From: Hampton, Waikele M.
To: Bitterman, Deborah;
Subject: FW: Final 2010 Gas Abatement Report
Date: Tuesday, January 04, 2011 1:08:01 PM
Attachments: Final 2010 Gas Abatement Annual Report FINAL.pdf

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Here you go.

From: Hampton, Waikele M.
Sent: Wednesday, December 22, 2010 4:04 PM
To: 'Irle, Pat (ECY)'
Cc: McKinney, Charlie (ECY)
Subject: Final 2010 Gas Abatement Report

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To: Pat Irle, Washington Department of Ecology
Charlie McKinney, Washington Department of Ecology

From: Waikele Hampton, Environmental Permit Coordinator
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943
Final 2010 Gas Abatement Report

Please find attached the Final 2010 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 Hampton
509-661-4627

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

2010 GAS ABATEMENTANNUAL REPORT

Prepared by:

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

December 2010

FINAL

TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**

1. INTRODUCTION **3**

1.1 Project Description **3**

1.1.1 Rocky Reach 3

1.1.2 Rock Island 6

1.2 Fixed Monitoring Site (FMS) Locations **9**

1.3 Regulatory Framework **10**

1.3.1 Washington State Department of Ecology (Ecology) Water Quality Numeric Criteria 10

1.3.2 Daily TDG Compliance Value Calculation 11

2. OPERATIONS **13**

2.1 Description of 2010 Fish-Spill Season Flow Characteristics **13**

2.2 Spill Configurations **14**

2.2.1 Rocky Reach 14

2.2.2 Rock Island 15

2.3 Fish Spill Program **15**

2.3.1 Fish Spill Quantities and Duration 16

2.3.1.1 Rocky Reach 17

2.3.1.2 Rock Island 18

3. IMPLEMENTATION RESULTS **19**

3.1 Fisheries Management **19**

3.1.1 Fish Bypass Efficiencies 19

3.1.2 Survival Studies 19

3.1.2.1 Rocky Reach 19

3.1.2.2 Rock Island 19

3.2 Biological Monitoring (GBT) **20**

3.3 Water Quality Forums **21**

3.4 Physical Monitoring (TDG) **21**

3.4.1 Data evaluation and analyses (QA/QC) 21

3.4.1.1 Data completeness 21

3.4.1.2 Calibration and Maintenance 22

3.4.2 TDG Monitoring Results 22
3.4.2.1 Rocky Reach 24
3.4.2.2 Rock Island 26
3.4.2.3 Wanapum Forebay 28
3.4.3 Discussion of Exceedances 28
3.4.3.1 Rocky Reach 28
3.4.3.2 Rock Island 29
3.4.3.3 Wanapum Forebay 29
3.4.3.4 Causes of Exceedances 29
3.4.3.5 Corrective Actions 29

4. TOTAL DISSOLVED GAS ABATEMENT MEASURES IMPLEMENTED IN 2010 ... 31

4.1 Operational 31

4.1.1 Rocky Reach 31
4.1.2 Rock Island 32

4.2 Structural 34

5. CONCLUSIONS 35

LITERATURE CITED 37

LIST OF FIGURES

Figure 1. Location of Rocky Reach and Rock Island projects on the Columbia River. 4

Figure 2. Location of forebay and tailrace fixed monitoring stations at Rocky Reach Project. 5

Figure 3. Location of forebay fixed monitoring station at Rock Island Project. 7

Figure 4. Location of tailrace fixed monitoring station below Rock Island Project. 8

Figure 5. Comparison of 2010 vs 10-year average (2000-2009) of mean daily discharge at Rocky Reach Dam. 13

Figure 6. Comparison of 2010 vs 10-year average (2000-2009) of mean daily discharge at Rock Island Dam. 14

Figure 7. Daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rocky Reach Dam during the 2010 fish spill season. 23

Figure 8. Daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rock Island Dam during the 2010 fish spill season. 23
Figure 9. Total volume spilled to change in %TDG saturation between forebay and tailrace at Rocky Reach Project, June 9 - August 20, 2010. 25
Figure 10. Total volume spilled to change in %TDG saturation between forebay and tailrace at Rocky Reach Project, April 1 – August 31, 2010. 25
Figure 11. Total volume spilled to change in %TDG saturation between forebay and tailrace at Rock Island Project, April 17 – August 20, 2010. 26
Figure 12. Total volume spilled to change in %TDG saturation between forebay to tailrace at Rock Island Project, April 1 – August 31, 2010. 27

LIST OF TABLES

Table 1. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Project, 2010. 16
Table 2. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Project, 2010. 17
Table 3. Summary of juvenile fish passage operations at Rocky Reach, April 1– August 31, 2010. 18
Table 4. Summary of juvenile fish passage operations at Rock Island, April 1 – August 31, 2010. 18
Table 5. Summary of Gas Bubble Trauma examinations at Rock Island in 2010. 20
Table 6. Overview of total dissolved gas data set during the 2010 fish-spill season. 22
Table 7. Average TDG levels in the forebays and tailraces of Rocky Reach and Rock Island and the forebay of Wanapum, April 1 – August 31, 2010. 22
Table 8. Rocky Reach and Rock Island projects: Average total volume spilled, percent total river flow spilled, and change in percent TDG from forebay to tailrace, April 1 – August 31. 27
Table 9. Number of 2010 fish-spill season TDG exceedances, Rocky Reach and Rock Island forebays and tailraces and Wanapum forebay. 28
Table 10. Rocky Reach fish-spill comparison, 2003-2010. 32
Table 11. Rock Island fish-spill comparison, 2003-2010. 33

APPENDICES

Appendix A TDG Operational Plans, Rocky Reach and Rock Island

Appendix B 2010 Rocky Reach Gas Abatement Plan

Appendix C 2010 Rock Island Gas Abatement Plan

Appendix D Dissolved Gas Levels at Rocky Reach, Rock Island, and Wanapum projects, 2010.

Appendix E Monthly Calibration Logs

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 2010.

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 2010 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 2010 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 2010 fish-spill season were lower than the 2000-2009 average (about 93% of average at Rocky reach, and 94% of average at Rock Island) over the entire fish-spill season. However, due to above average spring precipitation, high flows occurred in June. Also, due to low demand for power and surplus power from wind farms, high levels of involuntary spill also occurred in June.

During the 2010 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 during the spring migration (April 1 – June 8) and 9% of the daily average flow was spilled voluntarily for fish, as required by the HCP, during the summer migration (June 9 – August 31). An additional 8.01% was spilled involuntarily during this same time. To meet HCP fish passage requirements at Rock Island, 10.01% of the daily average flow was spilled voluntarily for fish during the spring migration (April 1 – June 8), while 19.99% of the daily average flow was spilled voluntarily for during the summer migration (June 9 – August 31).

No spill occurred outside of the fish passage season at either project in 2010.

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria on 9 days. TDG exceeded the modified Washington State water quality TDG criteria on 5 days in the Rocky Reach tailrace, 10 days in the Rock Island forebay, and 3 days in Rock Island tailrace during this monitoring period. Numeric criteria were exceeded on 21 days (using a method that eliminates the double-counting issue) in the Wanapum forebay. All exceedences occurred during the June period of high flows in the Columbia River.

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 2010 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 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, 2009, and again in 2010.

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. This testing continued into 2010. 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 and TDG levels monitored.

1.2 Fixed Monitoring Site (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 site. 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 March 2010 and received approval for both plans on April 2, 2010.

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 2010 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 2010 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2010 fish-spill season was compared to the 10-year average of mean daily flows from 2000-2009, as measured at the Rocky Reach Hydroelectric Project (Figure 5) and the Rock Island Hydroelectric Project (Figure 6). In general, 2010 mean daily averages were lower than the 2000-2009 average (about 93% of average at Rocky Reach and 94% of average at Rock Island) over the entire fish-spill season; however, beginning on June 9 and extending until approximately July 6, flows in at Rocky Reach and Rock Island in 2010 were significantly higher than the 10-year average flows. These high flows in June, compounded with low power demand, forced the majority of hydroelectric projects in the Mid-Columbia to spill involuntarily for headwater control. For a more thorough discussion of this flow/spill condition, please refer to Section 3.4.7 below.

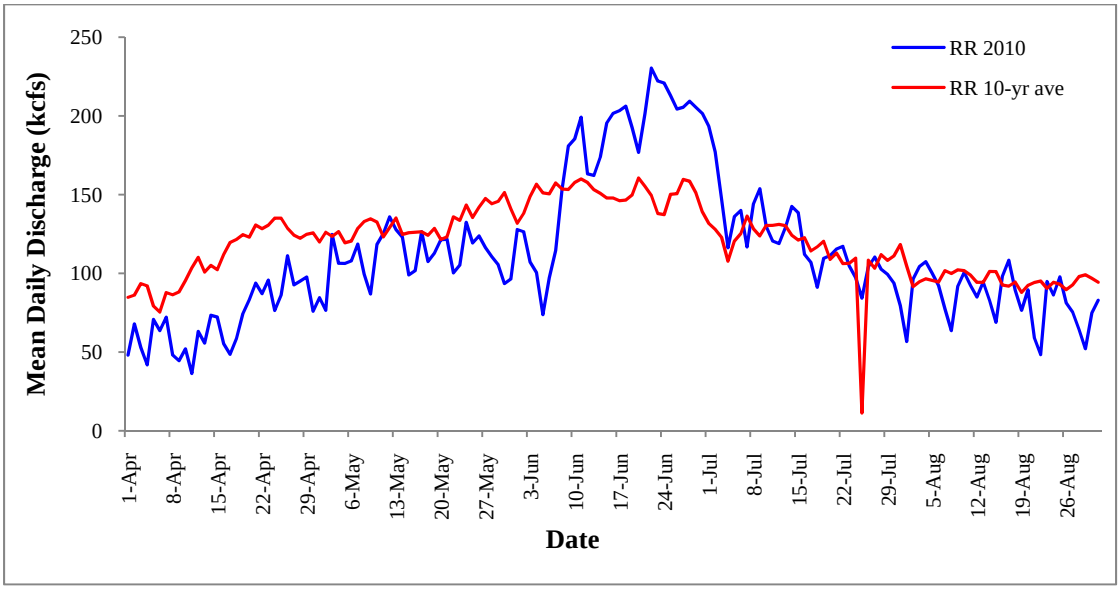

Figure 5. Comparison of 2010 vs previous 10-year average (2000-2009) of mean daily discharge at Rocky Reach Hydroelectric Project.

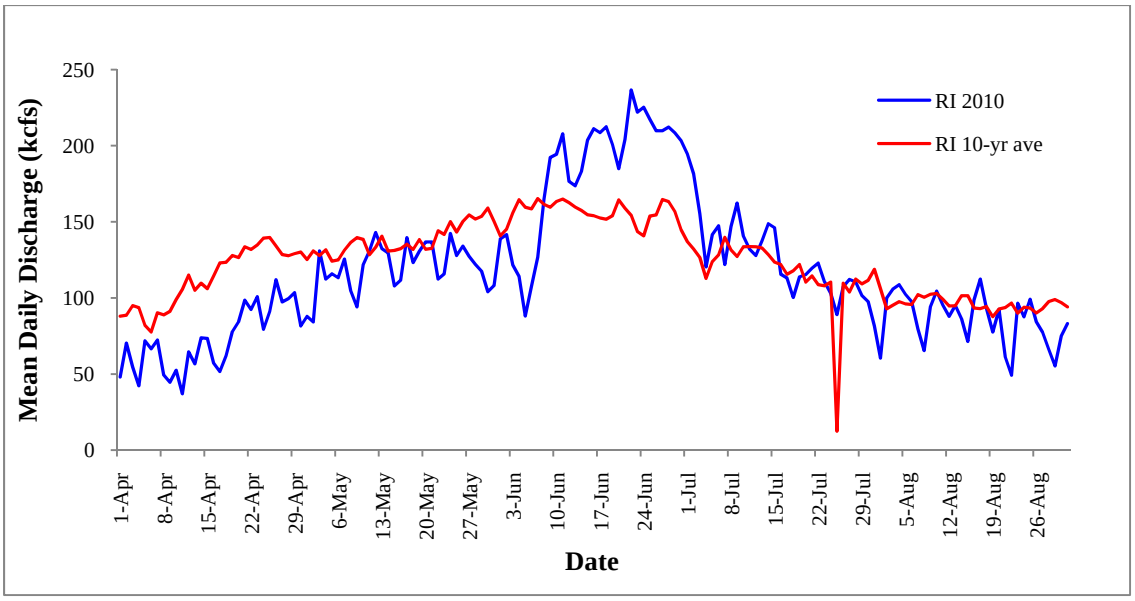

Figure 6. Comparison of 2010 vs previous 10-year average (2000-2009) of mean daily discharge at Rock Island Hydroelectric Project.

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 did not implement this action in 2010, but plans to develop a QAPP for said study during the winter of 2010/2011.

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 2010 during June at Rock Island in an attempt to maintain TDG compliance during high flow and spill events. This deviation included the closing of notched gates and the addition of gates 6 and 27.

2.3 Fish Spill Program

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

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

2.3.1 Fish Spill Quantities and Duration

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

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

Definitions of these spills can be found in the 2010 Rocky Reach and Rock Island Gas Abatement Plans.

In 2010, spill events at Rocky Reach were mostly voluntary from July 7-August, but mostly involuntary before July 7 due to high river flows and low energy demand. Of the total volume of water spilled at Rocky Reach, 53% was voluntary, while 47% was involuntary spill (primarily due to spill past units). The majority (95.6%) of the involuntary spill at Rocky Reach occurred from mid-June to early-July during low demand and high flows (flows were above the 10-year average flow from June 9 – approximately July 6). It is worth noting that the hydraulic capacity was not exceeded, but the regional capacity for energy was exceeded, thus the need for spill past unloaded units. During the months of July and August, only 9.4% and 1.4% of total spill, respectively, was involuntary. At Rock Island, 98.6% of water spilled was voluntary for fish, while only 1.4% of water spilled was involuntary.

Monthly average spills at Rocky Reach ranged from 0.0 to 39.4 thousand cubic feet per second (kcfs) (Table 1) and from 4.1 to 32.5 kcfs at Rock Island (Table 2). Minimum and maximum daily average spills at Rocky Reach varied from 0 to 82.1 kcfs and from 0 to 63.4 kcfs at Rock Island Project.

Table 1. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach, April 1 – August 31, 2010.

	Average Flow (Kcfs)	Average Spill (Kcfs)	Misc Flow (Kcfs)	Spill Purpose					
				Fish Spill			Other		
				Spill (Kcfs)	% of flow	% of Total Spill	Spill (Kcfs)	% of flow	% of Total Spill
April	69.48	0	.07	0	0	0	0	0	0
May	110.5	0	.07	0	0	0	0	0	0
June	135.43	39.41	.43	14.51	8.3	36.8	24.9	14.2	63.2
July	108.94	11.46	.43	10.38	8.6	90.6	1.08	.9	9.4
August	78.34	4.96	.43	4.89	5.8	98.6	.07	.1	1.4

Table 2. Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island, April 1 - August 31, 2010.

	Average Flow (Kcfs)	Average Spill (Kcfs)	Misc Flow (Kcfs)	Spill Purpose					
				Fish Spill			Other		
				Spill (Kcfs)	% of flow	% of Total Spill	Spill (Kcfs)	% of flow	% of Total Spill
April	66.94	4.07	1.5	4.07	5.6	100	0	0	0
May	106.55	12.06	1.5	12.06	10	100	0	0	0
June	149.42	32.45	1.5	31.33	17.1	96.55	1.12	.6	3.45
July	99.33	25.59	1.5	25.53	20.2	99.77	.06	.05	.23
August	72.30	12.29	1.5	12.29	14.3	100	0	0	0

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

2.3.1.1 Rocky Reach

During the spring of 2010, Chelan PUD operated the juvenile fish bypass system exclusively with no voluntary spill for yearling Chinook, steelhead, and sockeye passage. For yearling Chinook, Chelan PUD conducted a survival study testing alternative day/night tagged fish release methods. During this study the powerhouse operated under normal fish bypass operations, with no Project spill. The test was to evaluate the experimental differences between day time and night time releases for tagged juvenile yearling Chinook smolts, and the effects on Project survival for both groups of fish. This test included running the turbine units in best efficiency mode for power production to evaluate the differences in route-specific survival and Project survival with all available river flow passing through turbines.

To meet RRHCP survival standards for subyearling 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 2010. The summer spill program for subyearling Chinook began on June 9 and ended on August 20. Percent daily river flow spilled during the summer spill season amounted to 17.01%; however, only 9% was spill for fish, while the remaining 8.01% was involuntary spill due to higher than average flows and low power demand.

Summer spill covered 98.4% of the juvenile outmigration for subyearling Chinook.

Table 3 below provides a summary of the Juvenile Fish Passage Operations at Rocky Reach in 2010.

Table 3. Summary of juvenile fish passage operations at Rocky Reach, April 1 - August 31, 2010.

Date	Juvenile Fish Passage Program	Quantity	Notes
1-Apr	Juvenile Fish Bypass (JFB) Operation Began		Operated exclusively with no fish-spill during the spring (April 1 - June 8)
9-Jun	Summer Spill Initiated	9% of daily average river flow	Spill for subyearling Chinook
20-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. In 2010, Chelan PUD conducted a RIHCP Project Survival study for juvenile yearling Chinook and steelhead at a 10% Project spill level. Spring spill of 10% began on April 17 and was continued through June 8. Total fish-spill for the spring fish spill season amounted to 10.01% of the daily average river flow.

Rock Island fish spill increased to 20% upon onset of the summer outmigration of subyearling Chinook. Summer spill commenced on June 9 and continued through August 20. Total fish-spill for the summer fish spill season amounted to 19.99% of the daily average river flow.

Spring and summer spill covered >97% of the juvenile outmigration for steelhead, sockeye, yearling and subyearling Chinook.

Table 4 below provides a summary of the Juvenile Fish Passage Operations at Rock Island in 2010.

Table 4. Summary of juvenile fish passage operations at Rock Island, April 1 - August 31, 2010.

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

3. IMPLEMENTATION RESULTS

3.1 Fisheries Management

3.1.1 Fish Bypass Efficiencies

A fish bypass efficiency (the proportion of fish using the bypass system) study was conducted for yearling Chinook salmon at Rocky Reach in 2010. The study report has not yet been finalized, but preliminary results show a 53.57% fish bypass efficiency.

3.1.2 Survival Studies

Both the Rocky Reach and Rock Island HCPs include an overall project survival goal for adult and juvenile fish of 91%. However, biologists agree that at this time adult fish survival cannot be conclusively measured for each species covered by the plan. To compensate for the scientific unknowns, the HCPs set even higher standards for juvenile survival at each project– 95% juvenile dam passage survival and 93% juvenile project survival throughout the Project (i.e.,1,000 feet below the tailrace of the upstream dam to 1,000 feet below the tailrace of the project dam). Juvenile passage survival is the major component of the HCPs, but since the Projects are so distinct, different methods have been and will continue to be used at each dam to meet the survival goals set forth in the HCPs.

3.1.2.1 Rocky Reach

During the spring of 2010 Chelan PUD conducted a pilot survival test to evaluate the experimental differences between day time and night time releases for tagged juvenile yearling Chinook smolts and the effect on Project survival for both groups with no project spill.

PRELIMINARY results of the 2010 survival study showed a Project Survival of 92.50% for combined day and night yearling Chinook releases from below Wells Dam.

No studies were conducted in 2010 on steelhead or sockeye, as standards have been achieved for steelhead, and the sockeye studies are on hold for one year. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004.

3.1.2.2 Rock Island

During the spring of 2010, Chelan PUD conducted a survival study on yearling Chinook and steelhead. Results of the 2010 survival study showed a Project Survival of 94.28% and 96.52% for yearling Chinook and steelhead, respectively.

No studies were conducted in 2010 on sockeye, as survival studies for this species are complete at Rock Island under the 10% spill operations, putting sockeye in HCP Phase III Standards Achieved Status. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior), no survival studies for subyearling Chinook have been conducted since 2004.

3.2 Biological Monitoring (GBT)

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 until 2012. 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 gas bubble trauma (GBT) at Rock Island Dam between April 20 and August 18, 2010. 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 was greater than the yearling collection, the sample was changed to up to 100 subyearling Chinook salmon examined two days per week. Examinations followed Fish Passage Center (FPC) standardized procedure as outlined by FPC (2004).

A total of 2,449 yearling Chinook, subyearling Chinook, and steelhead were examined for GBT, with 0.16% showing external signs (Table 5). These external signs were seen only on April 20, April 22, and June 2, all before any TDG exceedances were measured at the projects. During high TDG levels in the Rocky Reach tailrace and Rock Island forebay, no GBT was observed in any of the fish examined.

Table 5. Summary of Gas Bubble Trauma Examinations at Rock Island in 2010.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		N	%	N	%	N	%
Chinook yearling	603	3	0.50%	3	0.50%	0	0.00%
Steelhead	817	1	0.12%	0	0.00%	1	0.12%
Chinook Subyearling	1029	0	0.00%	0	0.00%	0	0.00%
Total	2449	4	0.16%	3	0.12%	1	0.04%

3.3 Water Quality Forums

Because Chelan PUD staff was unable to attend the Corps's year-end TDG Monitoring and Quality Assurance/Quality Control (QA/QC) meeting, materials were requested and reviewed. Presentations from the various agencies conducting TDG (and other water quality) monitoring within the Columbia River Basin included topics on: monitoring locations, equipment used, data completeness, QA/QC and calibrations. Minimal discussion was spent on actual TDG results, their causes, and corrective actions. Agencies presenting at this meeting included the USGS, Corps, other mid-Columbia River PUDs, and private consultants.

Chelan PUD has regularly attended the Transboundary Gas Group Meeting since early in its history. This year's meeting has been postponed until the spring due to a light agenda and travel restrictions on many agencies.

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, 2010. TDG levels from these four sites 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). Prior to the start of fish spill-season, software and hardware upgrades were completed at each FMS to help increase the FMS system reliability. Throughout the 2010 monitoring season (April 1 - August 31), 100% of all possible data were collected at the Rocky Reach forebay and tailrace FMS. At the Rock Island forebay FMS, 84.09% of all possible data was collected, while at the Rock Island tailrace FMS, 99.05% of all possible data was collected (Table 8).

The data loss in the Rock Island forebay was a result of a damaged downpipe that took some time to repair and blown fuses in the communication system. These problems were resolved and are not expected to cause data losses in 2011.

Table 6. Overview of total dissolved gas data set during the 2010 fish-spill season.

Location	Available data collection hours	Number of omitted/ lost hourly readings	Percent data loss (%)
RRFB	3657	0	0
RRTR	3657	0	0
RIFB	3657	582	15.91
RITR	3657	2	0.05
Total	14628	584	3.99

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 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 2010 fish-spill season are presented in Table 7 below. Note that there were no hourly TDG values greater than 125% saturation during the 2010 fish-spill season.

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, 2010.

Location	Mean	Minimum	Maximum
Rocky Reach Forebay	109.9	104.5	120.9
Rocky Reach Tailrace	110.7	103.9	122.5
Rock Island Forebay	109.4	100.6	119.7
Rock Island Tailrace	112.7	105	121.4
Wanapum Forebay	110.4	103	120.1

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 site.

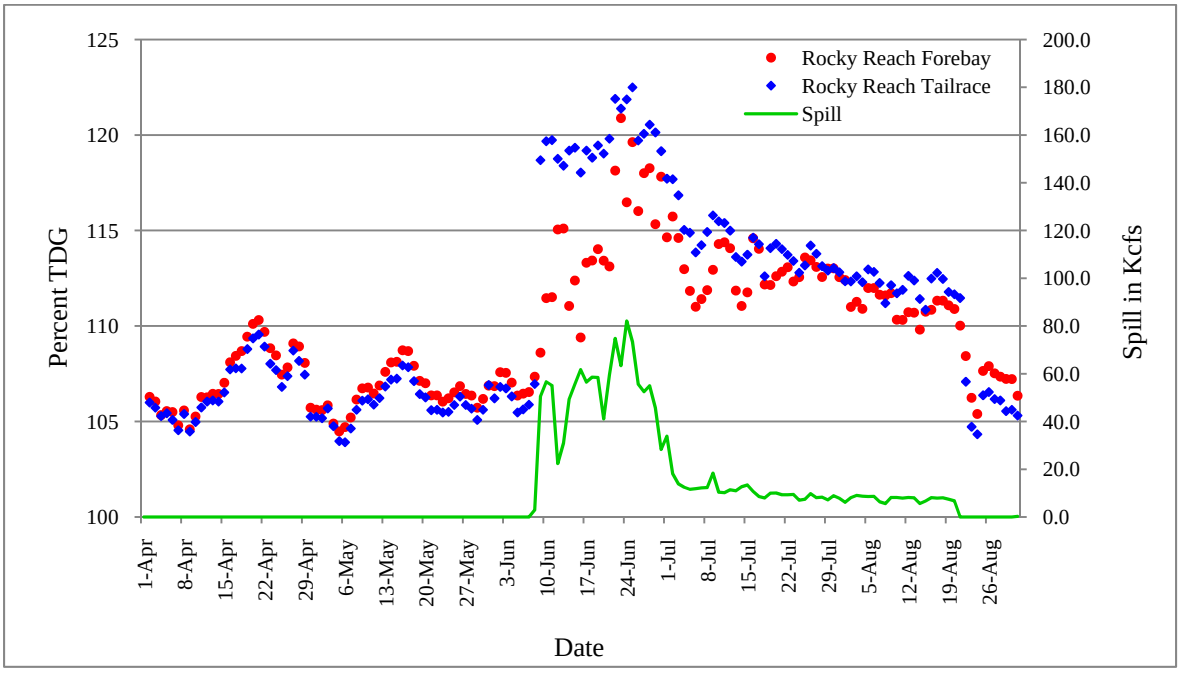

Figure 7. Spill volume and daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rocky Reach Dam during the 2010 fish spill season.

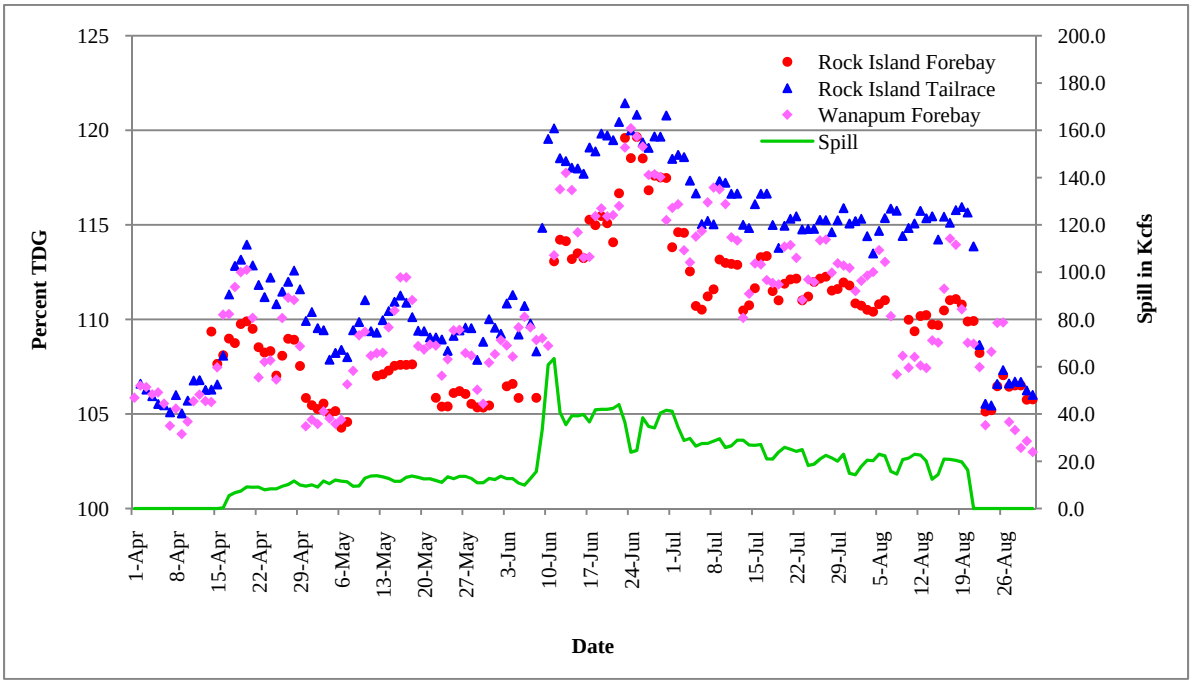

Figure 8. Spill volume and daily average TDG (based on the 12 highest consecutive hours) in the forebay and tailrace of Rock Island Dam and Wanapum forebay during the 2010 fish spill season.

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, 2010, TDG levels in the Rocky Reach forebay averaged 109.9% and ranged from 104.5% to 120.9%. TDG levels in the tailrace averaged 110.7% and ranged from 103.9% to 122.5%. The average (based on the 12 highest consecutive hours) change in percent TDG from the forebay to the tailrace was an increase of 0.8%, ranging from a decrease of 1.7% to an increase of 10.1%. A summary of this data can be found in Table 8 below.

Regression analysis showed a moderate relationship between the total volume spilled to percent change in TDG (r^2=.5598, Figure 9). This compares well to previous years, with the exception of 2007, when the relationship was strong. Because minimal water was spilled (and none for fish purposes) during the spring at Rocky Reach, spring TDG data is not included in this regression. 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.

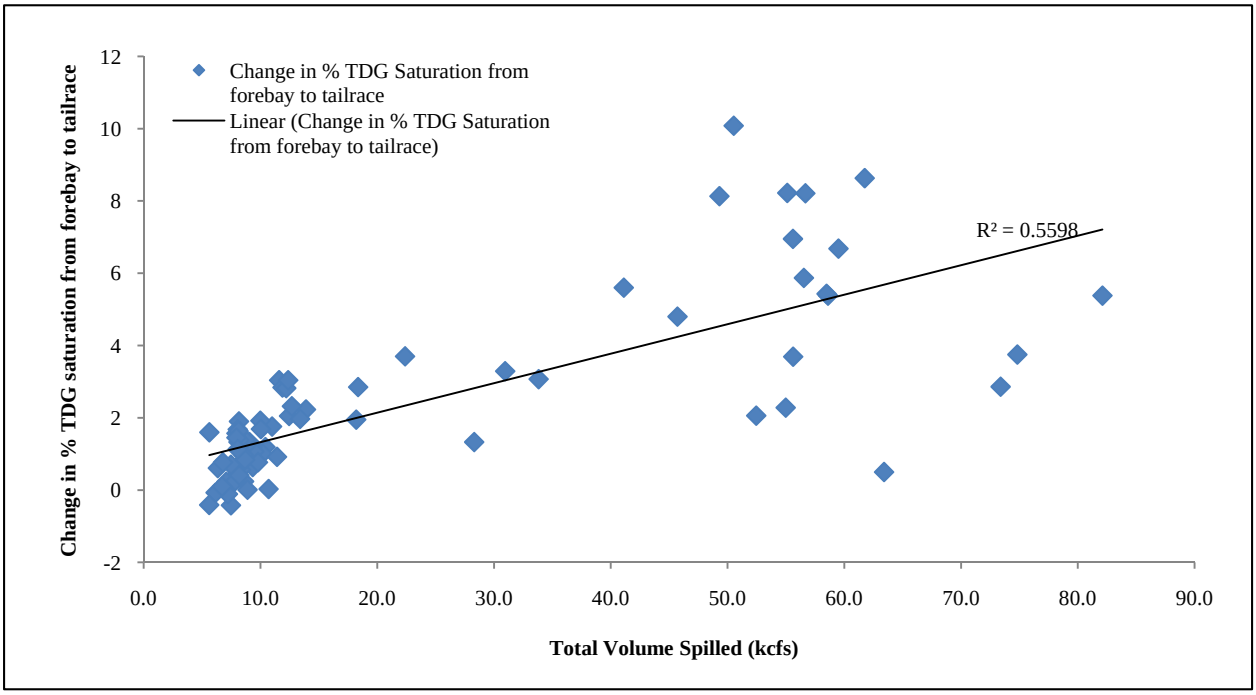

Figure 9. Total volume spilled to change in percent TDG saturation from forebay to tailrace at Rocky Reach Project, June 9 - August 20, 2010.

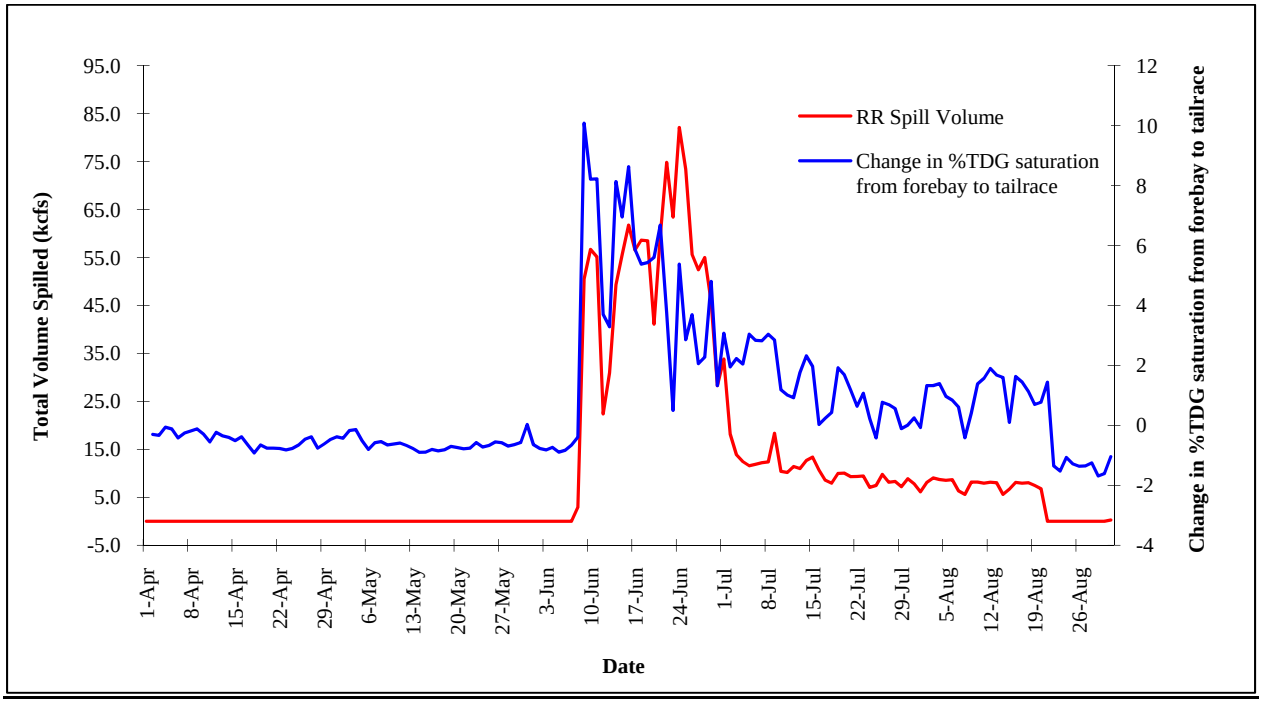

Figure 10. Total volume spilled to change in percent TDG saturation from forebay to tailrace at Rocky Reach Project, April 1 - Aug 31, 2010.

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, 2010, TDG levels in the Rock Island forebay averaged 110.1% and ranged from 104.3% to 119.7%. TDG levels in the tailrace averaged 112.7% and ranged from 105.0% to 121.4%. The average (based on the 12 highest consecutive hours) change in percent TDG from the forebay to the tailrace was an increase of 3.4%, ranging from a decrease of 3.1% to an increase 7.0%. A summary of this data can be found in Table 8 below.

Regression analysis showed a weak relationship between the total volume spilled to percent change in TDG (r^2=.0554, 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.

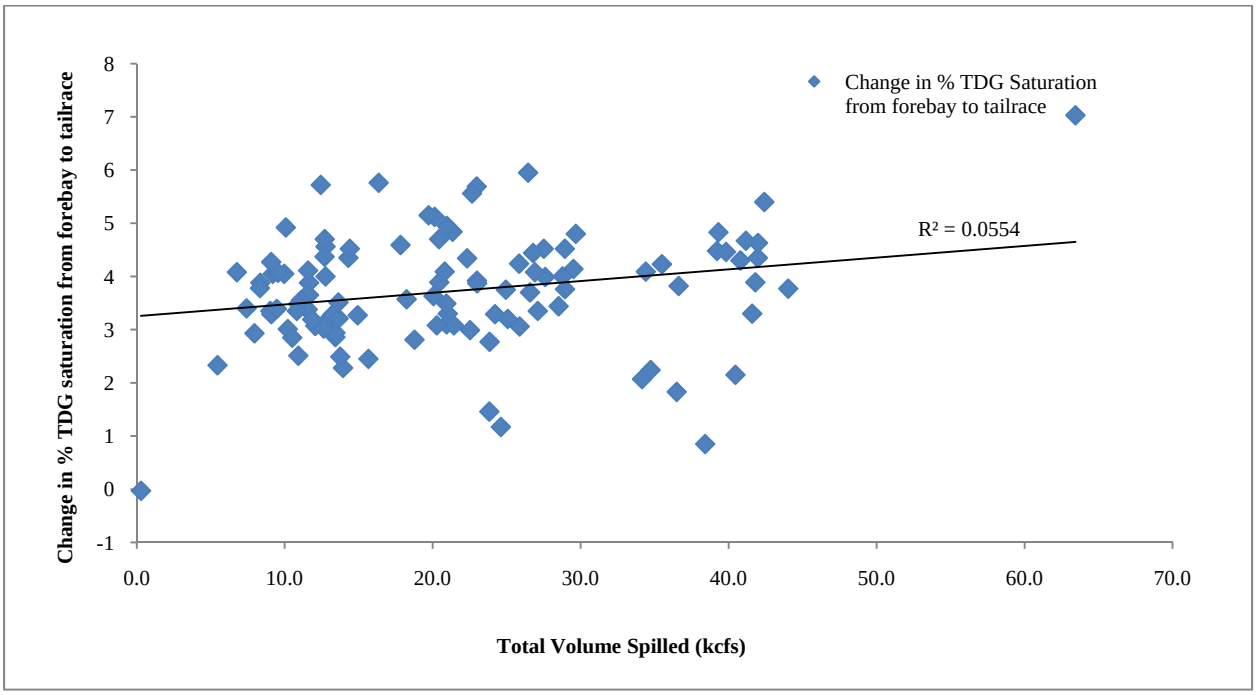

Figure 11. Total volume spilled to percent change in TDG from forebay to tailrace at Rock Island Project, April 17 - August 20, 2010.

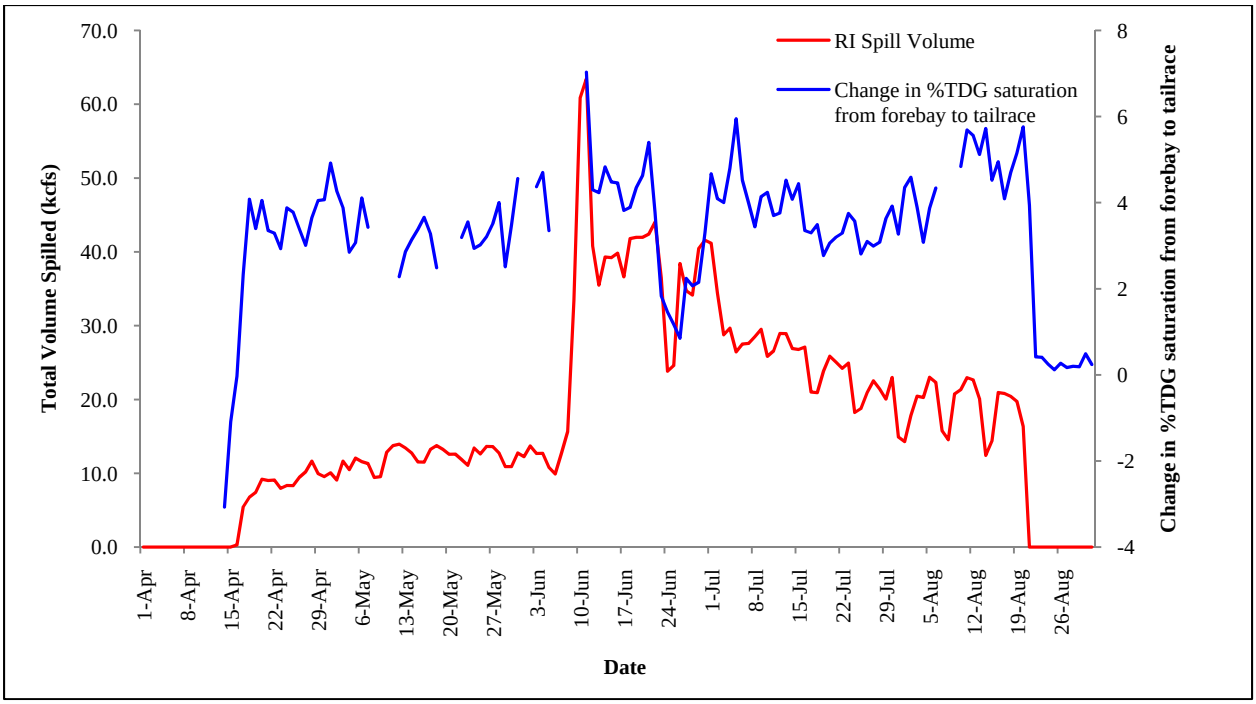

Figure 12. Total volume spilled to percent change in TDG from forebay to tailrace at Rock Island Project, April 1 - Aug 31, 2010.

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 Dams during the 2010 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, 2010.

	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	0.00	0.00	-0.5	4.09	5.83	2.7
May	0.00	0.00	-0.6	12.10	11.30	3.4
June	39.70	20.00	3.6	32.50	17.40	3.5
July	11.40	9.90	1.4	25.50	21.00	3.8
August	4.93	6.80	0.3	12.30	16.39	3.1
Average*	11.21	7.34	0.8	17.30	14.38	3.4

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

3.4.2.3 Wanapum Forebay

From April 1 to August 31, 2010, TDG levels in the Wanapum forebay averaged 110.4% and ranged from 103.0% to 120.1%.

3.4.3 Discussion of Exceedances

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria on 9 days (5.9% of the total number of days observed). TDG exceeded the modified Washington State TDG fish spill water quality criteria on 5 days (3.3% of the total number of days observed) in the Rocky Reach tailrace, 10 days (8.6% of the total number of days observed) in the Rock Island forebay, and 3 days (2.0% of the total numbers of days observed) in the Rock Island tailrace during this monitoring period. Numeric criteria were exceeded on 21 days (13.7% of the total number of days observed) (using the revised method that eliminates the double-counting issue) in the Wanapum forebay (Grant County PUD). Table 9 summarizes the exceedances measured during the 2010 TDG monitoring season.

Table 9. Number of 2010 fish-spill season TDG exceedances, Rocky Reach and Rock Island forebays and tailraces, and Wanapum forebay.

Location	Number of Exceedances*	Total # of Days Sampled	% Days > Standard	Number of 1-hr Maximum (>125%)	Total # of Hours Sampled	% Hours >125% standard
RRFB	9	152	5.9	0	3657	0
RRTR	5	152	3.3	0	3657	0
RIFB	10	128	7.8	0	3075	0
RITR	3	152	2	0	3657	0
WANFB	21	153	13.7	0	3672	0
Total	48	737	6.5	0	17,718	0

*>115% in forebay (FB) and >120% in tailrace (TR)

3.4.3.1 Rocky Reach

Of the five exceedances recorded in the tailrace of Rocky Reach, all occurred during high spill events (>26% of the daily average flow) and on days when the water coming into the Rocky Reach forebay was in exceedance of the 115% standard. The planned fish spill during this time was 9% of the daily average flow at Rocky Reach. The spill in excess of this 9% was spill past unloaded units due to a regional energy surplus. On these 5 days of tailrace exceedances, spill at Rocky Reach increased TDG an average 2.95% above the incoming TDG, as compared to increasing TDG an average of 6.5% June 9 -30, when the tailrace TDG was <=120%.

3.4.3.2 Rock Island

All 10 exceedances in the Rock Island forebay occurred with Rocky Reach spill in excess of 13% of the average flow (13.9%, and 22.27-37.91%), and above the fish-spill level of 9%. The TDG level during 6 of these 10 exceedances was less than the TDG level in the Rocky Reach forebay (by as much as 1.47%).

All three exceedances in the Rock Island tailracecurred on days when the Rocky Reach and Rock Island forebays exceeded the water quality standard (115%) and two occurred on days when the Rocky Reach tailrace exceeded the standard of 120%.

3.4.3.3 Wanapum Forebay

Of the 21 exceedances in the Wanapum forebay, only three occurred on days that the Rock Island tailrace exceeded the 120% standard. The average reduction in TDG between Rock Island tailrace and Wanapum forebay on these 21 days was a mere 2.04%, which is consistent with the seasonal average reduction of 2.2%

3.4.3.4 Causes of Exceedances

In June 2010, the Mid-Columbia experienced an abnormal event that resulted in above average flows passing the projects. This event was caused by a faster than normal filling of Grand Coulee followed by a rain event, which increased flows. With the reservoir already full, the water had to be passed through the project, either via spill or through the powerhouses. This spill at Grand Coulee resulted in higher than average flows at the Mid-C projects in June, which when combined with low demand on the power system and the resulting negative pricing, resulted in higher than normal levels of spill and TDG throughout the Mid-C system.

3.4.3.5 Corrective Actions

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

1. Implementation of the TDG Operational Plan.

2. In an effort for overall Columbia River TDG management, Central (Hourly Coordination) experimented with reallocating existing spill at various projects. It appeared beneficial to move the higher quantities of spill down river and reduce the spill at the upper river projects. Therefore, Central moved spill from Wells and put more on Rocky Reach so that the incoming Rocky Reach TDG would be reduced. The intention of this move was to lower overall TDG exposure to fish and provide a lower incoming TDG into Rocky Reach forebay.

3. Reduced the spill limit for both projects that Central was operating under. The spill limit began at 80 kcfs at both projects, but was reduced to 60 kcfs at Rocky Reach and 50 kcfs at Rock Island.

4. Chelan PUD adjusted spill, as possible, at both projects; and adjusted gate configurations at Rock Island to reduce TDG. These actions were consistent with the Operational Plans for TDG.

5. Chelan PUD used negative pricing to reduce spill past unloaded units at a monetary loss to the Mid-C PUDs and power purchasers. Specifically, Chelan PUD Executed a TDG Emergency Operations Agreement between Chelan PUD, Pacificorp, and ALCOA to further mitigate TDG at Rocky Reach. Central saw the execution of this Agreement as being very helpful in increasing generation and reducing spill at Rocky Reach.

4. TOTAL DISSOLVED GAS ABATEMENT MEASURES IMPLEMENTED IN 2010

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 2010 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 2010 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.

Table 10. Rocky Reach fish spill comparison, 2003-2010.

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**	

** Sockeye On/off spill test resulted in fewer days of spill in May
* Percentage of daily average river flow at Rocky Reach

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 2010 are shown in Table 11 below.

Table 11. Rock Island fish spill comparison, 2003-2010.

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**	

* 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 2010 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 2010.

At Rock Island Dam, Chelan PUD utilized the notched gates, the spill deflector, and the Over/Under spill gates during 2010 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

Few exceedances of the TDG criterion were observed in the Rocky Reach and Rock Island tailraces (5 and 3, respectively) in 2010. However, there were a number of days that the Rock Island and Wanapum forebays (10 and 21, respectively) exceeded the State water quality criteria, while the Rocky Reach and Rock Island tailrace generally remained within compliance levels of TDG saturation. This is not clearly understood but could be a result of increased TDG pressure associated with increased temperatures and minimal TDG dissipation between the projects. Because incoming gas levels were high (close to or above 115%) during the high flow events at both Rocky Reach and Rock Island, it is possible that powerhouse flows didn't have much dilution effect, thereby resulting in higher than expected forebay TDG levels at Rock Island and Wanapum.

While TDG levels generally decreased from the forebay of Rocky Reach to the forebay of Rock Island, a consistent increase in the TDG levels between the forebays of Rock Island and Wanapum dams was observed throughout the 2010 monitoring season. As has been observed in previous years, there were instances in 2010 when the Wanapum Dam forebay was out of compliance (>115%) with the State water quality standards, while the Rock Island tailrace remained within the accepted levels of TDG saturation. The mechanism that is causing this is not clearly understood, but could be a result of increased pressure associated with increased temperatures and minimal dissipation between Rock Island and Wanapum dams. As the reservoirs above Rocky Reach, Rock Island, and Wanapum dams are generally well mixed due to the projects' run-of-the-river nature, and generally no stratification occurs in the reservoirs, water temperature changes little with depth. However, water temperature increases slightly moving downstream between projects due to radiant heating. With each degree increase in temperature, there have been observed increases in TDG of nearly 3% (J. Carrol, pers. comm.). This increase occurs due to the laws of partial pressure associated with temperature increases. Because the reach between Rock Island and Wanapum dams is nearly two times the length of the reach between Rocky Reach and Rock Island dams, there is an increased time of exposure to radiant heating, and therefore a likelihood of increased heating. On average, there was a 0.8 degree C temperature increase between Rock Island tailrace and Wanapum forebay in 2010. This may, in part, explain the overall limited dissipation of TDG as the water flowed from the Rock Island tailrace to the Wanapum forebay.

Evaluation of the TDG data shows that TDG levels generally increased from the forebay to the tailrace at both Rocky Reach and Rock Island projects. Generally, there was an increase in TDG levels as the volume of water spilled increased. Unlike what has been observed in most previous years, the increase in

TDG levels with respect to the volume of water spilled was more pronounced between the Rocky Reach forebay and tailrace than between the Rock Island forebay and tailrace.

The extent of compliance with State water quality criteria was due in part to the fish spill programs at Rocky Reach and Rock Island. The fish spill programs at both projects were managed to maximize fish passage, meet HCP requirements, minimize voluntary spill, and still stay within the terms of the State fish spill water quality criteria. Additionally, voluntary spill levels at both projects were managed in real time as detailed in the TDG Operational Plan for each project. When Project operators observed instantaneous TDG levels that exceeded the criteria as set forth in the Plans, spill was reduced and TDG levels monitored, which also played a role in the minimization of TDG production at the projects.

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.

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APPENDIX A

TDG Operational Plans
Rocky Reach and Rock Island

2010 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.)

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 increasing spill 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.

2010 Rock Island 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.)

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 20 to 27
    - monitor for 2 hours, re-check 6-hour average
    - if TDG >120% for 6-hr average, open gate 20 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****

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. Order of notched gate closure: **29, 24, 18, 16**
   If we have to close any more gates than this, we have a big problem that we will need to be addressed by means other than continuing to reduce spill.

**** 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

2010
Total Dissolved Gas Abatement Plan
Rocky Reach Hydroelectric Project

http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/34832.pdf

APPENDIX C

2010
Total Dissolved Gas Abatement Plan
Rock Island Hydroelectric Project

http://erebus:8080/Workplace/getContent?vsId=%7B3F4FFCDD-CAC0-4464-948B-73C699ED6F55%7D&iut=12883943318162610132 30&objectStoreName=library_1&objectType=document&id=%7B0C43A41D-429D-437B-A492-89338C4DE818%7D

APPENDIX D

Hourly Dissolved Gas Levels at
Rocky Reach, Rock Island, and Wanapum projects
April - August 2010

April 2010. 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.

																				Reason for Spill (in % of total spill)			
	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
2010	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		106	105		105	105					106	105	106	0.00	0.00	47.31	49.79	0.00	0.00	n/a	n/a	n/a	n/a
2-Apr	106	106	106	106	106	105				107	106	106	107	0.00	0.00	65.43	70.33	0.00	0.00	n/a	n/a	n/a	n/a
3-Apr	106	105	105	106	105	105				106	105	106	106	0.00	0.00	51.64	54.53	0.00	0.00	n/a	n/a	n/a	n/a
4-Apr	105	105	106	105	105	105				106	105	106	106	0.00	0.00	40.40	42.69	0.00	0.00	n/a	n/a	n/a	n/a
5-Apr	106	105	106	105	105	105				106	105	106	106	0.00	0.00	40.40	42.69	0.00	0.00	n/a	n/a	n/a	n/a
6-Apr	106	105	105	105	104	105				105	105	105	106	0.00	0.00	62.33	66.71	0.00	0.00	n/a	n/a	n/a	n/a
7-Apr	105	104	106	105	104	105				105	105	106	104	0.00	0.00	71.75	73.80	0.00	0.00	n/a	n/a	n/a	n/a
8-Apr	106	105	106	105	105	106				106	105	107	105	0.00	0.00	47.16	49.34	0.00	0.00	n/a	n/a	n/a	n/a
9-Apr	105	104	105	104	104	105				105	105	105	104	0.00	0.00	44.74	47.21	0.00	0.00	n/a	n/a	n/a	n/a
10-Apr	105	105	106	105	105	105				106	105	106	105	0.00	0.00	50.60	53.46	0.00	0.00	n/a	n/a	n/a	n/a
11-Apr	106	106	107	106	105	106				107	106	107	106	0.00	0.00	35.60	38.96	0.00	0.00	n/a	n/a	n/a	n/a
12-Apr	106	106	106	106	106	106				107	106	107	106	0.00	0.00	62.38	65.35	0.00	0.00	n/a	n/a	n/a	n/a
13-Apr	106	106	107	106	106	106				106	106	106	106	0.00	0.00	55.94	58.24	0.00	0.00	n/a	n/a	n/a	n/a
14-Apr	106	106	106	106	106	106	109	107	111	106	106	106	106	0.00	0.00	71.45	73.58	0.00	0.00	n/a	n/a	n/a	n/a
15-Apr	107	107	107	107	106	107	108	106	107	107	106	107	107	0.00	0.00	72.64	76.62	0.00	0.00	n/a	n/a	n/a	n/a
16-Apr	108	108	109	108	107	108	108	108	108	108	108	108	110	0.00	0.28	53.53	56.76	0.00	0.89	n/a	n/a	100	0
17-Apr	108	108	109	108	108	108	109	109	109	111	111	114	110	0.00	5.46	47.42	51.07	0.00	12.34	n/a	n/a	100	0
18-Apr	109	108	110	108	107	108	109	108	109	113	112	115	112	0.00	6.76	56.68	64.08	0.00	12.16	n/a	n/a	100	0
19-Apr	109	109	110	109	108	109	110	109	110	113	112	116	113	0.00	7.42	74.17	78.37	0.00	14.38	n/a	n/a	100	0
20-Apr	110	110	110	109	109	110	110	110	110	114	113	115	113	0.00	9.19	81.92	86.99	0.00	14.50	n/a	n/a	100	0
21-Apr	110	110	110	110	109	110	110	109	109	113	111	115	110	0.00	9.03	91.11	99.46	0.00	11.26	n/a	n/a	100	0
22-Apr	110	109	109	109	108	109	109	108	108	112	111	114	107	0.00	9.09	86.79	92.99	0.00	13.40	n/a	n/a	100	0
23-Apr	109	108	109	108	107	108	108	108	109	111	110	113	108	0.00	7.95	94.47	100.88	0.00	9.83	n/a	n/a	100	0
24-Apr	108	108	108	108	107	108	108	107	108	112	111	115	108	0.00	8.35	75.70	82.32	0.00	11.84	n/a	n/a	100	0
25-Apr	107	107	107	107	106	107	107	107	107	111	110	114	107	0.00	8.32	86.05	91.08	0.00	10.34	n/a	n/a	100	0
26-Apr	108	107	108	107	107	108	108	108	108	111	110	114	110	0.00	9.46	110.88	115.06	0.00	9.68	n/a	n/a	100	0
27-Apr	109	109	109	109	108	109	109	109	109	112	112	113	111	0.00	10.20	88.93	96.34	0.00	13.00	n/a	n/a	100	0
28-Apr	109	108	109	108	108	108	109	108	108	113	111	114	111	0.00	11.64	93.41	102.03	0.00	14.04	n/a	n/a	100	0
29-Apr	108	106	108	107	106	107	108	106	107	112	110	116	109	0.00	9.97	95.81	107.49	0.00	12.44	n/a	n/a	100	0
30-Apr	106	105	105	105	105	106	106	105	105	110	109	113	104	0.00	9.54	73.92	84.34	0.00	14.90	n/a	n/a	100	0

May 2010. Number in bold exceed the water quality criteria.

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

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2010	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	106	105	106	105	105	105	105	105	106	110	110	113	105	0.00	10.07	84.36	89.59	0.00	13.18	n/a	n/a	100	0
2-May	106	105	106	105	105	106				110	109	112	104	0.00	9.08	74.44	85.12	0.00	14.28	n/a	n/a	100	0
3-May	106	105	106	106	105	106				109	108	112	105	0.00	11.64	123.20	130.64	0.00	11.56	n/a	n/a	100	0
4-May	105	104	105	105	104	104	105	104	109	108	107	110	105	0.00	10.51	104.86	111.96	0.00	10.43	n/a	n/a	100	0
5-May	104	104	105	104	104	104	105	104	105	108	108	112	104	0.00	12.06	104.08	116.96	0.00	12.02	n/a	n/a	100	0
6-May	105	105	105	104	104	104	104	104	105	108	108	113	105	0.00	11.57	106.79	116.09	0.00	12.32	n/a	n/a	100	0
7-May	105	105	105	105	104	105				108	108	109	107	0.00	11.33	114.67	123.18	0.00	9.67	n/a	n/a	100	0
8-May	106	106	106	106	105	106				109	109	111	107	0.00	9.44	98.71	106.01	0.00	10.22	n/a	n/a	100	0
9-May	107	106	107	106	106	106				110	110	113	109	0.00	9.55	85.55	93.43	0.00	11.89	n/a	n/a	100	0
10-May	107	107	107	106	106	106				111	110	113	109	0.00	12.86	119.65	124.93	0.00	12.19	n/a	n/a	100	0
11-May	106	106	107	106	105	106				109	109	111	108	0.00	13.76	124.30	131.91	0.00	11.12	n/a	n/a	100	0
12-May	107	106	107	106	106	106	107	106	107	109	109	111	108	0.00	13.94	134.93	144.23	0.00	10.60	n/a	n/a	100	0
13-May	108	107	108	107	106	107							108	0.00	13.42	126.25	135.87	0.00	10.77	n/a	n/a	100	0
14-May	108	108	108	107	107	107							110	0.00	12.76	121.32	128.16	0.00	11.69	n/a	n/a	100	0
15-May	108	108	108	107	107	107	108	107	108	111	110	114	110	0.00	11.55	98.02	107.52	0.00	13.03	n/a	n/a	100	0
16-May	109	108	109	108	108	108	108	107	108	111	111	114	112	0.00	11.52	101.03	113.28	0.00	11.84	n/a	n/a	100	0
17-May	109	108	108	108	107	108	108	107	108	111	109	112	112	0.00	13.22	125.31	140.70	0.00	10.59	n/a	n/a	100	0
18-May	108	107	108	107	106	107				110	109	111	111	0.00	13.75	107.07	124.34	0.00	11.49	n/a	n/a	100	0
19-May	107	107	108	106	106	107				109	109	111	109	0.00	13.26	109.59	129.66	0.00	11.33	n/a	n/a	100	0
20-May	107	105	106	106	105	106				109	108	109	108	0.00	12.58	119.85	140.55	0.00	9.29	n/a	n/a	100	0
21-May	106	106	106	106	105	106				109	108	110	109	0.00	12.61	120.66	137.40	0.00	9.24	n/a	n/a	100	0
22-May	106	106	106	106	105	106	106	105	106	109	109	111	109	0.00	11.85	99.61	113.69	0.00	11.55	n/a	n/a	100	0
23-May	106	106	106	105	105	106	105	105	106	109	108	110	107	0.00	11.09	105.05	117.26	0.00	9.97	n/a	n/a	100	0
24-May	106	106	106	106	105	106	105	105	106	108	108	109	108	0.00	13.42	130.02	145.17	0.00	9.63	n/a	n/a	100	0
25-May	107	106	107	106	106	106	106	106	106	109	109	110	109	0.00	12.63	119.24	129.00	0.00	10.87	n/a	n/a	100	0
26-May	107	106	107	106	106	107				109	109	112	109	0.00	13.64	122.65	135.04	0.00	10.81	n/a	n/a	100	0
27-May	106	106	107	106	106	106				110	109	114	108	0.00	13.63	113.88	130.71	0.00	12.89	n/a	n/a	100	0
28-May	106	107	107	106	106	106	106			110	109	113	108	0.00	12.75	96.69	109.84	0.00	13.10	n/a	n/a	100	0
29-May	106	105	106	105	105	105	105	105	105	108	107	109	106	0.00	10.91	105.55	119.41	0.00	9.26	n/a	n/a	100	0
30-May	106	106	106	106	105	106				109	108	110	106	0.00	10.91	92.16	106.73	0.00	10.61	n/a	n/a	100	0
31-May	107	107	107	107	106	106				110	109	113	108	0.00	12.75	96.69	109.84	0.00	13.10	n/a	n/a	100	0

June 2010. Number in bold exceed the water quality criteria.

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

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2010	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	107	107	107	106	106	106				110	109	110	108	0.00	12.25	126.52	142.12	0.00	9.00	n/a	n/a	100	0
2-Jun	108	107	108	107	107	107				109	109	110	109	0.00	13.72	123.52	141.82	0.00	10.18	n/a	n/a	100	0
3-Jun	108	107	107	107	106	107				111	110	114	109	0.00	12.69	106.57	124.20	0.00	12.38	n/a	n/a	100	0
4-Jun	107	107	107	106	106	107				111	110	114	108	0.00	12.70	97.49	115.27	0.00	14.05	n/a	n/a	100	0
5-Jun	106	106	108	105	105	106				109	109	112	110	0.00	10.81	72.43	87.48	0.00	13.42	n/a	n/a	100	0
6-Jun	106	106	106	106	105	106				111	109	113	110	0.00	9.91	96.85	110.64	0.00	10.38	n/a	n/a	100	0
7-Jun	107	106	107	106	106	106				110	109	112	110	0.02	12.71	114.73	128.76	0.02	12.84	0	100	100	0
8-Jun	107	102	108	107	106	109				108	108	109	109	2.93	15.65	157.51	164.99	1.38	9.68	0	100	100	0
9-Jun	109	108	109	119	116	121				115	112	121	109	50.53	33.40	181.81	195.41	25.83	16.36	35.4	64.6	68	32
10-Jun	111	111	112	120	120	120		113	114	120	119	122	109	56.67	60.84	185.81	197.74	30.97	30.67	74.6	25.4	84.1	15.9
11-Jun	112	110	113	120	119	121	113	113	114	120	119	121	113	55.11	63.43	198.90	208.09	28.43	31.14	65.3	34.7	92.4	7.6
12-Jun	115	114	115	119	117	119	114	113	115	119	118	119	**117**	22.39	40.79	162.33	177.03	14.57	23.28	69.8	30.2	90.9	9.1
13-Jun	115	113	115	118	118	119	114	113	115	118	117	119	**118**	30.95	35.49	161.31	176.17	19.73	20.24	49.2	50.8	100	0
14-Jun	111	110	111	119	119	120	113	111	113	118	116	119	**117**	49.30	39.31	173.02	186.21	28.73	21.22	34.3	65.7	100	0
15-Jun	112	111	113	119	119	120	114	113	114	118	117	118	115	55.60	39.21	196.06	204.50	28.76	19.14	29.6	70.4	100	0
16-Jun	109	109	113	118	117	119	113	112	112	118	116	118	113	61.75	39.82	204.53	209.48	30.32	19.08	27.3	72.7	100	0
17-Jun	113	111	116	119	118	120	**115**	114	116	119	118	121	113	56.53	36.62	201.13	208.20	28.72	17.60	30.6	69.4	100	0
18-Jun	113	112	115	119	119	120	115	114	116	119	118	119	115	58.60	41.80	203.95	212.87	28.93	19.70	30.6	69.4	100	0
19-Jun	114	113	115	119	119	120	**115**	115	116	120	119	120	**116**	58.48	41.97	191.37	200.03	30.88	21.07	31	69	100	0
20-Jun	113	113	114	119	118	119	115	114	115	120	119	120	115	41.12	41.98	174.87	186.84	24.19	22.51	44.2	55.8	100	0
21-Jun	113	112	112	120	119	123	114	113	114	119	118	119	**116**	59.50	42.41	204.70	204.47	28.44	20.94	32.6	67.4	100	0
22-Jun	**118**	114	122	**122**	121	124	**117**	116	118	120	119	121	**116**	74.81	44.02	227.64	236.26	33.05	18.62	24.3	75.7	90.3	9.7
23-Jun	**121**	118	122	**121**	121	122	**120**	118	120	**121**	121	122	**119**	63.40	36.49	220.24	223.51	29.06	16.21	28.9	71.1	100	0
24-Jun	**116**	116	118	**122**	122	123	**119**	118	119	120	119	121	**120**	82.11	23.82	215.71	224.53	37.91	10.18	24.4	75.6	98.8	1.2
25-Jun	**120**	118	120	**122**	122	124	**120**	119	120	**121**	120	122	**120**	73.38	24.60	210.51	217.02	35.26	11.36	26.6	73.4	100	0
26-Jun	**116**	114	117	120	119	120	**119**	115	116	119	118	119	**119**	55.62	38.41	203.13	208.48	27.49	18.46	34	66	100	0
27-Jun	**118**	116	119	120	120	120	**117**	116	117	119	118	119	**118**	52.45	34.73	203.82	208.86	25.84	16.62	36.7	63.3	100	0
28-Jun	**118**	116	118	**121**	120	121	**118**	117	118	120	119	121	**118**	54.98	34.15	209.12	211.97	26.24	16.12	33.5	66.5	100	0
29-Jun	115	115	115	120	119	121	**118**	115	117	120	118	120	**118**	45.71	40.46	201.76	206.88	22.27	19.73	39.7	60.3	98.7	1.3
30-Jun	**118**	116	119	119	118	120	**117**	115	118	**121**	118	122	115	28.31	41.59	201.14	202.19	13.90	20.84	65	35	100	0

July 2010. Number in bold exceed the water quality criteria.

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

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill) Rocky Reach		Rock Island	
2010	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	115	113	114	118	117	119	114	113	114	118	117	119	**116**	33.82	41.16	194.55	193.55	16.68	21.63	56	44	100	0
2-Jul	**116**	115	116	118	117	118	115	113	115	119	117	120	**116**	18.20	34.40	174.96	183.63	10.29	18.80	78.9	21.1	100	0
3-Jul	115	113	113	117	115	116	115	112	113	119	116	118	114	13.90	28.77	142.27	154.86	9.87	18.66	83.7	16.3	94	6
4-Jul	113	112	113	115	114	115	113	111	112	117	116	117	113	12.45	29.67	116.59	121.87	11.14	25.36	100	0	100	0
5-Jul	112	110	111	115	113	114	111	110	111	117	115	116	114	11.60	26.45	134.23	140.53	9.01	19.63	100	0	100	0
6-Jul	111	110	111	114	113	114	111	110	111	115	114	116	115	11.89	27.51	138.42	147.65	8.58	18.67	100	0	100	0
7-Jul	111	111	112	114	113	115	111	111	112	115	114	116	**116**	12.21	27.60	118.67	120.33	11.53	25.57	100	0	100	0
8-Jul	112	112	112	115	114	115	112	111	112	115	114	116	**117**	12.37	28.51	142.77	148.80	8.81	19.74	100	0	100	0
9-Jul	113	112	113	116	115	116	113	112	114	117	116	118	**117**	18.36	29.51	153.74	163.29	12.16	18.15	60.4	39.6	100	0
10-Jul	114	113	115	115	114	116	113	112	113	117	116	117	**116**	10.43	25.84	130.90	141.53	8.10	18.57	100	0	100	0
11-Jul	114	114	114	115	115	116	113	113	113	117	116	117	114	10.18	26.57	119.15	130.52	8.91	21.45	100	0	100	0
12-Jul	114	113	114	115	114	115	113	111	112	117	115	116	114	11.42	28.94	117.81	129.08	10.20	23.28	100	0	100	0
13-Jul	112	110	111	114	112	113	110	109	110	115	114	115	110	11.00	28.93	128.24	134.37	8.80	21.89	100	0	100	0
14-Jul	111	110	111	113	112	114	111	109	112	115	114	116	111	12.69	26.90	143.71	148.72	8.62	18.36	86.7	13.3	100	0
15-Jul	112	111	113	114	113	116	112	111	112	116	115	116	113	13.40	26.78	136.99	145.46	9.47	18.85	72.9	27.1	100	0
16-Jul	115	114	115	115	114	116	113	112	114	117	116	117	113	10.70	27.10	112.23	117.65	10.14	24.84	100	0	100	0
17-Jul	114	112	113	114	112	114	113	111	113	117	115	117	112	8.60	21.01	106.81	113.74	9.37	21.54	100	0	100	0
18-Jul	112	112	113	113	112	113	112	110	111	115	114	116	112	7.96	20.92	89.24	97.28	10.18	23.78	100	0	100	0
19-Jul	112	112	112	114	113	115	111	110	112	114	113	115	112	9.99	23.84	108.94	114.93	10.02	22.46	100	0	100	0
20-Jul	113	112	113	114	113	115	112	111	113	115	114	116	114	10.04	25.87	110.78	117.06	9.73	24.16	100	0	100	0
21-Jul	113	112	113	114	113	115	112	111	113	115	115	116	114	9.31	25.07	114.83	120.87	8.87	22.84	100	0	100	0
22-Jul	113	113	113	114	113	115	112	111	112	115	115	116	113	9.34	24.21	114.68	124.33	9.33	22.60	100	0	100	0
23-Jul	112	111	112	113	112	114	111	110	112	115	114	115	111	9.47	24.94	104.05	108.15	10.37	25.77	100	0	100	0
24-Jul	113	112	113	113	112	113	111	111	112	115	114	115	112	7.08	18.23	96.24	103.71	7.97	19.77	100	0	100	0
25-Jul	114	113	115	113	112	114	112	111	112	115	115	116	112	7.47	18.77	83.35	90.41	10.86	24.20	100	0	100	0
26-Jul	113	113	113	114	113	115	112	112	113	115	115	116	114	9.79	20.94	102.37	109.08	10.94	21.98	100	0	100	0
27-Jul	113	112	113	114	112	114	112	111	112	115	115	116	114	8.15	22.52	110.25	115.05	8.31	24.05	100	0	100	0
28-Jul	113	112	113	113	112	113	112	111	112	115	114	116	112	8.33	21.43	101.86	110.27	9.15	21.91	100	0	100	0
29-Jul	113	112	113	113	112	113	112	111	112	115	114	116	113	7.21	20.05	98.64	101.29	8.05	22.95	100	0	100	0
30-Jul	113	112	113	113	112	114	112	111	112	116	115	118	113	8.89	22.99	92.98	97.25	10.74	27.17	100	0	100	0
31-Jul	113	112	113	113	112	113	112	111	112	115	114	115	113	7.83	14.93	78.97	82.92	10.47	19.54	100	0	100	0

August 2010. Number in bold exceed the water quality criteria.

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

	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wan FB	Average Daily Spill		Total Flow		% Flow Spilled		Reason for Spill (in % of total spill)			
																				Rocky Reach		Rock Island	
2010	12-hr ave	24-hr ave	High	12-hr ave	24-hr ave	High	12-hr ave	24-hr ave	High	12-hr ave	24-hr ave	High	12-hr ave	RR	RI	RR	RI	RR	RI	Fish	Other	Fish	Other
1-Aug	112	112	112	112	111	112	111	111	111	115	115	117	111.5	6.16	14.30	55.02	60.20	12.67	27.85	100	0	100	0
2-Aug	111	111	112	112	111	113	111	110	111	115	114	116	112.0	8.12	17.82	95.03	102.09	9.90	19.35	100	0	100	0
3-Aug	111	111	112	113	112	114	111	110	111	114	113	117	112.3	9.06	20.44	105.26	108.18	9.58	22.24	100	0	100	0
4-Aug	111	110	111	112	111	112	110	110	111	113	113	115	112.5	8.73	20.28	106.68	109.40	8.88	19.81	100	0	100	0
5-Aug	112	112	112	113	112	114	111	110	111	115	114	117	113.7	8.56	23.00	100.25	103.55	10.45	27.89	100	0	100	0
6-Aug	112	112	112	113	112	114	111	110	111	115	115	116	113.0	8.68	22.32	88.67	98.26	12.40	28.11	100	0	100	0
7-Aug	112	111	111	112	111	112				116	114	119	110.2	6.35	15.77	77.03	80.58	9.70	25.29	100	0	100	0
8-Aug	112	111	112	111	110	112				116	114	120	107.1	5.61	14.55	63.07	67.83	10.84	27.46	99.8	0.2	100	0
9-Aug	112	111	112	112	111	113				114	114	117	108.1	8.19	20.75	91.54	95.51	9.58	24.48	100	0	100	0
10-Aug	110	109	110	112	111	112	110	109	110	115	114	117	107.5	8.18	21.34	100.06	104.43	9.87	25.65	100	0	100	0
11-Aug	110	110	111	112	111	112	109	109	110	115	115	117	108.0	7.95	22.97	92.62	93.93	9.34	27.82	100	0	100	0
12-Aug	111	110	111	113	111	114	110	110	110	116	115	117	107.6	8.16	22.66	85.25	88.92	11.05	31.44	100	0	100	0
13-Aug	111	110	111	112	111	113	110	109	110	115	114	119	107.4	8.05	20.13	93.69	96.31	10.45	25.73	100	0	100	0
14-Aug	110	109	110	111	110	111	110	109	110	115	114	118	108.9	5.63	12.43	82.64	85.95	9.98	20.27	99.6	0.4	100	0
15-Aug	111	110	111	111	110	111	110	109	111	114	114	117	108.8	6.72	14.39	68.85	72.12	12.30	23.25	82.7	17.3	100	0
16-Aug	111	110	111	112	111	113	110	110	111	115	115	117	111.6	8.13	20.95	97.35	100.66	10.09	25.01	100	0	100	0
17-Aug	111	111	112	113	112	113	111	110	112	115	115	117	114.3	7.95	20.81	108.05	112.77	8.48	21.79	100	0	100	0
18-Aug	111	111	112	112	111	113	111	110	111	116	115	116	114.0	8.05	20.43	88.22	91.79	11.71	28.56	100	0	100	0
19-Aug	111	110	111	112	111	113	111	109	110	116	115	117	110.5	7.47	19.72	75.64	78.93	13.32	33.64	100	0	100	0
20-Aug	111	110	110	112	111	112	110	109	110	116	114	119	108.8	6.79	16.35	88.61	93.89	9.86	22.30	100	0	100	0
21-Aug	110	109	109	111	108	110	110	109	110	114	109	113	108.7	0.00	0.00	58.14	61.15	0.00	0.00	n/a	n/a	n/a	n/a
22-Aug	108	107	107	107	105	106	108	106	107	109	106	107	107.5	0.00	0.00	50.35	51.57	0.00	0.00	n/a	n/a	n/a	n/a
23-Aug	106	105	106	105	104	105	105	104	106	106	105	106	104.4	0.00	0.00	94.27	98.38	0.00	0.00	n/a	n/a	n/a	n/a
24-Aug	105	105	106	104	104	105	105	105	105	105	105	107	108.3	0.00	0.00	85.32	89.25	0.00	0.00	n/a	n/a	n/a	n/a
25-Aug	108	107	108	106	105	107	106	105	107	107	106	107	109.8	0.00	0.00	96.42	99.58	0.00	0.00	n/a	n/a	n/a	n/a
26-Aug	108	108	108	107	106	107	107	107	107	107	107	107	109.8	0.00	0.00	79.59	82.42	0.00	0.00	n/a	n/a	n/a	n/a
27-Aug	108	107	108	106	106	107	106	106	107	107	106	107	104.6	0.00	0.00	74.78	77.16	0.00	0.00	n/a	n/a	n/a	n/a
28-Aug	107	107	108	106	105	106	107	106	107	107	106	107	104.2	0.00	0.00	63.47	66.74	0.00	0.00	n/a	n/a	n/a	n/a
29-Aug	107	107	108	106	105	106	107	106	107	107	106	107	103.2	0.00	0.00	50.85	54.32	0.00	0.00	n/a	n/a	n/a	n/a
30-Aug	107	107	107	106	105	106	106	105	106	106	106	106	103.6	0.00	0.00	74.18	74.53	0.00	0.00	n/a	n/a	n/a	n/a
31-Aug	106	106	106	105	105	107	106	105	106	106	106	106	103.0	0.30	0.00	83.76	82.84	0.24	0.00	n/a	n/a	n/a	n/a

APPENDIX E

Monthly Calibration Logs

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Apr-10
Arrival Time: 14:45
Departure Time: 15:15

Site: **RRH**
Probe ID: 37606

Calibration Type: Field

Date: 01-Apr-10 **Time:** 10:10

BP Station:
743.5 mmHg

	Std	Initial	Final
Temperature	16.81	16.7	N / C
TDG 100%	743.5	746	744
TDG 113%	843.5	845	844
TDG 126%	943.5	946	944
TDG 139%	1043.5	1046	1044
TDG membrane ID	CPUD-10-01		
Integrity Check	Pass		

Comments:

Report created April 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Apr-10
Arrival Time: 15:25
Departure Time: 16:20

Site: **RRDW**
Probe ID: 38865

Calibration Type: Field

Date: 01-Apr-10 **Time:** 10:15

BP Station:
743.5 mmHg

	Std	Initial	Final
Temperature	16.91	16.8	N / C
TDG 100%	743.5	746	744
TDG 113%	843.5	846	843
TDG 126%	943.5	946	944
TDG 139%	1043.5	1046	1044
TDG membrane ID	CPUD-10-02		
Integrity Check	Pass		

Comments:

Report created April 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Apr-10
Arrival Time: 13:35
Departure Time: 14:05

Site: **RIS**
Probe ID: 38641

Calibration Type: Field

Date: 01-Apr-10 **Time:** 10:20

BP Station:
743.5 mmHg

	Std	Initial	Final
Temperature	16.98	16.8	N / C
TDG 100%	743.5	745	N / C
TDG 113%	843.5	844	N / C
TDG 126%	943.5	945	N / C
TDG 139%	1043.5	1045	N / C
TDG membrane ID	CPUD-10-03		
Integrity Check	Pass		

Comments:

Report created April 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Apr-10
Arrival Time: 11:30
Departure Time: 13:00

Site: **RIGW**
Probe ID: 37607

Calibration Type: Field

Date: 01-Apr-10 **Time:** 10:30

BP Station:
743.5 mmHg

	Std	Initial	Final
Temperature	17.07	17.0	N / C
TDG 100%	743.5	744	N / C
TDG 113%	843.5	844	N / C
TDG 126%	943.5	944	N / C
TDG 139%	1043.5	1044	N / C
TDG membrane ID	CPUD-10-04		
Integrity Check	Pass		

Comments:

Report created April 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-10
Arrival Time: 15:15
Departure Time: 15:35

Site: **RRH**
Probe ID: 37606

Calibration Type: Field

Date: 03-May-10 **Time:** 15:20

BP Station:
739.6 mmHg

	Std	Initial	Final
Temperature	8.10	8.0	N / C
TDG 100%	739.6	740	N / C
TDG 113%	839.6	839	N / C
TDG 126%	939.6	939	N / C
TDG 139%	1039.6	1040	N / C
TDG membrane ID	CPUD-10-05		
Integrity Check	Pass		

Comments:

Report created May 31, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-10
Arrival Time: 14:20
Departure Time: 15:05

Site: **RRDW**
Probe ID: 38865

Calibration Type: Field

Date: 03-May-10 **Time:** 14:40

BP Station:
742.4 mmHg

	Std	Initial	Final
Temperature	7.90	7.8	N / C
TDG 100%	742.4	743	742
TDG 113%	842.4	843	842
TDG 126%	942.4	943	942
TDG 139%	1042.4	1044	1042
TDG membrane ID	CPUD-10-06		
Integrity Check	Pass		

Comments:

Report created May 31, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-10
Arrival Time: 13:15
Departure Time: 13:50

Site: **RIS**
Probe ID: 38641

Calibration Type: Field

Date: 03-May-10 **Time:** 13:25

BP Station:
743.8 mmHg

	Std	Initial	Final
Temperature	8.61	8.4	N / C
TDG 100%	743.8	745	N / C
TDG 113%	843.8	845	N / C
TDG 126%	943.8	945	N / C
TDG 139%	1043.8	1046	N / C
TDG membrane ID	CPUD-10-07		
Integrity Check	Pass		

Comments:

Report created May 31, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-10
Arrival Time: 11:45
Departure Time: 12:55

Site: **RIGW**
Probe ID: 37607

Calibration Type: Field

Date: 03-May-10 **Time:** 12:15

BP Station:
742.0 mmHg

	Std	Initial	Final
Temperature	8.71	8.6	N / C
TDG 100%	742	742	N / C
TDG 113%	842	842	N / C
TDG 126%	942	942	N / C
TDG 139%	1042	1043	N / C
TDG membrane ID	CPUD-10-08		
Integrity Check	Pass		

Comments:

Report created May 31, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jun-10
Arrival Time: 11:00
Departure Time: 12:10

Site: **RIGW**
Probe ID: 37607

Calibration Type: Field

Date: 08-Jun-10 **Time:** 11:35

BP Station:
747.1 mmHg

	Std	Initial	Final
Temperature	13.61	13.6	N / C
TDG 100%	747.1	749	747
TDG 113%	847.1	849	847
TDG 126%	947.1	949	946
TDG 139%	1047.1	1050	1047
TDG membrane ID	CPUD-10-04		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jun-10
Arrival Time: 12:35
Departure Time: 13:10

Site: **RIS**
Probe ID: 38641

Calibration Type: Field

Date: 08-Jun-10 **Time:** 12:50

BP Station:
745.0 mmHg

	Std	Initial	Final
Temperature	13.12	12.9	N / C
TDG 100%	745	749	745
TDG 113%	845	848	845
TDG 126%	945	949	945
TDG 139%	1045	1049	1045
TDG membrane ID	CPUD-10-03		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jun-10
Arrival Time: 13:45
Departure Time: 14:30

Site: **RRDW**
Probe ID: 38865

Calibration Type: Field

Date: 08-Jun-10 **Time:** 14:05

BP Station:
743.2 mmHg

	Std	Initial	Final
Temperature	13.21	13.1	N / C
TDG 100%	743.2	743	N / C
TDG 113%	843.2	843	N / C
TDG 126%	943.2	943	N / C
TDG 139%	1043.2	1043	N / C
TDG membrane ID	CPUD-10-02		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jun-10
Arrival Time: 14:35
Departure Time: 15:00

Site: **RRH**
Probe ID: 37606

Calibration Type: Field

Date: 08-Jun-10 **Time:** 14:45

BP Station:
740.9 mmHg

	Std	Initial	Final
Temperature	13.80	13.7	N / C
TDG 100%	740.9	742	N / C
TDG 113%	840.9	841	N / C
TDG 126%	940.9	941	N / C
TDG 139%	1040.9	1042	N / C
TDG membrane ID	CPUD-10-01		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-10
Arrival Time: 9:35
Departure Time: 10:30

Site: **RIGW**
Probe ID: 32546

Calibration Type: Field

Date: 10-Jun-10 **Time:** 9:00

BP Station:
743.6 mmHg

	Std	Initial	Final
Temperature	12.56	12.4	N / C
TDG 100%	743.6	745	744
TDG 113%	843.6	845	844
TDG 126%	943.6	945	943
TDG 139%	1043.6	1046	1044
TDG membrane ID	CPUD-10-08		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-10
Arrival Time: 10:50
Departure Time: 11:20

Site: **RIS**
Probe ID: 37607

Calibration Type: Field

Date: 08-Jun-10 **Time:** 11:35

BP Station:
747.1 mmHg

	Std	Initial	Final
Temperature	13.61	13.6	N / C
TDG 100%	747.1	749	747
TDG 113%	847.1	849	846
TDG 126%	947.1	949	946
TDG 139%	1047.1	1050	1047
TDG membrane ID	CPUD-10-04		
Integrity Check	Pass		

Comments:

Report created June 28, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-10
Arrival Time: 14:10
Departure Time: 14:35

Site: **RRH**
Probe ID: 37606

Calibration Type: Field

Date: 07-Jul-10 **Time:** 14:20

BP Station:
742.7 mmHg

	Std	Initial	Final
Temperature	16.80	16.7	N / C
TDG 100%	742.7	744	N / C
TDG 113%	842.7	843	N / C
TDG 126%	942.7	943	N / C
TDG 139%	1042.7	1044	N / C
TDG membrane ID	CPUD-10-05		
Integrity Check	Pass		

Comments:

Report created August 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-10
Arrival Time: 13:35
Departure Time: 14:10

Site: **RRDW**
Probe ID: 38865

Calibration Type: Field

Date: 07-Jul-10 **Time:** 13:50

BP Station:
744.9 mmHg

	Std	Initial	Final
Temperature	16.08	15.9	N / C
TDG 100%	744.9	745	N / C
TDG 113%	844.9	845	N / C
TDG 126%	944.9	945	N / C
TDG 139%	1044.9	1046	N / C
TDG membrane ID	CPUD-10-06		
Integrity Check	Pass		

Comments:

Report created August 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-10
Arrival Time: 12:25
Departure Time: 13:00

Site: **RIS**
Probe ID: 37607

Calibration Type: Field

Date: 07-Jul-10 **Time:** 12:40

BP Station:
746.3 mmHg

	Std	Initial	Final
Temperature	16.43	16.4	N / C
TDG 100%	746.3	747	N / C
TDG 113%	846.3	846	N / C
TDG 126%	946.3	946	N / C
TDG 139%	1046.3	1047	N / C
TDG membrane ID	CPUD-10-03		
Integrity Check	Pass		

Comments:

Report created August 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-10
Arrival Time: 11:30
Departure Time: 12:15

Site: **RIGW**
Probe ID: 32546

Calibration Type: Field

Date: 07-Jul-10 **Time:** 11:45

BP Station:
748.2 mmHg

	Std	Initial	Final
Temperature	16.20	16.1	N / C
TDG 100%	748.2	751	748
TDG 113%	848.2	851	848
TDG 126%	948.2	950	948
TDG 139%	1048.2	1050	1048
TDG membrane ID	CPUD-10-04		
Integrity Check	Pass		

Comments:

Report created August 05, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Aug-10
Arrival Time: 13:45
Departure Time: 14:10

Site: **RRH**
Probe ID: 37606

Calibration Type: Field

Date: 10-Aug-10 **Time:** 13:55

BP Station:
739.2 mmHg

	Std	Initial	Final
Temperature	19.40	19.3	N / C
TDG 100%	739.2	739	N / C
TDG 113%	839.2	839	N / C
TDG 126%	939.2	939	N / C
TDG 139%	1039.2	1040	N / C
TDG membrane ID	CPUD-10-01		
Integrity Check	Pass		

Comments:

Report created September 06, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Aug-10
Arrival Time: 13:10
Departure Time: 13:45

Site: **RRDW**
Probe ID: 38865

Calibration Type: Field

Date: 10-Aug-10 **Time:** 13:20

BP Station:
741.2 mmHg

	Std	Initial	Final
Temperature	18.70	18.6	N / C
TDG 100%	741.2	741	N / C
TDG 113%	841.2	840	N / C
TDG 126%	941.2	940	N / C
TDG 139%	1041.2	1041	N / C
TDG membrane ID	CPUD-10-02		
Integrity Check	Pass		

Comments:

Report created September 06, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Aug-10
Arrival Time: 11:50
Departure Time: 12:25

Site: **RIS**
Probe ID: 37607

Calibration Type: Field

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

BP Station:
742.8 mmHg

	Std	Initial	Final
Temperature	18.40	18.4	N / C
TDG 100%	742.8	741	743
TDG 113%	842.8	841	843
TDG 126%	942.8	941	943
TDG 139%	1042.8	1041	1043
TDG membrane ID	CPUD-10-03		
Integrity Check	Pass		

Comments:

Report created September 06, 2010

Columbia Basin Environmental

Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Aug-10
Arrival Time: 9:55
Departure Time: 10:45

Site: **RIGW**
Probe ID: 32546

Calibration Type: Field

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

BP Station:
743.8 mmHg

	Std	Initial	Final
Temperature	18.20	18.1	N / C
TDG 100%	743.8	741	744
TDG 113%	843.8	841	844
TDG 126%	943.8	941	944
TDG 139%	1043.8	1041	1044
TDG membrane ID	CPUD-10-04		
Integrity Check	Pass		

Comments:

Report created September 06, 2010