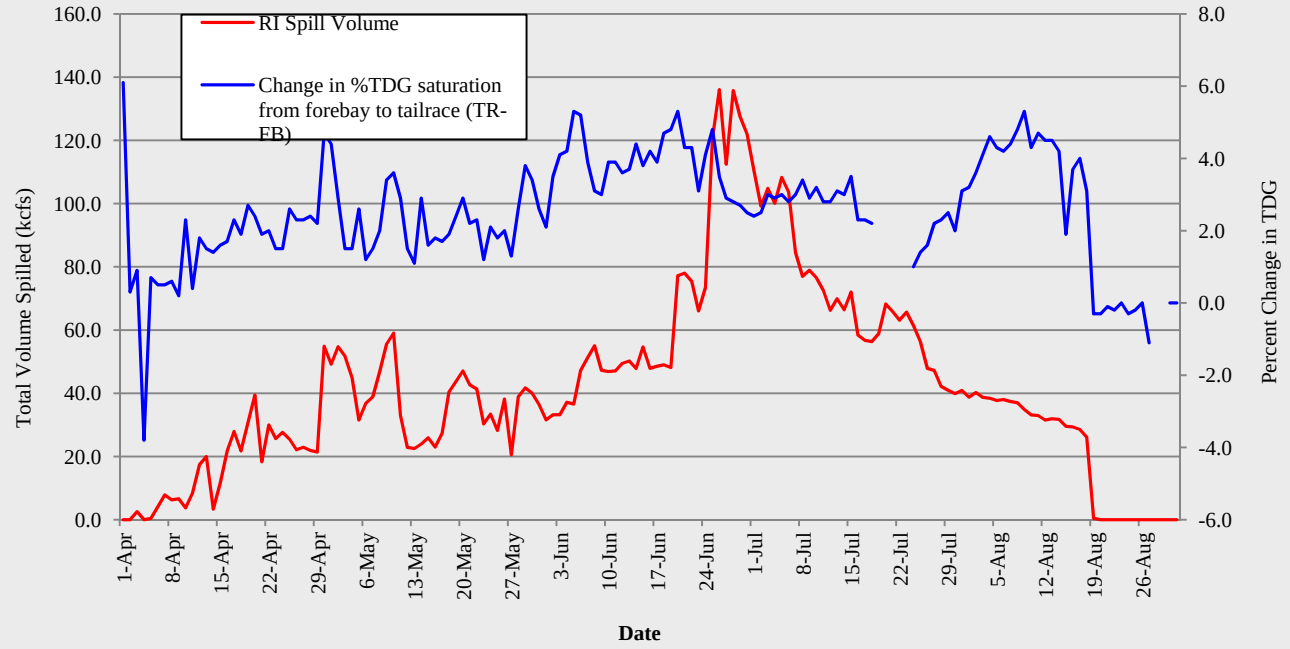

Figure 12. Total volume spilled to percent change in TDG from forebay to tailrace at Rock Island Project, April 1 - Aug 31, 2012.

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 2012 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, 2012.

	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	20.9	11.3	-1.0	16.8	9.1	1.6
May	39.8	18.1	1.8	37.8	17.2	2.3
June	69.1	26.9	1.9	66.2	26.4	3.9
July	104.7	40.8	-2.1	69.7	26.6	2.6
August	7.7	4.3	-1.8	19.9	11.6	2.4
Average*	48.5	20.3	-0.3	42.1	18.2	2.6
(Range)	(0-165.2)	(0-57.8)	(-5.8-6.1)	(0-136)	(0-42.5)	(-3.8-6.1)

***Averages and ranges shown here are of all daily 12-highest consecutive hours, not averages or ranges of the monthly averages.**

3.4.2.3 Wanapum Forebay

From April 1 to August 31, 2012, TDG levels in the Wanapum forebay averaged 118% and ranged from 106% to 130%.

3.4.3 Discussion of Exceedances

At both Rocky Reach and Rock Island dams, there are three compliance criteria for the 2012 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 94 days (62% of the total number of days observed). TDG exceeded the modified Washington State TDG fish spill water quality criteria on 58 days (38% of the total number of days observed) in the Rocky Reach tailrace, 92 days (61% of the total number of days observed) in the Rock Island forebay, and 66 days (45% of the total numbers of days observed) in the Rock Island tailrace during this monitoring period. Numeric criteria were exceeded on 113 days (74% 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 occurred during river flows that exceeded 7Q10 or when upstream forebay TDG levels were above the numeric criteria.

When the average of the 12 highest consecutive hourly discharge values in a 24-hour period exceeded the 7Q10 for the project; or when the upstream 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 below.

3.4.3.1 Rocky Reach

Tailrace 125% Standard

Total hours of TDG data collected during the 2012 fish spill season in the Rocky Reach tailrace equaled 3,664. Of these 3,664 hours; however, 875 hours were omitted from the data set due to flows in

exceedance of the 7Q10 flow. Of the remaining 2,789 hours when flows were below the 7Q10 flow, hourly tailrace TDG levels exceeded 125% **for 2 hours**.
Compliance with this standard was 99.9%.

Tailrace 120% Standard

TDG data was collected on 153 days during the 2012 fish spill season in the Rocky Reach tailrace. However, of those 153 days 35 were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. Of the remaining 118 days when flows were below the 7Q10 flow, the tailrace 12C-High TDG exceeded 120% on **28 days**.
Compliance with this standard was 76%.

Downstream (Rock Island) Forebay 115% Standard

TDG data was collected on 151 days during the 2012 fish spill season in the Rock Island forebay. However, of those 151 days 94 were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows or upstream forebay 12C-High TDG exceeding 115% . Of the remaining 57 days when flows were below the 7Q10 flow and the upstream forebay 12C-High TDG was below 115%, the Rock Island forebay 12C-High TDG exceeded 115% on **6 days**.
Compliance with this standard was 89%

3.4.3.2 Rock Island

Tailrace 125% Standard

Total hours of TDG data collected during the 2012 fish spill season in the Rock Island tailrace equaled 3,515. Of these 3,515 hours; however, 692 hours were omitted from the data set due to flows in exceedance of the 7Q10 flow. Of the remaining 2,823 hours when flows were below the 7Q10 flow, hourly tailrace TDG levels exceeded 125% for **181 hours.**
Compliance with this standard was 93.6%.

Tailrace 120% Standard

TDG data was collected on 148 days during the 2012 fish spill season in the Rock Island tailrace. However, of those 148 days 30 were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. Of the remaining 118 days when flows were below the 7Q10 flow, the tailrace 12C-High TDG exceeded 120% **on 40 days**.
Compliance with this standard was 66%.

Downstream (Wanapum) Forebay 115% Standard

TDG data was collected on 153 days during the 2012 fish spill season in the Wanapum forebay. However, of those 153 days 90 were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows or upstream forebay 12C-High TDG exceeding 115% .Of the remaining 63 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 24 days.

Compliance with this standard was 62%.

Table 9. Number of 2012 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	28	153	18	2	3664	-
RIFB	6	151	4			
RITR	40	148	27	181	3515	5
WANFB	24	153	16			
Total	98	605	16	183	7179	2.5

*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)

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).

Beginning in September 2011, Chelan PUD began leaving monitoring equipment in place during the non-fish spill season so as to be able to monitor TDG levels year round.

Between January 1 and March 31, 2012, the 110% criterion was exceeded 52, 61, 70, and 0 hours in the Rocky Reach tailrace, Rock Island forebay, Rock Island tailrace, and Wanapum forebay, respectively. Overall compliance January 1 – March 31 was 97.9%. All exceedances occurred March 28-31.

Between September 1 and December 25, 2012, the 110% criterion was exceeded on no hours at any of the FMS, resulting in overall compliance from September 1 to December 25 of 100%.

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 on March 17, 2012. The purpose of this meeting was to discuss alternative actions to mitigate the high TDG values that were anticipated to accompany the high flow conditions. This meeting brought together representatives from Natural Resources, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Association (BPA) and the Corps. Discussions included topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resources requirements (e.g. Hanford Reach fall Chinook flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.
- 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 Rock Island's unique water passage capabilities. Several of the units at the Rock Island project can pass flow through the turbines without producing power (sluicing)*. Water exiting the turbines is discharged below the tailwater surface thus, not contributing to the production of TDG. In addition two of the project's spill gates also discharge below the tailwater surface. Water passed by either of these methods is classified as spilled energy. In certain conditions, these capabilities offer 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.

*It needs to be noted that although the "sluicing" operation at Rock Island was successful at mitigating TDG to some extent, it is not known at this time if it will be possible to implement this operation in the future due to wear and tear on equipment.

- 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.

4. TOTAL DISSOLVED GAS ABATEMENT MEASURES IMPLEMENTED IN 2012

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 2012 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 2012 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 testing three alternate spillway configurations to determine if any would be efficient at minimizing TDG.

Table 10. Rocky Reach fish spill comparison, 2003-2012.

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**	

* 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, 2003-2012.

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**	

* 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 2012 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 2012.

At Rock Island Dam, Chelan PUD utilized the notched gates, the spill deflector, and the Over/Under spill gates during 2012 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.

5. CONCLUSIONS

TDG values were elevated throughout the mid-Columbia River for much of the 2012 fish-spill season due to a higher than normal run-off, which resulted in high incoming TDG levels and flows in excess of the established 7Q10 flow for Rocky Reach and Rock Island dams. The flows exceeding 7Q10 values resulted in increased involuntary spill at both projects, as well as the rest of the Mid-C. 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.

During the 2012 fish spill season, 70% of all TDG exceedances (in the Rocky Reach tailrace, Rock Island forebay and tailrace, and Wanapum forebay) occurred when either flow volumes were greater than the 7Q10 flows or 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%)	99.9%
Rocky Reach Tailrace (120%)	76%
Rock Island Forebay (115%)	89%
Rock Island Tailrace (125%)	93.6%
Rock Island Tailrace (120%)	66%
Wanapum Forebay (115%)	62%

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.

LITERATURE CITED

Pickett, P., H. Rueda, and M. Herold. *Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt.* Washington State Department of Ecology, Olympia,WA, and U.S. Environmental Protection Agency, Portland, OR. June 2004.

Schneider, Michael L. and Steven C. Wilhelms. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management.U.S. Army Engineer Research and Development Center, Vicksburg, MS. 2005.

Steig, T.W., K.K. Kumagai, B.J. Rowdon, c.P. Mott and C. Tunnicliffe. 2011. Route Specific passage and juvenile Chinook and steelhead salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2010. Final report for Chelan County Public Utility District No. 1, Wenatchee, WA., by Hydroacoustic Technology, Inc, Seattle WA.

APPENDIX A

TDG Operational Plans

Rocky Reach and Rock Island

2012 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 visa versa for the opening process.

2012 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 visa versa for the opening process.

APPENDIX B

2012

Total Dissolved Gas Abatement Plan
Rocky Reach Hydroelectric Project

http://www.chelanpud.org/rr-Resource-Documents-WaterQuality.cfm

APPENDIX C

2012

Total Dissolved Gas Abatement Plan
Rock Island Hydroelectric Project

http://www.chelanpud.org/8048.html

APPENDIX D

Dissolved Gas Levels at Rocky Reach,
Rock Island, and Wanapum Projects, 2012

April 2012. 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 (% total spill)			
																				Rocky Reach		Rock Island	
2012	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	111	110	112	113	108	110	109	109	110	115	109	110	111	0.0	0.0	117.8	126.4	0.0	0.0	0	100	0	100
2-Apr	109	105	108	107	105	106	109	106	108	109	106	109	112	1.9	0.0	143.7	145.8	1.1	0.0	0	100	0	100
3-Apr	105	104	105	106	105	107	106	105	108	107	106	109	112	6.2	2.5	160.0	164.3	3.2	1.3	0	100	0	100
4-Apr	110	108	110	106	105	107	108	105	110	105	103	104	110	0.0	0.0	148.8	152.5	0.0	0.0	0	100	0	100
5-Apr	110	109	110	107	107	107	109	108	110	110	109	110	106	2.4	0.4	162.0	162.8	1.2	0.2	0	100	0	100
6-Apr	109	109	110	107	107	108	109	108	110	110	109	110	106	9.8	4.2	165.9	166.9	5.6	2.5	0	100	0	100
7-Apr	110	109	112	107	107	109	109	108	109	109	109	110	108	11.3	7.8	162.4	163.3	6.2	4.4	0	100	0	100
8-Apr	115	115	116	110	109	111	**116**	114	116	117	114	117	109	11.6	6.3	150.3	156.1	7.7	4.1	0	100	0	100
9-Apr	115	115	115	114	113	114	**117**	116	117	117	116	117	111	36.3	6.6	174.1	171.6	20.8	4.1	0	100	0	100
10-Apr	115	114	115	113	111	113	114	114	116	117	114	116	**116**	1.4	3.8	169.9	173.2	0.9	2.1	0	100	0	100
11-Apr	114	112	113	110	110	111	114	111	114	114	112	114	**116**	6.0	8.4	160.2	157.9	3.4	5.1	0	100	0	100
12-Apr	112	111	111	111	110	112	111	111	112	113	112	113	**116**	14.6	17.4	165.1	168.3	8.7	10.4	0	100	0	100
13-Apr	112	111	112	112	112	112	113	112	114	114	113	115	112	17.9	20.0	167.1	169.5	10.8	11.8	0	100	0	100
14-Apr	111	110	110	112	110	112	113	110	111	114	111	113	111	9.3	3.3	143.1	144.0	5.4	2.2	0	100	0	100
15-Apr	109	110	110	112	111	113	112	110	112	113	111	114	111	16.1	11.7	163.3	169.4	9.3	7.3	0	100	0	100
16-Apr	110	108	109	110	108	111	112	108	110	113	110	112	111	12.5	21.8	163.5	161.7	7.2	13.0	0	100	0	100
17-Apr	109	108	110	111	110	113	111	110	112	113	113	114	110	26.6	27.9	176.2	178.7	14.5	15.6	0	100	64	36
18-Apr	112	111	112	113	112	113	112	111	113	114	114	115	111	22.4	21.8	166.5	172.7	13.6	12.8	0	100	79	21
19-Apr	111	109	111	112	111	113	112	110	113	115	113	116	112	28.2	30.7	179.9	184.1	15.0	16.2	0	100	60	40
20-Apr	**116**	114	117	115	114	116	**117**	114	119	119	117	120	112	59.5	39.4	187.1	191.4	31.5	20.4	0	100	49	51
21-Apr	115	115	116	115	114	115	**118**	116	119	120	117	120	**116**	22.8	18.3	176.3	182.1	12.8	10.1	0	100	99	1
22-Apr	115	114	114	114	113	115	**116**	115	116	118	117	118	**120**	31.9	30.0	187.8	191.9	16.9	15.5	0	100	64	36
23-Apr	**116**	116	117	115	114	117	**118**	116	120	120	118	121	**120**	48.6	25.7	190.5	194.2	25.2	13.2	0	100	76	24
24-Apr	115	115	115	116	115	117	**118**	116	117	120	118	119	**120**	52.1	27.6	203.2	208.0	25.8	13.2	0	100	75	25
25-Apr	**118**	116	118	115	114	118	**116**	116	117	119	118	120	**119**	43.1	25.5	179.0	186.0	23.0	13.5	0	100	73	27
26-Apr	**118**	117	118	116	114	117	**118**	117	119	**121**	119	122	**119**	20.6	22.1	156.0	168.8	13.2	13.0	0	100	76	24
27-Apr	**116**	115	116	113	112	114	115	114	116	118	116	118	**116**	24.7	22.9	175.0	186.8	13.6	12.2	0	100	82	18
28-Apr	113	113	114	113	111	114	115	112	113	117	115	116	115	19.5	21.9	153.4	160.8	11.1	13.5	0	100	73	27
29-Apr	114	113	114	113	112	114	114	114	115	116	116	117	**117**	17.2	21.4	192.0	200.0	8.7	10.7	0	100	93	7
30-Apr	**118**	117	119	115	114	117	**117**	116	117	**122**	120	123	**117**	53	55	232	235	23	23	0	100	43	57

May 2012. 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 (% total spill)			
																				Rocky Reach		Rock Island	
2012	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	**120**	119	121	**121**	118	123	**119**	119	120	**124**	122	125	**116**	70.5	49.2	228.9	232.6	30.8	21.1	0	100	47	53
2-May	**120**	120	121	**124**	124	124	**120**	120	120	**123**	122	123	**119**	62.5	54.7	244.2	243.8	25.6	22.4	0	100	45	55
3-May	**124**	123	125	**126**	125	**126**	**123**	122	124	**124**	124	125	**121**	55.2	51.8	244.8	241.4	22.5	21.4	0	100	47	53
4-May	**123**	121	121	**126**	124	125	**123**	121	122	**124**	123	124	**121**	73.7	45.1	236.3	239.0	31.3	18.7	0	100	53	47
5-May	**121**	121	122	**124**	124	124	**120**	120	120	**123**	121	124	**118**	67.5	31.5	221.1	225.2	30.9	13.8	0	100	71	29
6-May	**122**	121	122	**124**	124	124	**121**	121	122	**123**	122	123	**120**	56.2	36.8	227.0	229.2	24.9	16.0	0	100	62	38
7-May	**121**	120	122	**124**	124	125	**121**	121	122	**123**	122	123	**123**	47.7	38.8	217.1	218.8	22.0	17.6	0	100	56	44
8-May	**120**	119	119	**123**	123	123	**121**	119	120	**123**	121	122	**123**	49.1	46.8	220.2	219.2	22.2	21.3	0	100	47	53
9-May	**119**	117	119	**123**	123	123	**119**	118	118	**123**	122	124	**123**	67.1	55.6	232.4	228.8	29.0	24.0	0	100	41	59
10-May	**119**	118	119	**123**	122	124	**120**	118	121	**123**	122	124	**117**	67.3	59.0	238.7	238.1	28.2	24.8	0	100	40	60
11-May	**121**	120	122	**123**	123	124	**120**	120	121	**123**	121	122	**121**	53.2	33.0	212.3	213.1	25.1	15.5	0	100	65	35
12-May	**121**	118	120	**123**	120	123	**121**	119	120	**122**	120	122	**121**	25.5	22.9	185.7	192.7	13.6	11.8	0	100	84	16
13-May	**118**	117	118	118	116	119	**118**	116	117	119	118	119	**123**	6.3	22.5	179.1	185.8	3.4	12.1	0	100	82	18
14-May	**116**	115	117	116	115	117	115	114	116	118	116	117	**123**	8.7	24.0	200.8	205.1	4.0	11.6	0	100	86	14
15-May	**119**	118	120	**121**	120	121	**118**	116	118	119	118	120	**122**	62.6	25.9	202.7	213.0	31.1	12.1	0	100	82	18
16-May	**119**	119	120	**121**	119	121	**118**	118	119	120	119	120	**118**	14.0	23.0	183.1	194.0	7.6	11.8	0	100	84	16
17-May	**119**	118	120	120	119	120	**117**	117	118	119	118	120	**116**	31.4	27.3	208.1	218.1	14.8	12.5	0	100	80	20
18-May	**122**	121	123	**123**	122	124	**121**	119	121	**123**	121	123	**116**	39.1	40.4	211.5	219.4	18.1	18.5	0	100	54	46
19-May	**119**	119	120	119	119	121	**118**	118	120	120	120	122	**118**	29.4	43.7	228.0	227.6	12.5	19.1	0	100	52	48
20-May	**121**	120	123	120	120	123	**119**	118	120	**122**	121	124	**119**	30.3	47.1	227.1	229.2	12.5	20.4	0	100	49	51
21-May	**122**	121	123	**123**	122	124	**121**	120	121	**123**	122	124	**120**	39.8	42.6	222.3	225.5	17.5	18.9	0	100	53	47
22-May	**121**	120	121	**124**	122	124	**120**	119	121	**123**	122	123	**120**	42.3	41.4	206.7	215.8	20.3	19.1	0	100	52	48
23-May	**120**	119	121	**122**	120	122	**119**	118	119	120	120	121	**119**	21.3	30.3	194.1	204.1	11.0	14.9	0	100	67	33
24-May	**119**	118	120	120	119	121	**117**	116	117	119	119	120	**119**	32.5	33.4	219.1	225.1	14.7	14.7	0	100	67	33
25-May	**119**	119	120	**121**	121	122	**118**	118	119	120	120	121	**119**	37.0	28.3	216.3	220.5	17.1	12.8	0	100	78	22
26-May	**120**	120	121	**123**	123	123	**120**	119	120	**122**	121	124	**118**	50.8	38.2	223.4	228.4	22.7	16.6	40	60	60	40
27-May	**122**	120	122	**122**	121	123	**120**	119	120	**121**	120	121	**118**	21.3	20.6	183.7	193.9	11.3	10.6	78	22	94	6
28-May	**117**	117	118	118	117	118	**116**	115	116	119	118	120	**117**	15.6	38.9	181.0	186.9	8.5	20.8	100	0	96	4
29-May				116	116	117	113	113	113	117	116	117	**116**	20.8	41.7	199.8	202.6	10.2	20.9	86	14	97	3
30-May				116	116	117	114	114	115	118	117	118	115	19.4	40.0	190.9	198.8	10.2	20.3	89	11	99	1
31-May	**116**	115	116	116	116	116	114	114	115	117	117	117	115	16.0	36.5	188.9	195.5	8.5	18.7	100	0	100	0

June 2012. 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 (% total spill) Rocky Reach		Rock Island	
2012	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	**116**	116	116	116	116	117	115	115	116	118	117	118	**117**	12.4	31.6	183.8	196.1	6.5	15.9	100	0	100	0
2-Jun	**116**	115	116	116	115	116	114	114	114	118	117	118	**116**	14.4	33.2	144.3	164.3	10.1	20.4	90	10	99	1
3-Jun	115	114	115	116	115	117	113	113	114	118	117	118	**116**	17.3	33.2	153.3	167.2	11.1	20.0	80	20	100	0
4-Jun	113	112	114	114	114	115	112	111	112	116	115	117	**116**	17.5	37.2	168.2	184.0	10.4	20.3	87	13	99	1
5-Jun	114	113	115	113	113	114	111	111	112	117	116	117	115	15.9	36.6	132.9	145.4	12.2	26.0	75	25	79	21
6-Jun	111	110	112	117	115	117	112	111	114	117	116	119	110	47.1	47.2	214.4	220.5	21.4	21.2	41	59	93	7
7-Jun	**118**	116	118	120	119	122	**117**	116	119	**121**	120	122	113	67.0	51.3	232.1	234.4	28.5	21.8	31	69	91	9
8-Jun	**119**	118	121	**123**	123	123	**120**	120	121	**123**	123	123	**116**	80.4	55.0	236.6	242.6	34.0	22.7	26	74	88	12
9-Jun	**119**	119	121	**122**	122	123	**119**	119	119	**122**	122	123	**117**	60.5	47.3	226.2	227.3	26.8	20.8	34	66	96	4
10-Jun	115	115	115	120	120	121	**116**	116	117	120	119	121	**116**	42.5	46.8	223.9	221.7	19.0	21.1	47	53	95	5
11-Jun	**116**	115	116	**121**	120	121	**117**	116	117	**121**	119	121	**118**	46.2	47.1	226.9	225.0	20.5	20.9	44	56	96	4
12-Jun	**118**	117	119	**122**	122	123	**119**	118	119	**122**	121	123	**118**	66.2	49.5	230.1	230.5	28.8	21.4	31	69	93	7
13-Jun	**120**	119	121	**123**	122	123	**119**	119	120	**123**	122	123	**118**	55.8	50.2	225.1	228.6	24.7	22.0	36	64	91	9
14-Jun	**118**	117	119	**121**	121	122	**117**	117	118	**121**	121	122	**118**	43.4	47.8	220.2	220.4	19.7	21.9	46	54	92	8
15-Jun	115	115	116	120	120	121	**117**	116	117	120	120	121	**118**	46.0	54.7	226.7	226.7	20.3	24.2	44	56	83	17
16-Jun	**116**	116	116	120	118	120	**116**	115	117	**121**	119	121	**119**	33.0	47.9	227.0	221.1	14.3	21.6	62	38	92	8
17-Jun	**116**	116	116	**121**	120	121	**117**	116	117	**121**	120	121	**119**	39.5	48.5	220.4	222.1	17.8	22.0	50	50	92	8
18-Jun	115	114	116	119	119	119	115	115	116	120	119	120	115	47.6	49.0	220.9	227.6	21.4	21.5	42	58	93	7
19-Jun	115	114	116	118	117	118	114	113	115	119	118	120	113	32.2	48.1	215.8	220.6	14.9	21.7	60	40	92	8
20-Jun	**117**	115	119	**121**	120	122	**118**	116	119	**123**	121	124	**116**	79.1	77.2	262.0	261.5	30.2	29.5	30	70	68	32
21-Jun	**122**	121	122	**123**	122	123	**121**	120	122	**126**	125	126	**121**	72.7	78.0	257.3	254.3	28.3	30.8	32	68	65	35
22-Jun	**123**	122	123	**123**	123	124	**121**	121	122	**126**	125	126	**122**	91.6	75.5	267.5	262.3	34.5	28.7	26	74	70	30
23-Jun	**123**	122	123	**123**	121	125	**123**	121	123	**126**	125	126	**120**	51.1	66.0	225.9	229.1	21.3	29.0	40	60	69	31
24-Jun	**120**	119	122	**122**	122	123	**120**	119	120	**124**	123	125	**121**	84.8	73.4	271.5	264.4	31.1	27.7	29	71	72	28
25-Jun	**125**	123	127	**125**	125	128	**124**	123	126	**129**	128	131	**120**	142.9	120.6	312.0	310.2	45.8	38.6	20	80	51	49
26-Jun	**129**	128	129	**128**	127	130	**128**	128	129	**132**	131	132	**121**	165.2	136.0	306.2	322.7	54.0	42.1	17	83	47	53
27-Jun	**131**	130	132	**127**	126	129	**128**	128	129	**131**	131	132	**127**	141.3	112.5	299.6	302.3	47.2	37.1	19	81	54	46
28-Jun	**131**	130	131	**129**	127	130	**129**	129	130	**132**	132	133	**130**	163.9	135.7	310.3	319.5	52.8	42.5	17	83	47	53
29-Jun	**131**	131	132	**130**	127	132	**130**	129	131	**133**	132	133	**129**	142.5	127.4	298.8	312.3	47.3	40.7	19	81	49	51
30-Jun	**131**	130	131	**130**	129	131	**130**	129	130	**132**	132	133	**130**	154.2	122.1	293.6	311.4	52.6	39.2	17	83	51	49

July 2012. 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 (% total spill)			
																				Rocky Reach		Rock Island	
2012	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	**130**	129	131	**129**	128	130	**129**	129	130	**132**	131	132	**129**	140.1	110.5	279.5	296.6	50.1	37.1	18	82	54	46
2-Jul	**128**	128	129	**127**	126	128	**127**	126	128	**130**	129	131	**129**	149.6	99.2	278.4	289.0	53.8	34.3	17	83	58	42
3-Jul	**128**	127	128	**128**	126	131	**128**	127	129	**131**	130	132	**128**	164.6	104.8	284.9	291.9	57.8	35.9	16	84	56	44
4-Jul	**129**	127	130	**129**	127	130	**128**	127	129	**131**	130	131	**126**	126.6	100.1	278.0	286.2	45.2	34.8	20	80	57	43
5-Jul	**129**	128	129	**126**	125	127	**128**	127	128	**131**	130	131	**129**	138.5	108.2	284.5	294.2	48.7	36.7	18	82	54	46
6-Jul	**129**	129	130	**124**	124	125	**127**	127	128	**130**	130	130	**130**	125.0	103.6	267.1	286.4	46.9	36.1	19	81	55	45
7-Jul	**126**	125	127	**126**	125	126	**126**	126	127	**129**	129	130	**130**	124.1	84.5	252.7	263.3	49.2	32.1	18	82	62	38
8-Jul	**122**	122	122	**125**	125	126	**124**	124	125	**128**	127	129	**129**	121.1	77.0	256.0	264.5	47.5	28.9	19	81	69	31
9-Jul	**123**	123	124	**125**	124	126	**125**	124	126	**128**	127	129	**128**	118.0	78.9	263.0	267.8	44.8	29.3	20	80	68	32
10-Jul	**125**	124	126	**124**	123	125	**125**	124	125	**128**	127	130	**126**	119.3	76.6	265.8	265.7	45.0	28.8	20	80	69	31
11-Jul	**126**	125	128	**125**	123	126	**125**	124	126	**128**	128	129	**127**	118.6	72.5	253.8	259.7	46.6	27.8	19	81	72	28
12-Jul	**126**	126	128	**123**	123	124	**125**	125	126	**128**	128	129	**128**	119.0	66.2	253.3	254.9	47.1	26.0	19	81	77	23
13-Jul	**125**	124	125	**124**	123	125	**125**	124	126	**128**	128	129	**127**	118.5	69.9	266.9	262.8	44.4	26.5	20	80	75	25
14-Jul	**127**	126	128	**124**	124	125	**125**	125	127	**128**	128	129	**126**	110.3	66.4	266.1	267.6	41.3	24.8	22	78	81	19
15-Jul	**125**	125	126	**125**	124	126	**125**	125	126	**129**	128	130	**126**	112.2	72.0	266.4	264.5	42.2	27.1	21	79	73	27
16-Jul	**124**	124	125	**122**	121	122	**124**	123	124	**126**	126	127	**126**	100.1	58.4	263.2	261.8	38.0	22.3	24	76	90	10
17-Jul	**125**	125	125	**121**	120	122	**124**	124	124	**126**	126	127	**126**	100.4	56.7	251.6	253.3	39.9	22.5	23	77	89	11
18-Jul	**125**	124	125	119	119	120	**124**	123	124	**126**	126	127	**125**	88.9	56.3	243.1	248.2	36.5	22.7	25	75	88	12
19-Jul	**123**	123	124	120	119	121	**123**	123	124		124	124	**125**	95.8	58.9	259.9	265.0	36.9	22.1	24	76	90	10
20-Jul	**124**	124	125	120	120	121	**123**	123	124				**124**	102.3	68.2	264.1	271.7	38.8	25.1	23	77	80	20
21-Jul	**125**	124	125	**121**	120	121	**125**	124	125				**123**	97.2	65.8	264.7	271.7	36.7	24.2	25	75	83	17
22-Jul	**125**	124	125	**121**	121	122	**125**	124	126				**125**	97.0	63.1	258.1	267.1	37.5	23.6	24	76	85	15
23-Jul	**123**	122	124	120	119	121	**123**	122	124				**123**	96.1	65.6	255.9	264.1	37.6	24.8	24	76	80	20
24-Jul	**125**	123	125	119	119	120	**124**	123	124	**125**	124	125	**124**	86.4	61.4	256.5	247.6	33.7	24.8	27	73	81	19
25-Jul	**125**	124	125	120	119	121	**124**	124	125	**126**	126	126	**125**	90.0	56.4	246.5	239.5	36.6	23.5	25	75	85	15
26-Jul	**124**	123	125	118	118	119	**124**	123	124	**125**	125	126	**126**	64.4	47.9	225.7	219.4	28.2	22.0	32	68	92	8
27-Jul	**121**	120	121	117	117	118	**121**	120	121	**123**	122	124	**125**	69.3	47.2	223.4	219.8	31.1	21.5	29	71	93	7
28-Jul	**118**	118	119	117	116	117	**120**	119	120	**122**	121	123	**122**	71.3	42.2	214.6	214.0	33.2	19.7	27	73	100	0
29-Jul	**119**	118	119	116	116	118	**119**	119	120	**122**	121	122	**120**	63.6	41.0	199.8	196.1	31.6	21.0	28	72	96	4
30-Jul	**118**	118	119	118	117	119	**120**	119	121	**122**	122	123	**120**	72.1	39.9	210.1	205.8	34.2	19.5	26	74	100	0
31-Jul	**117**	116	117	115	115	116	**118**	117	118	**121**	120	121	**119**	44.8	40.9	199.8	200.4	22.7	20.3	40	60	98	2

August 2012. 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 (% of total spill)			
																				Rocky Reach		Rock Island	
2012	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	**116**	116	116	114	114	115	**117**	116	117	120	119	120	**119**	32.0	38.8	198.9	197.1	15.9	19.9	56	44	100	0
2-Aug	**116**	115	116	114	113	114	**117**	115	117	120	119	121	**118**	27.3	40.3	189.3	190.7	14.4	21.2	62	38	95	5
3-Aug	115	114	115	112	111	112	115	114	116	119	118	120	**116**	18.9	38.7	177.5	179.5	10.7	21.7	85	15	93	7
4-Aug	115	114	115	112	111	112	115	114	115	119	118	120	**117**	16.4	38.4	183.9	186.5	8.9	20.6	100	0	97	3
5-Aug	115	115	116	111	111	112	115	114	116	119	118	120	**118**	16.3	37.7	184.0	187.7	8.9	20.3	100	0	100	0
6-Aug	**116**	115	116	112	111	112	115	115	116	120	119	120	**118**	16.7	38.0	179.4	179.5	9.3	21.1	96	4	94	6
7-Aug	115	114	115	112	111	112	115	114	116	120	118	120	**118**	16.6	37.4	179.9	180.8	9.2	20.7	98	2	97	3
8-Aug	114	114	114	111	111	112	114	114	114	119	118	119	**118**	16.4	37.0	176.5	181.6	9.4	20.7	97	3	98	2
9-Aug	113	113	114	112	111	113	114	113	114	119	117	119	**116**	22.3	34.9	167.9	167.8	12.8	20.8	68	32	96	4
10-Aug	114	113	114	111	110	113	113	113	113	117	117	118	**116**	3.7	33.2	176.2	185.2	2.0	17.9	0	100	100	0
11-Aug	114	114	114	110	109	110	113	112	114	118	117	118	**116**	0.0	33.0	161.9	164.8	0.0	20.0	0	100	100	0
12-Aug	114	113	114	109	109	110	113	112	113	118	116	118	**116**	0.0	31.5	168.9	173.7	0.0	18.3	0	100	100	0
13-Aug	114	114	114	110	109	110	113	112	113	118	117	118	**116**	0.0	31.9	163.9	164.1	0.0	19.4	0	100	100	0
14-Aug	114	113	114	109	109	110	112	112	113	117	116	117	115	0.0	31.8	156.9	161.6	0.0	19.6	0	100	100	0
15-Aug	113	112	113	111	110	112	112	112	113	114	114	116	114	0.0	29.6	140.0	141.7	0.0	21.2	0	100	96	4
16-Aug	113	112	113	112	111	112	112	111	112	116	115	116	114	0.7	29.4	159.5	158.6	0.5	18.6	0	100	100	0
17-Aug	113	112	113	112	111	112	112	111	112	116	115	117	115	0.0	28.5	154.3	156.5	0.0	18.5	0	0	100	0
18-Aug	114	114	114	113	112	113	113	112	113	116	115	117	**116**	0.5	26.1	151.3	149.8	0.2	17.9	0	100	100	0
19-Aug	114	113	114	114	114	115	113	112	113	113	112	113	116	12.0	0.5	163.8	168.0	6.8	0.3	0	100	0	0
20-Aug	113	113	114	113	113	115	113	112	113	113	112	113	115	1.8	0.0	145.2	152.0	1.1	0.0	0	100	0	0
21-Aug	114	113	114	115	114	117	113	112	113	113	112	113	114	13.7	0.0	152.0	153.9	8.6	0.0	0	100	0	0
22-Aug	**116**	116	117	116	116	117	115	114	116	115	114	116	112	8.9	0.0	150.6	154.3	5.5	0.0	0	100	0	0
23-Aug	**118**	117	118	116	116	118	115	114	116	115	114	116	110	8.6	0.0	147.6	152.2	5.2	0.0	0	100	0	0
24-Aug	**116**	115	117	115	114	117	115	114	116	115	114	116	109	0.0	0.0	139.0	145.3	0.0	0.0	0	0	0	0
25-Aug	111	111	112	111	110	112	112	111	112	111	111	113	112	0.0	0.0	132.9	139.2	0.0	0.0	0	0	0	0
26-Aug	109	109	109	108	108	109	109	109	110	109	108	110	114	0.0	0.0	125.6	135.4	0.0	0.0	0	0	0	0
27-Aug	108	108	109	108	107	108	108	107	108	107	104	108	114	0.0	0.0	116.4	120.0	0.0	0.0	0	0	0	0
28-Aug	108	108	109	108	107	108		107	107	108	107	108	111	0.0	0.0	132.2	136.1	0.0	0.0	0	0	0	0
29-Aug	108	108	108	107	107	107		108	108	108	107	108	108	0.0	0.0	132.6	138.9	0.0	0.0	0	0	0	0
30-Aug	108	108	109	108	107	108	108	107	108	108	107	108	107	0.0	0.0	143.9	147.0	0.0	0.0	0	0	0	0
31-Aug	110	110	111	110	110	113	110	109	110	110	109	110	108	4.9	0.0	130.9	140.1	3.4	0.0	0	100	0	0

APPENDIX E

Monthly Calibration Logs

Site	InstrID	Date	Time	BP mmHg	Temperature (°C)			TDG Pressure (mmHg)				Deviation from STD TDG %Saturation			
				STD	STD	Probe	Diff	100%	113%	126%	139%	100%	113%	126%	139%
RIGW	32546	01/31/12	13:15	747.9	4.0	4.0	0.0	749	849	949	1049	-0.1	-0.1	-0.1	-0.1
RIGW	32546	04/04/12	11:00	744.2	5.2	5.1	0.1	745	845	945	1045	-0.1	-0.1	-0.1	-0.1
RIGW	32546	05/01/12	12:50	743.0	9.6	9.4	0.2	744	844	944	1044	-0.1	-0.1	-0.1	-0.1
RIGW	32546	05/31/12	12:20	747.8	13.0	12.9	0.1	748	848	948	1048	0.0	0.0	0.0	0.0
RIGW	32546	07/02/12	13:30	741.9	15.2	15.1	0.1	743	843	943	1043	-0.1	-0.1	-0.1	-0.1
RIGW	32545	07/24/12	13:15	746.0	17.5	17.4	0.1	747	847	948	1049	-0.1	-0.1	-0.3	-0.4
RIGW	32545	08/15/12	10:05	747.2	19.0	18.7	0.3	747	846	946	1046	0.0	0.2	0.2	0.2
RIGW	32545	10/22/12	11:05	744.8	14.0	13.8	0.2	742	841	941	1041	0.4	0.5	0.5	0.5
RIS	37606	01/31/12	14:15	746.7	3.0	2.9	0.1	746	846	946	1047	0.1	0.1	0.1	0.0
RIS	37606	04/04/12	12:20	742.9	4.9	4.8	0.1	742	842	942	1042	0.1	0.1	0.1	0.1
RIS	37606	05/01/12	14:00	741.8	9.0	8.8	0.2	741	841	941	1041	0.1	0.1	0.1	0.1
RIS	37606	05/31/12	11:30	746.7	12.4	12.6	-0.2	746	846	945	1046	0.1	0.1	0.2	0.1
RIS	37606	07/02/12	12:05	741.7	14.5	14.5	0.0	741	841	941	1042	0.1	0.1	0.1	0.0
RIS	37606	08/15/12	11:00	745.8	19.0	18.9	0.1	745	845	945	1046	0.1	0.1	0.1	0.0
RIS	37606	08/29/12	10:30	747.7	18.0	17.9	0.1	747	847	947	1047	0.1	0.1	0.1	0.1
RIS	37606	10/22/12	12:05	743.4	14.2	14.1	0.1	741	841	940	1041	0.3	0.3	0.5	0.3
RRDW	38865	01/31/12	15:30	745.4	2.8	2.7	0.1	748	847	947	1048	-0.3	-0.2	-0.2	-0.3
RRDW	38865	04/04/12	13:45	741.8	5.2	5.1	0.1	741	841	941	1041	0.1	0.1	0.1	0.1
RRDW	38865	05/01/12	10:40	741.7	8.7	8.5	0.2	741	840	940	1041	0.1	0.2	0.2	0.1
RRDW	38865	05/31/12	10:05	746.1	12.9	12.7	0.2	746	846	946	1046	0.0	0.0	0.0	0.0
RRDW	38865	07/02/12	9:40	742.5	14.0	13.9	0.1	743	842	942	1043	-0.1	0.1	0.1	-0.1
RRDW	38865	08/15/12	12:25	744.5	18.9	18.7	0.2	745	844	944	1044	-0.1	0.1	0.1	0.1
RRDW	38865	10/22/12	13:40	741.8	14.0	13.9	0.1	740	840	940	1040	0.2	0.2	0.2	0.2
RRH	37607	01/31/12	16:15	744.1	2.8	2.8	0.0	746	846	946	1047	-0.3	-0.3	-0.3	-0.4
RRH	37607	04/04/12	14:20	741.1	6.1	6.1	0.0	743	842	942	1043	-0.3	-0.1	-0.1	-0.3
RRH	37607	05/01/12	11:15	740.0	9.2	9.1	0.1	739	839	939	1040	0.1	0.1	0.1	0.0
RRH	37607	05/31/12	9:15	745.3	12.8	12.7	0.1	745	845	946	1046	0.0	0.0	-0.1	-0.1
RRH	37607	07/02/12	10:20	740.3	14.1	14.1	0.0	743	842	942	1043	-0.4	-0.2	-0.2	-0.4
RRH	32607	08/15/12	13:10	742.6	19.7	19.6	0.1	744	844	944	1044	-0.2	-0.2	-0.2	-0.2
RRH	37607	10/22/12	14:20	741.0	14.2	14.1	0.1	735	835	935	1036	0.8	0.8	0.8	0.7

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-Jan-12
Arrival Time: 16:05
Departure Time: 16:35

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 31-Jan-12 **Time:** 16:15

BP Station:
744.1 mmHg

	Std	Initial	Final
Temperature	2.80	2.8	N / C
TDG 100%	744.1	746	744
TDG 113%	844.1	846	844
TDG 126%	944.1	946	944
TDG 139%	1044.1	1047	1044
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-Jan-12
Arrival Time: 15:15
Departure Time: 15:55

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 31-Jan-12 **Time:** 15:30

BP Station:
745.4 mmHg

	Std	Initial	Final
Temperature	2.80	2.7	N / C
TDG 100%	745.4	748	745
TDG 113%	845.4	847	845
TDG 126%	945.4	947	945
TDG 139%	1045.4	1048	1045
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-Jan-12
Arrival Time: 14:00
Departure Time: 14:35

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 31-Jan-12 **Time:** 14:15

BP Station: 746.7 mmHg	**Std**	**Initial**	**Final**
Temperature	3.00	2.9	N / C
TDG 100%	746.7	746	N / C
TDG 113%	846.7	846	N / C
TDG 126%	946.7	946	N / C
TDG 139%	1046.7	1047	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-Jan-12
Arrival Time: 12:20
Departure Time: 13:35

Site: RIGW
Probe ID: 32546

Calibration Type: Field

Date: 31-Jan-12 **Time:** 13:15

BP Station:
747.9 mmHg

	Std	Initial	Final
Temperature	4.00	4.0	N / C
TDG 100%	747.9	749	N / C
TDG 113%	847.9	849	N / C
TDG 126%	947.9	949	N / C
TDG 139%	1047.9	1049	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 04-Apr-12
Arrival Time: 14:10
Departure Time: 14:45

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 04-Apr-12 **Time:** 14:20

BP Station:
741.1 mmHg

	Std	Initial	Final
Temperature	6.10	6.1	N / C
TDG 100%	741.1	743	740
TDG 113%	841.1	842	840
TDG 126%	941.1	942	940
TDG 139%	1041.1	1043	1041
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 04-Apr-12
Arrival Time: 13:30
Departure Time: 14:00

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 04-Apr-12 **Time:** 13:45

BP Station:
741.8 mmHg

	Std	Initial	Final
Temperature	5.20	5.1	N / C
TDG 100%	741.8	741	N / C
TDG 113%	841.8	841	N / C
TDG 126%	941.8	941	N / C
TDG 139%	1041.8	1041	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 04-Apr-12
Arrival Time: 12:10
Departure Time: 12:50

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 04-Apr-12 **Time:** 12:20

BP Station: 742.9 mmHg	**Std**	**Initial**	**Final**
Temperature	4.90	4.8	N / C
TDG 100%	742.9	742	N / C
TDG 113%	842.9	842	N / C
TDG 126%	942.9	942	N / C
TDG 139%	1042.9	1042	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 04-Apr-12
Arrival Time: 10:30
Departure Time: 11:50

Site: RIGW
Probe ID: 32546

Calibration Type: Field

Date: 04-Apr-12 **Time:** 11:00

BP Station:
744.2 mmHg

	Std	Initial	Final
Temperature	5.20	5.1	N / C
TDG 100%	744.2	745	N / C
TDG 113%	844.2	845	N / C
TDG 126%	944.2	945	N / C
TDG 139%	1044.2	1045	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-May-12
Arrival Time: 11:05
Departure Time: 11:45

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 01-May-12 **Time:** 11:15

BP Station: 740.0 mmHg	**Std**	**Initial**	**Final**
Temperature	9.20	9.1	N / C
TDG 100%	740	739	740
TDG 113%	840	839	839
TDG 126%	940	939	939
TDG 139%	1040	1040	1040
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-May-12
Arrival Time: 10:20
Departure Time: 11:00

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 01-May-12 **Time:** 10:40

BP Station:
741.7 mmHg

	Std	Initial	Final
Temperature	8.70	8.5	N / C
TDG 100%	741.7	741	742
TDG 113%	841.7	840	842
TDG 126%	941.7	940	942
TDG 139%	1041.7	1041	1042
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-May-12
Arrival Time: 13:45
Departure Time: 14:15

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 01-May-12 **Time:** 14:00

BP Station:
741.8 mmHg

	Std	Initial	Final
Temperature	9.00	8.8	N / C
TDG 100%	741.8	741	N / C
TDG 113%	841.8	841	N / C
TDG 126%	941.8	941	N / C
TDG 139%	1041.8	1041	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-May-12
Arrival Time: 12:35
Departure Time: 13:25

Site: RIGW
Probe ID: 32546

Calibration Type: Field

Date: 01-May-12 **Time:** 12:50

BP Station: 743.0 mmHg	**Std**	**Initial**	**Final**
Temperature	9.60	9.4	N / C
TDG 100%	743	744	743
TDG 113%	843	844	843
TDG 126%	943	944	943
TDG 139%	1043	1044	1043
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-May-12
Arrival Time: 9:10
Departure Time: 9:40

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 31-May-12 **Time:** 9:15

BP Station: 745.3 mmHg	**Std**	**Initial**	**Final**
Temperature	12.80	12.7	N / C
TDG 100%	745.3	745	745
TDG 113%	845.3	845	845
TDG 126%	945.3	946	945
TDG 139%	1045.3	1046	1045
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-May-12
Arrival Time: 9:50
Departure Time: 10:20

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 31-May-12 **Time:** 10:05

BP Station:
746.1 mmHg

	Std	Initial	Final
Temperature	12.90	12.7	N / C
TDG 100%	746.1	746	N / C
TDG 113%	846.1	846	N / C
TDG 126%	946.1	946	N / C
TDG 139%	1046.1	1046	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-May-12
Arrival Time: 11:20
Departure Time: 11:45

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 31-May-12 **Time:** 11:30

BP Station:
746.7 mmHg

	Std	Initial	Final
Temperature	12.40	12.6	N / C
TDG 100%	746.7	746	N / C
TDG 113%	846.7	846	N / C
TDG 126%	946.7	945	N / C
TDG 139%	1046.7	1046	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 31-May-12
Arrival Time: 12:05
Departure Time: 12:45

Site: RIGW
Probe ID: 32546

Calibration Type: Field

Date: 31-May-12 **Time:** 12:20

BP Station:
747.8 mmHg

	Std	Initial	Final
Temperature	13.00	12.9	N / C
TDG 100%	747.8	748	N / C
TDG 113%	847.8	848	N / C
TDG 126%	947.8	948	N / C
TDG 139%	1047.8	1048	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 02-Jul-12
Arrival Time: 10:10
Departure Time: 11:00

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 02-Jul-12 **Time:** 10:20

BP Station: 740.3 mmHg	**Std**	**Initial**	**Final**
Temperature	14.10	14.1	N / C
TDG 100%	740.3	743	740
TDG 113%	840.3	842	839
TDG 126%	940.3	942	940
TDG 139%	1040.3	1043	1040
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 02-Jul-12
Arrival Time: 9:20
Departure Time: 10:00

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 02-Jul-12 **Time:** 9:40

BP Station:
742.5 mmHg

	Std	Initial	Final
Temperature	14.00	13.9	N / C
TDG 100%	742.5	743	N / C
TDG 113%	842.5	842	N / C
TDG 126%	942.5	942	N / C
TDG 139%	1042.5	1043	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 02-Jul-12
Arrival Time: 11:55
Departure Time: 12:40

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 02-Jul-12 **Time:** 12:05

BP Station:
741.7 mmHg

	Std	Initial	Final
Temperature	14.50	14.5	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	1042	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 02-Jul-12
Arrival Time: 13:00
Departure Time: 14:15

Site: RIGW
Probe ID: 32546

Calibration Type: Field

Date: 02-Jul-12 **Time:** 13:30

BP Station:
741.9 mmHg

	Std	Initial	Final
Temperature	15.20	15.1	N / C
TDG 100%	741.9	743	N / C
TDG 113%	841.9	843	N / C
TDG 126%	941.9	943	N / C
TDG 139%	1041.9	1043	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 24-Jul-12
Arrival Time: 12:35
Departure Time: 13:55

Site: RIGW
Probe ID: 32545

Calibration Type: Field

Date: 24-Jul-12 **Time:** 13:15

BP Station:
746.0 mmHg

	Std	Initial	Final
Temperature	17.50	17.4	N / C
TDG 100%	746	747	746
TDG 113%	846	847	846
TDG 126%	946	948	946
TDG 139%	1046	1049	1046
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Aug-12
Arrival Time: 13:00
Departure Time: 13:25

Site: RRH
Probe ID: 32607

Calibration Type: Field

Date: 15-Aug-12 **Time:** 13:10

BP Station:
742.6 mmHg

	Std	Initial	Final
Temperature	19.70	19.6	N / C
TDG 100%	742.6	744	N / C
TDG 113%	842.6	844	N / C
TDG 126%	942.6	944	N / C
TDG 139%	1042.6	1044	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Aug-12
Arrival Time: 12:10
Departure Time: 12:50

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 15-Aug-12 **Time:** 12:25

BP Station:
744.5 mmHg

	Std	Initial	Final
Temperature	18.90	18.7	N / C
TDG 100%	744.5	745	N / C
TDG 113%	844.5	844	N / C
TDG 126%	944.5	944	N / C
TDG 139%	1044.5	1044	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Aug-12
Arrival Time: 10:50
Departure Time: 11:20

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 15-Aug-12 **Time:** 11:00

BP Station:
745.8 mmHg

	Std	Initial	Final
Temperature	19.00	18.9	N / C
TDG 100%	745.8	745	N / C
TDG 113%	845.8	845	N / C
TDG 126%	945.8	945	N / C
TDG 139%	1045.8	1046	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 15-Aug-12
Arrival Time: 9:45
Departure Time: 10:30

Site: RIGW
Probe ID: 32545

Calibration Type: Field

Date: 15-Aug-12 **Time:** 10:05

BP Station:
747.2 mmHg

	Std	Initial	Final
Temperature	19.00	18.7	N / C
TDG 100%	747.2	747	N / C
TDG 113%	847.2	846	N / C
TDG 126%	947.2	946	N / C
TDG 139%	1047.2	1046	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 29-Aug-12
Arrival Time: 10:25
Departure Time: 10:45

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 29-Aug-12 **Time:** 10:30

BP Station:
747.7 mmHg

	Std	Initial	Final
Temperature	18.00	17.9	N / C
TDG 100%	747.7	747	N / C
TDG 113%	847.7	847	N / C
TDG 126%	947.7	947	N / C
TDG 139%	1047.7	1047	N / C
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 22-Oct-12
Arrival Time: 14:00
Departure Time: 14:45

Site: RRH
Probe ID: 37607

Calibration Type: Field

Date: 22-Oct-12 **Time:** 14:20

BP Station:
741.0 mmHg

	Std	Initial	Final
Temperature	14.20	14.1	N / C
TDG 100%	741	735	741
TDG 113%	841	835	841
TDG 126%	941	935	941
TDG 139%	1041	1036	1041
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 22-Oct-12
Arrival Time: 11:55
Departure Time: 12:30

Site: RIS
Probe ID: 37606

Calibration Type: Field

Date: 22-Oct-12 **Time:** 12:05

BP Station:
743.4 mmHg

	Std	Initial	Final
Temperature	14.20	14.1	N / C
TDG 100%	743.4	741	743
TDG 113%	843.4	841	843
TDG 126%	943.4	940	942
TDG 139%	1043.4	1041	1043
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 22-Oct-12
Arrival Time: 13:30
Departure Time: 14:00

Site: RRDW
Probe ID: 38865

Calibration Type: Field

Date: 22-Oct-12 **Time:** 13:40

BP Station:
741.8 mmHg

	Std	Initial	Final
Temperature	14.00	13.9	N / C
TDG 100%	741.8	740	742
TDG 113%	841.8	840	842
TDG 126%	941.8	940	942
TDG 139%	1041.8	1040	1042
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 22-Oct-12
Arrival Time: 10:45
Departure Time: 11:40

Site: RIGW
Probe ID: 32545

Calibration Type: Field

Date: 22-Oct-12 **Time:** 11:05

BP Station:
744.8 mmHg

	Std	Initial	Final
Temperature	14.00	13.8	N / C
TDG 100%	744.8	742	745
TDG 113%	844.8	841	845
TDG 126%	944.8	941	945
TDG 139%	1044.8	1041	1045
TDG membrane ID			
Integrity Check			

Comments:

Report created November 01, 2012

APPENDIX F

Response to Comments

A DRAFT report was submitted to Pat Irle at Department of Ecology on November 4, 2012. The comments below were received on December 7, 2012.

Department of Ecology Comment	Chelan PUD Response
It would be good to include the compliance results in the Executive Summary and the Conclusions.	A summary of compliance results has been added to the Executive Summary and the Conclusions.
It's not clear to me how much value there is in including an average of the three compliance standards. If you decide to keep, could you explain the purpose?	Averages of the three compliance standards have been removed.