
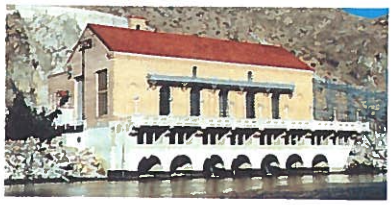


PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
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May 1, 2017

Ms. Kimberly D. Bose, Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

VIA ELECTRONIC FILING

Subject: Rocky Reach Hydroelectric Project, FERC No. 2145
Article 401 and Appendix A, Sections 5.4, 5.5 and 5.7 –
Annual Water Quality Monitoring Report and QAPP Update

Dear Secretary Bose:

The Federal Energy Regulatory Commission (Commission or FERC) issued the "*Order Modifying and Approving Quality Assurance Project Plan Pursuant to Article 401 and Appendix A*" for the Rocky Reach Hydroelectric Project No. 2145 (Project) on November 3, 2010.[1]

As specified in the Order, the Public Utility District No. 1 of Chelan County (Chelan PUD) is required to file an annual Quality Assurance Project Plan (QAPP) report with the Commission by May 1 of each year for the duration of the license. Chelan PUD is required to file the annual QAPP report to the Washington Department of Ecology (Ecology) by March 1 and provide Ecology a minimum of 30 days to comment on the report. Please note that Ecology approved the extended filing date of March 10 for Chelan PUD to submit the draft report. Chelan PUD is required to include documentation of consultation with Ecology and its response to any comments received. (See Appendix E of the filing.)

Annual Water Quality Monitoring

Section 5.7(8) of Appendix A requires reporting water quality monitoring results, along with an annual summary report, in order for Ecology to track the Project's progress toward meeting and remaining in compliance with state water quality standards. Therefore, Chelan PUD has renamed the report to *Annual Water Quality Monitoring Report* (formerly Annual Water Assurance Project Report), to provide a clearer description of the report's objective.

As specified in Paragraph 4 of the Order, Chelan PUD is to conduct water quality monitoring activities at the locations and frequency as described in the table below:

[1] 133 FERC ¶ 62,115

	Parameter (metric)	Location(s)	Frequency
1.	Temperature (degrees Celsius)	Rocky Reach forebay and tailrace, Rock Island forebay	Hourly, April-October
2.	Temperature (degrees Celsius)	Juvenile fish bypass, adult fishway	Hourly for one year
3.	Total dissolved gas (TDG) (% saturation)	Rocky Reach forebay and tailrace, Rock Island forebay	Hourly, April-August

Chelan PUD has completed Item No. 2 above; namely, the water temperature monitoring of the juvenile bypass system and adult upstream fishway in consultation with Ecology and the Rocky Reach Fish Forum. No additional water temperature monitoring is required for the juvenile bypass system and adult upstream fishway. Items No. 1 and 3 are required for the term of the License or until such monitoring is no longer required by Ecology.

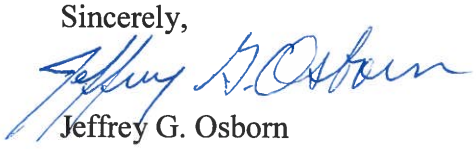
Total dissolved gas (TDG) and temperature monitoring is currently conducted at both the Rocky Reach and Rock Island hydroelectric projects. TDG and temperature data collected during the non-fish spill season (January 1 through March 31 and September 1 through December 31) are reported in the Annual Water Quality Monitoring Report. TDG and temperature data collected during the fish spill period (April 1 through August 31) is reported in the Total Dissolved Gas Annual Report, which is Appendix B of the filing.

Annual QAPP Update

Additionally, Chelan PUD annually reviews its 2010 QAPP in accordance with Article 401 and Appendix A, Section 5.7(2). Based on Chelan PUD's yearly review of the collected water quality data, there are no proposed updates to the 2010 QAPP.

If you have any questions or require additional information, please contact me or Marcie Clement at (509) 661-4186.

Sincerely,



Jeffrey G. Osborn
License Compliance Supervisor
(509) 661-4176
jeff.osborn@chelanpud.org

Attachment: Annual Water Quality Monitoring Report and QAPP Update

cc: Erich Gaedeke (FERC-PRO)
Mark Peterschmidt (Ecology)
Rocky Reach Fish Forum

2016
ANNUAL WATER QUALITY MONITORING REPORT AND QAPP UPDATE

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

May 1, 2017

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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Terms and Abbreviations

401 Certification	water quality certification
7-DADMax	seven day average of the daily maximum temperatures
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
CE-QUAL-W2	Water quality and hydrodynamic model in a longitudinal and vertical dimension
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FMS	fixed monitoring station
GBT	gas bubble trauma
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
Project	Rocky Reach Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RRFF	Rocky Reach Fish Forum
SCADA	supervisory control and data acquisition system
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

This annual water quality monitoring report is being submitted to the Federal Energy Regulatory Commission (FERC) as required by Article 401 and Appendix A, Sections 5.4, 5.5 and 5.7 of the Rocky Reach License.

Section 5.7(1) and (2) required Chelan County Public Utility District No.1 (Chelan PUD) to prepare a Quality Assurance Project Plan (QAPP) (Chelan PUD, 2010) for all studies included in the Water Quality Management Plan (WQMP) of the Rocky Reach Settlement Agreement (Chelan PUD, 2006) and to update the QAPP annually based on a yearly review of data quality.

FERC issued their order modifying and approving the QAPP for the Rocky Reach Project on November 3, 2010. The QAPP (Appendix A) provides the basic framework for all the water quality monitoring and reporting required in the Rocky Reach 401 Certification. For 2017, Chelan PUD does not have any updates for the QAPP (Chelan PUD, 2010).

Chelan PUD has prepared this annual water quality report to summarize the results of the following:

- 2016 total dissolved gas data collected and analyzed from January 1 through March 31 and September 1 through December 31 (non fish-spill season) as requested by Ecology in their December 14, 2011 letter to Chelan PUD.

- 2016 water temperature data collected and analyzed in the Rocky Reach forebay and tailrace, April 1 through October 31 as required by Section 5.5(1)(a).

- 2016 hourly water temperature data provided by Public Utility District No.1 of Douglas County (Douglas PUD) from the Wells Dam tailrace as required by Section 5.5(1)(a).

Water quality data collected in 2016 at Rocky Reach FMS included hourly TDG and water temperature data. Results indicated that there were 10 days that exceeded the 110 percent TDG standard during the non-fish spill season. The 7-DADMax of 17.5°C was exceeded 40 days in the forebay.

In accordance with the 401 Certification, Chelan PUD will continue its hourly TDG and water temperature monitoring. Additionally, Chelan PUD will continue its annual reporting of the data for the purposes of tracking the Project's progress toward meeting and remaining in compliance with the State water quality standards.

SECTION 1: INTRODUCTION

The Rocky Reach Hydroelectric Project (Project), owned and operated by Chelan PUD, is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project consists of an 8,235-acre reservoir; a 2,847 foot long by 130 foot high concrete gravity dam spanning the river, including a powerhouse and spillway; a juvenile fish bypass system (JBS), and hatchery facilities.

Section 5.7(1) and (2) required Chelan County Public Utility District No.1 (Chelan PUD) to prepare a Quality Assurance Project Plan (QAPP) for all studies included in the Water Quality Management Plan (WQMP) of the Rocky Reach Settlement Agreement (Chelan PUD, 2006) and to update the QAPP (Chelan PUD, 2010) annually based on a yearly review of data quality. FERC issued their order modifying and approving the QAPP for the Rocky Reach Project on November 3, 2010. The QAPP (Chelan PUD, 2010) (Appendix A) provides the basic framework for all the water quality monitoring and reporting required in the Rocky Reach 401 Certification. Upon our review of water quality data collected in 2016, no changes or updates are needed to the QAPP. The data collected and summarized in this report were collected in accordance with the Rocky Reach QAPP.

Section 5.7(8) of the 401 Certification requires the submittal of an annual report of water quality monitoring results by March 1 of each year to Ecology. Ecology will use the monitoring results to track the Project's progress toward meeting and remaining in compliance with the state water quality standards. Additionally, the FERC order modifying and approving the QAPP (Chelan PUD, 2010) requires the submittal of the final report to the FERC by May 1 of each year. Chelan PUD requested an extension from Ecology (March 10, 2017) for submitting the 2016 annual report. Ecology approved this extension.

Chelan County Public Utility District No.1 (Chelan PUD) prepared this annual report to summarize the results of the following water quality parameters in accordance with Section 5.7(8) of the 401 Certification:

- 2016 total dissolved gas data collected and analyzed from January 1 through March 31 and September 1 though December 31 (non fish-spill season) as requested by Ecology in their December 14, 2011 letter to Chelan PUD.

- 2016 water temperature data collected and analyzed in the Rocky Reach forebay and tailrace, April 1 through October 31 as required by Section 5.5(1)(a).

- 2016 hourly water temperature data provided by Douglas PUD from the Wells Dam tailrace as required by Section 5.5(1)(a).

Section 3 of this report discusses the water quality monitoring results and summarizes the data collected in 2016.

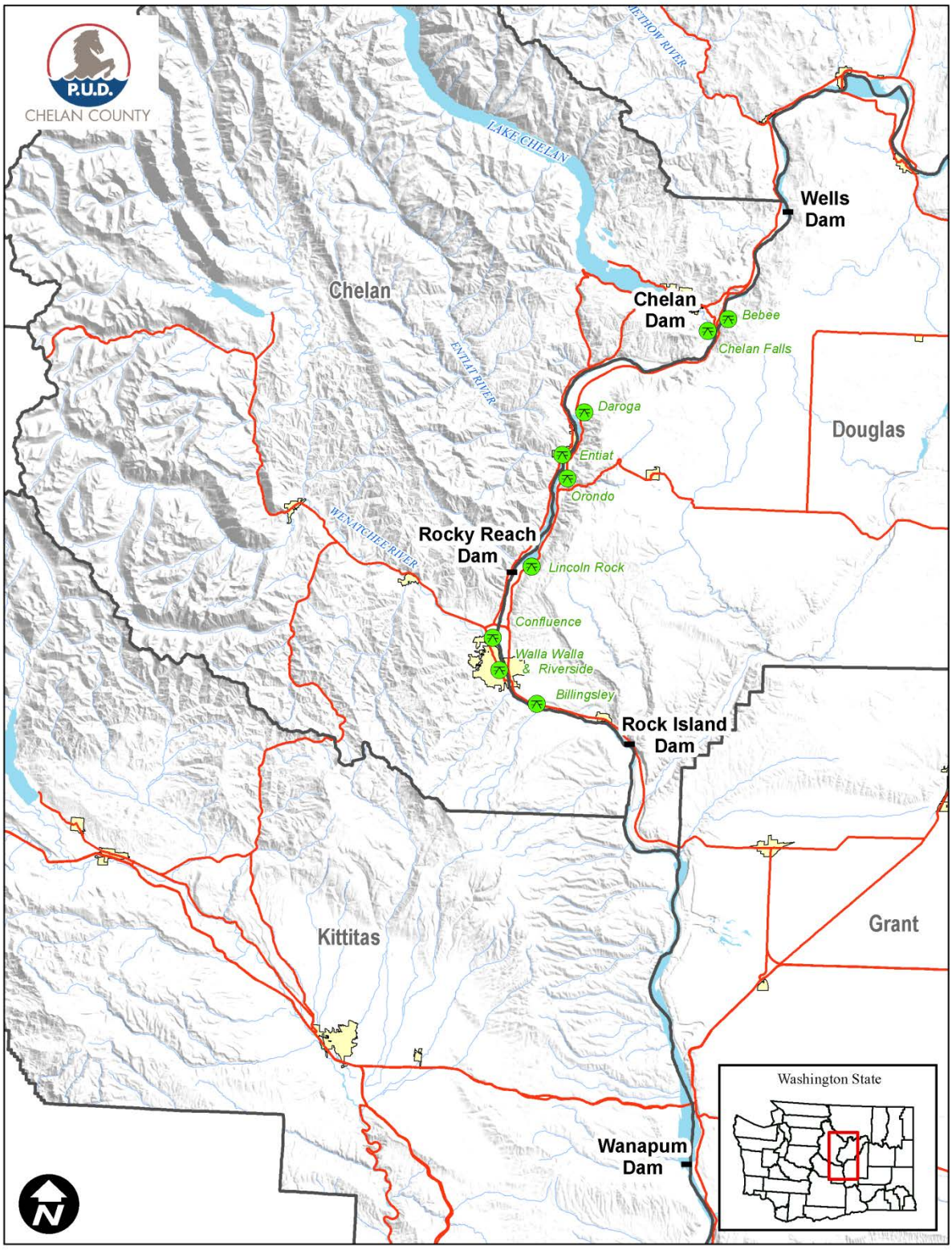

Figure 1-1: Project Location

SECTION 2: MONITORING PROCEEDURES

2.1 Quality Assurance Project Plan

The water quality data for the Rocky Reach Project summarized in this report were collected in accordance with Chelan PUD's FERC and Ecology approved QAPP (Chelan PUD, 2010). The QAPP provides details on water quality monitoring methods and procedures, including the following:

- purpose of monitoring;
- sampling procedures, frequency and equipment;
- analytical methods and quality control procedures;
- data handling and assessment procedures; and
- monitoring protocols.

The purpose of the water quality monitoring and data collection is to provide information on water quality conditions within the Project as well as verify compliance with applicable water quality standards and conditions within the 401 Certification. The QAPP (Chelan PUD, 2010) can be found in Appendix A of this report. In accordance with Section 5.7(2), Chelan PUD shall review and update the QAPP annually based on a yearly review of data quality. Upon our review of water quality data collected in 2016, no changes or updates are needed for the QAPP.

2.2 Regulatory Framework

2.2.1 Total Dissolved Gas

The Washington State water quality numeric criteria for TDG (Washington Administrative Code (WAC) 173-201A-200(1)(f)) address standards for the surface waters of Washington State. Under the water quality standards (standards), TDG shall not exceed 110 percent at any point of measurement in any State water body.

2.2.2 7Q10 Flows

Section 5.4.1(b) of the 401 Certification (Ecology, 2006) and WAC 173-201A-200(f)(i) state that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for Rocky Reach Dam was calculated to be 252 thousand cubic feet per second (kcfs).

2.2.3 Water Temperature

WAC 173-201A-200(1)(c) designates the segment of the Columbia River within the Project as salmonid spawning, rearing, and migration; therefore, water temperature must remain below 17.5°C, as measured by the seven-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C. Temperature in in the Rocky Reach reservoir as measured at the forebay will be used for compliance purposes.

Certain sections of the Columbia River within the Project are classified as impaired for temperature under Section 303(d) of the Clean Water Act. Portions of the Columbia River upstream of the Project are also classified as impaired for temperature. Ecology has indicated that a Total Maximum Daily Load (TMDL) for temperature is expected to be developed by the Environmental Protection Agency (EPA) that will establish a final wasteload and load allocation for temperature (Ecology, 2016).

2.3 Fixed Monitoring Stations

In accordance with Section 5.4.1(a) of the 401 Certification (Ecology, 2006), Chelan PUD currently operates and maintains two fixed-site water quality monitoring stations (FMS) at the Rocky Reach Project that record barometric pressure (millimeters of mercury (mm/Hg)), TDG percent saturation, and temperature (degrees Celsius). Barometric pressure, TDG percentage saturation, and temperature are recorded at 15-minute intervals, throughout the year in accordance with Chelan PUD's Ecology and the FERC approved QAPP (Chelan PUD, 2010).

These water quality data are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the United States Army Corps of Engineers (USACE), Columbia River Basin Water Management Division on an hourly basis and posted on their site on their website. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data.

In 2011, Ecology requested that Chelan PUD begin monitoring TDG year round during the next monitoring season (2012). Monitoring of TDG during the non fish-spill season (January through March and September through December) began in 2012. In 2016, it was discovered that the TDG data used to compile hourly averages and daily maximums by Chelan PUD was in fact a reading from the top of the hour as opposed to hourly averages. For the non fish-spill monitoring season, top of the hour calculation had been used from 2012 through 2015. The data submitted to the USACE was correctly submitted as hourly averages. Chelan PUD notified Ecology on October 10, 2016 of the error, and committed to re-evaluate the data from 2012 through 2015. Additionally, Chelan PUD requested and extension (March 10, 2017) to submit the annual report to Ecology. Ecology approved the extension. Evaluation of the differences in reporting top of the hour verses hourly averages are discussed further in Section 3.1.2.2.

Each Chelan PUD FMS is equipped with a Hydrolab® Minisonde® 5, enclosed in a submerged conduit. These Hydrolab® Minisonde® 5's or probes are connected to an automated system that allows Chelan PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. Probes are maintained and calibrated as outlined in the QAPP (Chelan PUD, 2010) through contract services provided by Columbia Basin Environmental, LLC.

The forebay FMS are located on the upstream face of Rocky Reach and Rock Dam (Figure 2-1). The probe is lowered down a conduit, secured to the upstream face of the Project, and submerged to a depth of approximately 15 feet. The tailrace FMS is located downstream of the Project approximately one third of a mile downstream of the spillway on the JBS outfall (Figure 2-1), as required by the 401 Certification (Ecology, 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.

Figure 2-1: Rocky Reach project, forebay, tailrace and fixed monitoring stations.

SECTION 3: RESULTS

3.1 Total Dissolved Gas

3.1.1 Fish-Spill Season

Section 5.4(1)(a) of the 401 Certification requires Chelan PUD to submit an annual report related to TDG and fish-spill data collected during the fish-spill season to Ecology. The Draft 2016 Annual Total Dissolved Gas Report was reviewed and approved by Ecology on March 7, 2017. This report covered TDG monitoring data results collected during the fish-spill season (April 1 – August 31) and therefore is not covered in this summary report. The 2016 Annual Total Dissolved Gas Report can be found in Appendix B of this report.

3.1.2 Non Fish-Spill Season

As described in Section 5.4(2) of the 401 Certification; for the purposes of compliance, the non-fish spill season defined as September 1 to March 31. Hourly TDG data were collected and analyzed from January 1 through March 31 and September 1 through December 31. Data collection, quality assurance and quality control (QA/QC) measures and analyses of TDG values mirror those described in the QAPP (Chelan PUD, 2010).

For the purposes of this summary report, data recorded during 2016 were analyzed for exceedances from current water quality standards during the non-fish spill season. Suspect or erroneous values were omitted from the analysis, but are further explained in the text and in Table 3-1 below.

Table 3-1 displays the number of hourly TDG values that were omitted/lost from the dataset due to various QA/QC issues. Two hours were lost in the forebay and two hours lost in the tailrace due to updates to the supervisory control and data acquisition (SCADA) system.

Table 3-1: Hourly TDG values omitted/lost during 2016

Data losses/erroneous data of the 1-DMax April 1			
Location	**Total Available Hours**	**Lost/erroneous Data Hours**	**Percent Data Loss**
Rocky Reach forebay	5,112	2	0.04
Rocky Reach tailrace	5,112	2	0.04
Total	**10,224**	**4**	**0.04**

The summary values (mean, standard deviation, minimum, and maximum) for all hourly TDG measurements during non-fish spill season are presented in Table 3-2 below.

Table 3-2: Summary of hourly total dissolved gas measurements from each fixed monitoring station during the 2016 non-fish-spill season

Location	Data Collection Period	Mean[1]	Standard deviation	Min[1]	Max[1]
Rocky Reach forebay	Jan 1-Mar 31	98.8	2.8	93.5	104.3
	Sept 1-Dec 31	97.8	2.5	92.9	103.3
Rocky Reach tailrace	Jan 1-Mar 31	99.7	2.8	94.7	118.4
	Sept 1-Dec 31	98.6	3.0	93.4	114.1
[1]All values represent percent saturation					

3.1.2.1 Total Dissolved Gas Exceedances

There were 10 daily TDG exceedances during the non-fish spill season for 2016. Table 3-3 displays the number of TDG daily exceedances from current water quality standards as measured at the FMS. The hourly TDG values from each day during the non-fish spill season from each FSM station can be found in Appendix C.

Table 3-3: Number of 2016 non-fish spill season total dissolved gas exceedances

Location	Data Collection Period	Exceedances of 110 percent criteria	Total days	Percent above standard
Rocky Reach forebay	Jan 1-Mar 31	0	91	100
	Sept 1-Dec 31	0	122	100
Rocky Reach tailrace	Jan 1-Mar 31	3	91	96.7
	Sept 1-Dec 31	7	122	94.3
Total		**10**	**426**	**97.7**

Figure 3-1 displays the daily maximum TDG readings from each twenty-four hour period during the non-fish spill season from each FMS station. The daily maximum TDG values from each day during the non-fish spill seasons from each FMS station can be found in Appendix C.

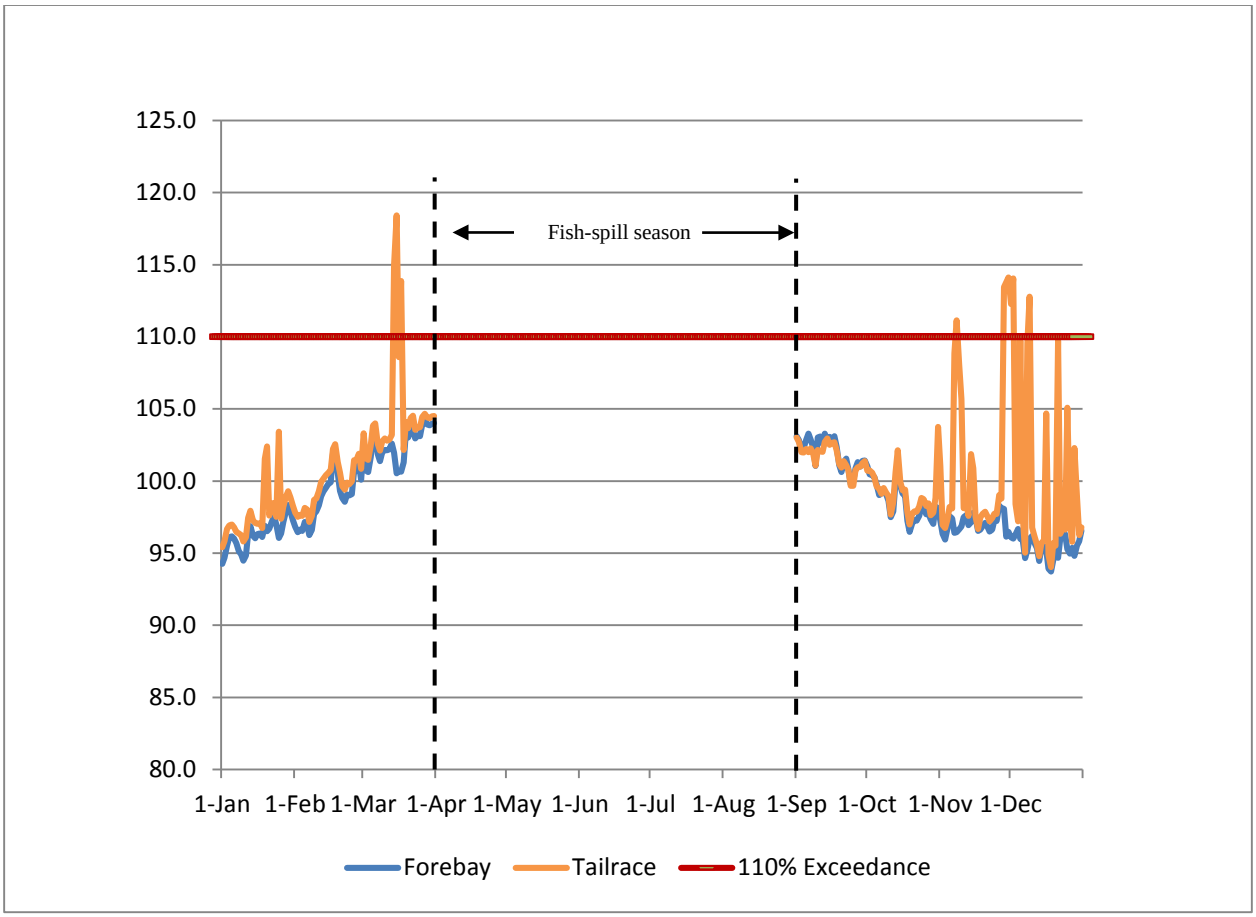

Figure 3-1: Daily maximum TDG readings from each FMS

3.1.2.2 Evaluation of Exceedances from 2012 Through 2015

In 2011, Ecology requested that Chelan PUD begin monitoring TDG year round during the next monitoring season (2012). Monitoring of TDG during the non fish-spill season (January through March and September through December) began in 2012. In 2016, it was discovered that the TDG data used to compile hourly averages and daily maximums by Chelan PUD was in fact a reading from the top of the hour as opposed to hourly averages. Chelan PUD notified Ecology of this error on October 10, 2016, and committed to re-evaluate the data from 2012 through 2015.

All Rocky Reach tailrace and Rock Island forebay TDG data for 2012 through 2015 was re-run using the proper hourly average calculation for each hour of data. Rocky Reach forebay (Wells Dam tailrace) and Rock Island tailrace (Wanapum Dam forebay) data were not re-run as compliance at those locations were evaluated using Douglas and Grant PUD's data from their projects. Daily hourly averages from 2012 through 2015 were compared to the previous top of

the hour data set. Differences in the top of the hour and hourly averages were reviewed to determine if the difference would have resulted in an exceedance or non-exceedance. A total of 40,752 hours of data were evaluated. Of those 40,752 hours, 33 hours resulted in a change (0.08 percent) of an exceedance or non-exceedance. Results of the comparisons are discussed further below.

3.1.2.3 Rocky Reach Tailrace

Out of 20,376 hours of data that were compared (top of the hour versus hourly average) from the 2012 through 2015 non fish-spill period, 11 hours using the hourly average should have resulted in a daily exceedance of the 110 percent standard at the Rocky Reach tailrace. Conversely, 20 hours were counted as exceedances using the top of the hour that should not have been counted as an exceedance of the 110 percent standard, thereby resulting in a total of nine exceedances that should have been counted in the Rocky Reach tailrace.

3.1.2.4 Rock Island Forebay

Out of 20,376 hours of data that were compared (top of the hour versus hourly average) from the 2012 through 2015 non fish-spill period, one hour using the hourly average should have resulted in a daily exceedance of the 110 percent standard at the Rock Island forebay. Conversely, one hour counted as an exceedance using the top of the hour should not have been counted, thereby resulting in zero exceedances in the Rock Island forebay.

3.2 Water Temperature

Section 5.5(1)(a) of the 401 Certification provides three conditions regarding water temperature monitoring as listed below:

1. Chelan PUD shall monitor temperatures in the forebay and tailrace annually from April through October for the term of the New License and any subsequent annual licenses or until such monitoring is no longer required by Ecology, whichever occurs sooner.

2. Chelan PUD monitor water temperatures in the juvenile bypass system and upstream fishway for one year, unless Ecology determines, in consultation with the Rocky Reach Fish Forum (RRFF), that additional monitoring is required.

3. Chelan PUD shall also compile hourly water temperature data from the Wells dam tailrace for the term of the New License or any subsequent annual licenses or until such data collection is no longer required by Ecology, whichever occurs sooner.

Items numbed 1 and 3 are required for the term of the License or until such monitoring is no longer required by Ecology and are reported in Section 3.2.1 of this report. Chelan PUD has completed item number 2 above; water temperature monitoring of the juvenile bypass system and upstream fishway in consultation with Ecology and the RRFF (Chelan PUD, 2013)(Chelan PUD, 2014). No additional water temperature monitoring is required for the juvenile bypass system and upstream fishway.

*3.2.1 **Water Temperature from Rocky Reach Forebay, Tailrace, and Wells Dam Tailrace***

Water temperature data were collected on an hourly basis during the monitoring season. Daily maximum temperatures from the three sites were used to determine the 7-DADMax. Data collection, QA/QC, and analyses of water temperature data followed those described in the QAPP (Chelan PUD, 2010). Overall data loss in 2016 was five hours of the combined 10,272 available hours or 0.05 percent data loss, which was well within the 90 percent data completeness data quality objective as specified in the QAPP. Table 3-4 demonstrates the number of hours that data was omitted/lost for the 2016 monitoring season.

Table 3-4: Overview of the water temperature data losses/erroneous data of the 1-DMax, April 1 through October 31, 2016

Data losses/erroneous data of the 1-DMax April 1			
Location	**Total Available Hours**	**Lost/erroneous Data Hours**	**Percent Data Loss**
Rocky Reach forebay	5,136	2	0.0
Rocky Reach tailrace	5,136	3	0.1
Total	**10,272**	**5**	**0.05**

Table 3-5 provides a summary of the 7-DADMax in the Wells tailrace, Rocky Reach forebay and tailrace. In general, water temperatures peaked during the period of July 1 through September 30, to values equal to or greater than 17.5 ºC. During this period, temperatures exceeded 17.5ºC on 78 days in the Wells tailrace and 82 days in the Rocky Reach forebay. When the differences in temperature were evaluated between the Wells tailrace and the Rocky Reach forebay, 40 of those days resulted in an increase above 0.3ºC. When the differences in temperature were evaluated between the Rocky Reach forebay and tailrace, 44 of those days resulted in an increase above 0.3 ºC. Also during this same time period, water temperatures measured at the Rocky Reach tailrace were, on average, 0.03ºC lower than water temperatures measured in the forebay. Figure 3-2 presents a graphical display of the 7-DADMax values. All temperature data is presented in Appendix D of this document.

Table 3-5: Summary of 7-DADMax temperature criterion in the Rocky Reach forebay, Rocky Reach tailrace, and Wells tailrace in 2016.

Location	**Data Collection Period**	**Mean[1]**	**Standard Deviation**	**Minimum[1]**	**Maximum[1]**
Wells tailrace	4/1—10/31	15.4	3.5	7.1	19.4
RR FB	4/1—10/31	15.7	3.5	7.5	19.8
RR TR	4/1—10/31	15.7	3.4	7.5	19.7
[1]All values are in degrees Celsius					

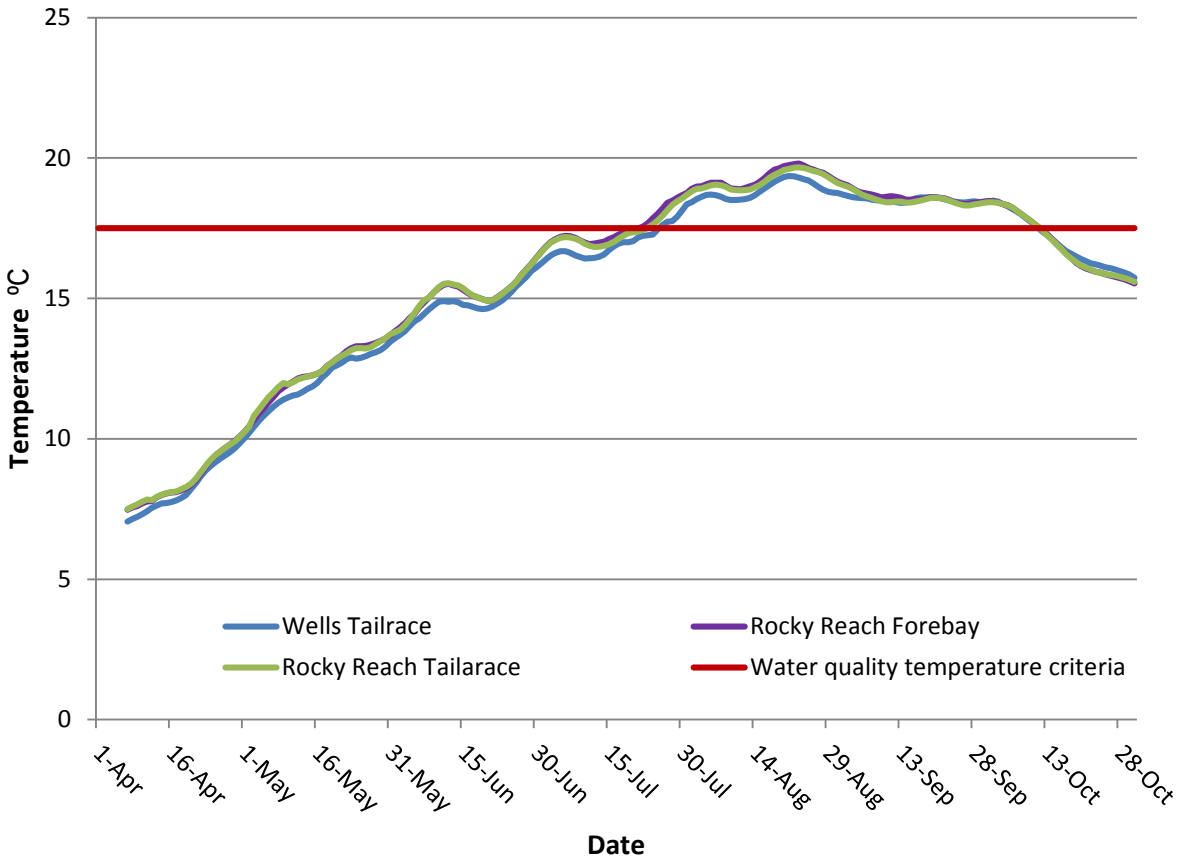

Figure 3-2: 7-DADMax Temperatures in the Wells tailrace, Rocky Reach forebay and tailrace.

*3.2.2 **Water Temperature Modeling***

Section 5.5(1)(c) of the 401 Certification states temperature data from the Project forebay, tailrace and Wells Dam tailrace will be used to run the CE-QUAL-W2 model in Year five of the License to evaluate the Project's compliance with numeric temperature criteria. However, in a letter received by Chelan PUD on April 21, 2014, Ecology recommended that modeling temperature in the Rocky Reach pool be postponed until such time as it may be recommended by Ecology. Chelan PUD is currently coordinating with the USACE regarding their modeling efforts on the Columbia River and will continue this coordination.

SECTION 4: CONCLUSIONS

Water quality data collected in 2016 at Rocky Reach FMS included hourly TDG and water temperature data. Results indicated that there were 10 days that exceeded the 110 percent TDG standard during the non-fish spill season. The 7-DADMax of 17.5°C was exceeded 40 days in the forebay.

In accordance with the 401 Certification, Chelan PUD will continue its hourly TDG and water temperature monitoring. Additionally, Chelan PUD will continue its annual reporting of the data for the purposes of tracking the Project's progress toward meeting and remaining in compliance with the State water quality standards.

In review of the 2016 data quality, no changes or updates are required for the current QAPP (Chelan PUD, 2010). Chelan PUD will continue to follow and implement the Ecology and the FERC approved QAPP for the 2017 water quality data collection season.

SECTION 5: LIST OF LITERATURE

Chelan PUD. 2006. Rocky Reach Comprehensive Settlement Agreement, Attachment B, Rocky Reach Comprehensive Plan, Chapter 2, Water Quality Management Plan. Chelan PUD, Wenatchee, WA.

Chelan PUD. 2010. Quality Assurance Project Plan Rocky Reach Water Quality Monitoring and Reporting. Chelan PUD, Wenatchee, WA.

Chelan PUD. 2016. Gas Abatement Annual Report, Rocky Reach and Rock Island Hydroelectric Projects. Chelan PUD, Wenatchee, WA.

Federal Energy Regulatory Commission (FERC). 2009. Order Issuing New License for Public Utility District No. 1 of Chelan County, 126 FERC ¶ 61,138, Washington D.C.

Washington State Department of Ecology (Ecology). 2006. Water Quality Certification for the Rocky Reach Project. Order No. 3155 dated March 17, 2006.

Washington State Department of Ecology. "Columbia River Projects." Water Quality Improvement Projects (TMDLs). Washington State Department of Ecology, Dec. 2015. Web. 17 Feb. 2016. http://www.ecy.wa.gov/programs/wq/tmdl/TMDLsbyWria/tmdlColumbiaRvr.html

APPENDIX A: 2010 QUALITY ASSURANCE PROJECT PLAN ROCKY REACH HYDROELECTRIC PROJECT



PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
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February 19, 2010

VIA ELECTRONIC FILING

Honorable Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

Subject: Rocky Reach Hydroelectric Project, FERC No. 2145
Article 401 and Appendix A, Sections 5.7(1) and (2) – Quality Assurance Project Plan

Dear Secretary Bose and Deputy Secretary Davis:

The Federal Energy Regulatory Commission (Commission or FERC) issued the "Order on Offer of Settlement and Issuing New License" (License) and "Order on Rehearing and Clarification" for the Rocky Reach Hydroelectric Project No. 2145 (Project) on February 19, 2009, and May 21, 2009, respectively. In accordance with License Article 401 and Certification Condition Numbers 5.7(1) and 5.7(2) of Appendix A – Section 401 Water Quality Certification of the License, the Public Utility District No. 1 of Chelan County (Chelan PUD) is required to file a Quality Assurance Project Plan (QAPP) within one year of License issuance and annually thereafter with the Commission.

Chelan PUD hereby files the QAPP, which includes all water quality monitoring, including TDG and temperature studies, the proposed GBT study, and monitoring water quality in shallow water habitat in the reservoir. It also includes, at a minimum, a list of parameters to be monitored, a map of sampling locations, and descriptions of the purpose of the monitoring, sampling frequency, sampling procedures and equipment, analytical methods, quality control procedures, data handling and data assessment procedures, and reporting protocols.

Appendix B provides the record of consultation with the Washington Department of Ecology in preparing the QAPP.

If you have any questions or require additional information, please contact me or Waikele Hampton at (509) 661-4627.

Sincerely,

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Enclosures: Final Quality Assurance Project Plan

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QUALITY ASSURANCE PROJECT PLAN
Rocky Reach Water Quality Monitoring and Reporting

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

February 19, 2010

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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ACRONYMS AND ABBREVIATIONS LIST

cfs	cubic feet per second
Chelan PUD	Public Utility District Number 1 of Chelan County
CRO	Central Region Office of Ecology
CWA	Clean Water Act
DO	dissolved oxygen
DQO	data quality objectives
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
kcfs	thousands of cubic feet per second
mg/L	milligrams per liter
mmHg	millimeters of mercury
MQO	measurement quality objective
N/A	not applicable
NIST	National Institute of Standards and Technology
PI	PI System® from OSIsoft®
Project	Rocky Reach Hydroelectric Project
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	standard method
SOP	standard operating procedure
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WAS	Watershed Assessment Section
WQA	Water Quality Assessment

SECTION 1: BACKGROUND

The Rocky Reach Hydroelectric Project is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project's installed capacity under the license is 865.76 megawatts.

This Federal Energy Regulatory Commission (FERC) licensed Project includes a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The Project consists of:

- A forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- A powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- A spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate; with a combined hydraulic capacity of 980 kcfs;
- Two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide; and
- An east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet.

The Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. These are located between spillway bays 8 and 9, at the center of the dam adjacent to powerhouse unit 11, and at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also several submerged orifice entrances at each end of the powerhouse. Fish pass from the entrances into fish collection channels, which converge to guide fish to a pool and weir fish ladder with a counting station at the fishway exit that is near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cfs and a gravity intake provides attraction water for the spillway entrance. The juvenile fish bypass system includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

Figure 1-1: Project Location

The water quality monitoring program described in this Quality Assurance Project Plan (QAPP) is necessary to fulfill the requirements set forth by the Washington State Department of Ecology (Ecology) in the Section 401 water quality certification (401 Certification), Order No. 3155 issued on March 17, 2006, and incorporated into the License by Ordering Paragraph (D) on February 19, 2009. The 401 Certification incorporates, by reference, the Water Quality Management Plan, which is Chapter 2 of the Comprehensive Plan, Attachment B to the Settlement Agreement. This QAPP was prepared in accordance with the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology, 1993).

To accomplish these measures in accordance with the 401 Certification, the Public Utility District Number 1 of Chelan County (Chelan PUD) will monitor and evaluate total dissolved gas (TDG) in the Project forebay and tailrace (401 Certification, Section 5.4(1)(a)), water temperature in the Project forebay, tailrace, juvenile bypass system, and adult fishway (401 Certification, Section 5.5); and temperature, dissolved oxygen (DO) concentrations, and pH in selected macrophyte beds in the Reservoir (401Certification, Section 5.6). In addition, Chelan PUD will prepare and implement a study of gas bubble trauma (GBT). This QAPP is designed to describe the proposed sampling, monitoring and assessment methods, and subsequent reporting requirements.

In addition to the above mentioned monitoring, Chelan PUD will monitor TDG in the Rock Island forebay. This location is not included in Section 5.4(1)(a) of the 401Certification; however, Chelan PUD is required to report data from this location as per Section 5.4(4) of the 401 Certification.

Chelan PUD plans to coordinate the macrophyte bed monitoring with required resident fish monitoring (as per Chapter 6 of the Comprehensive Plan), which, because additional time is needed to prepare a study plan for the GBT study, will not be conducted until after 2010. These studies will be included in a subsequent annual QAPP update/revision. For these reasons, macrophyte bed monitoring and the GBT study will not be described in this QAPP.

Using the data collected in the first five years of the New License, Chelan PUD will run the CE-QUAL-W2 model to evaluate Project compliance with numeric temperature criteria. An additional QAPP will be drafted to address the modeling effort.

It is necessary to note that some of the monitoring described in this QAPP may not be conducted if unsafe conditions exist. At this time it is not possible to know if unsafe conditions exist, and if so, whether they are temporary or permanent. If permanently unsafe conditions exist, Chelan PUD will consult with Ecology to determine an appropriate alternative.

1.1 REGULATORY FRAMEWORK

1.1.1 Total Dissolved Gas

Washington Administrative Code (WAC) 173-201A-200(1)(f)) establishes, and Ecology administers, Washington state water quality standards for TDG during the non-fish and fish-spill seasons . The current

standard for TDG (in percent saturation) during the non-fish spill season (September 1 through March 31) is 110% for any hourly measurement.

For projects on the Snake and Columbia rivers, the current standard for TDG (in percent saturation) during the fish-spill season (generally assumed to fall between April 1 through August 31) is 120% in the tailrace of the dam spilling water for fish and 115% in the forebay of the next downstream dam, based on the average of the 12 highest consecutive hourly readings in a 24-hour period. A one-hour, 125% maximum standard for TDG also applies throughout the Project during the fish-spill season.

Prior to 2008, the method used to calculate the daily TDG compliance value during the fish-spill season was based on the average of the 12 highest hourly values in a 24-hour period, starting at 0100 hours and ending at 2359 hours. This method was based on Ecology's 1997 Water Quality Standards. In Ecology's 2006 revision to the Water Quality Standards the method for calculating the TDG compliance value was changed to the 12 highest consecutive hourly readings in a 24-hr period.

The revision did not define how to implement the new standard so on April 2, 2008 Ecology sent a letter to all Columbia and Snake river dam operators requesting the use of a rolling average method for calculating the 12 highest consecutive hourly TDG readings in a 24-hour period, beginning at 0100 hours (Ecology 2008). Using a rolling average that begins at 0100 hours results in counting the hours 1400 hours through 2359 hours 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 based on the same group of hours.

This "double-counting" of some of the hourly TDG values could potentially lead to critical management decisions that alter operational or physical characteristics of a particular hydroelectric project. Because there is not yet a formally established method to address this "double counting" issue, in 2009 Chelan PUD followed the methodology below to address such:

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.

Use of the above methodology allowed for the monitoring of consecutive hours while eliminating "double counting". Chelan PUD understands and appreciates the need for consist compliance monitoring and reporting throughout the basin and will modify or replace the methodology described above at such time as Ecology provides an approved method.

1.1.2 Water Temperature

WAC 173-201A-602 designates the section of the Columbia River within the Project as a "salmonid spawning, rearing, and migration" water body (formerly Class A) and therefore water temperature must

remain below 17.5°C, as measured by the 7-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.

1.1.3 Dissolved Oxygen and pH

The water quality criteria for DO within the Project require that DO be greater than 8.0 milligrams per liter (mg/L). When DO is lower than the criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(f)).

WAC 173-201A-200(1)(g) provides that pH shall be within the range of 6.5 to 8.5 units with a human-caused variation within the above range of less than 0.5 units.

1.2 HISTORICAL WATER QUALITY INFORMATION

The Columbia River at the Project is designated under current Washington State water quality standards as a "salmonid spawning, rearing, and migration" water body (formerly Class A). Water quality of this designation must meet or exceed the requirements for all or substantially all uses. The characteristic uses for the Project segment of the Columbia River include propagation of fish and wildlife (including salmonid species), water supply (domestic, irrigation, industrial), recreation, navigation and commerce (including power generation).

The Reservoir meets water quality standards numeric criteria for DO, pH, turbidity, and fecal coliform (Chelan PUD, 2004; Table 7 in PDEA). The mid-Columbia River, including the Reservoir is currently listed as impaired for TDG and water temperature with five sites on or near the Reservoir per the 2002/2004 candidate list (Section 303(d) of the Clean Water Act (CWA)). At times, water comes into the Reservoir with temperatures or TDG levels that exceed the numeric criteria. The existence of the Project does have the potential to increase water temperatures during the summer due to the effects of the Reservoir on total water surface area and increased travel time of water moving through the Reservoir. Spill operations at the Project can increase TDG levels in the Columbia River below the Project.

Chelan PUD has conducted water quality surveys within Rocky Reach Hydroelectric Project reservoir targeting specific water quality concerns; some of these studies include annual monitoring over multiple years. In coordination with the US Army Corps of Engineers, Chelan PUD has monitored water temperature at the fishway since 1965 and TDG in the forebay since 1982. More intensive monitoring of temperature and TDG was initiated in 1996. The monitoring data sets consist of daily temperature only (1965 - 1981), hourly temperature and TDG in the forebay (April - August, 1982 - present), and hourly TDG and temperature below the tailrace of the Rocky Reach Hydroelectric Project dam (April – August, 1997 - present). TDG monitoring with improved equipment and calibration procedures during the spring and summer seasons was initiated in 1995 for the forebay and 1997 for the tailrace (McDonald and Priest, 1997; Koehler and McDonald, 1997, 1998).

Douglas PUD has conducted comparable studies at Wells Hydroelectric Project dam, which are the headwaters to the Rocky Reach Hydroelectric Project reservoir. Transparency data are available for both the Rocky Reach Hydroelectric Project dam forebay and the Wells Hydroelectric Project dam forebay (1993 – present) from secchi disk readings from the fishways.

The Rocky Reach Project generally has no adverse effect on the objectives and narrative requirements of the water quality standards. The Project and the Reservoir maintain the water quality, habitat and accessibility necessary to support all the existing beneficial and designated uses included in the standards (WAC 173-201A). These uses include primary contact recreation; aesthetic enjoyment; sports fishing; boating; water supply for domestic, industrial, and agricultural uses; and fish and wildlife habitat, including habitat for spawning, rearing and migration of cold –water salmonid species. The Reservoir has clean, clear water with high water transparency, very low fecal coliform content, and high DO concentrations.

SECTION 2: PROJECT DESCRIPTION

According to the 401 Certification, monitoring, assessment, and reporting are required. Each will be discussed in this QAPP.

The goal of the QAPP is to determine compliance with Washington's numeric water quality criteria (WAC 173-201A). This QAPP was prepared to guide Chelan PUD in this effort. If criteria are not being met, subsequent goals may include identifying any impacts due to ongoing Project operations on the regulated parameters; and determining and implementing any reasonable and feasible solutions to exceedances.

The following are the monitoring requirements of the Rocky Reach 401 Certification. Chelan PUD must:

- Maintain two fixed monitoring stations at Rocky Reach Dam to monitor TDG levels annually from April through August, one in the forebay and one in the tailrace for the term of the New License;
- Monitor hourly water temperatures in the forebay and tailrace annually from April through October for the term of the New License;
- Monitor water temperatures in the juvenile fish bypass system and upstream fishway for one year;
- Monitor DO, temperature, and pH in shallow water habitats, including macrophyte beds, in the Reservoir for one year; and
- Prepare and implement a study of Gas Bubble Trauma.

The reporting of these data includes submitting:

- In year 5 of the effective date of the New License, a report summarizing the results of all TDG studies performed to date, and describing whether compliance with numeric criteria has been attained;
- A Gas Abatement Plan to Ecology for review and approval by April of the year of implementation;
- An annual report to Ecology in an approved format that includes the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, spill levels, and biological effects of GBT;
- Hourly TDG information to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible;
- An annual report to Ecology in an approved format that includes a data assessment of compliance with state water quality criteria, summaries of the data, and a list of any water quality exceedances; and
- Immediate reports to Ecology's Spills Response Program of any spills into state waters, spills onto land where contaminants could potentially drain into state waters, or cause fish kills or any other significant water quality problems.

SECTION 3: ORGANIZATION AND SCHEDULE

This section includes key personnel assigned to the project and an associated organizational chart, and time schedules for field operations, project deliverables, budgeting, and funding information.

3.1 KEY PERSONNEL

This project is to be conducted primarily by Chelan PUD personnel, with assistance as needed, to expedite the process, reduce costs, or improve quality (if needed). All personnel conducting work will have sufficient skills and experience to complete the necessary tasks at a high level of quality. This plan has been designed by Chelan PUD, and is anticipated to be conducted by the personnel outlined in Table 3-1:.

Table 3-1: Key Personnel

Personnel	Responsibility
Waikele Hampton	*Chelan PUD Environmental Permit Coordinator / Project Manager*. Lead responsible for project management, jointly responsible for report generation, data interpretation, field sampling methodology development, and sampling and monitoring.
Steven Hays	*Chelan PUD Fish and Wildlife Senior Advisor*. Jointly responsible for report generation and/or review, data interpretation, and field sampling methodology development. Senior technical review for all reports.
Michelle Smith	*Chelan PUD Licensing and Natural Resource Compliance Manager*. Responsible for QAPP and report review and approval, and funding approval.
Rosana Sokolowski	*Chelan PUD Licensing & Compliance Coordinator*. Responsible for administrative support of QAPP, sampling, data entry, and reporting.
Debby Bitterman	*Chelan PUD Administrative Assistant.* Responsible for administrative support of QAPP.
Charlie McKinney	*Ecology WQ Section Manager, Central Regional Office (CRO).* Oversees Ecology participation regarding 401 certification and Settlement Agreement.
Jon Merz	*Ecology Watershed Unit Supervisor, CRO.* Provides Ecology staff to assist PUD in compliance with 401 Certification and Settlement Agreement. Reviews Ecology work documents.
Patricia Irle	*Ecology Hydropower Projects Manager, CRO.* Lead responsible for tracking compliance with terms of 401 Certification and Settlement Agreement. Includes review of reports and the QAPP and assistance in meeting other requirements as defined in the 401 certification and Settlement Agreement.
To be determined (may be contracted out)	*Field sampler.* Responsible for field activities (including equipment maintenance), documentation and health and safety during field operations. Jointly responsible for report generation as needed.
Kris Pomianek	*Community Outreach Advisor.* Responsible for website creation and maintenance.
Jeff Mettler	*Power Management, P.I. Interface person.* Responsible for providing assistance with data management and recovery.
Ron Franklin	*Health and Safety Officer*. Responsible for overall aspects of health and safety for the QAPP project work.

3.2 SCHEDULE

The schedules below will be closely managed to ensure that no deadlines are missed, or parameter reporting requirements overlooked, unless a Force Majeure event arises, as provided in the Rocky Reach Settlement Agreement.

3.2.1 Monitoring Schedule

The schedule that will be followed has been developed from the requirements stated in the 401 Certification.

Table 3-2: Monitoring Schedule

Parameter	Monitoring Schedule	Comments
TDG	Annually Hourly April-August	Monitors located in the forebay and tailrace of Rocky Reach and in the forebay of Rock Island.
Spill as a surrogate for TDG	Hourly (This will be necessary only during spill events outside of the fish spill season.)	Data collected during the fish spill season will be used to further refine the linear regression developed by Schneider and Wilhelms (2005)
Temperature	Annually, Hourly April - October	Forebay and tailrace
Temperature	Hourly for one year	Juvenile bypass and upstream fishway
Macrophyte beds (temp, DO, pH)	Frequency is TBD; one-year study	This study will be conducted at a later date (likely in 2011)[1]
GBT	TBD	This study will be conducted at a later date (no sooner than 2011)

[1] ***Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for a side-by-side look at macrophyte bed water quality conditions and fish presence/use.***

3.2.2 Reporting Schedule

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

Chelan PUD will report exceedances of the water quality criteria within 48 hours to Ecology's CRO. Note that it may not be possible to provide temperature exceedances that are based on shifts in the temperature from natural because modeling is required to determine this type of exceedance.

3.3 BUDGET AND FUNDING

A preliminary budget has been developed to aid in planning for this work. For the sake of the initial budget, it is assumed that the forebay and tailrace temperature and TDG data will be collected real-time and the remainder of the temperature data will be logged and downloaded monthly or quarterly.
Chelan PUD will fund the monitoring and reporting described herein. These funds will be made available internally earmarked well in advance of the initiation of the monitoring (likely a minimum of two years prior) to ensure sufficient funding is provided.

SECTION 4: DATA QUALITY OBJECTIVES (DQO)

The primary objective for collecting data is to track compliance with water quality standards. The purpose of the QAPP is to identify the methods and standards used to make that determination/decision. Data quality objectives (DQOs) are statistical statements of the level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. They describe what data are needed, and how the data will be used to address the concerns being investigated. The DQOs also establish numeric limits that ensure the data collected are of sufficient quality and quantity for data user applications.

The overall DQO is to ensure that data of known and acceptable quality are provided. Proper execution of each task will yield consistent results that are representative of the media and conditions measured. All data will be calculated and reported in conventional units to allow comparability of the data. There are two types of DQOs, including decision quality objectives and measurement quality objectives (MQOs).

The acquired data will be used to characterize the water quality of the Rocky Reach Reservoir and tailrace. Decision quality objectives to obtain this information are to:

- Generate scientific data of sufficient quality to withstand scientific and legal scrutiny.
- Gather and develop data in accordance with procedures appropriate for its intended use.
- Conduct all methods/procedures specified for this project in compliance with Ecology requirements for environmental investigations.

To ensure that the MQOs of the monitoring effort are within the limits of the work, specific criteria for data parameters have been established as appropriate.

4.1 DECISION QUALITY OBJECTIVES

For this effort, the data collection must be designed in such a manner that the results can be used to determine if the water quality criteria have been met; therefore, quality objectives at the level of the decision are required. These objectives will be met by carefully determining the number of measurements taken to represent a given condition. The Sampling Process Design (Section 5.0) addresses the requirements of the decision quality objectives.

The success of obtaining these objectives can be measured by ensuring that the representativeness, completeness and comparability are controlled. Each is described below.

4.1.1 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. For this investigation, representativeness is a qualitative parameter that is primarily concerned with proper design of the sampling program, and can be best satisfied by ensuring that the monitoring locations are properly located with a sufficient number of data collected.

4.1.2 Comparability

The comparability criterion is a qualitative characteristic that expresses the confidence with which one data set can be compared to another. Principal comparability issues are field sampling techniques, and standardized concentration units and reporting formats. Data comparability is achieved using standard

field sampling techniques and measuring methods; however, comparability is limited by the other MQOs because only when precision and bias (accuracy) are known can data sets be compared with confidence.

4.1.3 Completeness

Completeness is defined as the percentage of valid analytical determinations compared to the total number of determinations. A reasonable completeness goal is 90 percent. Typical field or electronics problems may result in completeness of less than 100 percent. Completeness will be evaluated and documented throughout all monitoring, and corrective actions taken as warranted on a case-by-case basis.

4.2 MEASUREMENT QUALITY OBJECTIVES (MQOS)

The term "data quality" refers to the level of uncertainty associated with a particular data set. Data quality associated with environmental measurement is a function of the sampling plan rationale and procedures used to collect the samples, as well as the monitoring methods and instrumentation used in making the measurements. Uncertainty cannot be eliminated entirely from environmental data. However, quality assurance (QA) programs effective in measuring uncertainty in data are employed to monitor and control deviation from the desired DQOs. Sources of uncertainty that can be traced to the sampling component are poor sampling plan design, incorrect sample handling, faulty sample transportation (if applicable), and inconsistent use of standard operating procedures (SOPs). The most common sources of uncertainty that can be traced to the analytical component of the total measurement system are calibration and contamination (i.e. equipment not "resetting" or fully equilibrating in a new sampling location).

One of the primary goals of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible, and that the methodology employed is actually measuring the parameters in an acceptable manner.

For the field measurements to be conducted under this QAPP (temperature and TDG) MQOs can be specified. Each of the MQOs that pertain to this QAPP is further discussed below. The goals for this effort are outlined in Table 4-1:**.**

Table 4-1: MQOs

Parameter	Smallest Reference Level for Decision Making	Range of Instrument	Precision (Duplicate Samples)	Bias/ Accuracy	Sensitivity/ Resolution
Temperature	0.3°C	-5 to 50°C	20% RPD or ±0.05 units, whichever is least	± 0.1°C	0.01°C
TDG	1% saturation	400 – 1,300 mmHg	N/A	±0.1 % of span	1 mmHg

RPD = relative percent difference
TDG = total dissolved gas
mmHg = millimeters of mercury

4.2.1 Precision

Precision is a measure of the reproducibility of an analysis or set of analyses under a given set of conditions, and generally refers to the distribution of a set of reported values about the mean. The overall precision of a sampling event has both a sampling and an analytical component. The precision provides transparency into presence of random error such as field sampling procedures, handling, and data collection/analysis method. A reduction of precision could be introduced to this work in several ways including using equipment that is not sensitive enough (see Sensitivity below), collecting measurements over a large spatial or temporal regime, using a wide range of types of equipment, etc. A means of determining the precision of a measurement is to conduct duplicate sampling (e.g. making the same measurement in the same location at approximately the same time with the same type of equipment) and looking at the variability in results.

4.2.2 Bias

Bias (otherwise known as accuracy) is the difference between the population mean and the true value of the parameter being measured. Bias in measurements obtained under this QAPP may be introduced by faults in the sampling design (e.g. all of the temperature measurements collected in one location that is not indicative of the mixed flow or strata of interest), inability to measure all forms of the parameter of interest (e.g. inability of a thermometer to reach a temperature regime needed due to physical obstacles), improper or insufficient calibration of instrumentation and/or equipment. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

4.2.3 Sensitivity

Sensitivity denotes the rate at which the analytical response varies with the concentration of the parameter being measured, or the lowest concentration of a parameter that can be detected (often referred to as "resolution" for water quality equipment). For this work, equipment must be selected that provides tight enough tolerances to ensure that the data collected are described to the necessary precision. For example, if water criterion for temperature is concerned with a temperature shift of greater than 0.3 degrees Celsius, then the equipment should be able to measure the water temperature with sensitivity less than 0.3 degrees Celsius, preferably by an order of magnitude. Often, the accuracy is much larger than the resolution. If this is the case, the accuracy is the smallest verifiable value reported by the instrument.

SECTION 5: SAMPLING PROCESS DESIGN

The sampling process design includes the parameters of interest, the measurement location and the frequency of monitoring. The goal of the sampling process design is to ensure that the quality objectives for this effort can be met. The 401 Certification has outlined the requirements for the parameters, frequency, basic location, and schedule of sampling (see Table 5-1).

Table 5-1: Monitoring Parameters, Locations, Frequency, and Criteria

Parameter	Location(s)	Frequency	Metric	Standards
Temperature	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-October	degrees Celsius	17.5[1]
Temperature	Juvenile Fish Bypass, Adult Fishway	Hourly for one year	degrees Celsius	17.5[1]
TDG	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-August	% Saturation	120% in tailrace 115% of forebay (as per special fish passage criteria) 110% during outside of fish spill season

[1] When a water body's temperature is warmer than the criteria (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F).
When the background condition of the water is cooler than the criteria, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge); and
(B) Incremental temperature increases resulting from the combined effect of all nonpoint source activities in the water body must not, at any time, exceed 2.8°C (5.04°F).

5.1 MONITORING LOCATION AND DEPTH

The general locations for measurements have been identified in the 401 Certification and are more specifically define below. These locations are included in Table 5-1.

5.1.1 Forebay and Tailrace TDG and Temperature

Annual hourly TDG and temperature data will be measured at Chelan PUD's existing fixed monitoring stations, located in the forebay and tailrace of the Project, as well as in the forebay of the Rock Island Project. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of either the TDG or temperature readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rocky Reach forebay fixed monitoring station is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station is located approximately 0.38 mile downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is

east of mid-channel, and is minimally impacted by powerhouse flows when the project is passing water over the spillway (Schneider and Wilhelms, 2005). See Figure 5-1:.

The Rock Island forebay fixed monitoring station is affixed to the project, located on the west side of the river, near the right bank fishway and Powerhouse 2 (Figure 5-2:). The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations.

Figure 5-1: Locations of the Forebay and Tailrace Fixed Monitoring Stations at Rocky Reach.

Figure 5-2: Location of the Rock Island Forebay Fixed Monitoring Station.

5.1.2 Juvenile Bypass System Temperature

Downloadable data loggers will be deployed in the juvenile bypass system where gatewell water enters the system and at the juvenile sampling facility. Chelan PUD has not yet determined precisely how these instruments will be mounted in the bypass system, but it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

A data logger previously deployed in the entrance to the system will also be used to monitor temperature data in the juvenile fish bypass system.

5.1.3 Upstream Fishway Temperature

Downloadable data loggers will be deployed in two locations of the upstream fishway. Two loggers will be installed at the exit of the fishway, at depths of 703' elevation and near the bottom of the exit to collect data from both shallow and deep portions of the water column. A third logger will be installed near the bottom of the ladder section above where pumped attraction water from the tailrace enters the fishway. Chelan PUD has not yet determined precisely how these instruments will be mounted in the fishway, but again, it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

SECTION 6: MONITORING PROCEDURES

The following sections present the monitoring procedures that will be used to implement the requirements of the 401 Certification.

6.1 FREQUENCY

Table 5-1 provides the frequency that each water quality parameter will be measured. These frequencies follow the requirements of the 401 Certification, which provide that forebay and tailrace TDG and temperature be monitored on an hourly basis, April to August and April to October, respectively. Hourly temperature monitoring in the juvenile bypass system and upstream fishway will be initiated upon approval of this QAPP and will be conducted for one year, unless Ecology determines, in consultation with the Rocky Reach Fish Forum, that additional monitoring is necessary.

6.2 EQUIPMENT

Forebay and tailrace temperature and TDG data will be collected using instruments that can immediately transmit the data to Chelan PUD headquarters, allowing for real-time data recording. The fishway and juvenile fish bypass temperature data will be collected using a logging device that can be downloaded on a monthly or quarterly basis.

All temperature monitoring equipment will be of sufficient quality to meet the MQOs (Table 4-1:). The monitoring equipment will be Hydrolab's DataSondes or MiniSondes, or Hobo Water Temperature Pro Data Logger, or equivalent. Specifications for all types of equipment described herein are provided in Appendix A. Any of these types of monitoring equipment are referred to as merely equipment in the following discussion.

TDG will be measured using Hydrolab DataSondes or MiniSondes, which use a pressure transducer mounted behind a rigid gas-permeable silicone membrane to measure amount of total dissolved gaseous compounds dissolved in a liquid. The measurement quality objectives, range, precision, accuracy, and resolution of the TDG sensor are provided in Table 4.1. (See Appendix A for Equipment Specifications). TDG will be measured in mmHg and then converted to percent saturation using barometric pressure measurements recorded by a certified barometer located at the project. The conversion equation is as follows:

TDG in percent saturation = (TDG mmHg/barometric pressured mmHg) x 100

To the extent possible, sampling methods will follow protocol established by Hydrolab (or alternative manufacturer), the most current version of the Ecology Field Sampling and Measurements Protocols for the Watershed Assessment Section (Ecology, 1993), and this QAPP.

SECTION 7: QUALITY CONTROL

Field sampling and measurement protocols will follow those described in the Watershed Assessment Section (WAS) protocol manual (Ecology, 1993). Prior to deployment, instruments will be calibrated in a lab and the calibration verified by side-by-side readings. Specific quality control for each parameter measurement is described as follows.

7.1 TEMPERATURE QUALITY CONTROL

For all field-deployed equipment, a pre-and post-calibrated protocol will be conducted in accordance with the manufacturer's recommendations to document instrument bias and performance at representative temperatures. The accuracy of the field thermometers (data loggers and real-time equipment) will be maintained by a two-point comparison between the field equipment and a certified reference thermometer. This comparison will be made prior to and after logger deployment, and at a minimum of annually for real-time equipment. The certified reference thermometer to be used will have a National Institute of Standards and Technology (NIST) Traceable certification. If the mean difference between the NIST-certified thermometer and the field equipment differs by more than the manufacturer's reported specifications during the pre-study calibration, then the thermometer of interest (Sonde or logger) will not be deployed.

Additionally, each month or quarter when the data are downloaded from the loggers Chelan PUD staff will inspect the equipment to ensure it has not been damaged, has sufficient battery power (with the exception of equipment that does not show battery life, which will be replaced prior to expected battery failure), shows no signs of biofouling, and is generally in good condition. It will be cleaned as needed and replaced if damaged. The real-time equipment will be inspected and maintained in accordance with the manufacturer's recommendations.

7.2 TDG QUALITY CONTROL

Calibration and maintenance of the individual sensors of the Hydrolab® multi-probes will continue to follow the manufactures recommendations and regionally accepted methods used by other resource agencies conducting similar monitoring programs, such as the USGS, U.S. Army Corps of Engineers, and other mid-Columbia River Dam operators. The general calibration, maintenance, and deployment methods for the multi-probes also follow regionally accepted methods.

SECTION 8: DATA MANAGEMENT PROCEDURES

Data management will vary depending on whether it is transmitted in real-time or logged and downloaded periodically. The data that are collected in real-time will be automated to be transmitted directly into Chelan PUD's P.I. system as they are collected. This data management system is used on a regular basis across the Chelan PUD to manage power, flows, temperatures and many other parameters. Data that are logged and downloaded monthly or quarterly will be manually added to the P.I. system for consistent ease of availability and safe, archived keeping.

The reported data are anticipated to include the location of collection, the time of collection (by the interval determined if real-time), hourly data (averaged over the hour if more than one reading is collected per hour), and the date of collection.

SECTION 9: ADAPTIVE MANAGEMENT

The 401 Certification incorporates by reference Adaptive Management as defined in the Settlement Agreement. Additionally, conditions within the 401 Certification set forth Adaptive Management processes and measures to achieve full compliance with standards and constitute a water quality attainment plan under WAC 173-201A-510(5). Under Adaptive Management, it may be necessary to revise/modify sampling procedures/locations, as necessary to ensure quality data collection.

SECTION 10: AUDITS AND REPORTS

A process is needed to ensure that the QAPP is implemented correctly, that the quality of the data is acceptable, and that corrective actions are implemented in a timely manner.

10.1 AUDITS

In order to assure that the proper measurement procedures are taking place and to determine if changes in the procedures are needed, two forms of audits will be conducted: field audits and reporting audits, each of which is discussed below.

10.1.1 Field Audits

Once per year the project manager will accompany or oversee Chelan PUD water quality field staff (or contractor) in the field to monitor and audit all field activities including calibrations, maintenance, and multi-probe deployment methods, and safety activities. The auditor will focus on ensuring that all SOPs are followed, calibrations are conducted in compliance with manufacturers' specifications when applicable, and this QAPP is followed. The auditor will provide a brief write up of their observations including any deviations from QAPP and whether it should be changed or the process in the field needs to be addressed. The project manager will be responsible for ensuring that, if needed, any corrective actions meet Ecology and FERC approval, and that each corrective action is implemented. A subsequent audit may be required to ensure that the change has been successfully implemented.

10.1.2 Reporting Audits

It is the responsibility of the Chelan PUD to ensure that all of the reporting requirements of the 401 Certification have been met. The project manager and Licensing and Compliance Coordinator will be responsible for keeping track of the mandated reporting and confirming that it has been met. Specifically, the project manager will access the website monthly or quarterly, as appropriate, to check that the necessary data are present, legible and correct. Additionally, the project manager will review the annual reports to make sure that the data presented are accurate, and verifiable (see Section 12). Any deviations from requirements will be rectified and Ecology will be notified of the deviation and corrective action.

10.2 REPORTS

Reporting will be conducted in a variety of ways, which will depend primarily on the frequency of monitoring.

10.2.1 Periodic Updates

Data collected will be evaluated and flagged to indicate any water quality exceedances and measures taken by the Chelan PUD to address the exceedances. The Chelan PUD will report exceedances of the water quality criteria within 48 hours to the Ecology CRO.

10.2.2 Annual Reports

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and

measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). Presentation of the TDG monitoring results in the annual report should include the following:

- Flow during the preceding year (cfs over time);
- Spill during the preceding year (cfs and duration);
- Reasons for spill;
- TDG levels during spill (hourly);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP; and
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG standards.

This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

SECTION 11: DATA REVIEW, VERIFICATION, AND QUALITY ASSESSMENT

Data will be downloaded from the meters or the P.I. system to a spreadsheet and reviewed for outliers and values not conforming to the MQOs. If the objectives have not been met, the project manager will decide how to qualify the data and how the data should be used in the analysis or whether the data should be rejected. As appropriate, the project manager will assign additional data qualifiers where necessary or reject data from further use. Data that is rejected from further use will be recorded in a deleted data database with a description of why the data was rejected, as well as any adjustments needed to correct the reason for the data rejection. These deleted data will then be presented in the annual water quality monitoring report under the QA/QC sections.

Data completeness will be adequate if monitoring is completed with data meeting the MQOs at least 85 percent of the time. A lower rate of data completeness may be acceptable, which will be determined in an overall review of data. All data meeting MQOs will be used.

The results analyses will be evaluated for compliance with acceptance criteria. This evaluation will include collection of temperature data for subsequent modeling, and a statistical evaluation of other data to the numeric criteria. It is anticipated that the average and variance of all data will be assessed to determine the frequency that any numeric water quality criteria have been exceeded, if any. Once the data have been reviewed, verified, and validated, the project manager will determine if the data are of usable quality to make decisions for which the study was designed.

SECTION 12: REFERENCES

APHA, AWWA, and WEF, 1995. Standard Methods for the Examination of Water and Wastewater, Nineteenth Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

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Ecology, 2004. Guidelines for Preparing Quality Assurance Project plans for Environmental Studies. Publication No. 04-03-030, Revision of Publication No. 01-03-003. July 2004.

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Parametrix, Inc., and Rensel Associates 2001. Water quality monitoring report – Rocky Reach reservoir, water year 2000. Rocky Reach Hydroelectric Project No. 2145. Prepared by Parametrix, Inc., Kirkland, Washington, in association with Rensel Associates, Aquatic Science Consultants, University of Idaho, for Chelan PUD.

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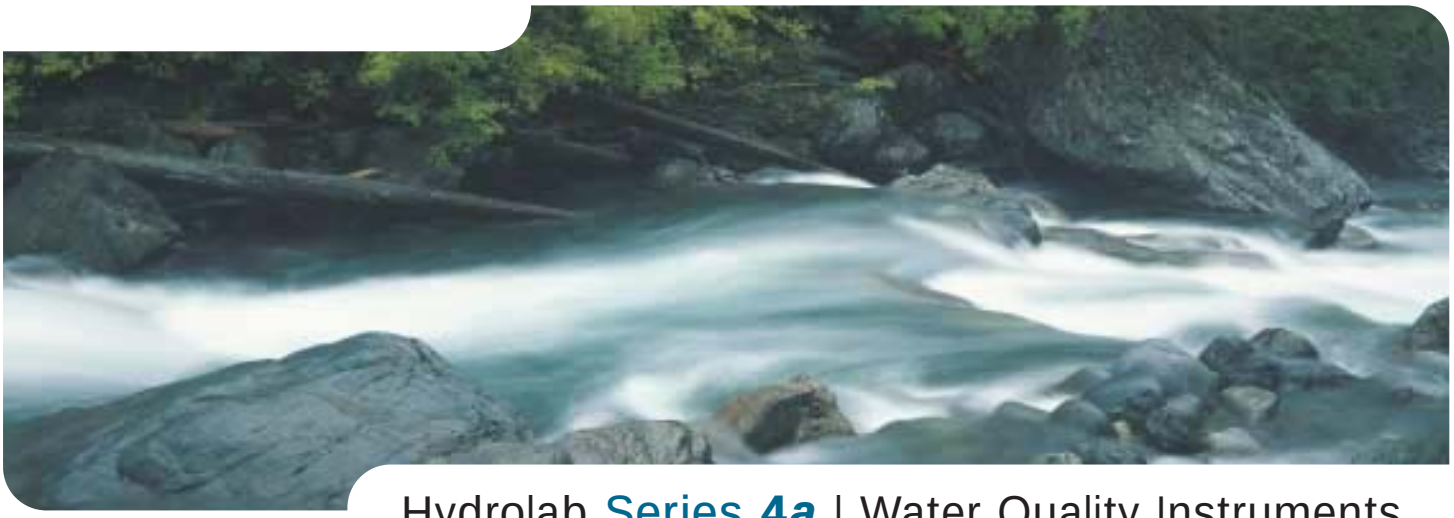
APPENDIX A: SPECIFICATIONS FOR PROPOSED EQUIPMENT

HYDROLAB®
A HACH COMPANY BRAND

THE WORLD LEADER IN MULTI-PARAMETER WATER QUALITY MONITORING INSTRUMENTATION

> Superior sensor technology > Unsurpassed reliability > Best warranty in the industry



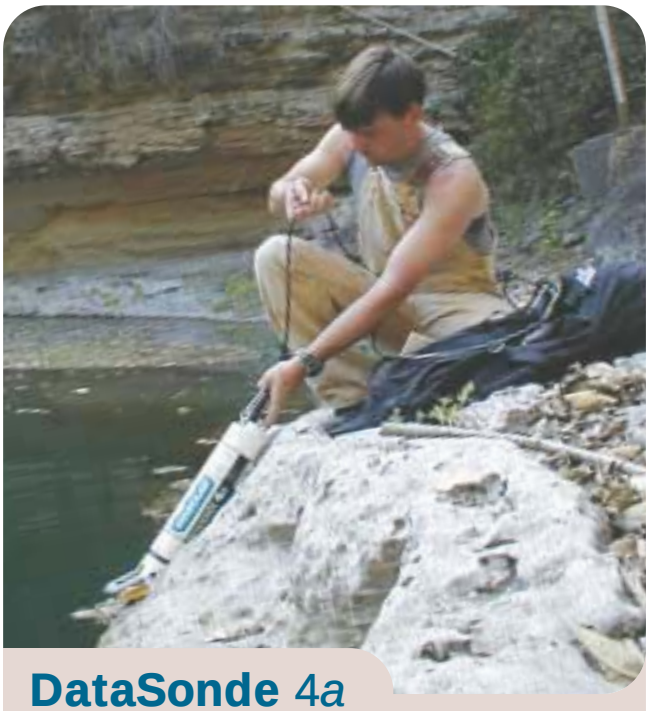
Hydrolab Series ***4a*** | Water Quality Instruments

Helping you preserve the world's water

Hydrolab Series **4a** | Water Quality Instruments

> *For over 40 years Hydrolab has been known for manufacturing reliable water quality instruments.*
> *The Series 4a continues that tradition with several enhancements that provide you with even greater value.*
> *Now, as part of Hach Company, you can expect continuous innovation from Hydrolab, now and into the future!*

*Both the **DataSonde 4a** and the **MiniSonde 4a** are well suited for profiling and spot-checking applications, and are available with battery packs and memory to use for long-term monitoring. Data can be downloaded to the **Surveyor 4a** or a PC.*



DataSonde 4a

> Seven built-in expansion ports
> Designed for in-situ and flow-through applications
> Measures up to 15 parameters
> Excellent long-term deployment capability

MiniSonde 4a

> Four built-in expansion ports
> 1.75" diameter housing – ideal for ground water monitoring, portability, and limited space environments
> Measures up to 10 parameters

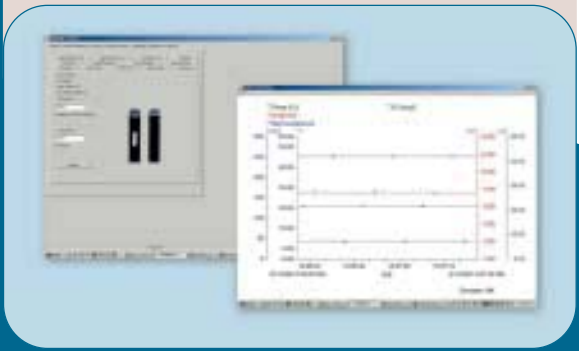
Series **4a** water quality instruments provide the best long-term value: > Easy to use and maintain

Surveyor 4a

- Rugged, waterproof (NEMA 6) case with hand strap
- Displays parameters in real-time or stores data automatically (up to 375,000 measurements)
- Data presented in real-time graphical form or tabular format
- Optional GPS and barometric pressure

Hydras3 LT

- Easy-to-use GUI
- Real-time multiparameter time series graphs *and* vertical profiling
- Simple calibration of any parameter
- Set-up data logging runs in a snap
- One click download for field data collection
- Simultaneous, multiple probe download capability
- Available for free download at www.hydrolab.com



*Superior **Sensor** Technology*

At the heart of the Series 4a instruments is Hydrolab's superior sensor technology. Advanced design and sensor technology make these instruments the most reliable in the field. The Series 4a features watertight sensors based on superior technology to produce instruments that are longer lasting, more reliable, less expensive, and easier to maintain. This means lower operating costs in the long run, and better value for you.

*The **DataSonde 4a** and **MiniSonde 4a** system, proven during years of field testing, provides the following advantages:*

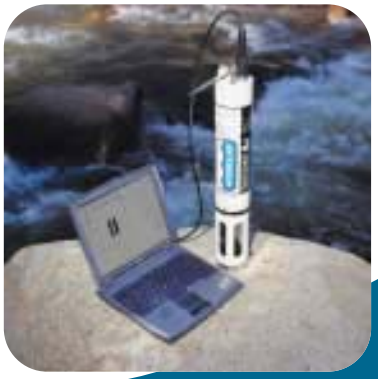
- *Sensor connection is protected from the environment*
- *Fewer components for smoother, glitch-free operation*
- *Sensors cannot become loose or trap water or debris*

> Superior sensor technology > Unsurpassed reliability > Guaranteed after-sale support

Hydrolab Series **4*a***

Engineered for dependable performance and durability in the field, Series 4*a* water quality instruments by Hydrolab can measure up to 15 parameters at once. These rugged instruments offer the highest long-term value, providing you years of reliable water quality data.

The three components of Hydrolab's Series 4*a* product line are the DataSonde 4*a*, MiniSonde 4*a* and Surveyor 4*a*. These instruments come with a two-year warranty – the best you'll find in the industry.



- > Configured to fit your specific need
- > Profiling or long-term deployment
- > Surface or ground water
- > Remote or attended monitoring

Hydrolab Series 4*a*: DataSonde 4*a* | MiniSonde 4*a* | Surveyor 4*a*

- Temperature
- Conductivity
- Dissolved Oxygen
- Rebuildable pH
- ORP
- 4-Beam Turbidity
- Self-Cleaning Turbidity
- Level & Depth
- Chlorophyll a
- Blue-Green Algae
- Rhodamine WT
- Li-Cor® Ambient Light
- Ammonium/Ammonia
- Nitrate
- Chloride
- GPS
- Barometric Pressure
- Transmissivity
- Total Dissolved Gas

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TYPICAL PERFORMANCE SPECIFICATIONS

	RANGE	ACCURACY	RESOLUTION	AVAILABLE INSTRUMENT *
Temperature	-5 to 50° C	±0.10° C	0.01° C	D, M
Specific Conductance	0 to 100 mS/cm	±1% of reading; ±0.001 mS/cm	4 digits	D, M
pH	0 to 14 units	±0.2 units	0.01 units	D, M
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L at ≤ 20 mg/L ±0.6 mg/L at > 20 mg/L	0.01 mg/L	D, M
ORP	-999 to 999 mV	±20 mV	1 mV	D, M
Depth Vented Level 0-25 m 0-100 m 0-200 m	0 to 10 m 0 to 25 m 0 to 100 m 0 to 200 m	±0.003 m ±0.05 m ±0.05 m ±0.1 m	0.001 m 0.01 m 0.01 m 0.1 m	D, M D, M D, M D, M
Salinity	0 to 70 ppt	±0.2 ppt	0.01 ppt	D, M
4-Beam Turbidity	0 to 1000 NTU	±5% of reading; ±1 NTU	0.1 NTU (<100 NTU) 1 NTU (≥100 NTU)	D
Self-Cleaning Turbidity	0 to 3000 NTU	±1%, up to 100 NTU ±3%, 100-400 NTU ±5%, 400-3000 NTU	0.1, up to 400 NTU 1.0, 400-3000 NTU	D, M
Ammonium/Ammonia	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Nitrate	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Chloride	0.5 to 18,000 mg/L	Greater of ±5% of reading or ±2 mg/L (typical)	4 digits	D, M
Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg	D, M
Ambient Light	0 to 10,000 µmol $s^{-1}m^{-2}$	±5% of reading or ±1 µmol $s^{-1}m^{-2}$	1 µmol $s^{-1}m^{-2}$	D
Chlorophyll *a*	0 to 500 µg/L 0 to 50 µg/L 0 to 5 µg/L	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 µg/L	D, M
Rhodamine WT	0 to 1000 ppb 0 to 100 ppb 0 to 10 ppb	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 ppb	D, M
Blue-Green Algae	100 to 2,000,000 cells/mL 100 to 200,000 100 to 20,000	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 cells/mL	D, M
Barometric Pressure	500 to 850 mmHg	±10 mmHg	0.1 mmHg	S
Global Positioning System	-90 to 90° Latitude -18 to 180° Longitude	25 m CEP (50%) without SA and DGPS 2 m CEP (50%) with DGPS	0.1”	S

* D = DataSonde 4*a* M = MiniSonde 4*a* S = Surveyor 4*a*

INSTRUMENT SPECIFICATIONS

Computer Interface	RS-232, SDI-12
Memory	DataSonde 4*a* – 120,000 measurements MiniSonde 4*a* – 120,000 measurements Surveyor 4*a* – 375,000 measurements
Battery Supply	DataSonde 4*a* – 8 C batteries MiniSonde 4*a* – 8 AA batteries Surveyor 4*a* – rechargeable nickel metal hydride
Typical Battery Life (1-hour intervals)	DataSonde 4*a* – 313 days MiniSonde 4*a* – 114 days Surveyor 4*a* – 12-16 hours
Operating Temperature	-5 to 50° C
Maximum Depth	DataSonde 4*a* & MiniSonde 4*a* – 225 m
Size	DataSonde 4*a*: Outer diameter – 3.5”/8.9 cm; Length – 23”/58.4 cm; Weight – 7.4 lbs/3.35 kg MiniSonde 4*a*: Outer diameter – 1.75”/4.4 cm; Length – 21”/53.3 cm; Weight – 2.2 lbs/1.0 kg with extended battery pack: 29.5”/74.9 cm, Weight – 2.9 lbs/1.3 kg Surveyor 4*a*: 11x4x5”/27.9x10.2x3.8 cm, Weight – 2 lbs/0.9 kg

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BENEFITS & SPECIFICATIONS

- Uses a pH glass sensor
- Both feature a single refillable, flowing junction reference electrode OR optional low ionic strength electrode
- Standard reference electrode is more reliable, lasts longer, is easily maintained, and refills in seconds
- Reference electrode is maintained and refilled independently of pH and/or ORP
- Two-year warranty

pH SENSOR

Range	0 to 14 pH units
Accuracy	±0.2 units
Resolution	0.01 units

ORP SENSOR

Range	-999 to 999 mV
Accuracy	±20 mV
Resolution	1 mV

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BENEFITS & SPECIFICATIONS

DISSOLVED OXYGEN SENSOR

- Uses field-proven Clark Cell technology
- Provides a continuous steady-state reading
- Low maintenance – no need to recondition the sensor
- Two-year warranty

Range	0 to 50 mg/L
Accuracy	±0.2 mg/L for 20 mg/L or less ±0.6 mg/L for over 20 mg/L
Resolution	0.01 mg/L

SPECIFIC CONDUCTANCE SENSOR

- Hydrolab uses the four graphite electrode cell methodology:
  - Increases sample exchange
  - Open cell design provides more reliable data
  - Reduces measurement error due to fouling and air bubbles (bubbles rise above the electrodes out of the way and debris and sediment fall below)
  - Easily maintained without damaging electrodes
  - Resists corrosion
- Also measures salinity, resistivity, and TDS
- Two-year warranty

Range	0 to 100 mS/cm
Accuracy	±1% of reading, ±0.001 mS/cm
Resolution	4 digits

SAMPLE CIRCULATOR

Only Hydrolab offers a sample circulator for more reliable readings. The DataSonde 4*a* and MiniSonde 4*a* integrated sample circulator facilitates fast, accurate, steady-state dissolved oxygen measurements. Other sensors receive similar benefits.

- Creates a flow of water past the sensors
- Provides “sufficient sample flow across membrane surface” in accordance with Standard Methods Article 4500-OG
- Reduces response time – important to detect moving contaminant plumes or movement within water column
- Reduces sensor fouling – sweeps away inert debris and biological growth
- Allows deployment in any environment, even in poorly mixed areas

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HOBO® Water Temp Pro

AWARD-WINNING TECHNOLOGY AE50 HOBO® WEATHER STATION HOBO® WATER TEMP PRO

Size/Weight: 11.4 x 3.0 cm (4.5" X 1.19") with 6.4 mm (0.25") hole in mounting bail
42 grams (1.5 oz)

$110

The durable HOBO Water Temp Pro has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. A temperature-compensated real time clock provides better than ± 1 minute per month time accuracy. Designed with a durable streamlined case for extended deployment in fresh or salt water up to 50°C, the Water Temp Pro is equipped with an infrared (IR) interface for data offload in the field, even when the logger is wet.

Key Specifications

Measurement Range: 0° to 50°C (32°F to 122°F) in water (nonfreezing); –20°C to 70°C (-4°F to 158°F) in air

Waterproof: To 120 m (400 ft)

Accuracy: ±0.2°C at 0 to 50°C (± 0.36°F at 32° to 122°F)

Resolution: 0.02°C at 25°C (0.04°F at 77°F)

Time accuracy: Better than ±1 minute per month

Capacity: 21,580 12-bit measurements

CE Compliant with all relevant directives in the European Union (EU)

Bp BoxCar®Pro-compatible

Features

Accurate:
12-bit resolution and precision sensor for ±0.2°C accuracy at 0° to 50°C (±0.36°F accuracy at 32°F to 122°F)
Includes a NIST-traceable accuracy certificate at room temperature
Real-time clock for better than ±1 minute per month time accuracy

Easy to Use:
High-speed infrared (IR) interface offloads full logger <30 seconds
Programmable start time/date
User-selectable sampling interval: 1 second to 9 hours
Uses popular BoxCar® Pro 4.3+ for system launch and data retrieval

Reliable:
Factory-replaceable battery lasts 6 years (typical); temperature extremes will reduce battery life
Battery level indication at launch
Offload data, check logger and battery status while logging using BoxCar Pro
Non-volatile EEPROM memory retains measurements even if battery fails
Blinking LED confirms operation with option to suppress signal during logging
UV-stable plastic for long-term immersion in fresh or salt water*
Rugged, streamlined case design withstands years of use in stream conditions
Rated for use up to 50°C in water, 70°C in air
The dark gray case blends in, minimizing chances of tampering
Optional protective boot for high water flow, flooding, or conditions with debris *(see pg. 38)*

Detailed Specifications

Response Time: 5 minutes in water, 12 minutes in air moving 2 m/sec, typical to 90%
Memory modes: Stop when full or Wrap-around when full
Data offload: Readout full logger in < 30 seconds while logging or when stopped
Buoyancy: +13 grams (0.5 oz) (fresh water at 25°C); +17 grams (0.6 oz) with optional boot
Battery : One 3.6 V Lithium, factory replaceable ONLY
Battery Life: 6 years typical, temperature extremes reduce battery life
Drop proof to 1.5 m (5')
Note: NIST-traceable certification at additional temperature points is also available through Onset at additional cost.

The HOBO Water Temp Pro received an AE50 award for product innovation from the American Society of Agricultural Engineer's Resource *magazine.*

** Not for prolonged exposure to chlorinated water.*

IR Basestation for HOBO® Water Temp Pro

Operating Range: 0° to 40°C (32° to 104°F) 0 to 95% RH
Size/Weight: 3.2 x 6.4 x 1.5 cm (1.3 x 2.5 x 0.6 in.); 54 g (2.0 oz)

$60

The Infrared (IR) Basestation is required for communications between the HOBO Water Temp Pro and the PC. Simply place the logger 4 to 5 inches away from an IR Basestation (connected to a PC) within the 30° angle of view to read out the Water Temp Pro. The IR Basestation requires a 9-pin serial port in the PC. For use with USB port, see USB-to-Serial Adapter (pg 43). The Water Temp Pro is not compatible with IR ports on PCs or laptops.

Note: The IR Basestation is not waterproof.

HOBO Water Temp Pro Ordering

Description	Part No.	Qty. 1-9	10-99	100+
HOBO Water Temp Pro	H20-001	$110	$102	$94
IR Basestation	BST-IR	$60	$56	$51
Protective boot—black	BOOT-BLK	$15	$14	$13
Protective boot—white	BOOT-WHT	$15	$14	$13
Factory replacement battery service		$35		
Replacement caps				
Cap for Water Temp Pro (without Boot)	85-CAPLUG-H20	$2		
Cap for Boot-BLK	85-CAPLUG-H20-B	$2		
Cap for Boot-WHT	85-CAPLUG-H20-W	$2		
Software				
BoxCar Pro 4.3 Starter Kit (Windows®)	BCP4.3-ON	$95	$88	$81

Note: A BoxCar Pro Starter Kit and IR Base Station are required to operate the HOBO Water Temp Pro. Each starter kit includes software, computer interface cable and software manual. See page 42 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

underwater

StowAway® TidbiT®

$119

Small size: approx.
3.0 x 4.1 x 1.7 cm thick
(1.2 x 1.6 x 0.65"); 23 gm (0.8 oz)

The StowAway TidbiT is Onset's smallest data logger and is widely used for monitoring temperatures in streams, lakes, oceans, and soils. Small size, rugged case and alarm indication also make this a popular choice for monitoring conditions in shipping applications.

Key Specifications

Ideal for underwater applications up to 30° C

StowAway TidbiT: Model TBI32-05+37

Range†: -4° to 37°C (24° to 99°F)
Accuracy: ±0.2° at 20°C (±0.4° at 70°F)
Resolution: 0.16° at 20°C (0.29° at 70°F)

StowAway TidbiT: Model TBI32-20+50

Range†: -20° to 50°C (-4° to 122°F)
Accuracy: ±0.4°at 20°C (±0.8° at 70°F)
Resolution: 0.3°C at 20°C (0.6° at 70°F)

Capacity: 32,520 measurements

† *Specified range is narrower than nominal range due to precision calibration process. Using TidbiT Temp loggers in wet environments (>90% RH) over 86°F (30°C) for extended periods of more than 8 weeks cumulative may lead to premature failure. For applications over 30°C, use the HOBO Water Temp Pro (pg 35).*
Note: For Onset's lowest cost underwater temperature monitoring solutions, see HOBO Pendant Temp (pg 17). For depths greater than 300m see HOBO Stainless Temp (pg 18).

Features and Specifications

Waterproof to 300 m (1000 feet)
IR communications and Optic Shuttle for readout when wet—even underwater!
Programmable start time/date or triggered start on location with Optic Coupler or magnet
Small Size and Alarm Indication
5-year, non-replaceable battery (typical use*)
NIST-traceable temperature accuracy certificate available
Multiple sampling with minimum, maximum or averaging
Mounting tab
Time accuracy: ±1 minute per week at 20°C (68°F)
Memory modes: Stop when full, Wrap-around when full
Response time in water: 5 minutes (typical to 90%)
Response time in air moving 1m/second: 20 minutes

** 16 three-month deployments in water (35° to 80°F) with 4 minute or longer intervals (no multiple sampling)*

Optic Shuttle™

$199

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x 1.0" thick)
without coupler; 28.35 g (1 oz)

The pocket-sized Optic Shuttle provides a convenient way to readout and relaunch TidbiT data loggers and bring the data back to your host PC.

Features and Specifications

Waterproof to 15 psi (30 feet)
128K capacity enough for 4 full 32K loggers
Data offload time from logger: 6 minutes typical from 32K logger
Data readout time to PC: 3 minutes typical for complete offload
TidbiT Coupler and Optic Coupler included
Uploads the same data to a PC as if the data were read out directly from the logger
6 year factory-replaceable battery (typical)

Optic Base Station™

$80

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x .95" thick)
without coupler; 56.7 g (2 oz)

The Optic Base Station is used to communicate between the host computer and either a StowAway TidbiT data logger or an Optic Shuttle. An Optic Coupler and TidbiT Coupler for connecting the base station to loggers are also included.

StowAway TidbiT Ordering

Description	Part No.	Qty. 1-9	10-99	100+
32K StowAway TidbiT				
(-4° to 37°C)	TBI32-05+37	$119	$110	$101
(-20° to 50°C)	TBI32-20+50	$119	$110	$101
Optic Base Station for TidbiT	DSA	$80	$74	$68
Optic Shuttle for TidbiT	DTA128B	$199	$183	$169
Software				
BoxCar Pro 4.3 Starter Kit (Windows)	BCP4.3-ON	$95	$88	$81
BoxCar 3.7 Starter Kit (Windows)	BC3.7-ON	$20	$19	$17

Note: A BoxCar Pro 4.3 or BoxCar 3.7 starter kit and an Optic Base Station are required to operate the TidbiT loggers. Each starter kit includes software, computer interface cable and software manual. The Optic Base Station includes an Optic Base Station, Optic Coupler and TidbiT Coupler. See pages 42-43 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

B BoxCar®-compatible

Bp BoxCar®Pro-compatible

CE Compliant with all relevant directives in the European Union (EU)

APPENDIX B: CONSULTATION RECORD

B.1 Comments Letters Received

Email From Patricia Irle
Received January 1, 2010

Hi, Kelee -

I've attached a copy of the draft QAPP with some comments. However, I think it would be helpful if you could address the comments below, and submit it for another review. At that time, I'll send Section 4 to our in-house expert… (I think he needs some of the following information to do a thorough job…)

General comments:

1) TDG. How will determine whether TDG standards are being met during non-fish-spill season?
2) Temperature. QAPP notes (page 3) that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.
3) Temperature in the bypass. How do you expect to apply the standard here?
4) Please include all sampling locations.

Thanks!
Pat
(509) 454-7864

B.2 Response to Comments

Date	Section	Agency Comment	Chelan PUD Response
1/5/10	General	How will Chelan PUD determine whether TDG standards are being met during non-fish-spill season?	As per Section 5.4 (1)(a) of the 401 Certification which states: "Outside of the fish spill season, Chelan PUD may use spill as a surrogate for TDG levels," Chelan PUD will use spill as a surrogate for TDG levels outside the fish spill season. This use of spill as a surrogate for TDG levels is made possible by a linear regression developed by Schneider and Wilhelms (2005). Chelan PUD will continue to refine said regression using data collected during the April – August fish spill season.
		Temperature in the bypass. How do you expect to apply the standard here?	Monitoring will confirm whether temperatures in the bypass system increase from the entrance (forebay) to exit (sampling facility). Any observed temperature increases will be evaluated to determine impact on Columbia River temperatures.
		Please include all sampling locations.	Forebay and tailrace TDG and temperature locations have been identified in Section 5.1.1. Juvenile bypass temperature collection locations are stated in Section 5.1.2. Fishway temperature locations are stated in Section 5.1.3.
	Section 1 3rd paragraph	Says three, then lists four groups….	Language has been revised in response to comment.
	Section 1	QAPP notes that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.	This may be a misinterpretation of what is written. As per Section 5.5(1)(b) of the 401 Certification, "Chelan PUD will collect or compile meteorological and water temperature data, including hourly water temperature data from the Wells Dam tailrace, for at least the first 5 years of New License; such data shall be of sufficient quality to meet technical peer review group standards for running the model." As stated previously in the Section and in the 401, Chelan PUD will collect temperature data in the forebay, fishways, juvenile bypass, and tailrace, as well as use data collected at Wells Dam.
	Table 3-2	"This study will be conducted at a later date (no sooner than 2011)." Why not?	Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for concurrent analyses of macrophyte bed water quality conditions and fish presence/use. Note added to the table to clarify this.
	Table 5-1	Regarding standards column: This does not make sense in terms of the two locations identified.	Chelan PUD does not fully understand your comment, as these *are* the numeric criteria, but the table has been revised to clarify.
	5.1.1 1st Paragraph	Note that there is a slight temperature gradient. Please discuss how this may affect the results.	The monitoring device is located deep enough in the water column to not be effected by near surface temperature gradients. Language has been added to the section in response to comment.
	5.1.1 2nd Paragraph	Can you cite the study?	Citation added.
	5.1.1 3rd Paragraph	Explain how this will affect the accuracy of the TDG results…	The monitoring device is located below the depth at which bubbles form on the membrane; therefore, no effect in accuracy is expected. Language has been added to the section in response to comment.

Date	Section	Agency Comment	Chelan PUD Response
	5.1.2 1st Paragraph	This should be part of this report.	Language revised in response to comment.
	5.1.2 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	5.1.3 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	Section 9	I don't know that we need this. If the project changes, it will require changes to the overall objectives. Why include here?	Chelan PUD does not intend to change any projects. This adaptive management section is intended to addresses the potential need to revise/modify procedures/locations to ensure quality data collection. The language in this section has been revised in an attempt to clarify the intent of the section.
	Section 9 3rd Paragraph	This, then, isn't adaptive management…. And shouldn't be in this section.	Paragraph deleted.
	General	Suggested grammatical, formatting, etc revisions.	Chelan PUD appreciates your time and effort in making these suggestions. The suggested changes have been accepted as appropriate.
2/4/10	Section 1	Our primary concern is with regard to collecting data for a future computer temperature model run. It is stated (page 3) that an additional QAPP will be drafted to address this modeling effort. Because the model is to be run based in the first five years of data, it is critical that a QAPP be prepared immediately, to address collection of this data. Please include a data for completing that QAPP.	This is a valid point. Water temperature data to be used in the model is addressed in this QAPP; however, we agree it is necessary to draft a second QAPP that addresses the climatic data that will be used in the model. In order to proceed with the additional QAPP, Chelan PUD feels it is necessary to work collaboratively with Ecology to decide what climatic data sources should be used in this effort. Once that is determined, we can proceed with the drafting of the climatic data QAPP. Because we do not have an anticipated completion date for the second QAPP, we have not added/revised language in this QAPP to address this comment.
		The draft document describes two annual reports that will be sent to Ecology as part of this QAPP; one due in April, one in December (see pages 9 and 25 of the report). It is not clear which document will include the results and analysis for the 110% standards. Please clarify.	Clarifying language added in response to comment. Please note that the December submittal will address TDG only. This report will be appended to the March 1 submittal that is to address all parameters addressed in this QAPP.
	Table 3-2	It is indicated that spill as a surrogate for TDG will collected hourly. A minor suggestion: for consistency, could you move the comment "This will be necessary only during spill events outside of the fish season" into the second column?	Table revised in response to comment.
	Table 3-2	TDG: You should be monitoring or compiling information at each of three sites: forebay and tailrace of Rocky Reach, and forebay of Rock Island. Please clarify.	Table revised in response to comment.
	Table 5-1	TDG: Please include Rock Island forebay in the table under "Locations". And, 110% under "standards".	Table revised in response to comment.

APPENDIX B: 2016 ANNUAL TOTAL DISSOLVED GAS REPORT

2016
TOTAL DISSOLVED GAS
ANNUAL REPORT

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145
and
ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

March 06, 2017

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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TERMS AND ABBREVIATIONS

7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
CCT	Confederated Tribes of the Colville Reservation
Chelan PUD	Public Utility District No. 1 of Chelan County
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
Grant PUD	Public Utility District No. 2 of Grant County
GBT	gas bubble trauma
HCP	Anadromous Fish Agreement and Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
msl	mean sea level
NMFS	National Marine Fisheries Service
project	Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RM	river mile
RRFF	Rocky Reach Fish Forum
SCADA	supervisory control and data acquisition
standards	Washington State water quality standards
TDG	total dissolved gas
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQC	water quality certification
WQMP	Water Quality Management Plan

EXECUTIVE SUMMARY

Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual report to summarize the results of the 2016 total dissolved gas (TDG) monitoring, associated spill, biological monitoring and gas abatement methods during the fish-spill period (April 1 through August 31) within the Rocky Reach and Rock Island Hydroelectric Projects.

During the 2016 fish-spill season, overall combined project compliance was 96.4 percent with the 115/120 percent standard and 99.97 percent with the 125 percent standard as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD). Exceedances of TDG numeric criteria were minimal with a total of 22 exceedances of the 115/120 percent standard. There were three exceedances of the 1-hour 125 percent standard in the Rocky Reach tailrace.

Mean daily discharge during the 2016 fish-spill season was compared to the 10-year average of mean daily discharge from 2006-2015, as measured at Rocky Reach (Figure 3-1) and Rock Island dams (Figure 3-2). Over the entire fish-spill season, mean daily flow discharges during the 2016 were lower than the 2006-2015 average (about 85 percent of average at Rocky Reach, and 88 percent of average at Rock Island dams).

In 2016, spill events at Rocky Reach Dam were involuntary (forced) April 1 through May 31 and both voluntary and involuntary May 29 through August 15 (summer fish-spill period). Between May 29 and the end of summer fish-spill on August 15, 9 percent of the total volume spilled was voluntary, while 0.5 percent was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 10, with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates.

To achieve HCP passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of nine percent of daily average river flow at the Rocky Reach Dam for a duration covering 95 percent of the subyearling outmigration during the summer of 2016. The summer spill program for subyearling passage began on May 29 and ended on August 15. Approximate percent daily river flow spilled during the summer period was nine percent.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Hydroelectric Project. Spring fish-spill of 10 percent began on April 10 and was continued through May 28. During the spring fish-spill period, 15 percent of total river flow was spilled. Of that 15 percent, 10 percent of it was voluntary spill for fish and five percent was forced spill due to higher river flows and generation limitations with units down at Rock Island Dam. Rock Island Dam fish-spill increased to 20 percent upon onset of the summer outmigration of subyearling Chinook. Summer spill began on May 29 and continued through

August 11. During the summer fish-spill period, 20 percent of total river flow was spilled. Of that 20 percent, 100 percent of it was voluntary spill for fish.

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of gas bubble trauma (GBT) between April 12 and June 7, 2016. During 2016 monitoring, 2,200 smolts were examined for GBT. Of these, 13, or 0.59 percent, showed signs of GBT.

In 2016, Chelan PUD implemented gas abatement measures as outlined in the Washington State Department of Ecology (Ecology) 401 Water Quality Certification (WQC) (Ecology, 2006).

Chelan PUD will continue to closely monitor TDG levels during the fish-spill season, while implementing the abatement measures outlined in Ecology's approved Gas Abatement Plans (GAP), the WQC (Ecology, 2006), and the Rocky Reach Hydroelectric Project Quality Assurance Project Plan (QAPP) (Chelan PUD, 2010b).

SECTION 2: *INTRODUCTION*

2.1 Report Organization

Specific requirements of this annual report are listed below as defined in Appendix A of the Federal Energy Regulatory Commission (FERC) License Order (FERC, 2009), Section 5.4(4) of the WQC (Ecology, 2006).

5.4(4) Total Dissolved Gas Annual Report

a) Flow over the preceding year (cubic feet per second over time)
b) Spill over the preceding year (cubic feet per second and duration)
c) Reasons for spill (e.g., for fish, turbine down time)
d) TDG levels during spill (hourly)
e) Summary of TDG exceedances and what was done to correct the excedances
f) Results of the fish passage efficiency (FPE) studies and survival per the Habitat Conservation Plan (HCP)
g) Analysis of monitoring data for confirmation or refinement of the regression equations in the Water Quality Management Plan (WQMP) (Table 2-7Analysis of the TDG monitoring in comparison to the regression equations use to predict compliance with the TDG numeric criteria
h) All monitoring and studies performed for TDG control and abatement

Chelan PUD has prepared this annual report to address the requirements of the WQC. The following Sections of the report specifically address the listed requirements for the fish-spill period as follows:

Section 1 – Project Description	• Project description • fixed monitoring stations • regulatory framework • HCP results
Section 2 – Operations	• Flow • Spill • Fish-spill programs

Section 3 – Results	• Monitoring results
	  ○ TDG
	  ○ biological (gas bubble trauma or GBT)
	  ○ regression analysis
	  ○ discussion of exceedances
	  ○ discussion of 2009-2015 data

Section 4 – Abatement measures and Corrective Actions	• Abatement measures • Corrective actions
Section 5 - Conclusions	• Summary

2.2 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. The Rocky Reach and Rock Island projects are located in mid-Washington State on the mainstem of the Columbia River and are owned and operated by Chelan PUD. This area is 59 river miles (RM), from the forebay of Rocky Reach Dam (RM 474) downstream to the forebay of Wanapum Dam (RM 415) owned and operated by the Public Utility District No. 1 of Grant County (Figure 2-1). There are 21 RM between Rocky Reach and Rock Island dams and 38 RM between Rock Island and Wanapum dams.

2.2.1 Rocky Reach Project Description

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

In 2003, Chelan PUD began operation of the juvenile bypass system (JBS), which continues to be the primary juvenile non-turbine passage route at Rocky Reach Dam. Testing completed during the first year of operation enabled Chelan PUD to determine the juvenile guidance efficiency of the JBS and estimate the level of spill necessary to meet the HCP survival standards. Voluntary spill is used at Rocky Reach Dam to supplement the effectiveness of the JBS, when needed, to maintain survival goals of the HCP (See Section 2.4 for details). Due to the effectiveness of the JBS, Chelan PUD has reduced or eliminated 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 JBS. During the subyearling Chinook migration (generally mid-June to mid/late August), a spill level of nine percent of daily flow (reduced from 15 percent) has been provided.

The 2016 fish-spill program at Rocky Reach Dam was managed to maximize fish passage, maintain HCP requirements, minimize voluntary spill, and still stay within the terms of Ecology's TDG fish-spill water quality criteria. Voluntary spill levels were managed in real time as detailed in the TDG Operational Plan (Appendix A) for Rocky Reach Dam.

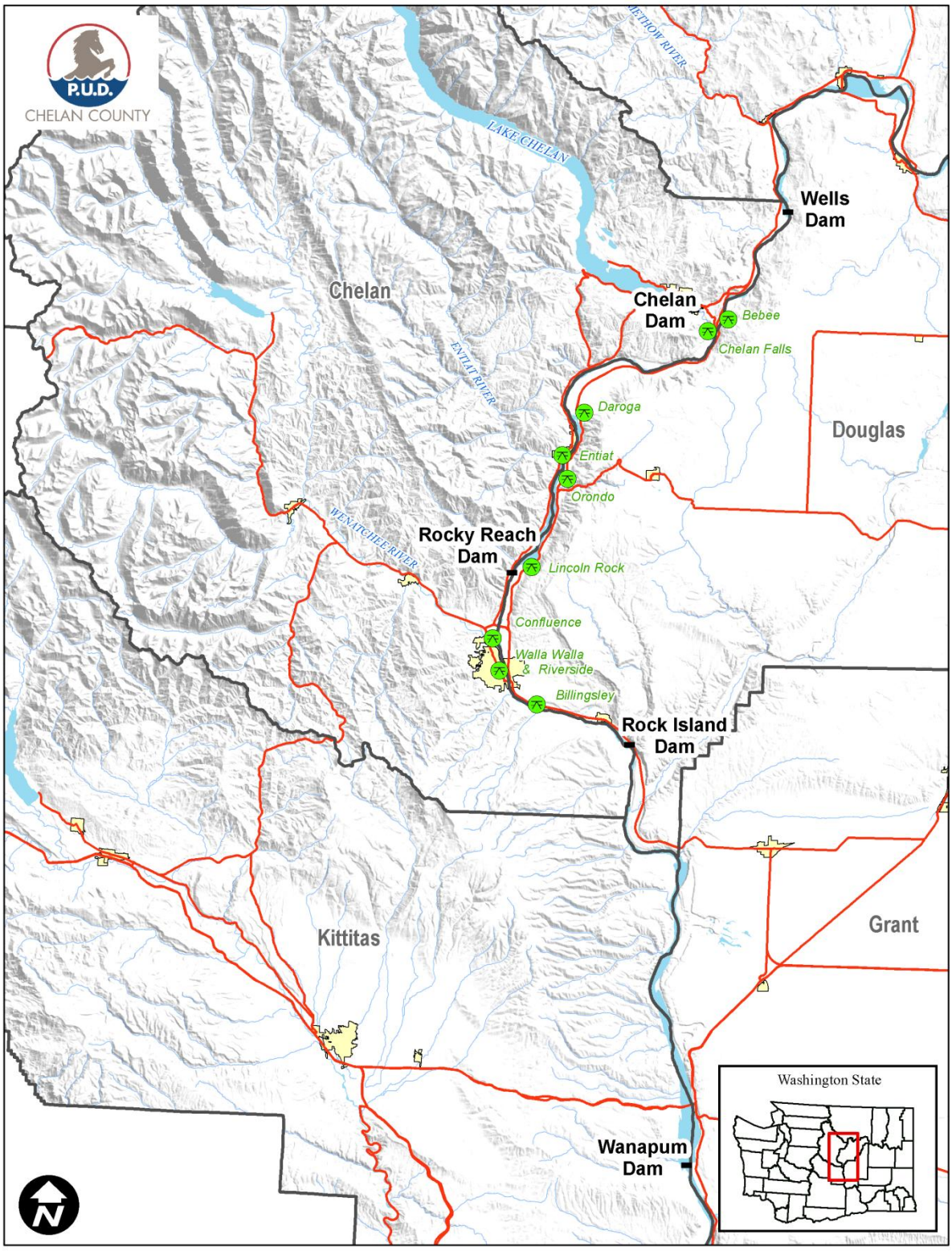

Figure 2-1: Project Location

2.2.2 Rock Island Project Description

The 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. The spillway is 1,184 feet 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 or cfs) surface spill for fish bypass (Figure 2-3). The normal maximum reservoir elevation of Rock Island project is 613 feet with a tailrace elevation of 572 feet, with a total head of 41 feet. Tailrace bathymetry below Rock Island is complex, and ranges in elevation from approximately 580 feet below bays 21-23 to approximately 520 feet below Bay 1. Chelan PUD has installed the following three TDG abatement structures at Rock Island:

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

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

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

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

2.3 Fixed Monitoring Stations

In accordance with Section 5.4.1(a) of the 401 WQC (Ecology, 2006), Chelan PUD currently operates and maintains four fixed-site water quality monitoring stations (FMS) that record barometric pressure (millimeters of mercury (mm/Hg)), TDG percent saturation, and temperature (degrees Celsius). Barometric pressure, TDG percentage saturation, and temperature are recorded

at 15-minute intervals, throughout the year in accordance with Chelan PUD's, Ecology and the FERC approved QAPP (Chelan PUD, 2010).

TDG data enables plant operators to adjust spill volume to maintain gas levels to reduce the likelihood of exceeding the TDG criteria. These 15-minute intervals are averaged into hourly readings for use in compiling daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the United States Army Corps of Engineers (USACE), Columbia River Basin Water Management Division on an hourly basis and posted on their website. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project (or the Rock Island Project) from the map and select TDG, Water Quality Data.

Each Chelan PUD FMS is equipped with a Hydrolab® Minisonde® 5, enclosed in a submerged conduit. These Hydrolab® Minisonde® 5's or probes are connected to an automated system that allows Chelan PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. Probes are maintained and calibrated as outlined in the QAPP (Chelan PUD, 2010).

Forebay FMS were located at fixed sites on the upstream face of Rocky Reach and Rock Island dams (Figures 2-2 and 2-3, respectively). The probes were lowered down a conduit, secured to the upstream face of each project, and submerged to a depth of approximately 15 feet.

Tailrace monitoring stations are located downstream of both projects. The Rocky Reach Dam monitoring station is located approximately one third of a mile downstream of the spillway on the JBS outfall (Figure 2-2), as required by the 401 WQC (Ecology, 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 Total Maximum Daily Load (TMDL).

No bridge or other permanent in-water structure is available downriver of Rock Island Dam on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the project on the eastern shoreline (Figure 2-4). This FMS has two means of deploying the probe; scaffolding that holds a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold. The fixed pipe was installed August 25, 2014 due to the extreme fluctuations of the Rock Island Dam tailrace as a result of the Wanapum Reservoir drawdown emergency.

Figure 2-2: Rocky Reach Dam, forebay, tailrace and fixed monitoring stations.

Figure 2-3: Rock Island Dam, forebay fixed monitoring station.

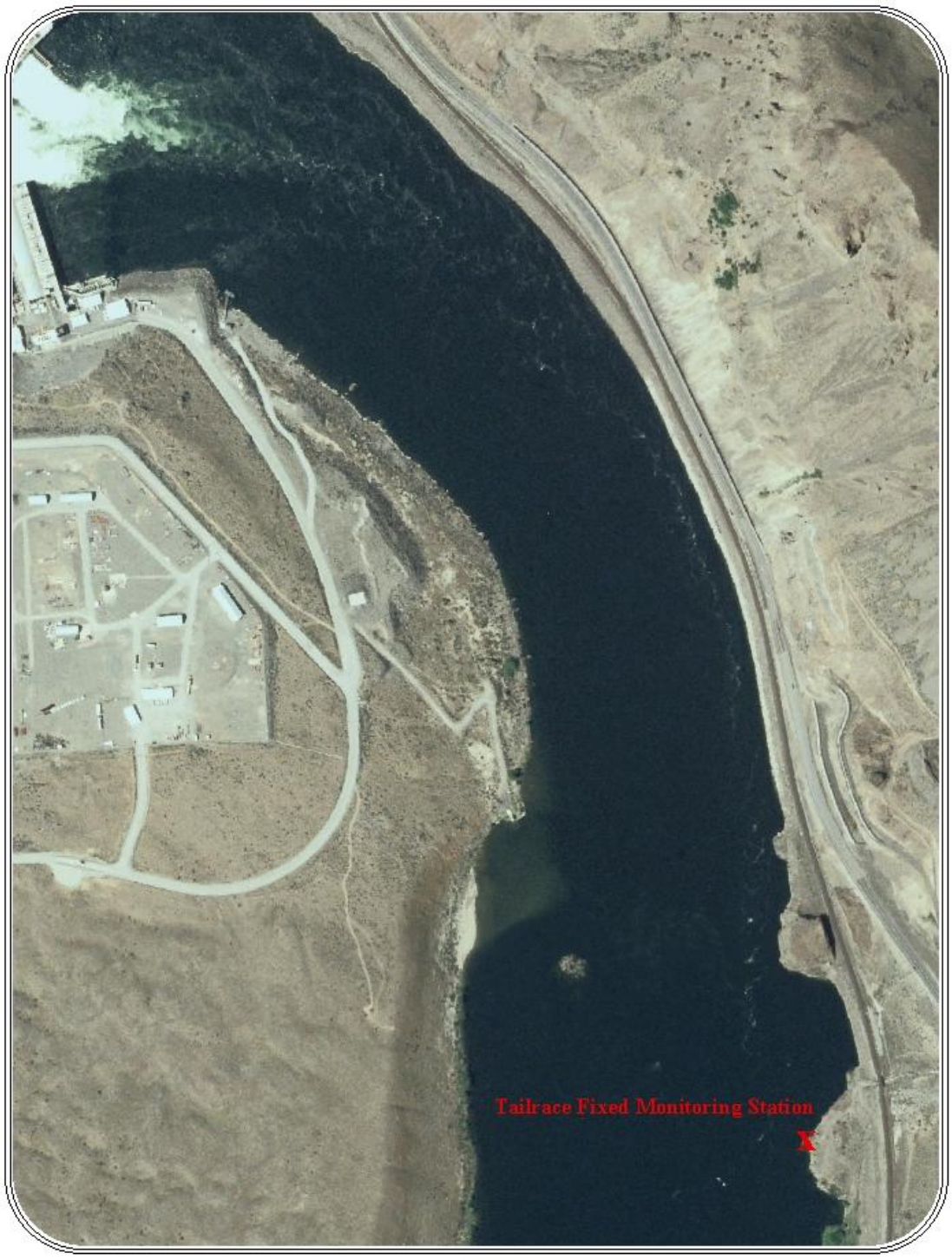

Figure 2-4: Rock Island Dam, tailrace fixed monitoring station.

2.4 Regulatory Framework

The Washington State water quality numeric criteria for TDG (Washington Administrative Code (WAC) 173-201A-200(1)(f)) address standards for the surface waters of Washington State. Under the water quality standards (standards), 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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers, there are three separate standards with regard to the TDG exemption: 1) in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one hour period and 2) TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next downstream dam as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period).

It is important to note that the TDG water quality standards identified above are intended to help protect aquatic life designated uses within the project. This includes Ecology's allowance of higher TDG levels during the fish-spill season, which allow dams to spill water to help achieve juvenile salmonid passage performance standards.

Specific passage performance or survival standards for the project are outlined in the HCP for the Rocky Reach Project. Specifically, the HCP provides that Chelan PUD achieve and maintain combined adult and juvenile project survival. The combined adult juvenile survival standard is 91 percent. The 91 percent standard is composed of 98 percent adult project passage survival and 93 percent juvenile project survival.

Chelan PUD is currently in Phase III - Standards Achieved. This means that the 91 percent adult-juvenile combined survival standard is achieved for the spring migrating HCP species; sockeye and spring Chinook salmon, and steelhead. Summer/fall subyearling Chinook salmon are in Phase III - Additional Juvenile Studies, due to limitations on acoustic tag technology for subyearlings and the unpredictable migration behavior of these Upper Columbia River subyearling Chinook salmon. Coho salmon, the last HCP species, is in Phase III - Standards Achieved - Interim.

Achieving the survival standards as described above and in addition to meeting TDG numeric criteria as outlined in WAC 173-201A-200(1)(f), are an integral part of meeting the water quality standards as described in the project's 401 WQC (Ecology, 2006).

2.4.1 7Q10 Flows

Section 5.4.1(b) of the 401 WQC (Ecology, 2006) and WAC 173-201A-200(f)(i) state that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for Rocky Reach Dam was calculated to be 252 thousand cubic feet per second (kcfs), and 264 kcfs at Rock Island Dam.

2.4.2 Daily Total Dissolved Gas Compliance Value Calculation Method

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

On May 21, 2008, Ecology requested, via memo, that all Columbia and Snake River dam operators use a rolling average method for calculating the twelve highest consecutive hourly TDG readings in a twenty-four hour period, beginning at 0100 hours, based on Ecology's 2006 revised water quality standards (Ecology, 2008a). Using a rolling average method that begins at 0100 hours results in counting the hours 1400 through 2359 twice: in the average calculations on the day they occur and on the next reporting day. As a result, a TDG water quality standard exceedance may be indicated on two separate days based on the same group of hours. For the 2016 fish-spill period, there were two instances of double counting, April 20 in the Rock Island forebay and June 7 in the Wanapum forebay.

In 2016, it was discovered that the TDG data used to compile 12-hour averages for calculations by Chelan PUD was in fact a reading from the top of the hour as opposed to hourly averages. The top of the hour calculation had been used from 2009 through 2015. The data submitted to the USACE was correctly submitted as hourly averages. Chelan PUD notified Ecology on October 10, 2016, requesting an extension on the Total Dissolved Gas Annual Report to re-evaluate the data from 2009 through 2015. Evaluation of the differences in reporting top of the hour verses hourly averages is discussed further in Section 4.3.3.

SECTION 3: *OPERATIONS*

3.1 Description of 2016 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2016 fish-spill season was compared to the 10-year average of mean daily discharge from 2006-2015, as measured at Rocky Reach (Figure 3-1) and Rock Island dams (Figure 3-2). Over the entire fish-spill season, mean daily flow discharges during the 2016 were lower than the 2006-2015 average (about 85 percent of average at Rocky Reach, and 88 percent of average at Rock Island dams).

With the exception of the month of April, average flow for all months during the spill season was lower than the monthly 10-year average at both projects. The maximum daily average flows observed at Rocky Reach and Rock Island dams during the spill season were 210 kcfs and 221 kcfs, respectively, on April 22. Of the 153 days during the spill season (April 1 through August 31), there were no instances where the daily average flows exceeded the 7Q10 value at Rocky Reach or Rock Island dams.

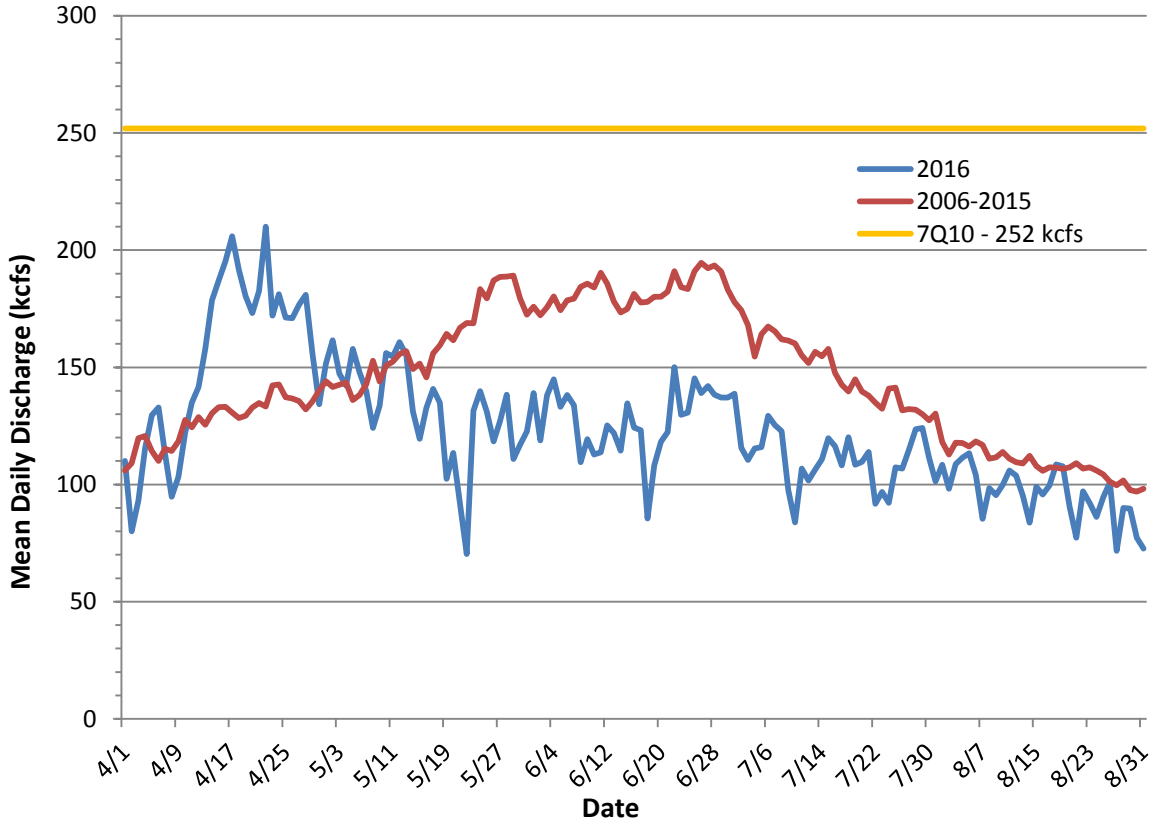

Figure 3-1: Comparison of 2016 vs. previous 10-year average (2006-2015) of mean daily discharge at Rocky Reach Dam.

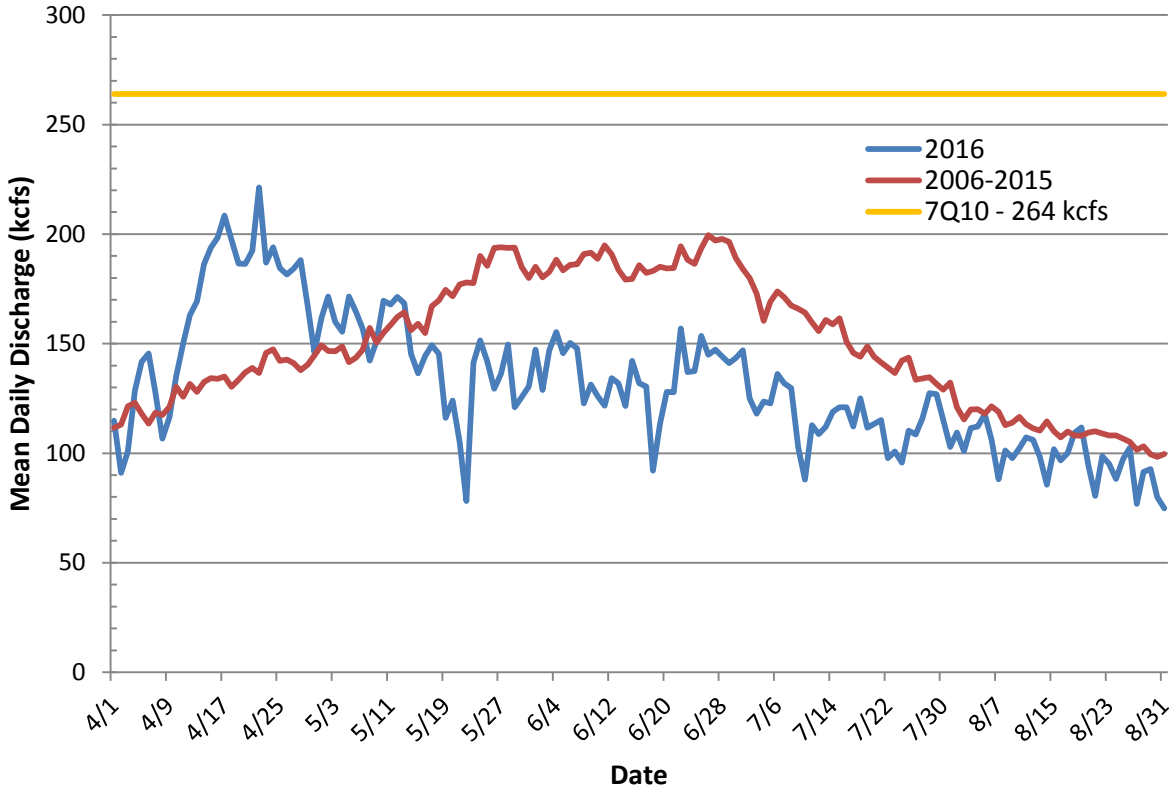

Figure 3-2: Comparison of 2016 vs. previous 10-year average (2006-2015) of mean daily discharge at Rock Island Dam.

3.2 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 Rock Island Dam are also instructed to inform the operators at Rocky Reach Dam when the Rock Island Dam forebay TDG level exceeds 115 percent. Since implementation of this plan, the number of TDG exceedances in the tailrace of each project has been reduced.

3.2.1 Rocky Reach Dam

The spill configuration used during the fish-spill season at Rocky Reach Dam is the standard spill configuration. This standard spill configuration uses gates 2 through 8 with a minimum discharge per spill bay of about four kcfs. This configuration was designed to create a crown-shaped pattern of turbulent flow below the spillway with decreasing velocities leading toward the fishway entrances, providing favorable guidance conditions for adult migrant salmon and steelhead. The same configuration 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 through 12 are used only in high

flow conditions when gates 2 through 8 cannot pass enough water. Deviation from the standard spill pattern occurs only during high flow and high spill events.

3.2.2 Rock Island Dam

Spill at Rock Island Dam is provided to cover 95 percent of the juvenile outmigration for steelhead, and sockeye, yearling and subyearling Chinook salmon.

Optimizing spill efficiency and reducing TDG levels has been a key task for Chelan PUD at Rock Island Dam. To accomplish this task, nine of the 32 spill gates have been modified with notches (notched spill gate) in the upper section of the spill gate, in order to provide efficient spill that also provides high juvenile salmonid passage survival. In addition to notched spill gates, three spill gates have been modified to pass spill over one gate and under another, termed over/under spill gates, effectively passing juvenile fish and reducing TDG levels in the tailrace associated with spill.

3.2.2.1 Existing Spill Plan

The existing juvenile fish-spill plan at Rock Island Dam is implemented for normal forebay and tail water elevations. The usual operating range for the Rock Island Dam forebay is 612 ft to 613 feet mean sea level (msl) and tail water is 570 feet. Spill for juvenile fish passage is provided between the first of April and up to the end of August each year.

Notched spill gates are numbers 1, 16, 18, 24, 26, and 29. These gates can be opened or closed sequentially by the operators using electric hoists. Over/under spill gates are numbers 30, 31, and 32. Once these gates are installed prior to the start of spring fish-spill season, they remain open until the close of the season. A mechanic crew installs the gates (in their operating configuration) with a crane, so the operators themselves cannot sequentially open or close the over/under gates as they do with the notched gates. As a result, Rock Island Dam can spill no less than 7.2 kcfs (total discharge for the three gates) from the date of installation (late March/early April) to the date of removal (late August/early September). Sequencing of the notched and over/under spill gates vary from year to year depending upon inflows, headwater control, and any scheduled maintenance of the gates.

3.3 Fish-Spill Programs

Specific survival standards for the project are outlined in the HCP for the Rocky Reach and Rock Island projects. Chelan PUD is required to meet and maintain survival standards for fish migrating through the projects. Reservoir and dam passage survival are the key components of project survival. Chelan PUD uses a different combination of tools to facilitate fish passage at the Rocky Reach and Rock Island dams because of each dam's unique features. At Rocky Reach Dam, passage is facilitated by the JBS, which is the primary method to increase juvenile dam passage survival. The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.

At Rock Island Dam, spill is still the preferred method of moving fish past the dam, with most of the spill being passed through the modified notched spill gates. Results of survival studies conducted at Rock Island Dam have enabled Chelan PUD to reduce voluntary (fish) spill in the

spring from 20 percent of the daily average flow to 10 percent of the daily average flow. Summer spill at Rock Island Dam remains at 20 percent of the daily average flow.

The fish-spill programs implemented by Chelan PUD at each project are dictated by the timing and duration of each species of outmigration. In the spring, generally mid April through early June, yearling Chinook salmon, steelhead and sockeye migrate past the projects, while subyearling Chinook salmon migrate during the summer, generally mid June to mid/late August. Appendix B contains the specific 2016 Fish-Spill Season Memoranda announcing the spring and summer fish-spill periods.

During the spring of 2016, Chelan PUD operated the Rocky Reach Dam JBS exclusively with no voluntary spill for yearling Chinook salmon, steelhead, and sockeye passage. Spring fish-spill began at Rock Island Dam on April 10, 2016 at 0001 hours and ended May 28, 2016 at 2400 hours (see Appendix B).

Summer fish-spill began on May 29, 2016 at 0001 hours immediately following the end of the spring fish-spill season and continued through 2400 hours on August 15, 2016 at Rocky Reach and August 11, 2016 at Rock Island dams (see Appendix B). Tables 3-1 and 3-2 provide a summary of the 2016 fish-spill for Rocky Reach and Rock Island dams respectively.

Table 3-1: Summary of fish-spill operations at Rocky Reach Dam.

Rocky Reach Dam			
Date	**Juvenile Fish Passage Program**	**Quantity**	**Notes**
1–April	JBS Operation Began		Operated exclusively with no fish-spill during the spring (April 1 – May 31)[1]
29–May	Summer Spill Initiated	Nine percent of daily average river flow	Spill for sub-yearling (summer) Chinook salmon
15–August	End of summer spill		
31–Aug	JBS Operation Ended		
Notes: [1] The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.			

Table 3-2: Summary of fish-spill operations at Rock Island Dam.

Rock Island Dam		
Date	**Juvenile Fish Passage Program**	**Quantity**
1-April	Fish Bypass Operation Began	
10-April	Spring Spill Initiated	10 percent daily average river flow
28-May	End of Spring Spill	
29-May	Start of Summer Spill	20 percent of daily average river flow
11-Aug	End of Summer Spill	
31-Aug	Fish Bypass Operation Ended	

3.4 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 may 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

Tables 3-3 and 3-4 show the monthly averages for river flow, total spill, fish-spill, and other spill for the Rocky Reach and Rock Island dams.

Table 3-3: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2016.

Month	**Average Flow kcfs**	**Average Spill kcfs**	**Spill Purpose**					
			Fish-Spill			**Other**		
			Spill kcfs	**Percent of flow**	**Percent of Total Spill**	**Spill kcfs**	**Percent of flow**	**Percent of Total Spill**
April	152.5	15.3	0.0	0.0	0.0	15.3	10.0	100.0
May	132.4	4.5	1.1	0.8	25.2	3.3	2.5	74.8
June	127.6	11.3	11.3	8.8	99.8	0.0	0.0	0.2
July	111.2	11.3	9.9	8.9	87.6	1.4	1.3	12.4
August	95.5	5.0	4.6	4.8	92.3	0.4	0.4	7.7

Table 3-4: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2016.

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish-Spill			Other		
			Spill kcfs	Percent of flow	Percent of Total Spill	Spill kcfs	Percent of flow	Percent of Total Spill
April	164.0	25.2	12.1	7.4	48.0	13.1	8.0	52.0
May	146.0	17.7	16.1	11.0	90.7	1.6	1.1	9.3
June	137.4	26.3	26.3	19.2	100.0	0.0	0.0	0.0
July	116.5	22.7	22.6	19.4	99.8	0.1	0.0	0.2
August	98.3	7.5	7.4	7.6	98.9	0.1	0.1	1.1

3.4.1 Voluntary and Involuntary Spill

In 2016, spill events at Rocky Reach Dam were involuntary (forced) April 1 through May 31 and both voluntary and involuntary May 29 through August 15 (summer fish-spill period). Between May 29 and the end of summer fish-spill on August 15, nine percent of the total volume spilled was voluntary, while 0.5 percent was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 10, with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates.

To achieve HCP passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of 9 percent of daily average river flow at the Rocky Reach Dam for a duration covering 95 percent of the subyearling outmigration during the summer of 2016. The summer spill program for subyearling passage began on May 29 and ended on August 15. Approximate percent daily river flow spilled during the summer period was nine percent.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Hydroelectric Project. Spring fish-spill of 10 percent began on April 10 and was continued through May 28. During the spring fish-spill period, 15 percent of total river flow was spilled. Of that 15 percent, 10 percent of it was voluntary spill for fish and five percent was forced spill due to higher river flows and generation limitations with units down at Rock Island Dam. Rock Island Dam fish-spill increased to 20 percent upon onset of the summer outmigration of subyearling Chinook. Summer spill began on May 29 and continued through August 11. During the summer fish-spill period, 20 percent of total river flow was spilled. Of that 20 percent, 100 percent of it was voluntary spill for fish.

SECTION 4: *RESULTS*

The following sections describe the 2016 fish-spill season flow characteristics compared to the previous ten-year average, the 2016 fish-spill season programs, the 2016 biological TDG monitoring results, and the TDG data for the fish-spill season.

4.1 Biological Evaluations

The following sections provide a summary of fisheries management and results from Gas Bubble Trauma (GBT) monitoring. Note that no survival studies were conducted in 2016.

No survival studies on spring migrants (yearling Chinook and sockeye salmon and steelhead) were conducted in 2016 as HCP survival standards have been achieved for all three species at both projects. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for summer/fall subyearling Chinook have been conducted since 2004.

4.1.1 Gas Bubble Trauma Monitoring

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach Project WQC (Ecology, 2006) requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. On April 21, 2014, Chelan PUD received a letter from Ecology postponing the GBT monitoring until such a time as is determined to be appropriate by Ecology. Ecology is currently evaluating the need for future GBT studies below Rocky Reach Dam. Currently, Chelan PUD conducts a Smolt Monitoring Program at Rock Island Dam.

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of GBT between April 12 and June 7. 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, the sample was changed from yearling to subyearling Chinook salmon when the subyearling Chinook salmon collection exceeded the yearling Chinook salmon collection. A random sample of up to 100 subyearling was examined two days per week. Examinations followed FPC standardized procedure as outlined by FPC (2016). During 2016 monitoring, 2,200 smolts were examined for GBT. Of these, 13, or 0.59 percent, showed signs of GBT. Table 4-1 provides the summary results of 2016 GBT monitoring.

Table 4-1: Number salmon and steelhead smolts examined for external signs of GBT of at Rock Island Dam in 2016.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		Number	Percent	Number	Percent	Number	Percent
Chinook yearling	717	10	1.39	10	1.39	0	0.00
Steelhead	495	2	0.40	2	0.40	0	0.00
Chinook Sub-yearling	988	1	0.10	1	0.10	0	0.00
Total	*2,200*	*13*	*0.59*	*13*	*0.59*	*0*	*0.00*

4.2 Data Evaluation and Analyses

Data collection, quality assurance/quality controls (QA/QC), and analyses of TDG values were conducted in accordance with the QAPP for the FMS (Chelan PUD, 2010). For this report, hourly TDG data recorded during 2016 were analyzed for apparent exceedances of current water quality standards. TDG values are rounded to the nearest number for example; 115.2 is rounded to 115, 115.5 is rounded to 116 (Ecology, 2008a).

All of the TDG probes used during 2016 were calibrated and maintained in accordance with the methods and schedules described in the QAPP (Chelan PUD, 2010). TDG probes that did not pass calibration tests were sent back to the manufacture for repair and/or replaced prior to deployment. Calibration reports are included in Appendix C of this report. Suspect or clearly erroneous TDG values were omitted from the analysis, but are included, as well as explanation for omission, in Appendix D of this report.

The data QA/QC issues during 2016 were related to the following issues; program upgrades, communication errors, and/or down time during calibration. Overall, data loss for Chelan PUD operated FMS during the 2016 fish-spill season was one hourly reading or 0.007 percent of the total available data collection hours. Table 4-2 displays the number of TDG values that were omitted from the dataset due to QA/QC issues during the 2016 fish-spill season.

Table 4-2: Overview of total dissolved gas data set during 2016 fish-spill season April 1 through August 31.

Location	Available data hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
RRFB	3,672	0	0
RRTR	3,672	0	0
RIFB	3,672	1	0.03
RITR	3,672	0	0
Total	*14,688*	*1*	*0.007*

Note: RRFB = Rocky Reach Dam Forebay, RRTR = Rocky Reach Dam Tailrace, RIFB = Rock Island Dam Forebay, RITR = Rock Island Dam Tailrace.
[1]See Appendix D for dates, times, and circumstances relating to omitted/lost data

4.3 Total Dissolved Gas Monitoring During the Fish-Spill Season

The following sections discuss the results of TDG monitoring from the 2016 fish-spill season within the project and at the Wanapum Dam forbay compliance point location. Specific sections of this document include TDG averages with associated figures for each FMS compliance point location, a breakdown of all TDG exceedances and possible explanations for those exceedances, and the connection between elevated TDG levels and involuntary spill during the 2016 fish-spill season. Summary values for all hourly average TDG measurements taken from each FMS during the 2016 fish-spill season are presented in Table 4-3 below.

Table 4-3: Summary hourly total dissolved gas measurements from each FMS during the 2016 fish-spill season.

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
RRFB	04/01 – 08/31	108.3	2.7	102.5	117.4
RRTR	04/01 – 08/31	112.8	4.6	102.4	123.4
RIFB	04/01 – 08/31	108.7	2.8	102.4	117.4
RITR	04/01 – 08/31	112.5	3.5	101.9	122.1
WANF	04/01 – 08/31	110.0	3.7	101.7	121.6
Notes: With the exception of standard deviation, values represent percent saturation RRFB = Rocky Reach Dam forebay, RRTR = Rocky Reach Dam tailrace, RIFB = Rock Island Dam forebay, RRTR = Rocky Reach Dam tailrace, WANF = Wanapum Dam forebay					

4.3.1

4.3.2 Total Dissolved Gas Averages

Total dissolved gas averages during the fish-spill season in Figures 4-1 through 4-9 display the average of the 12-highest consecutive hourly readings, spill vs. TDG, and a regression analysis of predicted TDG levels vs. actual TDG at Rocky Reach Dam tailrace. Figure 4-8 shows that actual 2016 TDG fish-spill data was higher than predicted regression equations in the WQMP, Table 2-7 (Chelan PUD, 2006). The average of the 12-highest consecutive hourly TDG readings from each day during the spring and summer fish-spill seasons from each FMS is presented in Appendix E of this report.

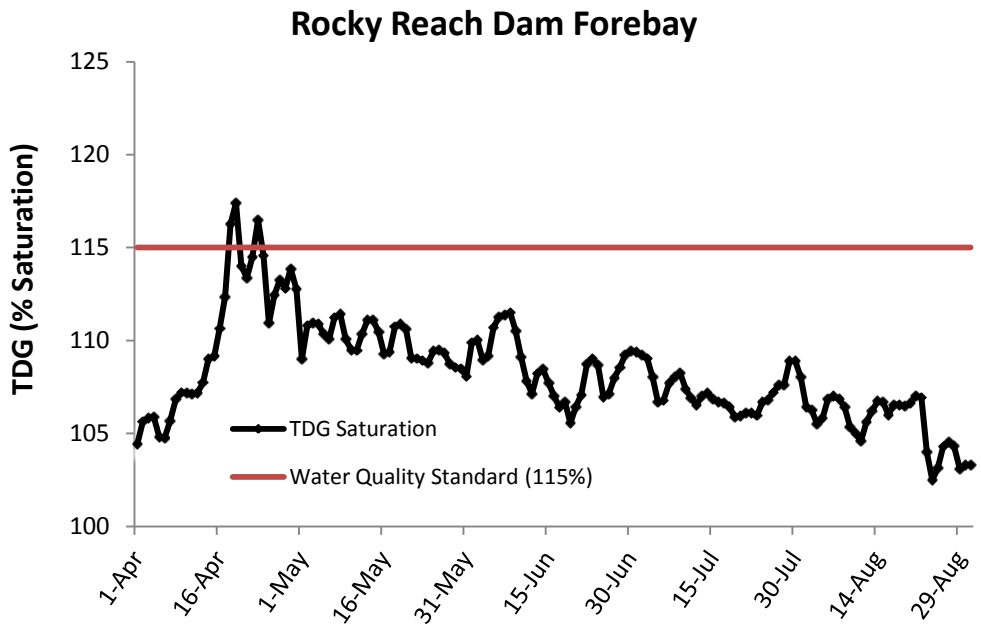

Figure 4-1: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rocky Reach Dam forebay FMS.

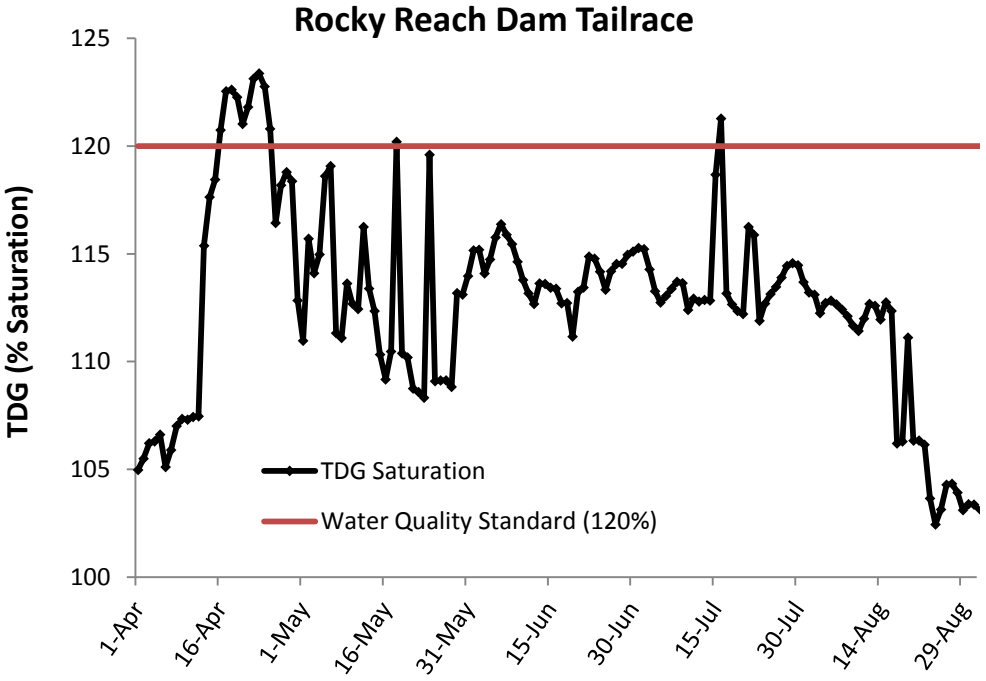

Figure 4-2: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rocky Reach Dam tailrace FMS.

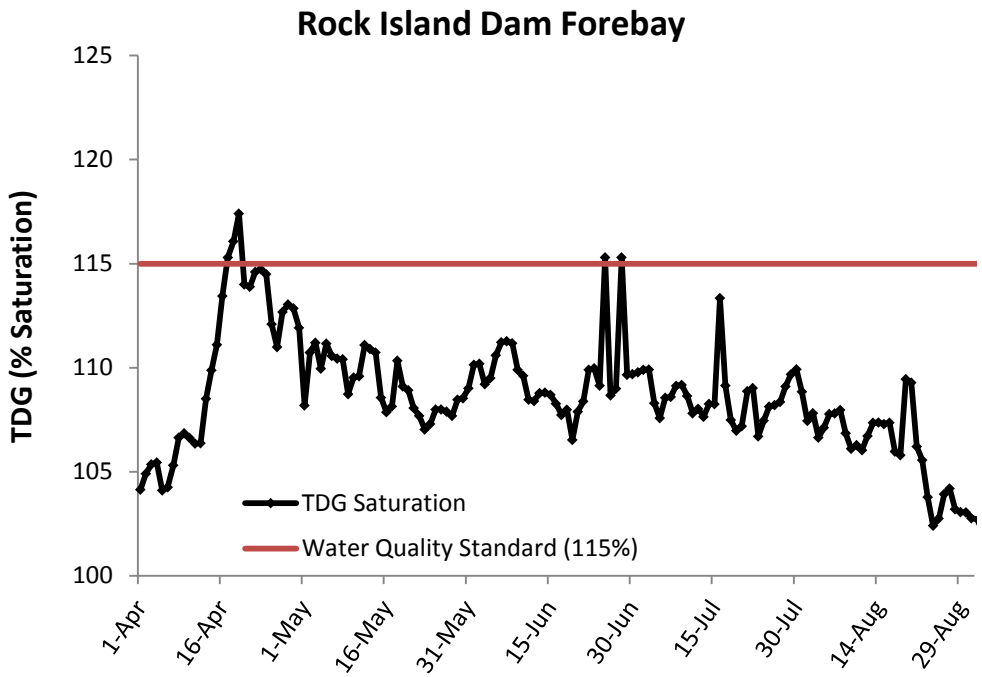

Figure 4-3: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rock Island Dam forebay FMS.

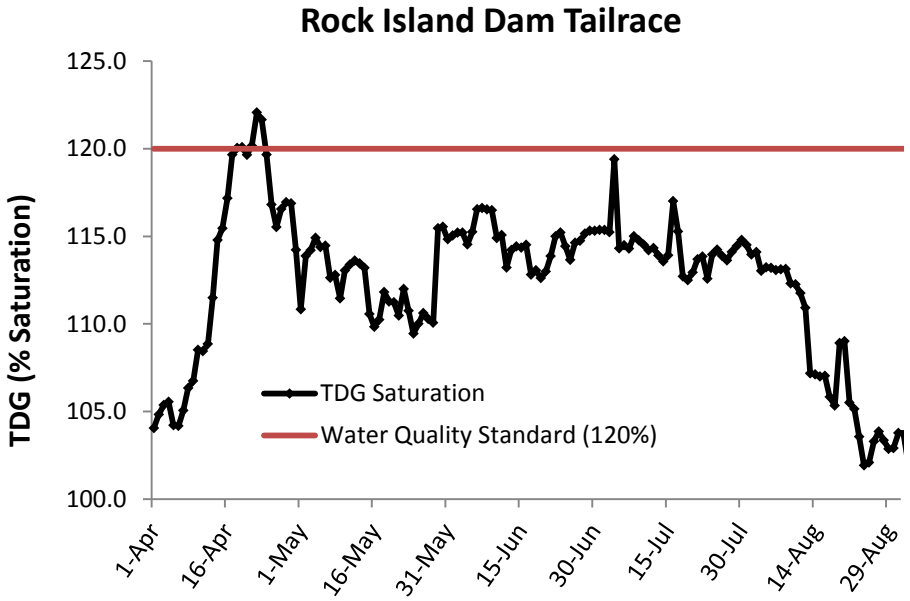

Figure 4-4: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rock Island Dam tailrace FMS.

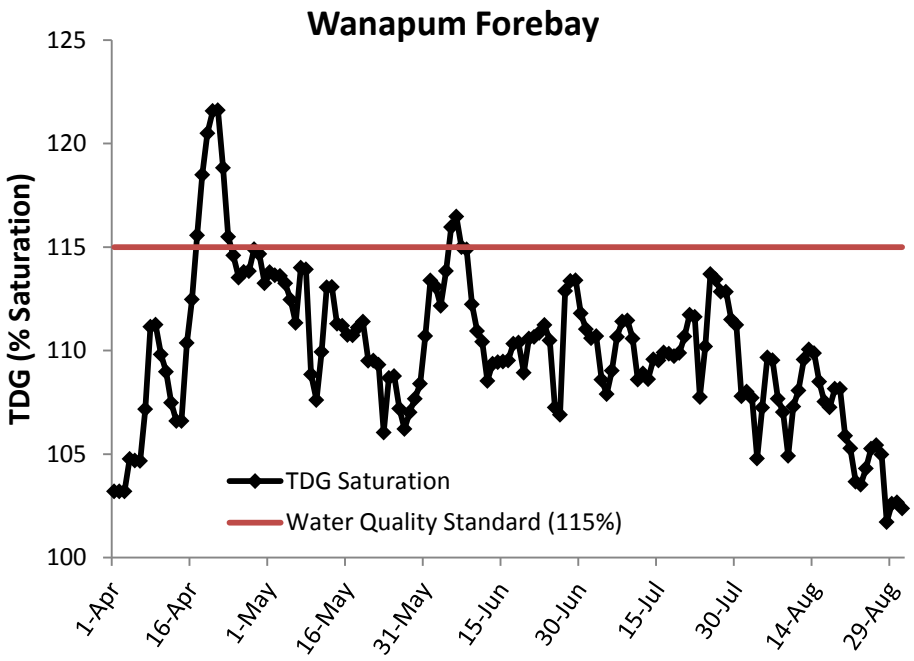

Figure 4-5: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Wanapum Dam forebay FMS.

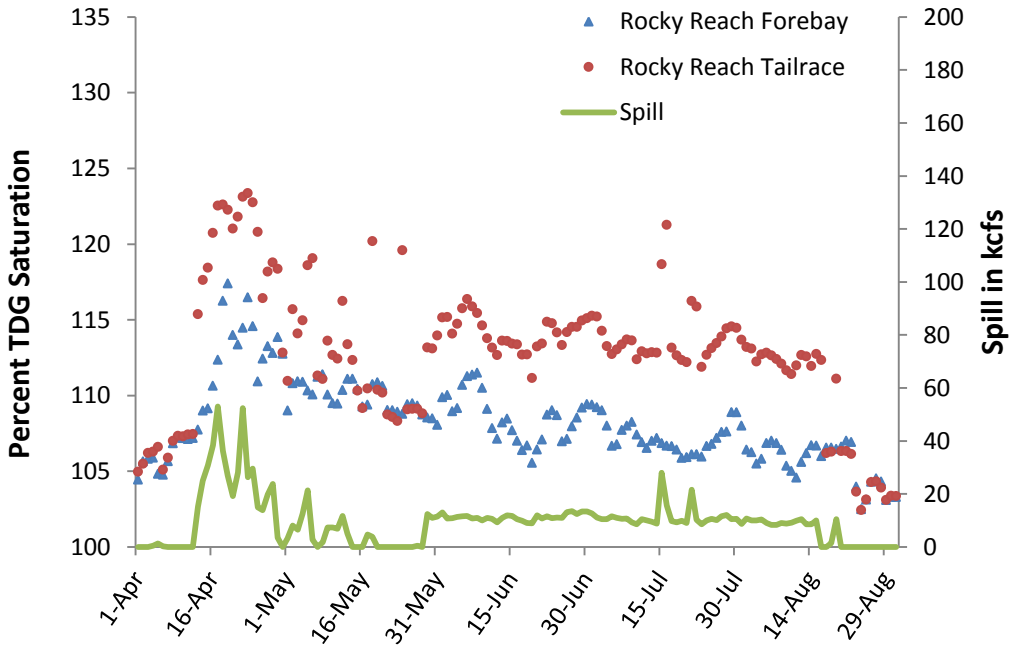

Figure 4-6: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rocky Reach Dam forebay and tailrace FMS.

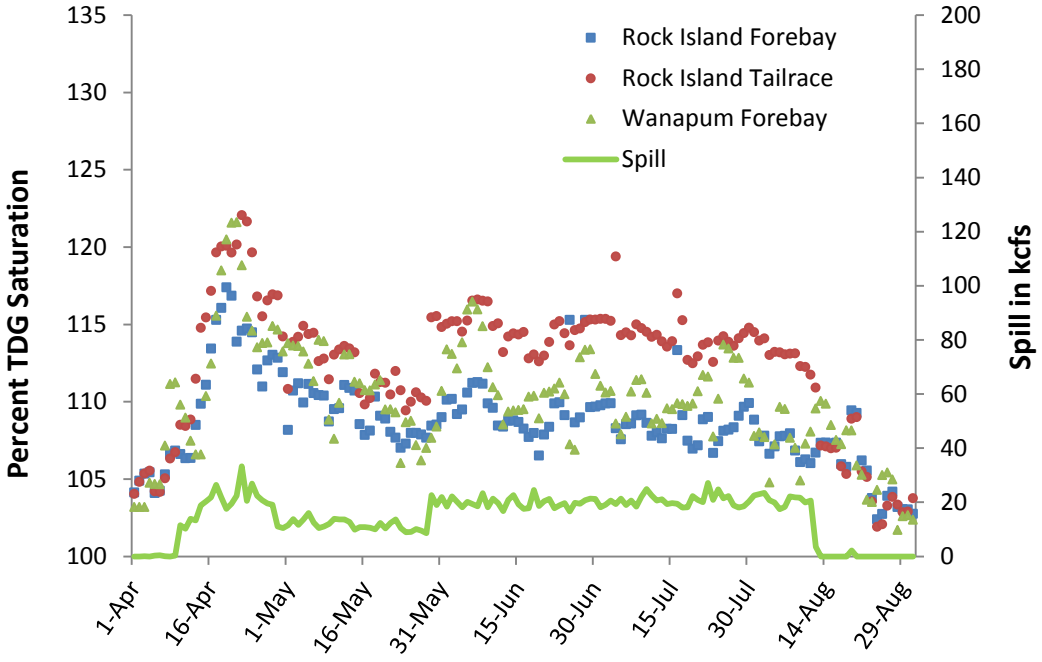

Figure 4-7: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rocky Island Dam forebay and tailrace and the Wanapum Dam forebay FMS.

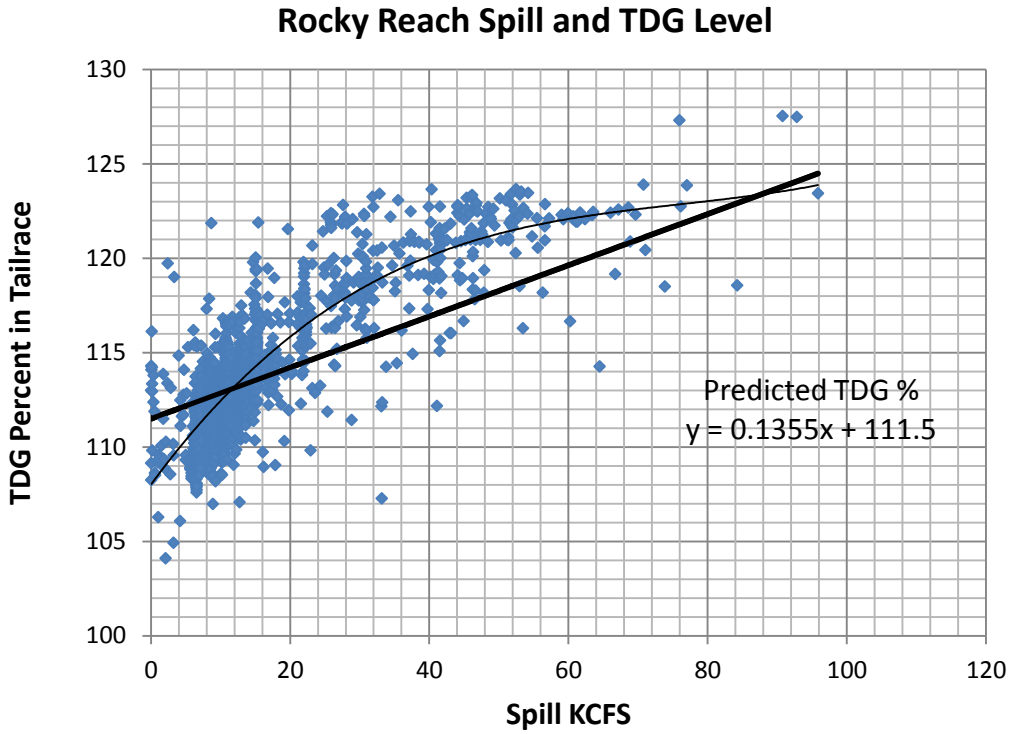

Figure 4-8: 2016 Rocky Reach Dam tailrace TDG percent vs. predicted TDG percent.

Table 4-4 displays the total number of times TDG levels exceeded the current water quality standards during the 2016 fish-spill season as measured at each of Chelan PUD's FMS along with Wanapum dam forebay compliance point (owned/operated by Grant PUD). The total number of exceedances also reflects the omission of exceedances caused by the previous day's hourly values, if those same hourly values also created a 12-hour average TDG value above standards for the previous day. Appendix C within this report presents all omitted data with explanations of why they were omitted.

Table 4-4: Summary of hourly averages total dissolved gas measurements from each FMS during the 2016 fish-spill season.

Location[1]	Number of 115/120 percent exceedances					Number of 125 percent exceedances		
	Spring Spill	Summer Spill	Total	Total # of days[2]	Percent below standard	Total hours	Total # of hours[2]	% below standard
RRTR	10	1	11	153	92.8	3,672	3	99.9
RIFB	3[3]	0	3	153	98.0	3,672	0	100
RITR	2	0	2	153	98.7	3,672	0	100
WANF	7	2	9	153	94.1	3,672	0	100
total	19	3	25	612	95.9	14,688	3	99.97

[1]RRTR = Rocky Reach tailrace, RIFB = Rock Island forebay, RRTR = Rocky Reach tailrace, WANF = Wanapum forebay

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

[3] These are not counted as an exceedance as incoming TDG levels were above the 115% in the Rocky Reach forebay

Exceedances of TDG numeric criteria were minimal during the 2016 fish-spill season, with a total of 22 exceedances of the 115/120 percent standard (96.4 percent below the standard). There were three exceedances of the 1-hour 125 percent standard in the Rocky Reach tailrace. All TDG data can be found in Appendix E of this report.

4.3.2.1 Discussion of Exceedances

Data analysis showed that water coming into the Rocky Reach forebay from upstream exceeded Washington State water quality criteria on three days (1.9 percent of the total number of days observed). TDG exceeded the modified Washington State TDG fish spill water quality criteria on 11 days (7.2 percent of the total number of days observed) in the Rocky Reach tailrace, three days (1.9 percent of the total number of days observed) in the Rock Island forebay, and two days (1.3 percent of the total numbers of days observed) in the Rock Island tailrace during this monitoring period. Numeric criteria were exceeded on nine days (5.8 percent of the total number of days observed) in the Wanapum forebay (Grant County PUD). These exceedances of the water quality criteria did not necessarily result in noncompliance. Many of the forebay exceedances occurred when the upstream dam's forebay exceeded 115 percent and were not counted as exceedances in accordance with WAC 173-201A-200(1)(f). Figure 3-6 shows the Rocky Reach Forbay and the

Rock Island Forebay Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season.

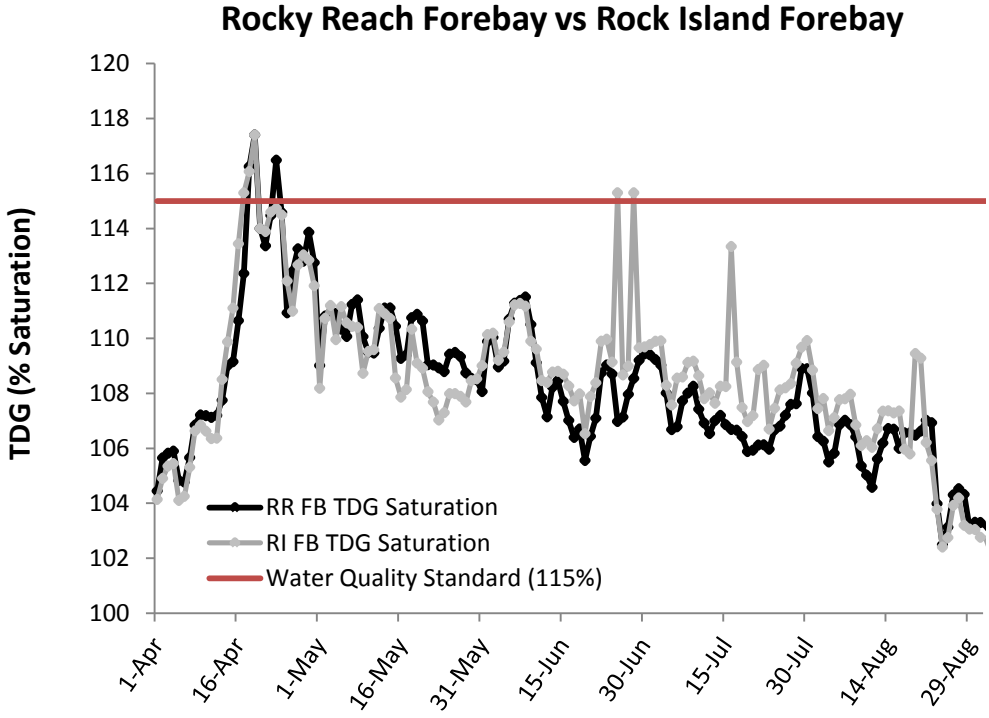

Figure 4-9: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2016 fish-spill season recorded at the Rocky Reach and Rock Island dam forebays FMS.

As previously stated, when the upstream dam's forebay TDG exceeded 115 percent, TDG values for that 24-hour period were omitted from the data set used for determination of compliance.

Noncompliance at each FMS is further detailed in the following sections and summarized in Table 4-4 above.

4.3.2.2 Rocky Reach

Tailrace 125 Percent Standard

Total hours of TDG data collected during the 2016 fish spill season in the Rocky Reach tailrace equaled 3,672. No hours were eliminated from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125 percent for three hours. Compliance with this standard was 99.9 percent.

Tailrace 120 Percent Standard
TDG data was collected on 153 days during the 2016 fish-spill season in the Rocky Reach tailrace. None of the data was omitted from the data set due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on 11 days. Compliance with this standard was 92.8 percent.

Downstream (Rock Island) Forebay 115 Percent Standard
TDG data was collected on 153 days during the 2016 fish spill season in the Rock Island forebay. However, of those 153 days two were omitted from the data set used for determination of compliance due to upstream forebay 12C-High TDG exceeding 115 percent and one was omitted due to double counting and the use of the alternate high value. The Rock Island forebay after previously mentioned data was omitted was 100 percent compliant with this standard.

4.3.2.3 Rock Island

Tailrace 125 Percent Standard
Total hours of TDG data collected during the 2016 fish spill season in the Rock Island tailrace equaled 3,672. No hours were omitted from the data set due to flows in exceedance of the 7Q10 flow. There were no exceedances of the standard. Compliance with this standard was 100 percent.

Tailrace 120 Percent Standard
TDG data was collected on 153 days during the 2016 fish spill season in the Rock Island tailrace. No days were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on two days. Compliance with this standard was 98.7 percent.

Downstream (Wanapum) Forebay 115 Percent Standard
TDG data was collected on 153 days during the 2016 fish spill season in the Wanapum forebay. The Wanapum forebay 12C-High TDG exceeded 115 percent on 9 days. Compliance with this standard was 94.1 percent.

4.3.2.4 Evaluation of Exceedances from 2009 Through 2015

In 2016, it was discovered that the TDG data used to compile 12-hour averages for calculations by Chelan PUD was in fact a reading from the top of the hour as opposed to the required hourly average. The top of the hour calculation had been used from 2009 through 2015. The data submitted to the USACE however was correctly submitted as hourly averages. Evaluation of the differences in reporting top of the hour verses hourly averages is discussed further below.

All Rocky Reach tailrace and Rock Island forebay TDG data for the 2009 through 2015 was re-run using the proper hourly average calculation for each hour of data. Rocky Reach forebay (Wells Dam tailrace) and Rock Island tailrace (Wanapum Dam forebay) data were not re-run as compliance at those locations were evaluated using Douglas and Grant PUD's data from their projects. 2009 through 2015 daily hourly averages were then compared to the previous data set that was top of the hour calculations. Differences in the top of the hour and hourly averages were reviewed at to determine if the difference would have resulted in an exceedance or non exceedance using the top of the hour versus the hourly average. Out of the differences that did make a change in a counted or non-counted exceedance/non-exceedance, those hours were evaluated in the 12-

hour rolling average to verify whether or not they would have resulted in a change of what was reported as an exceedance/non-exceedance. A total of 102,816 hours of data were evaluated. Of those 102,816 hours, 218 hours resulted in a change (0.2 percent) of an exceedance or non-exceedance. Further discussion of the exceedances/non-exceedances is below.

4.3.2.5 Rocky Reach Tailrace 120 Percent and 125 Percent Standard

Out of 51,408 hours of data (that were compared (top of the hour versus hourly average) from the 2009 through 2015 fish-spill period, 37 hours using the hourly average should have resulted in a daily exceedance of the 120 percent standard at the Rocky Reach tailrace. Conversely, 35 hours that were counted as exceedances using the top of the hour should not have been counted as an exceedance of the 120 percent standard at the Rocky Reach tailrace thereby resulting in two (exceedances that should have been counted in the Rocky Reach forebay that were not.

For the 125 percent standard, using the hourly average calculation 10 hours should have resulted in an exceedance. Conversely, 13 hours that were counted as exceedances using top of the hour calculation should not have been counted as an exceedance of the 125 percent standard thereby resulting in three hours that should not have been counted in the Rocky Reach tailrace that were.

4.3.2.6 Rock Island Forebay 115 Percent and 125 Percent Standard

Out of 51,408 hours of data that were compared (top of the hour versus hourly average) from the 2009 through 2015 fish-spill period, 53 hours using the hourly average should have resulted in a daily exceedance of the 120 percent standard at the Rock Island forebay. Conversely, 44 hours that were counted as exceedances using the top of the hour should not have been counted as an exceedance of the 120 percent standard at the Rocky Reach tailrace thereby resulting in nine exceedances that should have been counted in the Rocky Reach forebay that were not.

For the 125 percent standard, using the hourly average calculation 11 hours should have resulted in an exceedance. Conversely, 15 hours that were counted as exceedances using top of the hour calculation should not have been counted as an exceedance of the 125 percent standard thereby resulting in four hours that should not have been counted in the Rocky Reach tailrace that were.

SECTION 5: *TOTAL DISSOLVED GAS ABATEMENT MEASURES AND CORRECTIVE ACTIONS IMPLEMENTED IN 2016*

5.1 Operational

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

5.1.1 Rocky Reach Project

Results of survival studies have allowed Chelan PUD to greatly reduce spill and eliminate spill for fish at Rocky Reach Dam. The JBS is now operated exclusively, with no spill, for spring migrants; and spill during the summer migration has been reduced to 9 percent of the daily average flow. Spill levels from 2003 to 2016 are shown in Table 5-1 below. The JBS continues to be the most efficient non-turbine route for fish passage and does not require spill for its operation.

Table 5-1: Rocky Reach Dam fish-spill Comparison 2003-2016.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Percent Spill Level[1]
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 [2]
2005	Summer	10-Jun	15-Aug	67	9
Total				**85.5**	
2006	Spring	2-May	1-Jun	19.0	0/24 [2]
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**	

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Percent Spill Level[1]
2011	Spring	No Spill	No Spill	0	0
2011	Summer	4-Jun	12-Aug	70	9
Total				**70**	
2012	Spring	No Spill	No Spill	0	0
2012	Summer	26-May	9-Aug	76	9
Total				**76**	
2013	Spring	No Spill	No Spill	0	0
2013	Summer	5-June	21-August	78	9
Total				**78**	
2014	Spring	No Spill	No Spill	0	0
2014	Summer	24-May	24 - August	93	9
Total				**93**	
2015	Spring	No Spill	No Spill	0	0
2015	Summer	1-June	11-August	73	9
Total				**73**	
2016	Spring	No Spill	No Spill	0	0
2016	Summer	28-May	15-August	79	9
Total				**79**	

Notes: [1] Percentage of daily average river flow at Rocky Reach Dam. Two values in this column represents two different spill levels during the season (first value is the spill level for yearling Chinook and steelhead, second value is the spill level for sockeye.)
[2]24 days of on/off spill test for sockeye

The goal of the Rocky Reach Project GAP (Appendix E), approved by Ecology in April of 2016 is to implement measures to achieve compliance with the standards for TDG in the Columbia River at the project while continuing to meet the fish passage and survival standards set forth in the 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, nine percent 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 A).
3. Minimized spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoided spill, to the extent practicable, by continuing to participate in the Hourly Coordination Agreement, to the extent it reduces TDG.
5. Maximized powerhouse discharge as appropriate up to 212 kcfs.
6. Continued the analysis of the three alternate spillway configurations that were tested in 2011 and 2012 (Chelan PUD, 2013) to determine if any would be efficient at minimizing TDG. Chelan PUD is currently in the process of writing the program for gate operation in order to implement the flattened spill gate configuration during the non-fish-spill period.

5.1.2 Rock Island Project

After meeting the HCP juvenile survival standards for all spring migrating species under a 20 percent spring spill regime in 2006, Chelan PUD has implemented a spill reduction study resulting in spring (voluntary) fish-spill being reduced to 10 percent of the daily average river flow. Spill levels from 2003 to 2016 are shown in Table 4-2 below.

Table 5-2: Rock Island Dam fish-spill comparison, 2003-2016.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Percent Spill Level[1]
2003	Spring	17-Apr	31-May	45	20
2003	Summer	1-Jun	16-Aug	77	20
Total				**122**	
2004	Spring	17-Apr	8-Jun	53	20
2004	Summer	9-Jun	4-Aug	57	20
Total				**110**	
2005	Spring	17-Apr	9-Jun	54	20
2005	Summer	10-Jun	9-Aug	61	20
Total				**115**	
2006	Spring	17-Apr	13-Jun	58	20
2006	Summer	14-Jun	11-Aug	59	20
Total				**117**	
2007	Spring	17-Apr	1-Jun	46	10
2007	Summer	2-Jun	21-Aug	81	20
Total				**127**	
2008	Spring	17-Apr	7-Jun	52	10
2008	Summer	8-Jun	16-Aug	70	20
Total				**122**	
2009	Spring	17-Apr	9-Jun	54	10
2009	Summer	10-Jun	17-Aug	69	20
Total				**123**	
2010	Spring	17-Apr	8-Jun	53	10
2010	Summer	9-Jun	20-Aug	73	20
Total				**126**	
2011	Spring	17-Apr	3-Jun	48	10
2011	Summer	4-Jun	24-Aug	82	20
Total				**130**	
2012	Spring	17-Apr	27-May	41	10
2012	Summer	28-May	18-Aug	83	20
Total				**124**	
2013	Spring	17-Apr	4-June	49	10
2013	Summer	5-June	18-Aug	75	20
Total				**124**	
2014	Spring	17-Apr	23 – May	37	10
2014	Summer	24 - May	24 - Aug	93	20
Total				**130**	

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Percent Spill Level[1]
2015	Spring	16-Apr	23 – May	46	10
2015	Summer	1-Jun	11 - Aug	72	20
Total				**128**	
2016	Spring	10-Apr	28-May	49	10
2016	Summer	29-May	11-Aug	75	20
Total				**124**	
Notes: Percentage of daily average river flow at Rock Island Dam					

The goal of the Rock Island Project GAP (Appendix G) approved by Ecology in April of 2016, 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 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 percent to 10 percent 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 A).
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.

5.1.3 Regional Coordination

Chelan PUD participates in various water quality forums as listed below.

Spring Operations Meeting: Annual participation in regional spill/project operation meeting with representatives from Chelan, Douglas, and Grant PUDs, as well as Bonneville Power Administration (BPA) and the USACE. Natural Resources, Marketing, and Operations

Post-Spill Season Monitoring System Review: The USACE hosts a year-end TDG monitoring and QA/QC meeting, at which presentations are made from the various agencies conducting TDG and other water quality monitoring within the Columbia River Basin. Topics include data completeness, quality, calibration results, new or improved monitoring methods, etc. Agencies presenting at this meeting included the United States Geological Services, USACE, other mid-Columbia River PUDs, and private consultants. Chelan PUD has participated in these yearend meetings.

Transboundary Gas Group: Ecology hosted meetings to discuss regional TDG issues and concerns. Chelan PUD has attended these meetings regularly. Although the frequency of the Transboundary Gas Group meetings has lessened, Chelan PUD will attend the next scheduled meeting.

5.2 Structural

No structural modifications were made or utilized at Rocky Reach or Rock Island dams in 2016.

5.3 Corrective Actions

Actions taken to maintain/regain compliance with the TDG standards in 2016 included:

- Implementation of the TDG Operational Plan.

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

- Attempted to maximize turbine flows by setting minimum generation requirements, which included establishing a common methodology for setting minimum generation requirements specific to Rocky Reach and Rock Island dams for the management of TDG. Each dam's minimum generation requirements were then allocated to power purchasers that receive a percentage of the projects' output.

- Participation in regional spill/project operation meeting in the spring. This meeting brought together representatives from Natural Resources, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Administration (BPA) and the USACE. Discussions included topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resources requirements (e.g. Hanford Reach fall Chinook salmon flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.

- Implementation of the Spill Priority List which included, for example, having the Mid-Columbia project (i.e. Grant, Chelan, and Douglas PUDs) operators working to coordinate spill to reduce the overall TDG on the entire Columbia River system. The Columbia River Basin projects Spill Priority List provided guidance to federal river operators when there was insufficient generation request available to pass the needed amount of water through the Federal Columbia River Power System. A mechanism through hourly coordination was used to shift load from the non-federal projects to the federal projects (by mutual agreement) to reduce the amount of spill (and associated TDG levels) that would otherwise occur at the federal projects using the Spill Priority List. Although this measure may not have resulted in direct decreases in TDG at Chelan PUD's projects (and in some cases it may have increased TDG within Chelan PUD's project if spill was shifted to either Rocky Reach or Rock Island dams in order to reduce spill at another project within the system), it was meant to help mitigate high TDG levels throughout the entire Columbia River system.

- Preemptive spill can be used to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. The spill rate could be stabilized if a project's storage was used to absorb flow fluctuations from upstream projects. Generally, a target operation of one foot from the allowed maximum at each project could be used. When flows spike high, the storage could be used to lower the need for spill; when flows drop, the storage quantities could be reestablished by maintaining spill rates. Allowing a greater amount of storage to absorb variations can be an effective method in stabilizing spill flows but it can also provide adequate time for adjusting spill to meet survival study objectives and TDG requirements.

SECTION 6: *CONCLUSIONS*

During the 2016 fish-spill season, overall combined project compliance was 96.4 percent with the 115/120 percent standard and 99.97 percent with the 125 percent standard as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD). Chelan PUD will continue to closely monitor TDG levels during the fish-spill season and implement the gas abatement measures in accordance with Ecology approved GAPs, the Rocky Reach Project 401 WQC (Ecology, 2006), and the Rocky Reach Project QAPP (Chelan PUD, 2010).

SECTION 7: *LIST OF LITERATURE*

Chelan PUD. 2006. Rocky Reach Comprehensive Settlement Agreement, Attachment B, Rocky Reach Comprehensive Plan, Chapter 2, Water Quality Management Plan. Chelan PUD, Wenatchee, WA.

Chelan PUD. 2010. Quality Assurance Project Plan Rocky Reach Water Quality Monitoring and Reporting. Chelan PUD, Wenatchee, WA.

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Fish Passage Center (FPC). 2016. Gas Bubble Trauma Monitoring Program Protocol for Juvenile Salmonids. April 2009. http://www.fpc.org/smolt/gasbubbletrauma.html.

Federal Energy Regulatory Commission (FERC). 2009. Order Issuing New License for Public Utility District No. 1 of Chelan County, 126 FERC ¶ 61,138, Washington D.C.

Washington State Department of Ecology (Ecology). 2006. Water Quality Certification for the Rocky Reach Project. Order No. 3155 dated March 17, 2006.

Washington State Department of Ecology (Ecology). 2008. Memo to Columbia and Snake River Dam Operators; RE: Method for averaging 12 consecutive daily average high TDG readings in any one day. Sent by Mr. Chris Maynard on April 2, 2008.

Washington State Department of Ecology (Ecology). 2008a. Memo to Columbia and Snake River Dam Operators; RE: Clarification of WAC 201A-200(1)(f)(ii), Measuring Total Dissolved Gas (TDG) During Fish-spill on the Columbia and Snake Rivers. Sent by Susan Braley on May 21, 2008.

APPENDIX A: 2016 TDG OPERATION PLANS

2016 Rocky Reach Operational Plan

for Total Dissolved Gas During Fish Spill Season

April 1 through August 31

(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

2016 Rock Island TDG Operational Plan

During Fish Spill Season (April 1 through 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%, reopen notched gates in the reverse order of closure**

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, **please contact Thad Mosey (661-4451, cell 670-5594) and Marcie Steinmetz (661-4186, cell (509) 280-1955) immediately** so they can determine the next steps to take.

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

APPENDIX B: FISH-SPILL MEMOS

From:	Clement, Marcie
To:	Clement, Marcie
Subject:	Start of 2016 Spring Fish Spill at the Rock Island Project - Sunday, 10 April
Date:	Thursday, January 12, 2017 12:19:26 PM
Importance:	High

From: Pwr Mgt - Chelan Environmental
Sent: Friday, April 08, 2016 2:16 PM
Subject: Start of 2016 Spring Fish Spill at the Rock Island Project - Sunday, 10 April
Importance: High

Good Afternoon, Everyone.

The purpose of this email is to notify all of you that Rock Island Dam will begin spring fish spill on **Sunday, 10 April 2016, at 00:00 hours**. The daily spill percentage will be **10% of the day average river flow forecasted for the Project**.

Similar to the last two years, the juvenile sockeye have arrived early at Rock Island. We are observing 120 to 210 sockeye daily in the RI bypass collections. The Realtime program is predicting that the passage mark for sockeye through 7 April is 3.2%. With today's collection of 209 sockeye, the predicted passage mark will be over 4% through today.

We recognize that 10 April is an early start for spring fish spill. The Rock Island project reached the 5% passage marks for sockeye early in 2014 (10 April) and 2015 (11 April). The District missed the 5% passage mark for sockeye in 2015 due to the difference between the expected total sockeye passage and the actual total passage (based on the seasonal total collection in the bypass trap). As a result of this difference, the District started spill five days too late in 2015. Given the pattern of sockeye migration over the last two years and the fact that we missed the mark last year, we want to be cautious about the start of spill this spring.

Consistent with the past 13 years, spill will be "shaped" in hourly blocks within each 24-hour day to provide slightly more spill volume during periods when juvenile salmon are passing the dam, and less volume during hours with lower fish passage. The average spill rate of all blocks will equal 10% of day average river flow.

Spring spill normally continues through the end of May at 10%. Summer fish spill will be 20% of the day average flow and usually begins the first week of June.

Please call or send an email, if you have any questions regarding Rock Island's fish spill program for 2016.

Thank you.

Thad

Thad Mosey

Chelan County PUD

(509) 670-5594

From:	Clement, Marcie
To:	Clement, Marcie
Subject:	28 May update: Start of 2016 Summer Fish Spill at Rocky Reach and Rock Island dams on 29 May at 0000 hours
Date:	Thursday, January 12, 2017 12:26:44 PM
Importance:	High

From: Pwr Mgt - Chelan Environmental
Sent: Saturday, May 28, 2016 1:08 PM
Subject: 28 May update: Start of 2016 Summer Fish Spill at Rocky Reach and Rock Island dams on 29 May at 0000 hours
Importance: High

Hello Everyone.

The hatchery subyearling Chinook have finally arrived in big numbers at Rocky Reach today, 28 May. The crew identified **489** hatchery subyearlings in today's collection at Rocky Reach. A total of 18 hatchery subyearlings were identified at Rock Island.

As a result, summer fish spill will start tomorrow, 29 May, at 0000 hours at both Rocky Reach and Rock Island dams.

I will send out the spill memos ASAP this afternoon for Sunday through Wednesday fish spill.

Thank you.

Thad

From:	Clement, Marcie
To:	Clement, Marcie
Subject:	FW: Confirmation - Rock Island Dam will end fish spill at midnight tonight, 11 August
Date:	Thursday, January 12, 2017 12:29:56 PM
Importance:	High

From: Pwr Mgt - Chelan Environmental
Sent: Thursday, August 11, 2016 10:24 AM
Subject: Confirmation - Rock Island Dam will end fish spill at midnight tonight, 11 August
Importance: High

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at Rock Island Dam tonight, 11 August, at 2400 hours (midnight).

Rock Island Operators, System Operators, and Energy Planning, please disregard the fish spill memo for 12 and 13 August.

Thank you.

Thad

From:	Clement, Marcie
To:	Clement, Marcie
Subject:	FW: Confirmation - Rocky Reach Dam will end fish spill at midnight tonight, 15 August
Date:	Thursday, January 12, 2017 12:30:46 PM

From: Pwr Mgt - Chelan Environmental
Sent: Monday, August 15, 2016 3:54 PM

Subject: Confirmation - Rocky Reach Dam will end fish spill at midnight tonight, 15 August

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at Rocky Reach Dam tonight, 15 August, at 2400 hours (midnight).

Rocky Reach Operators, System Operators, and Energy Planning, please disregard the fish spill memo for 16 August.

Thank you, again, for your patience as we faced the challenge of an unusually low subyearling Chinook salmon index count at the Rocky Reach fish sampling facility this season. With a careful approach in timing the end of spill and excellent communications with the HCP Coordinating Committee, we are confident in our decision to end spill tonight.

Thad

APPENDIX C: CALIBRATION REPORTS

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Jan-16
Arrival Time: 9:00
Departure Time: 9:50

Site:
RIGW

FMS ID	65721		65721	
Time	9:15		9:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.9	746		746
Temp ºC		4.6		4.6
TDGsat		96.4		99.2
TDG mmHg		719		740

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 19-Jan-16
BP Station: 743.9 mmHg
Time: 9:20

	Std	**Initial**	**Final**
Temperature ºC	4.11	4.2	N / C
TDG 100%	743.9	748	744
TDG 113%	843.9	846	845
TDG 126%	943.9	946	945
TDG 139%	1043.9	1046	1044
Depth m	N/A		

Comments: 938

Report created January 31, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Jan-16
Arrival Time: 10:35
Departure Time: 11:15

Site:
RIS

FMS ID	65719		65719	
Time	10:45		11:10	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.8	745		744
Temp ºC		4.6		4.6
TDGsat		96.2		100.1
TDG mmHg		717		745

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 19-Jan-16
BP Station: 742.9 mmHg
Time: 10:50

	Std	**Initial**	**Final**
Temperature ºC	4.32	4.5	N / C
TDG 100%	742.9	743	N / C
TDG 113%	842.9	844	N / C
TDG 126%	942.9	944	N / C
TDG 139%	1042.9	1044	N / C
Depth m	N/A		

Comments: 929

Report created January 31, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Jan-16
Arrival Time: 16:00
Departure Time: 12:35

Site:
RRDW

FMS ID	65718		65718	
Time	12:10		12:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.3	738		737
Temp ºC		4.7		4.7
TDGsat		97.3		104.3
TDG mmHg		718		769

Comments: TDG = 739 mmHg @ 13:00

Calibration Type: Field
Probe ID: 65718
Date: 19-Jan-16
BP Station: 740.1 mmHg
Time: 12:15

	Std	**Initial**	**Final**
Temperature ºC	4.45	4.6	N / C
TDG 100%	740.1	740	N / C
TDG 113%	840.1	841	N / C
TDG 126%	940.1	941	N / C
TDG 139%	1040.1	1041	N / C
Depth m	N/A		

Comments: 911

Report created January 31, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 19-Jan-16
Arrival Time: 12:35
Departure Time: 13:20

Site:
RRH

FMS ID	65720		65720	
Time	12:40		13:15	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	737.2	737		737
Temp ºC		4.6		4.6
TDGsat		96.5		97.4
TDG mmHg		711		718

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 19-Jan-16
Time: 12:45
BP Station: 737.4 mmHg

	Std	**Initial**	**Final**
Temperature ºC	4.30	4.4	N / C
TDG 100%	737.4	736	N / C
TDG 113%	837.4	836	N / C
TDG 126%	937.4	937	N / C
TDG 139%	1037.4	1037	N / C
Depth m	N/A		

Comments: 939

Report created January 31, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Mar-16
Arrival Time: 9:45
Departure Time: 10:30

Site:
RRDW

FMS ID	65718		65718	
Time	9:55		10:25	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	744.3	740	744.3	740
Temp ºC		4.4		4.4
TDGsat		101.1		103.6
TDG mmHg		748		767

Comments: TDG = 756 mmHg @ 11:00.

Calibration Type: Field
Probe ID: 65718
Date: 01-Mar-16
Time: 10:00
BP Station: 744.3 mmHg

	Std	Initial	Final
Temperature ºC	4.17	4.3	N / C
TDG 100%	744.3	742	744
TDG 113%	844.3	842	844
TDG 126%	944.3	942	944
TDG 139%	1044.3	1042	1044
Depth m	N/A		

Comments: 967; New TDG membrane.

Report created April 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Mar-16
Arrival Time: 10:35
Departure Time: 11:15

Site:
RRH

FMS ID	65720		65720	
Time	10:40		11:10	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	739.8	740	739.9	739
Temp ºC		4.4		4.3
TDGsat		100.4		102.6
TDG mmHg		743		758

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 01-Mar-16
Time: 10:45
BP Station: 739.8 mmHg

	Std	Initial	Final
Temperature ºC	4.27	4.4	N / C
TDG 100%	739.8	738	740
TDG 113%	839.8	838	840
TDG 126%	939.8	938	940
TDG 139%	1039.8	1038	1040
Depth m	N/A		

Comments: 964; New TDG membrane.

Report created April 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Mar-16
Arrival Time: 11:45
Departure Time: 12:35

Site:
RIS

FMS ID	65719		65719	
Time	12:05		12:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	741.7	744	741.6	744
Temp ºC		4.4		4.4
TDGsat		100.4		103.4
TDG mmHg		747		769

Comments: TDG = 751 mmHg @ 13:00.

Calibration Type: Field
Probe ID: 65719
Date: 01-Mar-16
Time: 12:10
BP Station: 741.6 mmHg

	Std	Initial	Final
Temperature ºC	4.27	4.4	N / C
TDG 100%	741.6	742	N / C
TDG 113%	841.6	842	N / C
TDG 126%	941.6	942	N / C
TDG 139%	1041.6	1042	N / C
Depth m	N/A		

Comments: 941; New TDG membrane.

Report created April 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Mar-16
Arrival Time: 12:50
Departure Time: 13:55

Site:
RIGW

FMS ID	65721		65721	
Time	13:00		13:40	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.0	743	741.5	742
Temp ºC		4.4		4.4
TDGsat		100.5		103.5
TDG mmHg		747		768

Comments: TDG = 747 mmHg @ 14:00.

Calibration Type: Field
Date: 01-Mar-16
Time: 13:05

Probe ID: 65721
BP Station: 742 mmHg

	Std	Initial	Final
Temperature ºC	4.37	4.5	N / C
TDG 100%	742.0	741	742
TDG 113%	842	841	842
TDG 126%	942	941	942
TDG 139%	1042	1040	1042
Depth m	N/A		

Comments: 948; New TDG membrane.

Report created April 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Apr-16
Arrival Time: 8:30
Departure Time: 9:30

Site: RRDW

FMS ID	65718		65718	
Time	8:55		9:25	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	754.5	752	754.6	752
Temp ºC		7.5		7.5
TDGsat		104.3		106.5
TDG mmHg		784		801

Comments: TDG = 786 mmHg @ 10:00

Calibration Type: Field
Probe ID: 65718
Date: 05-Apr-16
Time: 9:00
BP Station: 754.6 mmHg

	Std	Initial	Final
Temperature ºC	7.69	7.8	N / C
TDG 100%	754.6	757	755
TDG 113%	854.6	856	855
TDG 126%	954.6	957	955
TDG 139%	1054.6	1056	1055
Depth m	N/A		

Comments: 957; New TDG membrane.

Report created April 28, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Apr-16
Arrival Time: 9:35
Departure Time: 10:10

Site: RRH

FMS ID	65720		65720	
Time	9:40		10:05	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	752.6	752	752.8	752
Temp ºC		7.5		7.5
TDGsat		103.6		104.8
TDG mmHg		779		788

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 05-Apr-16
Time: 9:45
BP Station: 752.7 mmHg

	Std	Initial	Final
Temperature ºC	7.96	8.1	N / C
TDG 100%	752.7	754	N / C
TDG 113%	852.7	854	N / C
TDG 126%	952.7	954	N / C
TDG 139%	1052.7	1054	N / C
Depth m	N/A		

Comments: 959; New TDG membrane.

Report created April 28, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Apr-16
Arrival Time: 11:10
Departure Time: 11:50

Site:
RIS

FMS ID	65719		65719	
Time	11:15		11:45	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	755.9	758	756.0	758
Temp ºC		7.6		7.6
TDGsat		104.2		105.8
TDG mmHg		790		802

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 05-Apr-16
BP Station: 756 mmHg
Time: 11:20

	Std	Initial	Final
Temperature ºC	10.13	10.3	N / C
TDG 100%	756.0	757	N / C
TDG 113%	856	857	N / C
TDG 126%	956	957	N / C
TDG 139%	1056	1056	N / C
Depth m	N/A		

Comments: 954; New TDG membrane.

Report created April 28, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Apr-16
Arrival Time: 12:15
Departure Time: 14:10

Site: RIGW

FMS ID	65721		65721	
Time	12:20		12:55	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	757.0	758	757.3	758
Temp ºC		7.5		7.5
TDGsat		104.4		106.9
TDG mmHg		791		810

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 05-Apr-16
BP Station: 757 mmHg
Time: 12:25

	Std	Initial	Final
Temperature ºC	10.69	10.8	N / C
TDG 100%	757.0	759	757
TDG 113%	857	859	857
TDG 126%	957	960	957
TDG 139%	1057	1060	1057
Depth m	N/A		

Comments: 967; New TDG membrane.

Report created April 28, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-16
Arrival Time: 9:35
Departure Time: 10:45

Site:
RRDW

FMS ID	65718		65718	
Time	10:05		10:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	744.7	742	744.7	742
Temp ºC		11.1		11.2
TDGsat		110.8		112.0
TDG mmHg		822		831

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 03-May-16
BP Station: 744.9 mmHg
Time: 10:25

	Std	Initial	Final
Temperature ºC	12.64	12.8	N / C
TDG 100%	744.9	746	745
TDG 113%	844.9	846	845
TDG 126%	944.9	946	945
TDG 139%	1044.9	1047	1045
Depth m	N/A		

Comments: 974

Report created May 30, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-16
Arrival Time: 10:50
Departure Time: 11:30

Site:
RRH

FMS ID	65720		65720	
Time	10:55		11:25	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	742.8	742	742.6	742
Temp ºC		11.2		11.2
TDGsat		109.7		111.5
TDG mmHg		814		827

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 03-May-16
BP Station: 742.6 mmHg
Time: 11:05

	Std	Initial	Final
Temperature ºC	13.46	13.6	N / C
TDG 100%	742.6	742	743
TDG 113%	842.6	843	843
TDG 126%	942.6	943	943
TDG 139%	1042.6	1044	1043
Depth m	N/A		

Comments: 976

Report created May 30, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-16
Arrival Time: 12:00
Departure Time: 12:45

Site:
RIS

FMS ID	65719		65719	
Time	12:05		12:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	744.8	746	744.7	746
Temp ºC		11.2		11.2
TDGsat		108.6		110.7
TDG mmHg		810		826

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 03-May-16
BP Station: 744.8 mmHg
Time: 12:10

	Std	Initial	Final
Temperature ºC	12.08	12.2	N / C
TDG 100%	744.8	745	745
TDG 113%	844.8	845	845
TDG 126%	944.8	946	945
TDG 139%	1044.8	1046	1045
Depth m	N/A		

Comments: 956

Report created May 30, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-May-16
Arrival Time: 13:05
Departure Time: 13:45

Site:
RIGW

FMS ID	65721		65721	
Time	13:10		13:35	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	745.4	746	745.2	745
Temp ºC		11.1		11.1
TDGsat		112.2		114.2
TDG mmHg		837		851

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 03-May-16
BP Station: 745.4 mmHg
Time: 13:15

	Std	Initial	Final
Temperature ºC	12.08	12.2	N / C
TDG 100%	745.4	746	745
TDG 113%	845.4	846	845
TDG 126%	945.4	946	945
TDG 139%	1045.4	1045	1045
Depth m	N/A		

Comments: 957

Report created May 30, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Jun-16
Arrival Time: 8:30
Departure Time: 9:10

Site:
RRDW

FMS ID	65718		65718	
Time	8:45		9:00	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	741.3	738	741.4	738
Temp ºC		14.2		14.2
TDGsat		114.9		115.9
TDG mmHg		848		855

Comments: Recycled power to reinitialize radio comm

Calibration Type: Field
Probe ID: 65718
Date: 01-Jun-16
Time: 8:50
BP Station: 741.4 mmHg

	Std	Initial	Final
Temperature ºC	14.70	14.8	N / C
TDG 100%	741.4	741	N / C
TDG 113%	841.4	842	N / C
TDG 126%	941.4	942	N / C
TDG 139%	1041.4	1042	N / C
Depth m	N/A		

Comments: 960

Report created June 25, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Jun-16
Arrival Time: 9:15
Departure Time: 9:55

Site:
RRH

FMS ID	65720		65720	
Time	9:25		9:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.6	738	739.5	738
Temp ºC		14.2		14.2
TDGsat		108.7		108.9
TDG mmHg		802		804

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 01-Jun-16
BP Station: 739.6 mmHg
Time: 9:30

	Std	Initial	Final
Temperature ºC	15.29	15.4	N / C
TDG 100%	739.6	742	740
TDG 113%	839.6	841	840
TDG 126%	939.6	941	940
TDG 139%	1039.6	1040	1040
Depth m	N/A		

Comments: 960

Report created June 25, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Jun-16
Arrival Time: 10:30
Departure Time: 11:00

Site:
RIS

FMS ID	65719		65719	
Time	10:35		10:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	741.6	743	741.5	743
Temp ºC		14.3		14.3
TDGsat		109.2		110.5
TDG mmHg		811		821

Comments: Recycled power to reinitialize radio comm

Calibration Type: Field
Probe ID: 65719
Date: 01-Jun-16
Time: 10:40
BP Station: 741.5 mmHg

	Std	Initial	Final
Temperature ºC	15.27	15.4	N / C
TDG 100%	741.5	741	N / C
TDG 113%	841.5	841	N / C
TDG 126%	941.5	941	N / C
TDG 139%	1041.5	1041	N / C
Depth m	N/A		

Comments: 964

Report created June 25, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 01-Jun-16
Arrival Time: 11:20
Departure Time: 12:05

Site:
RIGW

FMS ID	65721		65721	
Time	11:30		11:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.4	742	742.1	742
Temp ºC		14.3		14.3
TDGsat		114.0		115.0
TDG mmHg		846		853

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 01-Jun-16
BP Station: 742.3 mmHg
Time: 11:35

	Std	Initial	Final
Temperature ºC	15.38	15.5	N / C
TDG 100%	742.3	742	N / C
TDG 113%	842.3	842	N / C
TDG 126%	942.3	942	N / C
TDG 139%	1042.3	1042	N / C
Depth m	N/A		

Comments: 949

Report created June 25, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-16
Arrival Time: 10:10
Departure Time: 10:45

Site:
RRDW

FMS ID	65718		65718	
Time	10:25		10:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	741.0	739	741.1	738
Temp ºC		16.9		16.9
TDGsat		113.1		115.0
TDG mmHg		836		849

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 07-Jul-16
BP Station: 741 mmHg
Time: 10:30

	Std	Initial	Final
Temperature ºC	17.15	17.3	N / C
TDG 100%	741.0	741	N / C
TDG 113%	841	842	N / C
TDG 126%	941	942	N / C
TDG 139%	1041	1041	N / C
Depth m	N/A		

Comments: 964

Report created August 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-16
Arrival Time: 10:50
Departure Time: 11:25

Site:
RRH

FMS ID	65720		65720	
Time	10:55		11:20	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.3	738	739.3	738
Temp ºC		16.9		16.8
TDGsat		107.2		106.8
TDG mmHg		791		788

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 07-Jul-16
BP Station: 739.3 mmHg
Time: 11:05

	Std	Initial	Final
Temperature ºC	17.61	17.7	N / C
TDG 100%	739.3	740	N / C
TDG 113%	839.3	840	N / C
TDG 126%	939.3	940	N / C
TDG 139%	1039.3	1040	N / C
Depth m	N/A		

Comments: 966

Report created August 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-16
Arrival Time: 12:00
Departure Time: 12:35

Site:
RIS

FMS ID	65719		65719	
Time	12:05		12:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	741.7	743	741.6	743
Temp ºC		17.1		17.1
TDGsat		108.1		109.2
TDG mmHg		803		811

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 07-Jul-16
Time: 12:15
BP Station: 741.7 mmHg

	Std	Initial	Final
Temperature ºC	17.75	17.9	N / C
TDG 100%	741.7	741	N / C
TDG 113%	841.7	842	N / C
TDG 126%	941.7	942	N / C
TDG 139%	1041.7	1041	N / C
Depth m	N/A		

Comments: 946

Report created August 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 07-Jul-16
Arrival Time: 13:10
Departure Time: 13:50

Site:
RIGW

FMS ID	65721		65721	
Time	13:15		13:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.5	743	742.3	743
Temp ºC		17.1		17.1
TDGsat		113.6		115.2
TDG mmHg		844		856

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 07-Jul-16
BP Station: 742.5 mmHg
Time: 13:25

	Std	Initial	Final
Temperature ºC	17.85	18.0	N / C
TDG 100%	742.5	742	N / C
TDG 113%	842.5	842	N / C
TDG 126%	942.5	942	N / C
TDG 139%	1042.5	1042	N / C
Depth m	N/A		

Comments: 946

Report created August 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-Aug-16
Arrival Time: 8:00
Departure Time: 8:45

Site:
RRDW

FMS ID	65718		65718	
Time	8:15		8:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	747.8	745	747.9	745
Temp ºC		19.1		19.1
TDGsat		109.9		111.8
TDG mmHg		819		833

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 03-Aug-16
Time: 8:20
BP Station: 747.9 mmHg

	Std	Initial	Final
Temperature ºC	19.09	19.2	N / C
TDG 100%	747.9	748	N / C
TDG 113%	847.9	848	N / C
TDG 126%	947.9	948	N / C
TDG 139%	1047.9	1048	N / C
Depth m	N/A		

Comments:

Report created August 22, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-Aug-16
Arrival Time: 8:50
Departure Time: 9:20

Site:
RRH

FMS ID	65720		65720	
Time	8:55		9:20	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	746.2	745	746.2	745
Temp ºC		19.1		19.1
TDGsat		105.0		104.4
TDG mmHg		782		778

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 03-Aug-16
Time: 9:00
BP Station: 746.3 mmHg

	Std	Initial	Final
Temperature ºC	19.21	19.3	N / C
TDG 100%	746.3	746	N / C
TDG 113%	846.3	846	N / C
TDG 126%	946.3	946	N / C
TDG 139%	1046.3	1046	N / C
Depth m	N/A		

Comments: 963

Report created August 22, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Aug-16
Arrival Time: 10:10
Departure Time: 10:45

Site:
RIS

FMS ID	65719		65719	
Time	10:15		10:40	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.7	750	748.7	750
Temp ºC		19.1		19.1
TDGsat		104.8		106.4
TDG mmHg		786		798

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 03-Aug-16
BP Station: 748.7 mmHg
Time: 10:25

	Std	**Initial**	**Final**
Temperature ºC	18.92	19.1	N / C
TDG 100%	748.7	749	N / C
TDG 113%	848.7	849	N / C
TDG 126%	948.7	949	N / C
TDG 139%	1048.7	1049	N / C
Depth m	N/A		

Comments: 968

Report created August 22, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 03-Aug-16
Arrival Time: 11:10
Departure Time: 12:15

Site:
RIGW

FMS ID	65721		65721	
Time	11:25		12:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	749.7	750	749.6	750
Temp ºC		19.1		19.1
TDGsat		112.0		114.3
TDG mmHg		840		857

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 03-Aug-16
BP Station: 749.8 mmHg
Time: 11:30

	Std	Initial	Final
Temperature ºC	20.28	20.4	N / C
TDG 100%	749.8	749	N / C
TDG 113%	849.8	849	N / C
TDG 126%	949.8	949	N / C
TDG 139%	1049.8	1049	N / C
Depth m	N/A		

Comments: 950

Report created August 22, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 06-Sep-16
Arrival Time: 10:00
Departure Time: 11:05

Site:
RIGW

FMS ID	65721		65721	
Time	10:15		10:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.4	744	743.4	744
Temp ºC		18.4		18.4
TDGsat		101.6		104.8
TDG mmHg		756		780

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 06-Sep-16
BP Station: 743.4 mmHg
Time: 10:20

	Std	**Initial**	**Final**
Temperature ºC	18.13	18.3	N / C
TDG 100%	743.4	743	N / C
TDG 113%	843.4	843	N / C
TDG 126%	943.4	942	N / C
TDG 139%	1043.4	1042	N / C
Depth m	N/A		

Comments: 967

Report created October 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 06-Sep-16
Arrival Time: 11:30
Departure Time: 12:05

Site:
RIS

FMS ID	65719		65719	
Time	11:40		12:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.3	744	742.5	743
Temp ºC		18.4		18.4
TDGsat		101.6		103.5
TDG mmHg		756		769

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 06-Sep-16
Time: 11:45
BP Station: 742.4 mmHg

	Std	Initial	Final
Temperature ºC	18.52	18.7	N / C
TDG 100%	742.4	742	N / C
TDG 113%	842.4	842	N / C
TDG 126%	942.4	942	N / C
TDG 139%	1042.4	1042	N / C
Depth m	N/A		

Comments: 951

Report created October 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 06-Sep-16
Arrival Time: 13:50
Departure Time: 14:25

Site:
RRH

FMS ID	65720		65720	
Time	13:55		14:20	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	738.7	738	738.7	738
Temp ºC		18.3		18.3
TDGsat		102.3		103.9
TDG mmHg		755		767

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 06-Sep-16
BP Station: 738.7 mmHg
Time: 14:00

	Std	Initial	Final
Temperature ºC	19.01	19.1	N / C
TDG 100%	738.7	739	N / C
TDG 113%	838.7	839	N / C
TDG 126%	938.7	939	N / C
TDG 139%	1038.7	1039	N / C
Depth m	N/A		

Comments: 963

Report created October 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 06-Sep-16
Arrival Time: 14:35
Departure Time: 15:10

Site:
RRDW

FMS ID	65718		65718	
Time	14:40		15:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.4	738	740.3	737
Temp ºC		18.3		18.3
TDGsat		101.8		103.8
TDG mmHg		751		765

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 06-Sep-16
BP Station: 740.4 mmHg
Time: 14:45

	Std	Initial	Final
Temperature ºC	18.51	18.6	N / C
TDG 100%	740.4	740	N / C
TDG 113%	840.4	840	N / C
TDG 126%	940.4	940	N / C
TDG 139%	1040.4	1040	N / C
Depth m	N/A		

Comments: 970

Report created October 02, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-Oct-16
Arrival Time: 9:10
Departure Time: 10:55

Site:
RIGW

FMS ID	65721		65721	
Time	9:25		10:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	751.9	753	751.4	752
Temp ºC		16.6		16.6
TDGsat		97.2		100.9
TDG mmHg		732		759

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 12-Oct-16
BP Station: 751.9 mmHg
Time: 9:30

	Std	Initial	Final
Temperature ºC	14.74	14.9	N / C
TDG 100%	751.9	749	752
TDG 113%	851.9	849	852
TDG 126%	951.9	949	952
TDG 139%	1051.9	1049	1052
Depth m	N/A		

Comments: 890

Report created November 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-Oct-16
Arrival Time: 11:20
Departure Time: 11:55

Site:
RIS

FMS ID	65719		65719	
Time	11:30		11:50	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	749.9	752	749.5	751
Temp ºC		16.5		16.5
TDGsat		96.8		99.3
TDG mmHg		728		746

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 12-Oct-16
BP Station: 749.8 mmHg
Time: 11:35

	Std	Initial	Final
Temperature ºC	15.66	15.8	N / C
TDG 100%	749.8	750	N / C
TDG 113%	849.8	850	N / C
TDG 126%	949.8	950	N / C
TDG 139%	1049.8	1050	N / C
Depth m	N/A		

Comments: 964

Report created November 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-Oct-16
Arrival Time: 12:50
Departure Time: 13:30

Site:
RRDW

FMS ID	65718		65718	
Time	13:00		13:25	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	748.0	745	747.8	745
Temp ºC		16.8		16.8
TDGsat		97.9		99.9
TDG mmHg		729		744

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 12-Oct-16
BP Station: 748 mmHg
Time: 13:05

	Std	Initial	Final
Temperature ºC	16.43	16.5	N / C
TDG 100%	748.0	748	N / C
TDG 113%	848	848	N / C
TDG 126%	948	948	N / C
TDG 139%	1048	1048	N / C
Depth m	N/A		

Comments: 973

Report created November 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-Oct-16
Arrival Time: 13:35
Departure Time: 14:05

Site:
RRH

FMS ID	65720		65720	
Time	13:40		14:00	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	745.6	745	745.1	745
Temp ºC		16.8		16.8
TDGsat		97.3		97.9
TDG mmHg		725		729

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 12-Oct-16
Time: 13:45
BP Station: 745.5 mmHg

	Std	Initial	Final
Temperature ºC	16.56	16.7	N / C
TDG 100%	745.5	746	N / C
TDG 113%	845.5	846	N / C
TDG 126%	945.5	946	N / C
TDG 139%	1045.5	1046	N / C
Depth m	N/A		

Comments: 973

Report created November 01, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 14-Nov-16
Arrival Time: 13:10
Departure Time: 14:35

Site:
RIGW

FMS ID	65721		65721	
Time	13:15		14:15	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m			4.2	
BP mmHg	746.1	747	746.2	747
Temp ºC		13.6	13.3	13.6
TDGsat		102.0	98.0	98.4
TDG mmHg		762	731	735

Comments: TDG values reading low upon arrival. Membrane passed test. Calibrated probe and replaced membrane.

Calibration Type: Field
Probe ID: 65721
Date: 14-Nov-16
BP Station: 746.2 mmHg
Time: 13:25

	Std	Initial	Final
Temperature ºC	13.75	13.9	N / C
TDG 100%	746.2	747	N / C
TDG 113%	846.2	847	N / C
TDG 126%	946.2	947	N / C
TDG 139%	1046.2	1047	N / C
Depth m	N/A		

Comments: 978

Report created December 07, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Dec-16
Arrival Time: 8:45
Departure Time: 9:35

Site:
RRDW

FMS ID	65718		65718	
Time	9:00		9:30	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	747.1	745	747.0	745
Temp ºC		10.3		10.3
TDGsat		96.1		98.1
TDG mmHg		716		731

Comments:

Calibration Type: Field
Date: 05-Dec-16
Time: 9:10

Probe ID: 65718
BP Station: 747 mmHg

	Std	Initial	Final
Temperature ºC	9.06	9.2	N / C
TDG 100%	747.0	747	N / C
TDG 113%	847	847	N / C
TDG 126%	947	947	N / C
TDG 139%	1047	1047	N / C
Depth m	N/A		

Comments: 973

Report created December 07, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Dec-16
Arrival Time: 9:45
Departure Time: 10:35

Site:
RRH

FMS ID	65720		65720	
Time	9:55		10:30	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	745.3	744	745.3	745
Temp ºC		10.3		10.2
TDGsat		95.8		97.6
TDG mmHg		713		727

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 05-Dec-16
BP Station: 745.3 mmHg
Time: 10:00

	Std	Initial	Final
Temperature ºC	9.19	9.3	N / C
TDG 100%	745.3	746	N / C
TDG 113%	845.3	846	N / C
TDG 126%	945.3	946	N / C
TDG 139%	1045.3	1046	N / C
Depth m	N/A		

Comments: 974

Report created December 07, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Dec-16
Arrival Time: 12:05
Departure Time: 13:00

Site:
RIGW

FMS ID	65721		65721	
Time	12:15		12:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.4	750	748.1	750
Temp ºC		10.1		10.1
TDGsat		95.7		97.5
TDG mmHg		718		731

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 05-Dec-16
BP Station: 748.4 mmHg
Time: 12:20

	Std	Initial	Final
Temperature ºC	8.20	8.3	N / C
TDG 100%	748.4	748	N / C
TDG 113%	848.4	848	N / C
TDG 126%	948.4	948	N / C
TDG 139%	1048.4	1048	N / C
Depth m	N/A		

Comments: 983; NewTDG membrane.

Report created December 07, 2016

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 05-Dec-16
Arrival Time: 13:50
Departure Time: 14:30

Site:
RIS

FMS ID	65719		65719	
Time	14:00		14:25	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	746.8	749	746.7	749
Temp ºC		10.1		10.1
TDGsat		95.6		97.6
TDG mmHg		716		731

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 05-Dec-16
BP Station: 746.8 mmHg
Time: 14:05

	Std	Initial	Final
Temperature ºC	8.61	8.8	N / C
TDG 100%	746.8	747	N / C
TDG 113%	846.8	847	N / C
TDG 126%	946.8	947	N / C
TDG 139%	1046.8	1047	N / C
Depth m	N/A		

Comments: 954

Report created December 07, 2016

APPENDIX D: 2016 DATA LOSSES

2016 Hours of Data losses at Rocky Reach and Rock Island Dams during the fish-spill season

Date	Rocky Reach			Rock Island		
	Forebay	Tailrace	Reason	Forebay	Tailrace	Reason
8/09/2016				1		Site maintenance - SCADA
Total	**0**	**0**		**1**	**0**	

Notes:
Calibration = probe is taken off line while calibration occurs
Communication error = probe not communicating/downloading data
Server patch = Upgrades to the server
Site maintenance = while Chelan PUD was upgrading the carriage that holds the probe, it was disconnected
System Control and Data Acquisition (SCADA) server down = Chelan PUD's data server was down

APPENDIX E: 2016 DATA

Hourly Total Dissolved gas readings during the 2016 fish-spill season

Notes:
Font = Exceedances of the water quality TDG numeric critera are in bold red. Note, all exceedances in the Rocky Reach Forebay are for the upstream Wells Dam Project. TDG is rounded to the nearest number: 115.2 is rounded to 115, therefore not in exceedance)
121.2 (119.6) = Instances of "double counting", value in parentheses represents the TDG value used to eliminate "double counting"
110.8 = Not counted toward exceedances because RR FB > 115 (for RI FB) or RI FB > 115 (for Wanapum FB).

2016	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
1-Apr	104.4	104.0	104.6	105.0	104.5	105.1	104.1	103.8	104.5	104.0	103.8	104.6	103.2	103.2	0.0	0.0	110.1	116.6	0.0	0.0	0.00	0.00	0.00	0.00
2-Apr	105.7	105.1	106.1	105.5	105.3	105.6	104.9	104.4	105.0	104.8	104.5	105.0	103.2	103.2	0.0	0.0	80.0	91.3	0.0	0.0	0.00	0.00	0.00	0.00
3-Apr	105.8	105.5	106.0	106.2	105.6	106.4	105.4	105.1	105.6	105.4	105.1	105.7	103.2	103.2	0.0	0.1	93.2	103.0	0.0	0.0	0.00	0.00	0.00	0.00
4-Apr	105.9	105.2	105.8	106.3	105.7	107.0	105.4	104.4	105.6	105.5	104.6	105.8	104.8	105.2	0.5	0.0	115.6	127.4	0.4	0.0	0.50	0.00	0.00	0.00
5-Apr	104.8	103.6	104.3	106.6	104.9	111.2	104.1	103.4	105.9	104.2	102.0	104.4	104.7	104.3	1.3	0.4	129.6	143.6	0.9	0.3	1.32	0.00	0.41	0.00
6-Apr	104.8	104.2	104.9	105.1	104.8	106.3	104.3	103.6	104.7	104.2	103.6	104.8	104.7	105.3	0.2	0.7	132.9	144.3	0.2	0.5	0.23	0.00	0.72	0.00
7-Apr	105.7	105.1	106.0	105.9	105.4	106.2	105.3	104.7	105.7	105.1	104.6	105.6	107.2	109.5	0.0	0.1	113.3	127.0	0.0	0.0	0.00	0.00	0.00	0.00
8-Apr	106.8	106.4	107.1	107.0	106.4	107.2	106.6	105.9	107.0	106.3	105.8	106.9	111.2	113.8	0.0	0.0	94.8	105.9	0.0	0.0	0.00	0.00	0.00	0.00
9-Apr	107.2	107.0	107.5	107.3	107.1	107.6	106.8	106.4	106.9	106.7	106.4	107.1	111.3	110.9	0.0	0.4	103.2	117.3	0.0	0.3	0.00	0.00	0.36	0.00
10-Apr	107.2	106.6	107.3	107.3	106.9	107.4	106.6	105.8	106.5	108.5	108.4	111.4	109.8	110.2	0.0	14.6	121.9	135.1	0.0	11.6	0.00	0.00	1.01	13.66
11-Apr	107.1	106.9	107.3	107.4	107.2	107.6	106.4	105.8	106.6	108.4	107.8	108.8	109.0	107.9	0.0	15.4	134.9	149.3	0.0	10.2	0.00	0.00	0.66	14.69
12-Apr	107.2	106.9	107.3	107.5	107.1	107.5	106.4	105.8	106.2	108.9	108.4	109.7	107.5	107.3	0.0	22.9	141.6	161.7	0.0	13.9	0.00	0.00	0.22	16.80
13-Apr	107.7	107.3	108.0	115.4	112.5	117.3	108.5	107.1	109.8	111.5	110.2	113.3	106.6	106.6	15.2	22.5	157.8	168.2	9.1	13.3	15.17	0.00	4.36	18.12
14-Apr	109.0	108.5	109.2	117.6	115.8	119.0	109.9	109.2	110.3	114.8	114.1	115.9	106.6	106.6	25.0	35.5	178.6	186.9	13.4	18.8	24.98	0.00	16.87	18.64
15-Apr	109.2	108.9	109.4	118.4	118.1	119.1	111.1	110.1	112.2	115.5	114.9	116.1	110.4	111.0	30.8	39.3	187.1	193.4	16.4	20.3	30.79	0.00	21.29	17.98
16-Apr	110.6	110.4	110.8	**120.7**	119.5	121.2	113.4	111.8	114.1	117.2	116.3	117.9	112.5	113.7	38.3	43.8	195.3	198.7	19.3	21.8	38.34	0.00	25.59	18.20
17-Apr	112.4	112.0	112.8	**122.5**	121.7	123.9	115.3	113.5	115.8	119.7	118.0	120.9	**115.6**	116.7	53.0	55.4	205.9	208.5	25.6	26.5	52.99	0.00	37.60	17.83
18-Apr	**116.3**	114.6	117.0	**122.6**	121.9	123.4	116.1	115.3	117.3	120.0	119.3	121.6	**118.5**	120.3	36.2	43.3	191.6	196.5	18.6	21.9	36.11	0.00	25.68	17.52
19-Apr	**117.4**	115.9	117.8	**122.3**	121.2	123.1	117.4	116.5	118.3	120.1	119.2	120.5	**120.5**	122.5	26.9	32.8	180.3	186.0	14.8	17.6	26.95	0.00	14.60	18.28
20-Apr	114.0	112.5	113.6	**121.0**	117.8	121.8	116.9 (114.0)	113.4	115.4	119.7	116.9	118.5	**121.6**	122.6	19.2	36.9	173.1	185.0	10.1	19.5	19.13	0.00	18.10	18.72
21-Apr	113.4	112.4	113.7	**121.8**	117.8	122.6	113.9	112.2	115.7	120.2	117.1	122.8	**121.6**	120.6	28.1	45.3	182.6	193.3	13.5	22.4	28.33	0.00	29.94	15.40
22-Apr	114.5	112.9	115.0	**123.1**	122.7	123.5	114.6	113.9	115.2	**122.1**	121.6	122.9	**118.8**	118.5	52.4	73.7	210.0	221.2	24.9	33.3	52.43	0.00	55.45	17.95
23-Apr	**116.5**	115.6	117.2	**123.4**	120.4	123.7	114.7	114.5	114.8	**121.7**	118.4	121.0	**115.5**	114.7	26.3	40.4	172.1	186.9	13.4	20.5	26.31	0.00	23.07	17.36
24-Apr	114.6	111.4	113.6	**122.8**	117.9	122.8	114.5	112.5	114.7	119.7	117.9	122.1	114.6	115.1	29.5	52.7	181.2	193.9	14.9	26.9	29.52	0.00	34.49	18.16
25-Apr	110.9	110.4	111.7	**120.8**	115.3	120.9	112.1	110.5	112.2	116.8	115.6	117.7	113.5	113.8	14.9	41.5	171.3	183.7	8.4	22.4	14.95	0.00	22.14	19.32
26-Apr	112.4	111.6	113.1	116.4	115.6	117.3	111.0	110.6	111.9	115.5	115.1	116.3	113.8	114.7	13.9	37.6	170.9	181.2	8.0	20.7	13.92	0.00	18.30	19.32
27-Apr	113.3	113.1	113.7	118.2	117.6	119.2	112.7	112.3	113.0	116.6	116.3	117.2	113.8	114.5	19.8	36.2	176.6	184.5	11.1	19.6	19.85	0.00	18.01	18.15
28-Apr	112.8	112.4	112.8	118.8	118.6	120.1	113.0	112.5	114.0	116.9	116.7	117.3	114.9	116.6	23.7	35.9	181.0	187.7	13.0	19.1	23.74	0.00	20.26	15.65
29-Apr	113.9	113.2	114.3	118.4	114.6	119.4	112.9	112.1	112.6	116.9	114.7	116.1	114.7	114.1	3.5	18.6	155.8	166.6	2.1	11.1	3.49	0.00	3.32	15.29
30-Apr	112.8	108.9	110.3	112.8	109.2	110.6	111.9	108.3	111.1	114.2	111.1	114.6	113.3	114.4	0.0	15.3	134.3	145.4	0.0	10.5	0.00	0.00	0.00	15.27
1-May	109.0	108.5	109.4	111.0	109.6	113.4	108.2	107.6	108.5	110.8	110.5	112.3	113.8	115.3	3.2	18.8	151.6	162.1	1.9	11.6	3.20	0.00	0.00	16.90
2-May	110.8	110.0	111.3	115.7	113.2	116.9	110.7	109.5	112.0	113.9	112.8	114.8	113.6	114.3	8.1	23.7	161.6	171.1	4.7	13.8	8.10	0.00	6.50	17.25
3-May	110.9	110.3	111.4	114.1	112.1	115.8	111.2	109.5	112.4	114.2	111.3	114.5	113.6	116.3	6.5	18.6	147.3	159.5	4.1	11.6	6.49	0.00	2.11	16.54

2016	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
4-May	110.9	110.1	110.5	115.0	112.8	120.3	110.0	109.4	110.4	114.9	113.5	120.1	113.3	113.8	12.5	20.2	142.1	155.9	7.6	13.6	12.53	0.00	3.47	16.80
5-May	110.3	109.4	110.0	118.6	115.7	120.4	111.2	110.1	112.0	114.4	114.1	116.9	112.5	111.7	21.3	27.9	157.9	171.7	12.2	16.1	21.34	0.00	10.58	17.37
6-May	110.1	109.4	110.9	119.1	111.1	117.9	110.6	109.4	111.2	114.5	112.6	115.6	111.3	111.7	2.7	20.7	147.9	165.0	1.8	12.4	2.71	0.00	3.04	17.68
7-May	111.2	111.1	111.4	111.3	110.8	111.2	110.4	109.7	111.1	112.6	112.3	113.5	114.0	115.2	0.0	16.7	139.9	157.1	0.0	10.5	0.00	0.00	0.14	16.59
8-May	111.4	110.7	111.6	111.1	110.8	112.2	110.4	108.8	109.5	112.8	111.5	113.0	113.9	112.5	1.8	15.6	124.1	142.2	1.3	11.0	1.81	0.00	0.31	15.29
9-May	110.1	108.0	109.2	113.6	110.2	118.9	108.7	107.6	110.6	111.5	110.7	112.6	108.8	108.3	7.4	18.2	133.8	150.8	5.0	12.1	7.37	0.00	0.00	18.18
10-May	109.5	108.9	110.2	112.7	111.6	115.5	109.5	107.7	110.5	113.1	111.4	113.7	107.6	107.4	7.3	23.5	156.1	169.7	4.7	13.9	7.36	0.00	4.47	19.12
11-May	109.5	108.7	109.8	112.4	111.1	116.3	109.6	108.4	110.2	113.4	111.9	113.7	109.9	110.7	6.9	23.3	154.6	168.1	3.9	13.7	6.88	0.00	6.10	17.15
12-May	110.4	110.1	110.6	116.2	113.6	118.6	111.1	109.6	112.2	113.6	112.8	113.9	113.1	115.0	11.7	23.7	160.7	172.1	7.0	13.7	11.70	0.00	6.99	16.69
13-May	111.1	110.2	111.5	113.4	112.1	114.5	110.9	109.1	111.3	113.5	112.2	113.9	113.1	111.8	5.0	21.4	155.3	168.0	3.1	12.7	5.02	0.00	4.57	16.81
14-May	111.1	110.2	110.5	112.3	110.1	110.4	110.7	109.0	110.7	113.2	110.9	113.7	111.3	111.4	0.0	14.4	131.1	146.1	0.0	9.9	0.00	0.00	0.00	14.40
15-May	110.4	109.6	110.4	110.3	109.5	110.4	108.6	108.2	108.5	110.6	109.8	110.8	111.2	110.7	0.0	14.7	119.5	136.3	0.0	10.9	0.00	0.00	0.00	13.27
16-May	109.3	108.9	109.2	109.2	108.6	109.0	107.9	107.5	108.1	109.8	109.6	110.8	110.8	111.5	0.0	15.5	132.8	144.3	0.0	10.8	0.00	0.00	0.00	15.57
17-May	109.4	109.0	109.7	110.5	109.4	117.8	108.1	107.5	108.5	110.2	109.6	111.2	110.7	110.6	4.7	15.9	140.7	150.1	2.8	10.5	4.77	0.00	0.43	15.54
18-May	110.8	110.2	111.0	120.2	111.3	119.2	110.3	109.3	111.8	111.8	111.4	113.0	111.1	111.4	3.9	14.5	135.0	142.8	2.2	10.0	3.85	0.00	1.81	12.67
19-May	110.9	110.6	111.1	110.4	110.2	110.6	109.1	108.5	109.1	111.3	111.0	112.6	111.4	111.4	0.0	13.2	102.3	115.1	0.0	12.4	0.00	0.00	0.00	12.60
20-May	110.6	109.2	110.1	110.2	108.9	109.4	108.9	108.2	108.9	111.2	110.4	111.8	109.5	109.8	0.0	12.3	113.4	124.9	0.0	10.4	0.00	0.00	0.00	12.33
21-May	109.0	109.0	109.2	108.7	108.6	109.0	108.1	107.3	107.8	110.5	110.2	111.7	109.5	109.9	0.0	11.9	91.8	103.8	0.0	12.3	0.00	0.00	0.00	11.98
22-May	109.0	108.8	109.2	108.6	108.0	108.3	107.7	107.1	107.6	112.0	111.2	113.3	109.3	108.1	0.0	9.9	70.3	78.7	0.0	13.7	0.00	0.00	0.00	9.88
23-May	108.9	108.3	108.8	108.3	108.2	108.7	107.0	106.9	107.1	110.7	109.6	110.5	106.0	105.8	0.0	14.7	131.4	140.9	0.0	10.5	0.00	0.00	1.49	13.26
24-May	108.8	108.2	109.1	119.6	108.1	108.8	107.3	106.8	107.7	109.4	108.6	109.7	108.7	109.9	0.0	13.5	139.8	150.9	0.0	9.0	0.00	0.00	0.00	13.45
25-May	109.4	109.1	109.8	109.1	108.7	109.4	108.0	107.5	108.4	110.0	109.7	110.4	108.8	107.8	0.0	12.6	131.0	141.7	0.0	9.1	0.00	0.00	0.00	12.63
26-May	109.5	109.2	109.6	109.1	109.0	109.4	108.0	107.6	108.4	110.6	110.3	111.5	107.2	107.2	0.0	12.6	118.5	129.1	0.0	10.1	0.00	0.00	0.00	12.59
27-May	109.3	108.8	109.3	109.1	108.7	110.2	107.9	107.4	108.1	110.3	109.9	110.5	106.2	106.1	0.4	12.8	127.0	137.3	0.3	9.5	0.43	0.00	0.22	12.57
28-May	108.7	108.2	108.6	108.8	108.1	109.3	107.7	107.2	107.6	110.1	109.5	110.4	107.0	107.9	0.0	12.6	138.3	149.4	0.0	8.5	0.00	0.00	0.00	12.66
29-May	108.5	108.4	108.8	113.2	112.6	113.6	108.5	107.7	108.8	115.5	112.9	116.2	107.7	108.0	12.4	25.0	110.1	119.7	12.2	22.7	0.00	12.43	0.00	25.00
30-May	108.5	107.5	108.0	113.1	112.5	113.3	108.5	108.0	108.9	115.5	113.0	114.5	108.4	109.2	11.0	24.0	117.0	127.0	9.6	19.0	0.00	10.96	0.00	24.02
31-May	108.1	107.6	108.6	114.0	113.2	114.3	109.0	108.3	109.5	114.8	113.8	115.5	110.7	112.0	11.5	27.8	122.6	131.3	9.6	22.0	0.00	11.41	0.00	27.83
1-Jun	109.9	109.4	110.2	115.2	114.5	115.6	110.1	105.0	110.5	115.0	112.5	115.5	113.4	113.9	13.0	26.9	139.0	147.5	9.3	18.4	0.00	13.06	0.00	26.91
2-Jun	110.0	109.3	110.0	115.2	113.9	115.1	110.2	109.4	109.9	115.2	114.6	115.4	113.1	111.4	10.7	28.2	118.9	128.5	9.1	22.1	0.00	10.77	0.00	28.24
3-Jun	109.0	107.8	108.6	114.1	113.1	115.0	109.2	108.7	109.4	115.2	113.9	115.2	112.2	113.4	10.8	28.5	138.2	146.2	8.4	20.1	0.00	10.83	0.00	28.47
4-Jun	109.2	108.4	109.5	114.7	113.5	115.7	109.5	108.4	110.3	114.5	113.3	115.3	113.8	114.9	11.4	28.5	144.9	155.7	7.8	18.2	0.00	11.39	0.00	28.43
5-Jun	110.7	110.0	111.1	115.8	114.6	116.8	110.6	109.8	111.3	115.3	114.7	115.7	116.0	117.3	11.5	29.1	133.1	145.2	8.9	20.2	0.00	11.52	0.00	29.06
6-Jun	111.3	110.8	111.7	116.4	115.3	117.1	111.2	110.6	111.8	116.5	115.4	117.1	116.5	117.7	11.6	29.0	138.8	150.8	8.3	19.3	0.00	11.80	0.00	29.04
7-Jun	111.4	111.1	111.6	115.9	114.8	116.0	111.3	110.6	111.7	116.6	115.3	116.7	116 (115.0)	116.0	10.7	27.0	132.8	147.3	8.2	18.5	0.00	10.70	0.00	26.96
8-Jun	111.5	110.9	111.6	115.5	114.5	115.4	111.2	110.2	110.9	116.5	115.8	117.4	114.9	113.5	11.0	28.0	109.1	123.6	10.4	23.4	0.00	10.86	0.00	27.97
9-Jun	110.5	109.4	110.1	114.6	113.7	114.4	109.9	109.4	110.3	116.5	113.8	115.9	112.2	111.5	10.0	23.3	119.4	132.7	8.6	18.2	0.00	10.10	0.00	23.31
10-Jun	109.1	108.1	108.7	113.8	113.0	114.3	109.6	108.3	108.9	114.9	114.0	115.6	110.9	110.9	11.0	26.4	112.9	125.2	9.7	21.4	0.00	11.08	0.00	26.42
11-Jun	107.9	107.0	107.6	113.2	111.8	113.9	108.5	107.2	108.2	115.1	112.6	115.6	110.4	109.9	10.6	23.9	113.7	122.7	9.5	19.7	0.00	10.69	0.00	23.90
12-Jun	107.1	107.0	107.3	112.7	111.8	113.6	108.4	107.6	109.1	113.2	112.1	114.1	108.5	109.3	9.3	22.3	125.3	135.1	7.6	16.8	0.00	9.46	0.00	22.34
13-Jun	108.2	107.9	108.5	113.6	112.8	114.0	108.8	108.1	109.2	114.2	113.5	115.0	109.4	109.6	11.0	27.1	122.0	131.6	9.0	20.9	0.00	10.94	0.00	27.12

2016	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
14-Jun	108.5	108.1	108.6	113.6	113.2	114.1	108.8	108.5	109.1	114.4	113.9	114.8	109.4	109.4	11.9	27.5	114.3	121.8	10.5	22.6	0.00	11.92	0.00	27.48
15-Jun	107.7	107.0	107.3	113.4	113.0	113.6	108.7	107.9	108.8	114.4	113.5	115.6	109.5	110.2	11.7	26.7	134.6	142.7	8.9	19.2	0.00	11.79	0.00	26.69
16-Jun	107.0	106.2	106.8	113.4	112.1	113.4	108.3	106.9	107.7	114.5	112.0	114.6	109.5	109.0	10.5	22.7	124.3	131.6	8.6	17.6	0.00	10.58	0.00	22.68
17-Jun	106.4	106.1	106.7	112.7	111.9	113.0	107.7	107.1	108.3	112.8	111.8	113.7	110.3	110.8	9.9	22.9	123.2	130.5	8.1	17.8	0.00	9.95	0.00	22.92
18-Jun	106.7	106.2	106.8	112.7	110.7	112.4	108.0	106.7	108.2	113.1	111.9	113.9	110.4	110.1	9.1	19.9	85.5	90.8	11.4	24.6	0.00	9.04	0.00	19.94
19-Jun	105.6	105.2	105.5	111.2	110.4	111.7	106.5	106.0	107.7	112.6	110.9	113.6	108.9	109.7	9.0	20.6	108.1	115.2	8.6	18.7	0.00	8.98	0.00	20.53
20-Jun	106.4	105.9	107.0	113.2	112.1	113.7	107.9	107.3	108.6	113.0	112.7	114.2	110.6	111.8	12.0	24.4	118.2	126.2	10.4	20.4	0.00	11.91	0.00	24.45
21-Jun	107.1	107.0	107.6	113.4	112.7	114.0	108.4	107.9	109.1	113.9	112.9	115.5	110.7	109.9	10.7	23.2	122.3	127.5	9.7	21.2	0.00	10.82	0.22	23.03
22-Jun	108.7	108.3	109.1	114.9	114.1	115.4	109.9	108.9	110.4	115.0	113.7	115.7	110.9	111.6	11.6	27.8	150.1	157.0	7.7	17.8	0.00	11.65	0.00	27.80
23-Jun	109.0	108.7	109.1	114.8	113.8	114.5	110.0	109.1	109.7	115.2	113.6	115.5	111.2	111.2	10.8	25.5	129.7	136.4	8.5	18.9	0.00	10.86	0.00	25.52
24-Jun	108.7	107.6	108.7	114.2	113.3	114.1	109.1	108.0	108.8	114.4	113.3	114.8	110.5	109.9	11.1	27.1	130.7	138.6	8.5	19.7	0.00	11.15	0.00	27.09
25-Jun	107.0	106.3	106.6	113.3	112.5	113.0	115.3	107.4	108.3	113.7	112.1	113.4	107.3	107.0	11.0	25.6	145.3	154.2	7.6	16.6	0.00	10.94	0.00	25.65
26-Jun	107.1	106.7	107.4	114.2	113.3	114.5	108.7	107.8	109.5	114.6	113.1	115.1	106.9	106.9	13.2	28.7	139.0	145.7	9.6	19.8	0.00	13.19	0.00	28.75
27-Jun	108.0	107.5	108.4	114.5	113.6	115.1	109.0	108.5	109.5	114.7	113.4	115.0	112.9	113.8	13.5	28.7	141.9	147.1	9.4	19.4	0.61	12.87	0.00	28.70
28-Jun	108.5	108.2	108.9	114.5	113.6	114.6	115.3	108.8	109.8	115.2	114.1	115.7	113.4	114.0	12.5	29.5	138.4	143.4	9.0	20.7	0.00	12.43	0.00	29.50
29-Jun	109.2	108.8	109.6	115.0	114.1	115.3	109.7	109.1	110.2	115.3	113.5	115.4	113.4	112.6	13.3	30.4	137.1	142.0	9.7	21.3	0.00	13.41	0.00	30.40
30-Jun	109.4	109.1	109.5	115.1	114.4	115.4	109.7	109.0	110.0	115.3	114.3	115.8	111.8	111.8	13.4	30.4	137.1	143.0	9.8	21.3	0.00	13.42	0.00	30.40
1-Jul	109.4	109.1	109.4	115.3	114.6	115.6	109.8	109.3	110.2	115.4	114.5	115.7	111.0	110.5	12.6	26.7	138.8	147.2	9.0	18.2	0.00	12.68	0.00	26.75
2-Jul	109.2	108.9	109.3	115.2	113.7	114.9	109.9	109.5	110.4	115.4	114.1	115.8	110.6	111.0	11.1	23.7	115.7	124.7	9.7	19.1	0.00	11.09	0.00	23.65
3-Jul	109.0	108.5	109.1	114.3	112.6	113.7	109.9	108.5	109.7	115.2	113.7	115.5	110.7	110.5	10.5	23.4	110.5	118.7	9.6	20.7	0.00	10.47	0.00	23.40
4-Jul	108.0	107.0	107.8	113.3	112.2	113.1	108.3	107.5	107.8	119.4	112.7	114.8	108.6	107.8	10.5	23.4	115.4	123.7	9.3	19.4	0.00	10.49	0.00	23.35
5-Jul	106.7	106.5	106.9	112.7	112.3	113.4	107.6	107.2	108.0	114.3	113.4	115.2	107.9	108.1	11.6	25.5	115.9	123.8	10.1	21.3	0.00	11.61	0.00	25.48
6-Jul	106.8	106.7	107.1	113.0	112.6	113.1	108.6	107.8	109.1	114.5	113.3	114.4	109.0	109.7	11.0	25.6	129.4	136.1	8.6	19.0	0.00	10.98	0.24	25.46
7-Jul	107.7	107.4	108.0	113.4	112.9	113.5	108.6	108.1	108.9	114.3	112.6	115.6	110.7	111.7	10.5	26.6	125.3	130.9	8.5	20.6	0.00	10.49	0.20	26.42
8-Jul	108.0	107.9	108.4	113.7	113.2	113.9	109.1	108.7	109.4	115.0	113.7	116.1	111.4	111.8	10.7	23.9	122.7	129.1	8.7	18.5	0.00	10.64	0.00	23.86
9-Jul	108.3	107.6	108.4	113.6	112.0	113.5	109.2	108.5	109.1	114.8	113.7	115.2	111.5	111.1	9.2	21.7	97.6	102.7	9.8	22.1	0.00	9.21	0.00	21.69
10-Jul	107.4	107.0	107.4	112.4	110.9	112.0	108.6	107.3	108.8	114.5	112.9	115.5	110.6	110.2	8.6	19.3	83.9	86.1	11.1	24.9	0.00	8.62	0.00	19.32
11-Jul	106.9	106.2	106.7	112.9	111.9	113.5	107.8	107.3	108.5	114.2	113.3	114.9	108.6	109.4	10.5	24.0	106.7	113.1	10.1	22.5	0.00	10.50	0.00	24.04
12-Jul	106.5	106.4	106.6	112.8	111.8	113.7	108.0	107.3	108.4	114.3	113.0	114.9	108.9	109.3	10.0	22.0	102.0	108.6	10.1	20.7	0.00	9.92	0.00	22.01
13-Jul	107.0	106.4	107.9	112.9	111.5	113.3	107.6	107.1	108.1	113.9	112.7	114.5	108.6	109.0	9.5	22.4	106.4	112.5	9.3	21.1	0.00	9.46	0.00	22.37
14-Jul	107.2	106.6	107.1	112.8	111.6	113.0	108.3	107.1	109.0	113.6	112.9	114.2	109.6	110.6	8.8	21.6	110.7	118.1	8.3	19.4	0.00	8.79	0.00	21.64
15-Jul	106.9	106.6	107.1	118.7	114.9	127.5	108.2	107.0	108.0	113.9	112.5	114.8	109.5	109.1	28.0	23.0	119.8	122.0	20.8	19.7	18.89	9.22	0.00	22.98
16-Jul	106.7	106.3	106.8	121.3	114.5	123.9	113.3	110.8	116.5	117.0	115.2	119.2	109.9	110.5	15.7	23.1	116.4	119.2	13.5	19.4	5.92	9.73	0.00	23.04
17-Jul	106.7	106.5	106.8	113.2	111.8	114.5	109.1	107.0	107.9	115.3	111.9	114.2	109.8	110.4	9.7	20.1	108.2	113.7	8.9	18.0	1.11	8.55	0.00	20.10
18-Jul	106.4	106.0	106.4	112.7	111.9	113.7	107.5	106.6	107.6	112.7	111.7	113.1	109.7	109.9	9.3	22.1	120.2	124.1	7.8	18.1	0.00	9.40	0.00	22.12
19-Jul	105.9	105.8	106.1	112.3	111.4	112.8	107.0	106.4	107.5	112.5	111.8	113.4	109.9	110.2	9.8	22.4	108.4	111.2	9.8	22.3	0.00	9.76	0.42	22.01
20-Jul	105.9	105.7	106.2	112.2	111.2	112.4	107.2	106.7	107.7	112.9	112.4	113.4	110.7	111.7	9.0	22.7	109.8	113.9	8.5	20.9	0.00	9.13	0.00	22.69
21-Jul	106.1	105.8	106.5	116.2	114.0	118.8	108.9	107.6	112.3	113.7	112.6	115.7	111.7	113.0	21.7	22.1	113.9	116.7	19.8	20.0	12.22	9.51	0.00	22.10
22-Jul	106.1	105.5	105.8	115.9	111.5	116.5	109.0	106.9	108.6	113.8	112.0	114.7	111.6	109.3	10.3	21.3	91.7	97.6	12.3	27.2	1.52	8.81	1.75	20.04
23-Jul	106.0	105.6	106.6	111.9	110.6	112.2	106.7	106.3	107.2	112.6	111.4	112.5	107.8	108.9	8.6	19.4	96.9	100.8	9.5	20.9	0.00	8.55	0.00	19.44
24-Jul	106.7	106.1	107.4	112.7	111.1	113.1	107.5	106.9	108.4	114.0	113.1	114.5	110.2	110.9	10.0	23.0	92.2	95.8	11.3	24.8	0.00	9.97	0.00	23.01
25-Jul	106.8	106.6	107.1	113.1	112.0	113.7	108.1	107.7	108.7	114.2	113.2	115.3	113.7	115.3	10.6	22.3	107.3	110.1	10.1	21.5	0.34	10.29	0.00	22.25

2016	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
26-Jul	107.2	106.8	107.7	113.5	112.1	114.0	108.2	107.3	108.2	113.9	112.6	114.6	113.4	112.3	10.2	22.5	106.8	108.2	9.9	22.3	0.00	10.13	0.00	22.42
27-Jul	107.6	107.2	108.0	113.9	112.5	116.2	108.4	107.7	109.0	113.6	112.6	114.5	112.8	114.5	11.5	21.5	114.8	117.4	9.8	18.8	2.10	9.48	0.00	21.47
28-Jul	107.6	107.3	108.1	114.4	113.3	116.5	109.1	108.4	109.4	114.1	113.1	114.6	112.8	112.4	12.1	22.9	123.6	127.0	9.6	18.0	1.51	10.50	0.00	22.87
29-Jul	108.9	108.4	109.5	114.6	113.5	115.1	109.7	108.8	110.6	114.4	113.3	115.3	111.5	112.3	10.5	22.8	124.2	126.6	8.5	18.5	0.00	10.51	0.00	22.76
30-Jul	108.9	108.2	108.6	114.5	113.3	114.8	109.9	108.7	109.9	114.8	113.8	115.4	111.2	109.7	10.6	22.2	111.2	113.7	9.8	20.3	0.00	10.55	0.00	22.27
31-Jul	108.0	106.7	107.3	113.7	111.5	113.1	108.8	107.2	108.4	114.5	112.1	114.5	107.8	107.3	8.7	20.0	101.3	102.9	9.8	22.6	0.00	8.71	0.00	20.02
1-Aug	106.4	105.7	106.6	113.2	112.1	114.0	107.4	106.6	108.7	114.0	112.6	114.8	108.0	109.5	10.7	24.0	108.5	109.5	10.5	23.1	0.00	10.78	0.00	24.06
2-Aug	106.3	105.8	106.1	113.1	111.4	112.6	107.8	106.1	108.1	114.1	112.4	114.5	107.7	106.9	10.0	22.8	98.2	100.5	10.6	23.5	0.00	10.06	0.00	22.83
3-Aug	105.5	105.0	105.4	112.2	111.1	112.9	106.6	106.1	107.2	113.0	109.8	113.4	104.8	105.0	10.0	22.9	108.7	112.0	9.4	20.8	0.00	10.04	0.00	22.98
4-Aug	105.8	105.3	106.2	112.7	111.7	113.0	107.1	106.6	107.9	113.2	112.5	114.2	107.2	107.5	10.4	22.2	111.4	112.3	9.5	20.0	0.00	10.43	0.00	22.19
5-Aug	106.9	106.5	107.2	112.8	111.9	113.6	107.8	107.3	108.3	113.2	111.9	113.5	109.7	110.8	9.1	20.1	113.4	117.7	8.1	17.4	0.00	9.09	0.00	20.05
6-Aug	107.0	106.8	107.2	112.7	111.4	113.1	107.8	107.1	108.5	113.1	112.1	113.7	109.5	108.0	8.3	18.3	104.1	107.9	8.4	18.3	0.00	8.37	0.00	18.27
7-Aug	106.9	106.5	107.1	112.4	110.4	112.7	108.0	106.9	108.0	113.1	112.5	114.2	107.7	107.5	8.4	18.0	85.3	87.4	10.6	22.2	0.00	8.35	0.00	17.95
8-Aug	106.4	105.3	105.6	112.1	110.8	112.4	106.8	106.1	107.1	113.1	111.7	114.5	107.0	106.8	9.0	20.0	98.4	100.7	9.6	21.8	0.00	9.03	0.00	20.05
9-Aug	105.4	105.0	105.4	111.7	110.3	112.6	106.1	105.9	106.7	112.3	111.5	113.4	104.9	107.0	8.8	20.7	95.5	99.3	9.6	21.7	0.00	8.85	0.00	20.68
10-Aug	105.0	104.4	104.6	111.4	110.2	112.1	106.3	105.7	106.6	112.3	111.0	113.8	107.3	107.9	9.2	19.8	99.9	103.6	9.4	20.0	0.00	9.16	0.00	19.80
11-Aug	104.6	104.2	104.9	112.0	110.7	112.3	106.0	105.5	106.6	111.8	110.9	112.1	108.1	108.6	9.9	21.1	105.9	107.7	9.7	20.6	0.00	9.98	0.00	21.07
12-Aug	105.6	105.0	106.1	112.7	111.7	113.3	106.7	106.0	108.0	110.9	106.7	111.4	109.6	110.2	10.5	2.4	103.8	106.2	10.8	3.5	0.00	10.61	0.00	0.00
13-Aug	106.2	105.7	106.5	112.6	111.0	112.3	107.4	107.0	108.0	107.2	106.9	108.0	110.1	111.1	8.6	0.0	95.1	97.4	10.2	0.0	0.00	8.57	0.00	0.00
14-Aug	106.7	106.3	107.1	112.0	110.7	112.7	107.4	107.0	107.7	107.1	106.7	107.5	109.9	110.5	8.5	0.0	83.6	85.5	12.0	0.0	0.00	8.45	0.00	0.00
15-Aug	106.7	105.7	106.3	112.7	111.3	113.5	107.3	106.7	107.8	107.0	106.4	107.4	108.5	108.9	10.0	0.0	99.0	102.5	10.5	0.0	0.00	10.03	0.00	0.00
16-Aug	106.0	105.7	106.3	112.4	106.0	109.8	107.4	106.3	107.4	107.0	106.1	107.3	107.5	108.9	0.0	0.0	95.8	97.1	0.0	0.0	0.00	0.00	0.00	0.00
17-Aug	106.6	106.2	107.1	106.2	105.6	106.6	106.0	105.0	106.1	105.8	104.4	105.6	107.3	107.9	0.0	0.0	99.5	100.2	0.0	0.0	0.00	0.00	0.00	0.00
18-Aug	106.6	106.1	106.9	106.3	105.9	107.3	105.8	105.4	106.2	105.3	105.0	105.6	108.2	109.5	1.4	0.0	108.5	109.5	0.9	0.0	1.42	0.00	0.00	0.00
19-Aug	106.5	105.6	106.2	111.1	108.2	120.4	109.4	107.0	114.4	108.9	107.3	112.4	108.2	107.0	10.5	2.6	107.8	111.2	8.9	2.2	10.46	0.00	2.58	0.00
20-Aug	106.6	106.2	106.9	106.3	105.8	106.7	109.3	105.4	106.5	109.0	105.0	106.4	105.9	106.2	0.0	0.0	90.4	94.2	0.0	0.0	0.00	0.00	0.00	0.00
21-Aug	107.0	106.7	107.6	106.3	105.9	106.6	106.2	105.7	106.4	105.5	105.1	105.8	105.3	105.3	0.0	0.0	77.2	79.5	0.0	0.0	0.00	0.00	0.00	0.00
22-Aug	106.9	104.6	106.1	106.1	104.2	105.5	105.6	104.0	105.3	105.1	103.8	104.7	103.7	104.5	0.0	0.0	97.1	99.2	0.0	0.0	0.00	0.00	0.00	0.00
23-Aug	104.0	102.5	103.3	103.7	102.4	102.9	103.8	102.2	102.9	103.6	102.0	103.2	103.5	104.5	0.0	0.0	92.1	95.8	0.0	0.0	0.00	0.00	0.00	0.00
24-Aug	102.5	102.2	102.9	102.4	101.7	102.7	102.4	101.8	102.5	101.9	101.3	102.0	104.3	105.2	0.0	0.0	86.2	89.2	0.0	0.0	0.00	0.00	0.00	0.00
25-Aug	103.1	102.6	103.5	103.1	102.4	103.5	102.8	102.3	103.1	102.1	101.7	102.6	105.3	106.2	0.0	0.0	94.5	97.8	0.0	0.0	0.00	0.00	0.00	0.94
26-Aug	104.3	103.9	104.5	104.3	103.7	104.5	103.9	103.2	104.4	103.3	102.9	103.8	105.4	107.0	0.0	0.0	100.9	102.7	0.0	0.0	0.00	0.00	0.00	0.00
27-Aug	104.5	104.4	104.6	104.3	103.9	104.5	104.2	103.5	104.3	103.9	103.6	104.0	105.0	102.3	0.0	0.0	71.7	74.7	0.0	0.0	0.00	0.00	0.00	0.00
28-Aug	104.3	103.2	103.9	103.9	103.1	103.3	103.2	102.9	103.2	103.4	102.6	103.0	101.7	102.4	0.0	0.0	90.0	92.0	0.0	0.0	0.00	0.00	0.00	0.00
29-Aug	103.1	102.8	103.4	103.1	102.6	103.3	103.1	102.7	103.2	102.9	102.7	103.0	102.6	103.4	0.0	0.0	89.7	92.3	0.0	0.0	0.00	0.00	0.00	0.00
30-Aug	103.3	103.2	103.4	103.4	102.8	103.5	103.0	102.5	103.1	102.9	102.5	102.9	102.7	103.0	0.0	0.0	77.3	79.1	0.0	0.0	0.00	0.00	0.00	0.00
31-Aug	103.3	103.0	103.3	103.4	102.5	103.3	102.8	102.6	102.9	103.8	102.9	109.0	102.4	103.2	0.0	0.0	72.6	75.7	0.0	0.0	0.00	0.00	0.00	0.00

APPENDIX F: ROCKY REACH PROJECT GAP

From:	Steinmetz, Marcie
To:	"Peterschmidt, Mark F. (ECY)"; Bowen, David (ECY)
Cc:	Smith, Michelle; Bitterman, Deborah; Osborn, Jeff; Sokolowski, Rosana
Subject:	FINAL 2016 Total Dissolved Gas Abatement Plans for Rocky Reach Hydroelectric Project
Date:	Friday, April 01, 2016 6:40:41 AM
Attachments:	FINAL 2016 Rocky Reach GAP 04-01-16 FN47499.pdf

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

To: David Bowen, Washington State Department of Ecology
Mark Peterschmidt, Washington State Department of Ecology

From: Marcie Steinmetz, Water Resource Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: FINAL 2016 Total Dissolved Gas Abatement Plan for Rocky Reach Hydroelectric Project

Mr. Bowen and Mr. Peterschmidt:

Attached is the FINAL 2016 Total Dissolved Gas Abatement Plan for Rocky Reach Hydroelectric Project.

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

Thank you,

Marcie Steinmetz | **Water Resource Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

2016 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

April 1, 2016

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FPE	Fish Passage Efficiency
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
JBS	juvenile bypass system
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RRFF	Rocky Reach Fish Forum
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan
WQS	Water quality standards

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) 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 by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2016 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rocky Reach Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), Rocky Reach Operations Plan, TDG Operational Plan, a Quality Assurance Project Plan (QAPP) for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

WAC water quality standard 173-201A-200(1)(f)(ii) provides a temporary criteria adjustment for hydroelectric dams on the Snake and Columbia Rivers, when spilling to aid in fish passage. To receive this criteria adjustment, an Ecology approved gas abatement plan is required. Section 5.4(2) in the 401 Certification for the Rocky Reach Project defines the non fish-spill season as September 1 through March 31 and the fish-spill season is April 1 through August 31.

The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage and an Ecology approved gas abatement plan is in place:

- TDG must not exceed an average of 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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).
- A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the GAP is to implement measures to achieve compliance with the WAC 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the 401 Certification. These measures include, but are not limited to:

1. Minimizing voluntary spill.
2. During downstream migrating juvenile fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to 212 thousand cubic feet per second kcfs.
6. Implement alternative spillway operations, using gates 2 through 12, to determine whether TDG levels can be reduced without adverse effects on fish passage. If effective, implement to reduce TDG.

Additionally, Chelan PUD proposes to implement the following measures, as required by the 401 Certification:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to United States Army Corps of Engineers (USACE) Columbia River Basin Water Management Division's website.
3. Prepare an annual report summarizing Chelan PUD's fish-spill season regarding; flow, TDG, gas bubble trauma (GBT) monitoring, and fish study results, and, in accordance with the previous (2015) GAP; submit to Ecology by December 31st.
4. Prepare an annual water quality report summarizing Chelan PUD's water quality monitoring (to include non fish-spill season TDG data); submit to Ecology by March 1st.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Rocky Reach Hydroelectric Project, located on the Columbia River downstream of Wells Dam (Figure 1-1). The Project is licensed as Project No. 2145 by the Federal Energy Regulatory Commission (FERC). The 401 Certification for the Project was issued by Ecology on March 17, 2006. The 401 Certification terms and conditions are incorporated in the new FERC license to operate the Project which was issued on February 19, 2009. Section 5.4.3 of the 401 Certification requires Chelan PUD to submit an annual GAP in accordance with Ecology's water quality standards for total dissolved gas TDG beginning on April 1 of the year of implementation.

This GAP is being submitted to Ecology according to WAC 173-201A-200(1)(f)(ii) and Section 5.4.3 of the 401 Certification. Chelan PUD respectfully submits this GAP with the goal of receiving a TDG criteria adjustment for commencing with the 2016 fish-spill season. This GAP provides details associated with proposed 2016 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

1.1 Project Description

The Rocky Reach Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). Chelan PUD received a new license (License) from the Federal Energy Regulatory Commission (FERC) on February 19, 2009, authorizing Chelan PUD to operate the Project dam and powerhouse for a period of 43 years.

The Project consists of a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The dam consists of:

- a forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- a powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- a spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate;
- two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide;
- an east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet and;
- Dryden weir and Tumwater dams' fish ladders and trapping facilities. (These facilities are located some distance away from the Project on the Wenatchee River).

The Rocky Reach Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. One entrance is located between

spillway bays 8 and 9, a second entrance is at the center of the dam adjacent to powerhouse unit 11, and a third entrance is at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also six submerged orifice entrances in operation; three at each end of the powerhouse. Fish pass from the entrances into fish collection and transportation channels, which converge to guide fish to a pool and weir fish ladder. There is a counting station at the fishway exit located near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cubic feet per second (cfs). A gravity intake provides additional attraction water for the spillway entrance. The juvenile fish bypass system (bypass system) includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

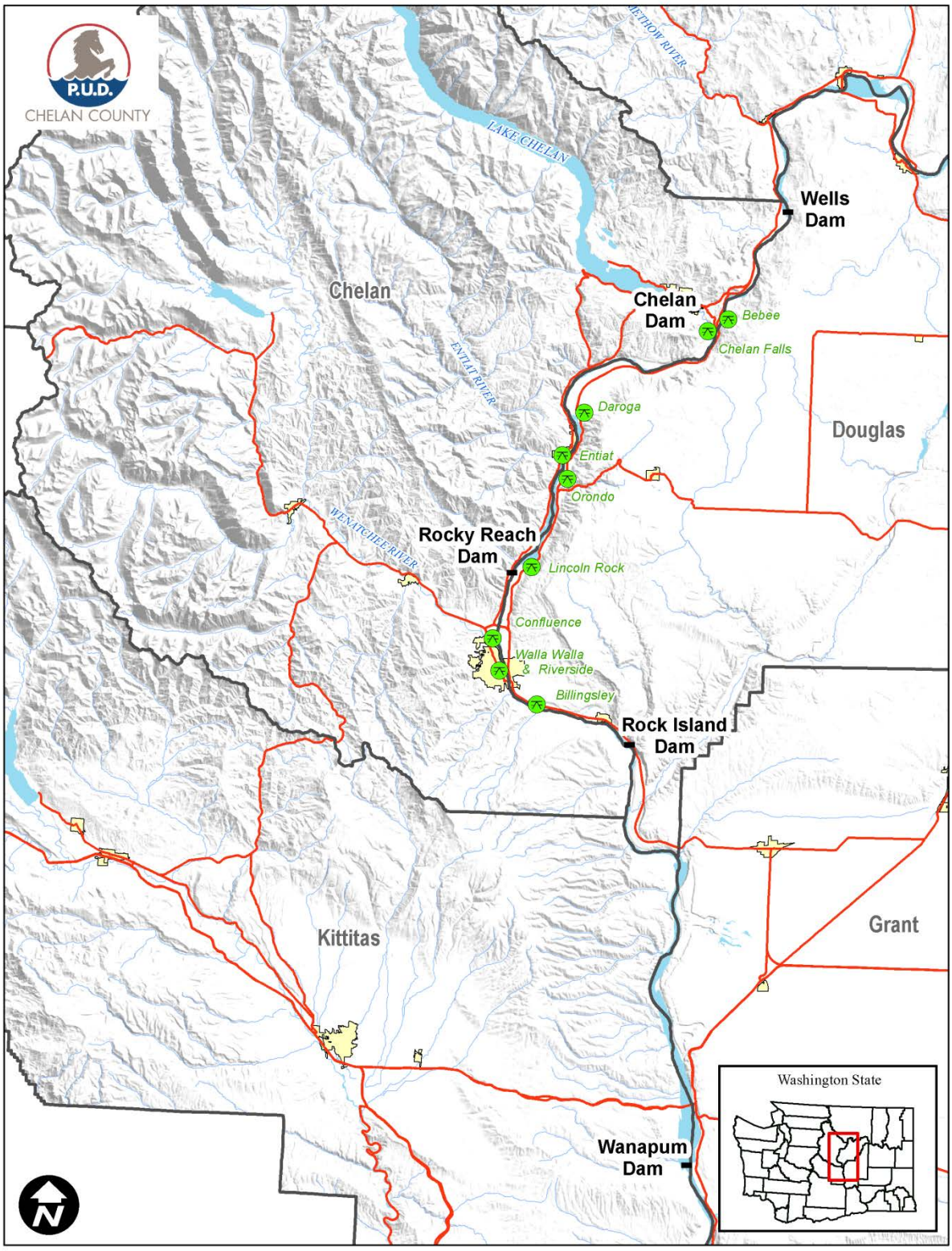

Figure 1-1: Location of Rocky Reach Hydroelectric Project on the Columbia River.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2015 flows at the Rocky Reach Project is shown below in Figure 1-2.

Mean daily discharge during the 2015 fish-spill season was compared to the 10-year average of mean daily discharge from 2005-2014, as measured at Rocky Reach Project. Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 71.6% of average at Rocky Reach Dam) over the entire fish-spill season.

Average flow for all months during the spill season was lower than the monthly 10-year average. The maximum hourly flows observed at the Project during the spill season were 138 kcfs, on April 3. Of the 153 days during the spill season (April 1 through August 31), there were no instances where the daily average flows exceeded the seven-day, ten-year frequency flood stage (7Q10) of 252 thousand cubic feet per second (kcfs).

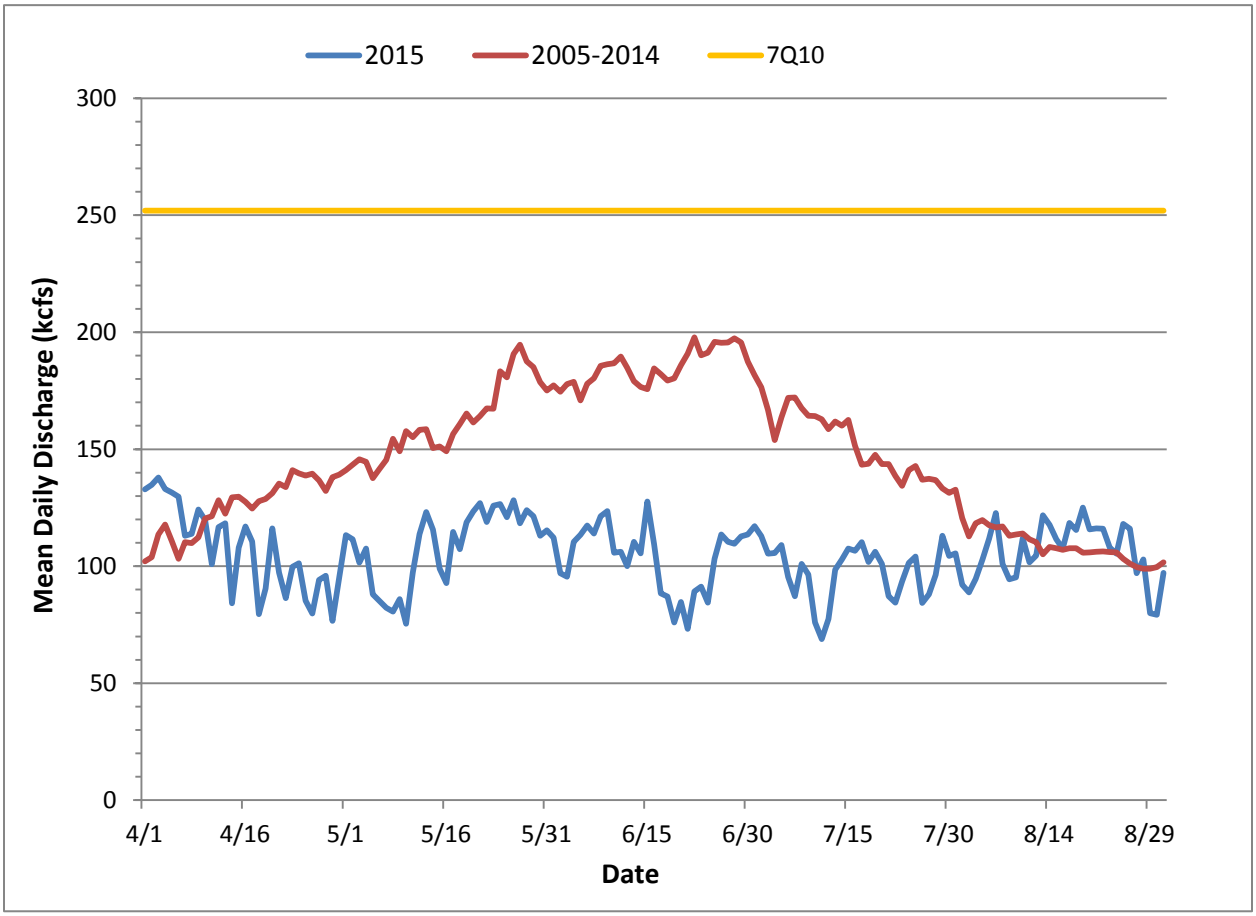

Figure 1-2: Comparison of 2015 vs. previous 10-year average (2005-2015) of mean daily discharge at Rocky Reach Dam.

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

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 an Ecology-approved gas abatement plan is in place. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, a temporary criteria adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG criteria adjustment. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill (for downstream migrating juveniles) season as April 1 through August 31 of each year. Non fish-spill season is defined as September 1 through March 31, unless otherwise specified in writing to Ecology following consultation with the Rocky Reach Fish Forum and the HCP Coordinating Committee.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rocky Reach Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood or 7Q10. The 7Q10 flood flow for the Rocky Reach Project was calculated to be 252 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). With the option for a temporary TDG criteria adjustment under an approved gas abatement plan, the TMDL set TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway

downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

Section 5.4.7 of the Rocky Reach Project 401 Certification states: "*This certification, along with the WQMP and the updated GAP, is intended to serve as the Rocky Reach Project's portion of the Detailed Implementation Plan (DIP) for the Mid-Columbia River and Lake Roosevelt TDG TMDL"*.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the MCHCA, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project through management of a positive or negative "bias" which assigns a project more or less generation depending on whether the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the MCHCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 2016 Rocky Reach Operations Plan

Article 402 of the Rocky Reach License requires an annual Operations Plan be submitted to the FERC by February 15 each year for approval (revised submittal date of March 30). This Operations Plan includes the following: (a) descriptions of fisheries (juvenile and adult) and water quality-related operating criteria for the Project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (b) descriptions of fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the Project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (c) an annual schedule for operation and inspection of these facilities. The information contained in the annual Operations Plan is relevant to Chelan PUD's TDG abatement activities and is therefore attached for reference as Appendix C to this GAP.

1.4.2 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rocky Reach HCP serves as the foundation for the fisheries management plan at Rocky Reach Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act (ESA). Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The Rock Reach HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including spill and the use of the JBS. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rocky Reach while operating the JBS exclusively.

1.4.3 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the United States Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the United States Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant PUDs), the USACE, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on ESA listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CCT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.4 Spill Operations

1.4.4.1 Spill Gate Configuration

The standard (fish) spill configuration used at Rocky Reach uses gates 2 through 8 with a minimum discharge per spill bay of about four 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 upstream migrating adult fishway entrances.

This spill pattern provides favorable guidance conditions for adult migrant salmon and steelhead. This spill configuration and alternate patterns were tested and it was determined this pattern was as good as, if not better than, the alternate patterns for upmigrating salmonids (Schneider and Wilhelms, 2005). The same pattern is used for juvenile downstream migrating 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.

Note that although the above referenced crown-shaped pattern may be as good as, if not better, than tested alternate patterns for upmigrating salmonids, it may not be ideal for TDG. According to Section 5.4(1)(b)(6) of the 401 Certification, Chelan PUD shall study alternative spillway operations using any of gates 2 through 12. In 2011 and 2012, Chelan PUD studied alternative spillway flow distribution patterns, in order to evaluate the potential to reduce total dissolved gas TDG levels, particularly during high spill levels (above 50 kcfs). Generally, all of the three alternative spill patterns studied resulted in lower TDG levels than the standard spill pattern. Of the three alternative patterns, the flat spill pattern (flow distributed evenly between spillway gates) had a slightly better TDG performance than the other two alternative patterns. Chelan PUD has presented these findings to Ecology, the Rocky Reach Fish Forum (RRFF) and Habitat Conservation Plan Coordinating Committee (HCP CC).

Chelan PUD, through the consultation process with Ecology, the RRFF, and the HCP CC, has developed a schedule to make the necessary changes to perform the new spill configuration. During the spring of 2016, computer programming of gates 9-12 for automated use will occur so that the gate configuration can be tested and ready in the fall of 2016. The gate configuration will only be used during the non fish-spill season. Chelan PUD will operate the new spill configuration as a pilot or test spill and further evaluate the results for a designated period of time. If upon operating under the new spill configuration data show that optimal results are not occurring as previously evaluated, Chelan PUD shall implement adaptive management in coordination with the RRFF and HCP CC. If operation under the new spill configuration provides significant reduction in TDG, Chelan PUD will incorporate the spill configuration into its regular operations during the non-fish spill season.

1.4.4.2 Spill Scenarios

There are six main scenarios that may result in spill at Rocky Reach Dam. These are described below:

Fish-spill

Spill is an ineffective method of bypassing downstream migrating juvenile fish away from the turbines at Rocky Reach Dam (Steig et. al., 1997) and, consequently, is not considered as the

solution for the long-term fish passage program. To minimize or eliminate the need for fish-spill, Chelan PUD is focusing its efforts on increasing the fish passage efficiency and survival through the juvenile fish bypass system (JBS).

The JBS continues to be the most efficient non-turbine route for downstream migrating juvenile fish passage at the Rocky Reach Project. The JBS does not require spill for its operation.

Spring Fish-spill Operations

Operating the JBS exclusively, Chelan PUD has been able to meet the HCP survival standards for the three spring migrants (spring/yearling Chinook, steelhead, and sockeye). Chelan PUD will continue operating the JBS exclusively, with no voluntary spill, during the spring of 2016.

Summer Fish-spill Operations

Summer spill at Rocky Reach for subyearling Chinook will be nine percent of day average flow. Commencement of summer spill will be determined using run-timing information at Rocky Reach. Summer spill generally begins in early June and ends in mid-August when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license (707 feet), to prevent overtopping of the Project, and to maintain optimum operational conditions. When spilling for fish or due to excess inflow or generation, the spillway is operated using gate settings that have been shown to limit TDG production and meet fish passage requirements (Schneider and Wilhelms, 2005). To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Columbia River Basin Water Management Division, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rocky Reach. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2015

1.5.1 TDG Compliance 2015

Over the course of the 2015 fish-spill season, there were no exceedances of the total dissolved gas (TDG) numeric criteria in either the forebay or tailrace of Rock Island Dam, nor at the forebay of Wanapum Dam. Information regarding spill for the 2015 fish-spill season are displayed in Table 1-1.

Table 1-1: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2015.

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish-Spill			Other		
			Spill kcfs	% of flow	% of Total Spill	Spill kcfs	% of flow	% of Total Spill
April	107.4	0.5	0.0	0.0	0.0	0.5	0.4	100.0
May	108.9	0.3	0.0	0.0	0.0	0.3	0.2	100.0
June	103.6	9.6	9.5	9.2	99.0	0.1	0.1	1.0
July	98.4	8.5	8.4	8.5	98.4	0.1	0.1	1.6
August	106.2	2.9	2.1	2.0	72.3	0.8	0.8	27.7

1.5.2 TDG Activities Implemented 2015

As defined in Section 5.4.1(b) of the 401 Certification, Chelan PUD implemented six actions to minimize voluntary and involuntary spill at Rocky Reach in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rocky Reach Project was the implementation of the operational spill programs and the ability to minimize spill through operation of the JBS. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to 212 kcfs.
- Contracted with Parametrix to have the data gathered during the 2011 and 2012 testing of alternative spillway configurations analyzed and summarized. The report has been reviewed by Ecology, the HCP CC and the RRFF. The results of the report are briefly summarized in Section 1.4.4.1.

1.5.3 TDG Structural Measures Implemented in 2015

No structural gas abatement measures were proposed or implemented at the Rocky Reach Project in 2015.

SECTION 2: PROPOSED 2016 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2016 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Section 5.4.1(b) of the 401 Certification requires Chelan PUD to manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and Anadromous Fish Agreement[2]. During the 2016 fish-spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. Minimize voluntary spill

   Success of the JBS has enabled Chelan PUD to reduce spill required for fish passage.

2. Manage voluntary spill in real time

   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).The TDG Operational Plan is updated annually and routed to the Project operators. It provides the operators a list of actions they are to follow if TDG meets the designated thresholds.

3. Minimize involuntary spill

   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. Participate in Hourly Coordination Agreement

   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. Maximize powerhouse discharge as appropriate up to hydraulic capacity

6. Implement alternative spillway operation

   Chelan PUD plans to implement the flattened spill configuration in the fall of 2016.

Per Section 5.4(5) of the 401 Certification, operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

[2] Additional conditions used to determine compliance with the water quality criteria for TDG can be found in Sections 5.4(1)(d)-(g) of the 401 Certification, as well as Section 4.4 of this Plan.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rocky Reach Project in 2016. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a QAPP.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rocky Reach Project to monitor hourly TDG levels annually. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The forebay fixed monitoring station (Figure 2-1) is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station (Figure 2-2) is located approximately 0.38 miles downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is east of mid-channel, and is minimally impacted by powerhouse flows when the Project is passing water over the spillway (Schneider and Wilhelms, 2005).

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental to perform calibrations and equipment maintenance during the 2016 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish-spill season, and every other month during the non fish-spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. Quality assurance/quality control (QA/QC) measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be maintained for all work done on the monitoring equipment, including monthly maintenance, calibration, exchange of instruments, and any other pertinent information.

TDG levels are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the United States Army Corps of Engineers (USACE), Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data[2].

[2]. The website for the United States Army Corps of Engineers, Columbia River Basin Water Management Division, Rocky Reach Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/#RRDW Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.

Figure 3-1: Location of forebay fixed monitoring station at Rocky Reach Hydroelectric Project.

3.2 Quality Assurance

Section 5.7.3 of the 401 Certification requires Chelan PUD to maintain a TDG monitoring program that is at least as stringent as the QA/QC calibration and monitoring procedures and protocols developed by the USGS monitoring methodology for the Columbia River.

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as Hydro Lab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's QAPP (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach Project WQC (Ecology, 2006) requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. On April 21, 2014, Chelan PUD received a letter from Ecology postponing the GBT monitoring until such a time as is determined to be appropriate by Ecology. Ecology is currently evaluating the need for future GBT studies below Rocky Reach Dam. Currently, Chelan PUD conducts a Smolt Monitoring Program at Rock Island Dam.

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct GBT monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead and subyearling Chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). The results of this monitoring effort will be included in the Gas Abatement Annual Report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

Section 5.7.6 of the 401 Certification requires hourly TDG information be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data[2].

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1 above, and any deviation from the TDG Operational Plan or the fish-spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft Gas Abatement Annual Monitoring Report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish-spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (gas bubble trauma) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP[3] used to predict compliance with TDG numeric criteria.

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[3] The WQMP is a response to Ecology's request that the PUD provided the scientific and biological basis for Ecology's Section 401 certification. It is the principal supporting document for the 401. As stated in Chapter 2 of the Comprehensive Plan (Attachment B to the Rocky Reach Settlement Agreement):

> *"Ecology is a participant in the Settlement Group negotiating conditions for relicensing of the Project, and has requested that Public Utility District No. 1 of Chelan County (Chelan PUD) help provide the scientific and biological basis for Ecology's Section 401 Certification. The Settlement Group has developed a Comprehensive Plan that provides the rationale and details behind proposed license articles that the Settlement Group will recommend for inclusion in the New License to be issued by FERC. The Rocky Reach Water Quality Management Plan is in response to Ecology's request and is contained in this chapter of the Comprehensive Plan.*

The WQMP includes Project background; background water quality; management considerations and options investigated; and protection, mitigation, and enhancement measures.

The analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG numeric criteria will include the following steps:

- Input relevant 2008 (post relocation of tailrace fixed monitoring site) and 2009-2015 data,
- Analyze to see if the relationship between quantity of spill and TDG yields a similar or different regression than that predicted for site FOP1 (located just downstream and landward of the current tailrace monitoring site (Figure 2)) in Schneider and Wilhelms (2005),
- If regression is different, look for patterns that may explain the difference,
- Determine if any differences in the regression affect the predictions in Schneider and Wilhelms (2005) to meet TDG standards up to 7Q10 flows.

4.4 Determination of Compliance in Year 5

As per Section 5.4(1)(d) of the 401 Certification, in Year 5 of the effective date of the New License, Chelan PUD shall prepare a report summarizing the results of all TDG studies performed to date, and describing whether compliance with the numeric criteria has been attained.

This report was submitted as a Draft to Ecology and the RRFF on October 31, 2014 and the HCP CC on November 25, 2014. The HCP CC requested an additional 30 day comment period extending the final due date to Ecology on January 30, 2015. Ecology approved the extension and final due date. Comments were received and incorporated into the final report submitted to Ecology on January 30, 2015. In a letter to Chelan PUD, dated July 15, 2015, Ecology determined that full compliance with the applicable numeric criteria for TDG had not been met and that aquatic life is not adversely affected at the Rocky Reach Project. Chelan PUD will in 2016, provide a report to Ecology evaluating what measures (operational and structural) may be reasonable and feasible to further reduce TDG production at the Project. Chelan PUD will also implement in the fall of 2016, the flattened spill gate configuration during the non fish-spill season.

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

As per Section 5.4(3) of the 401 Certification, the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

Additionally, beginning in year 10, and every 10 years thereafter, the revised annual GAP shall include a review of reasonable and feasible gas abatement options to incrementally reduce TDG caused by the Project, in light of new information and technology. If any reasonable and feasible measures are identified, Chelan PUD shall present the data and analysis to the RRFF and develop an implementation plan. The implementation plan shall be included in the GAP for review and approval by Ecology.

SECTION 6: CONCLUSIONS

Chelan PUD shall implement the measures presented Section 2 of this 2016 GAP. Implementation of these measures are intended to ensure compliance with the WAC for TDG in the Columbia River at the Rocky Reach Project during the fish-spill season while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Anadromous Fish Agreement. No structural gas abatement measures are planned at the Rocky Reach Project in 2016. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Federal Energy Regulatory Commission (FERC). 2009. Order on Offer of Settlement and Issuing New License, Project No. 2145-060.

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Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.

Schneider, M.L. and S.C. Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. Prepared by COE, Engineer Research and Development Center, for Chelan PUD. July 2005. http://www.chelanpud.org/rr_relicense/study/reports/7773_1.pdf

Steig, T.W., R. Adeniyi, and V. Locke. 1997. Hydroacoustic evaluation of the fish passage through the powerhouse, the spillway, and the surface collector at Rocky Reach Dam in the spring and summer of 1997. Report by Hydroacoustic Technology, Inc. to Chelan Co. PUD, Wenatchee, Wash.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCKY REACH HABITAT CONSERVATION PLAN

Anadromous Fish Agreement and Habitat Conservation Plan

Rocky Reach Hydroelectric Project

FERC License No. 2145

Offered for Signing
March 26, 2002

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Anadromous Fish Agreement and Habitat Conservation Plan
Rocky Reach Hydroelectric Project, FERC No. 2145

THIS AGREEMENT for the Rocky Reach Hydroelectric Project (Project) is entered into between the Public Utility District No. 1 of Chelan County, Washington, (District) a Washington municipal corporation; and the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), the Confederated Tribes of the Umatilla Indian Reservation (Umatilla) (collectively, the Joint Fisheries Parties or the JFP); and American Rivers, Inc., a Washington D.C., nonprofit corporation, (the JFP and American Rivers, are the fisheries parties (FP)). All entities are collectively referred to as the Parties.

INTRODUCTION

A. The site of the Project is habitat for Plan Species. Prior to this Agreement the needs of the Plan Species have been addressed through litigation and agreement. This Agreement is intended to constitute a comprehensive and long-term adaptive management plan for Plan Species and their habitat as affected by the Project.

B. The objective of this Agreement is to achieve No Net Impact (NNI) for each Plan Species affected by the Project on the schedule set out herein and to maintain the same for the duration of the Agreement. NNI consists of two components: (1) 91% Combined Adult and Juvenile Project Survival achieved by project improvement measures implemented within the geographic area of the Project, (2) 9% compensation for Unavoidable Project Mortality provided through hatchery and tributary programs, with 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. The Parties intend these actions to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of Plan Species.

C. The District will receive a Permit for Permit Species upon this Agreement becoming effective. If the District carries out its responsibilities for fish protection and mitigation Measures set out in this Agreement, and provides the necessary monitoring and evaluation all according to the time frames set out for each Measure, the Permit shall continue for the full term of this Agreement subject to Section 2 “Withdrawal From Agreement” and Section 10 “Endangered Species Act”. The Parties shall take the actions set out in this Agreement in support of the District before the Federal Energy Regulatory Commission (FERC) and in other forums.

D. Capitalized terms used in this Agreement are defined in Section 13 “Definitions”.

NOW, THEREFORE, IN CONSIDERATION of the mutual promises and conditions set forth herein, the Parties agree as follows:

SECTION 1 DURATION OF AGREEMENT

1.1 Term. This Agreement shall commence on the date the last Party signs this Agreement as more fully described in Section 1.2 "Staggered Effective Date" and shall continue for a period of fifty- (50) years, unless the Agreement terminates early. In addition, entities listed above that do not sign this Agreement are not a Party to this Agreement.

1.2 Staggered Effective Date.

1.2.1 Upon Signing. The portions of Section 5.4 "Phase 1 Plan to Achieve Survival Standard" related to 2002 operations, Section 4 "Coordinating Committee", and Section 11 "Dispute Resolution" shall become effective immediately upon at least NMFS, USFWS, WDFW and the District signing this Agreement, to the extent that it does not require substantial construction or structural modification of the Dam.

The Parties agree to join with the District's filing with FERC requesting that FERC issue appropriate orders: (1) to amend the Project's existing license to include this Agreement as a condition thereof, and (2) to terminate the Mid-Columbia Proceeding as it relates to the Project.

The District shall revise its incidental take permit application for Permit Species based upon this Agreement, and submit a direct take application for the Hatchery Compensation Program. This Agreement and its figures, tables and appendices shall constitute the District's habitat conservation plan in support of the District's incidental take permit application. The Supporting Documents are to be used as supporting documents to the Agreement and as such, do not by themselves, create contractual obligations under this Agreement or through the Permit issued by NMFS.

The Parties shall provide reasonable efforts to expedite any NEPA, SEPA, and other regulatory processes required for this Agreement to become fully effective. The Parties (except the lead agency) may file comments with the lead agency. Such comments will not advocate additional Measures or processes for Plan Species. The Parties shall provide reasonable efforts to expedite the approval process of the District's incidental take permit application.

1.2.2 Upon Completion of Regulatory Reviews. The remainder of this Agreement shall become effective on the later of the follow dates (the latter date is the "Effective Date") that: (1) the FERC issues a final order approving this Agreement and incorporating it into the Project's license, (2) the NMFS issues the District a Permit for the Project based upon this Agreement, and (3) the USFWS completes necessary consultations under the ESA.

However, any Party may withdraw from this Agreement within sixty- (60) days of the Effective Date in the event that: (1) the NMFS issues the District a Permit with terms and conditions in addition to or different from those set forth in this Agreement, (2) the FERC fails to include this Agreement, in its entirety, or adds terms or conditions

inconsistent with this Agreement as a license condition of the current Project license or a new long term Project license approved within the term of this Agreement, or (3) a Party as a result of compliance with NEPA or SEPA requires a material change to the terms or conditions of this Agreement. In order to withdraw from this Agreement, a Party shall provide all other Parties with notice of withdrawal and state in the notice the reason for withdrawal. The ability of a Party to withdraw from this Agreement pursuant to this paragraph terminates if not exercised within said period. The notices required by this section shall be in writing and either served in person or provided by U.S. Mail, return receipt requested.

1.3 Early Termination Events. This Agreement shall terminate automatically before the end of its term: (1) in the event the FERC issues the District a non-power license for the Project, (2) in the event the FERC orders removal of the Project, (3) in the event the FERC orders drawdown of the Project, or (4) the District withdraws from this Agreement based on Section 2 "Withdrawal From Agreement".

1.4 Termination or Transfer of License. The District's obligations under this Agreement shall terminate in the event its FERC license is terminated or transferred to another entity. The Parties agree that the terms of this Agreement shall be binding on their respective successors and assigns.

1.5 Continuation of Measures Upon Termination. Except as set forth in Section 7.4.5 "Account Status Upon Termination", Sections 9.1.1 and 9.1.3, Section 10.4 "Permit Suspension, Revocation and Re-Instatement" and Section 10.5 "Early Termination Mitigation", upon expiration of this Agreement, or in the event this Agreement is terminated, voided or determined for any reason to be unenforceable before the end of its term, then: (1) the District shall continue to implement the last agreed to Measures until the FERC orders otherwise, and (2) the Parties are not restrained in any manner from advocating to the FERC measures to replace the Agreement.

SECTION 2 WITHDRAWAL FROM AGREEMENT

2.1 Enough Already.

2.1.1 A Party may withdraw from this Agreement when at least fifteen- (15) years have elapsed from March 1, 1998, subject to the following conditions: (1) No Net Impact (NNI) has not been achieved or has been achieved but has not been maintained, or (2) the Project has achieved and maintained NNI but the Plan Species are not rebuilding and the Project is a significant factor in the failure to rebuild.

2.1.2 If NMFS and the District are in agreement as to specific Measures to remedy the failure to achieve or maintain NNI and the District promptly implements agreed measures that are applicable to the District, NMFS will refrain from suspending or revoking the Permit. In the event that NNI has not been achieved or has been achieved but has not been maintained by March 1, 2013, but the District is otherwise performing all obligations assigned to it in the Permit, and is otherwise in full compliance with all

terms and conditions of this Agreement and the Permit, NMFS and USFWS will not exercise their right to withdraw from this Agreement or revoke the Permit unless such withdrawal is to seek drawdown, dam removal, non-power operations, or actions for achievement of NNI. Should the District, NMFS, and USFWS agree under these circumstances, such actions may be pursued without withdrawal from the Agreement or suspension or revocation of the Permit.

2.2 Non-Compliance. A Party may elect at any time to withdraw from the Agreement based on non-compliance of another Party with the provisions of the Agreement, but only subject to the following procedures: (1) a Party asserts that another Party is not complying with the terms of the Agreement, (2) the Party documents and presents evidence supporting assertion of non-compliance in writing, (3) the issue of non-compliance is taken to dispute resolution, Section 11 "Dispute Resolution", unless waived. Following dispute resolution, a Party choosing to withdraw shall provide all other Parties with notice of withdrawal. The notice shall be in writing and either served in person or provided by U.S. Mail return receipt requested. The right to withdraw shall be waived if not exercised within sixty- (60) days of dispute resolution being completed. Section 2.6 "Withdrawal of Another Party" applies upon a Party's receipt of the notice provided in this section.

2.3 Governmental Action. A Party may elect to withdraw from this Agreement in the event that an entity with regulatory authority takes action that (1) is detrimental to the achievement of the obligations set forth in this Agreement and (2) that materially alters or is contrary to one or more terms set forth in this Agreement.

2.4 Impossibility. A Party may elect to withdraw from the Agreement in the event the Parties agree in writing that the obligations imposed by this Agreement are impossible to achieve.

2.5 Revocation of Permit. A Party may elect to withdraw from the Agreement if the NMFS revokes the Permit.

2.6 Withdrawal of Another Party. Upon receipt of such notice any other Party shall have 120 days from the date of a Party's notice of intent to withdraw, to provide notice to all Parties of its intention to withdraw from this Agreement, or this right to withdraw shall be waived.

2.7 Conditions Precedent to Withdrawal. Two conditions must be satisfied before a Party can withdraw from the Agreement pursuant to Sections 2.3 "Governmental Action", 2.4 "Impossibility", 2.5 "Revocation of Permit" or 2.6 "Withdrawal of Another Party". First, the Party desiring to withdraw from the Agreement shall provide notice to all other Parties of its intent to withdraw. The notice shall be in writing and either served in person or provided by U.S. Mail return receipt requested. The notice shall state the date upon which the Party's withdrawal shall become effective. The date upon which the Party's withdrawal becomes effective shall be no less than sixty- (60) days from the date the notice was provided to all other Parties. Second, prior to the date upon which the

Party's withdrawal becomes effective the withdrawing Party (Parties) must make itself (themselves) available for at least one policy meeting to allow remaining Parties to attempt to persuade the withdrawing Party (Parties) not to withdraw. The policy meeting must take place within the sixty- (60) day period or it is waived.

2.8 Effect of Withdrawal. Except as set forth in Section 1.5 "Continuation of Measures Upon Termination", Sections 9.1.1 and 9.1.3, Section 10.4 "Permit Suspension, Revocation and Re-Instatement" and Section 10.5 "Early Termination Mitigation", in the event a Party withdraws from this Agreement, this Agreement places no constraints on the withdrawing Party, shall not thereafter be binding on the withdrawing Party, and the withdrawing Party may exercise all rights and remedies that the Party would otherwise have.

SECTION 3 SURVIVAL STANDARDS AND ALLOCATION OF RESPONSIBILITY FOR NO NET IMPACT

3.1 No Net Impact ("NNI") shall be achieved on the schedule set out herein and maintained for the duration of the Agreement for each Plan Species affected by the Project. NNI consists of two components: (1) 91% Combined Adult and Juvenile Project Survival achieved by project improvement Measures implemented within the geographic area of the Project, (2) 9% compensation for Unavoidable Project Mortality provided through hatchery and tributary programs, with 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. Measures and survival standards, as provided in Section 5 "Passage Survival Plan", Section 7 "Tributary Conservation Plan" and Section 8 "Hatchery Compensation Plan", shall be evaluated, as provided in Section 4.7 "Progress Reports", and achieved no later than March 2013. The inability to measure a standard due to limitations of technology shall not be construed as a success or a failure to achieve NNI as further explained in Section 5.2.1 91% Combined Adult and Juvenile Survival and Section 5.2.2 "93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival".

3.2 The District shall be responsible for achieving 91% Combined Adult and Juvenile Project Survival, or 93% Juvenile Project Survival or 95% Juvenile Dam Passage Survival as provided in Sections 3 and 5 for each Plan Species affected by the Project. The District shall implement measurement and evaluation programs once approved by the Coordinating Committee. The District shall also be responsible for (1) funding the Tributary Conservation Plan as provided in Section 7; (2) providing the capacity and funding for the 7% Hatchery Compensation Plan as provided in Section 8; and (3) making capacity and funding adjustments to the Hatchery Compensation Plan to reflect and fully compensate for future increases in the run size of each Plan Species as provided in Section 8.3 "Hatchery Production Commitments". If the District is unable to achieve 91% Combined Adult and Juvenile Project Survival or 93% Juvenile Project Survival or 95% Juvenile Dam Passage Survival then the District shall consult with the Parties through the Coordinating Committee to jointly seek a solution. If a solution cannot be

identified to achieve the survival standards identified herein any Party may take action under Section 2.4 “Impossibility” or other provisions of this Agreement.

3.3 The Tributary Committee and Hatchery Committee shall develop plans and programs, which must include evaluation procedures, necessary to implement the Tributary Conservation Plan and the Hatchery Compensation Plan, respectively to compensate for Unavoidable Project Mortality. If Unavoidable Project Mortality is not compensated for through the Hatchery Compensation Plan and the Tributary Conservation Plan, the Hatchery Committee and the Tributary Committee, respectively may examine additional hatchery and tributary improvements to meet the obligation. If the Hatchery Committee and the Tributary Committee are unable to develop plans and programs to fully implement the Hatchery Compensation Plan and Tributary Conservation Plans, respectively, to meet compensation levels necessary to compensate for Unavoidable Project Mortality, then the respective committees may consult with the Coordinating Committee to jointly seek a solution.

3.4 Implementation of Measures to meet NNI shall follow the time frames set out in the Agreement. Where a deadline is not specified, implementation of Measures shall occur as soon as is reasonably possible.

SECTION 4 COORDINATING COMMITTEE

4.1 Establishment of Committee. There shall be a Coordinating Committee composed of one (1) representative of each Party, provided, that the Power Purchasers may participate as a non-voting observer through a single representative, whom they will designate from time to time. Each representative shall have one vote. Each Party shall provide all other Parties with written notice of its designated representative to the Coordinating Committee.

4.2 Meetings. The Coordinating Committee shall meet whenever requested by any two-(2) members following notice.

4.3 Meeting Notice. The Chair of the Coordinating Committee shall provide all committee members with a minimum of ten- (10) day’s advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

4.4 Voting. The Coordinating Committee shall act by unanimous vote of those members present in person or by phone for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Coordinating Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Coordinating Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a

meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Coordinating Committee. A Party may invoke this right only once per delayed item. If the Coordinating Committee cannot reach agreement, then upon request by any Party that issue shall be referred to Dispute Resolution.

4.5 Chair of Coordinating Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Coordinating Committee. The Chair is expected to prepare an annual list of understandings based on the results of studies, prepare progress reports, prepare meeting minutes, facilitate and mediate the meetings, and assist the members of the Coordinating Committee in making decisions. At least every three years, the Coordinating Committee shall evaluate the performance of the Chair of the Coordinating Committee.

4.6 Use of Coordinating Committee. The Coordinating Committee will be used as the primary means of consultation and coordination between the District and the FP in connection with the conduct of studies and implementation of the Measures set forth in this Agreement and for dispute resolution. Any entity not executing this Agreement shall not be a Party to this Agreement and shall not be entitled to vote on any committee established by this Agreement. However, any committee established by this Agreement may agree to allow participation of any governmental entities not a Party to this Agreement.

4.7 Authority. The Coordinating Committee shall oversee all aspects of standards, methodologies, and implementation (see Section 4.9 "Methodologies"). The Coordinating Committee shall: (1) establish the protocol(s) and methodologies to determine whether or not the survival standards contained in Section 5 "Passage Survival Plan" are being achieved for each Plan Species; (2) determine whether the Parties are carrying out their responsibilities under this Agreement; (3) determine whether NNI is achieved (see definition "NNI Achieved"); (4) determine the most appropriate standard in Section 5 "Passage Survival Plan" to be measured for each Plan Species; (5) approve all studies prior to implementation; (6) review study results, determine their applicability, and develop an annual list of common understandings based on the studies; (7) provide input on the District's choice of Measures during Phase I; (8) periodically adjust the Measures (after Phase I) to address survival and Unavoidable Project Mortality as provided herein; provided that no more than 9% Unavoidable Project Mortality shall be made up through hatchery and tributary compensation without concurrence of the Coordinating Committee, and hatchery compensation shall not exceed 7% and tributary funding shall not exceed 2% unless agreed to by the Coordinating Committee; (9) resolve disputes brought by the Hatchery and Tributary Committees, and (10) adjust schedules and dates for performance. If the Coordinating Committee cannot reach agreement, then these decisions shall be referred to dispute resolution as set forth in Section 11 "Dispute Resolution".

4.8 Progress Reports. Each year, with the assistance of the Chair of the Coordinating Committee, the Hatchery Committee and the Tributary Committee shall prepare an annual report to the Coordinating Committee describing their progress. Each year, the Coordinating Committee shall prepare an annual report to the Parties describing the progress toward achieving the survival standards contained in Section 5 "Passage Survival Plan", and common understandings based upon the studies. Annual progress reports shall include information learned from all studies, even those that were not considered to be valid tests. By March 2013, a comprehensive progress report shall be prepared by the District, at the direction of the Coordinating Committee assessing overall status in achieving NNI, and shall include the status of each Plan Species. Comprehensive progress reporting shall continue to occur at successive ten-year intervals.

4.9 Studies and Reports. All studies and reports prepared under this Agreement will be available to all members of the Coordinating Committee as soon as reasonably possible. Draft reports will be circulated through the Coordinating Committee representatives for comment, which shall be due within sixty- (60) days unless the Coordinating Committee decides otherwise, and comments will either be addressed or made an appendix to the final report. All reports will be finalized by March 31 of the year following the year the studies were performed, unless otherwise agreed to by the Coordinating Committee. The reports will be kept on file at the District. All studies will be conducted following techniques and methodologies accepted by the Coordinating Committee. All studies will be based on sound biological and statistical design and analysis. The Coordinating Committee shall have the ability to select an independent, third party for the purpose of providing an independent scientific review of any disputed survival studies results and/or reports.

4.10 Methodologies/Test Fish. The Coordinating Committee shall approve and the District shall implement the measurement of the survival standards contained in Section 5 "Passage Survival Plan" using best available technology and study designs. The Coordinating Committee shall attempt whenever possible to coordinate studies with other studies being performed within the Columbia River basin. The Coordinating Committee shall facilitate the availability of test fish for studies, which may include the rearing of additional fish.

SECTION 5 PASSAGE SURVIVAL PLAN

5.1 Survival Standard Decision Matrix. The decision making process for implementation of the survival standards explained in Sections 5.2 "Implementation of the Survival Standards" and 5.3 "Phased Implementation of Measures to Achieve the Survival Standards" is graphically depicted in Figure 1 "Survival Standard Decision Matrix".

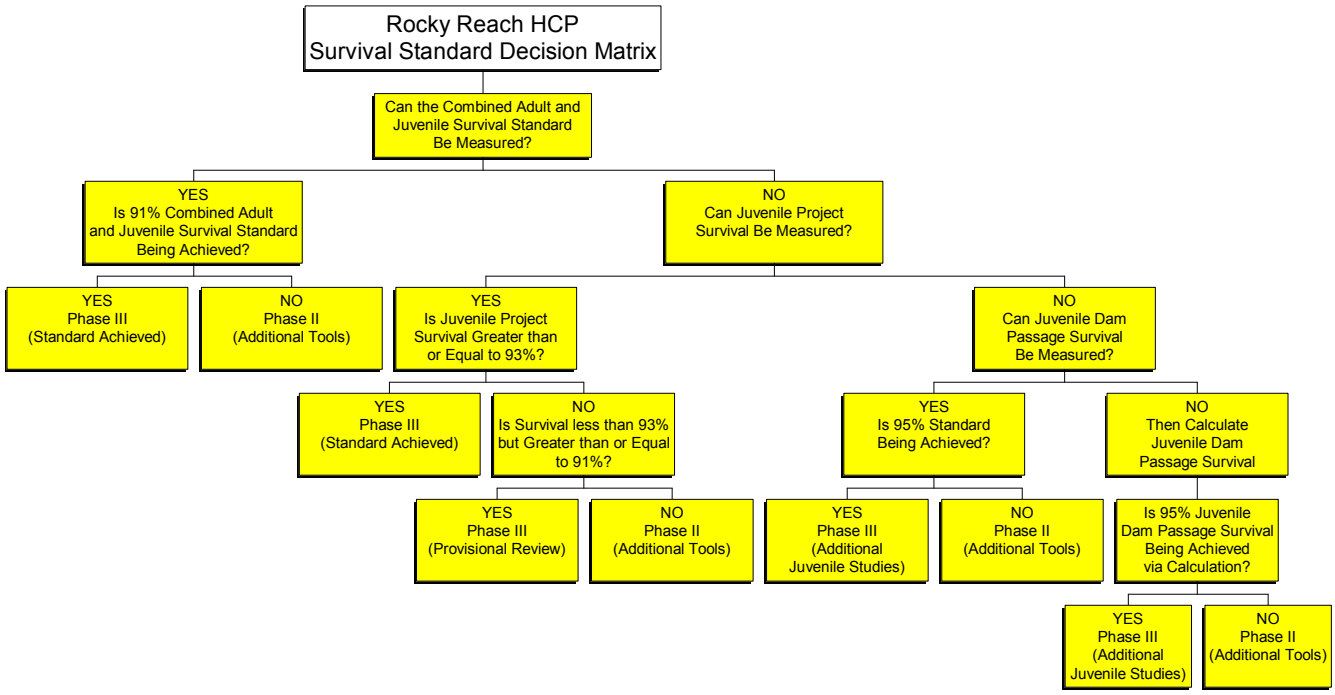


Figure 1, Survival Standard Decision Matrix.

5.2 Implementation of the Survival Standards

5.2.1 91% Combined Adult and Juvenile Survival. The District shall achieve and maintain Combined Adult and Juvenile Project Survival. The Combined Adult and Juvenile Survival standard is 91%. As of 2002, the Parties agree that adult fish survival cannot be conclusively measured for each Plan Species. Based on regional information, the Parties agree that adult survival is estimated to be 98-100%. Until technology is available to differentiate hydro-related mortality from natural adult losses, the District will implement the adult passage plan identified below. Given the present inability to differentiate between the sources of adult mortality, initial compliance with the Combined Adult and Juvenile Survival standard will be based upon the measurement of juvenile survival as provided below, Section "93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival". The District shall implement the measurement of adult survival at some time in the future if methodologies and study plans are agreed to by the Coordinating Committee. Mitigation measures will be adjusted at that time, if necessary, to address the new information.

5.2.2 93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival. Limitations associated with the best available technology have required the development of the following metrics for assessing juvenile fish survival standards at the Project. In order of priority they are (1) measured Juvenile Project Survival; (2) measured Juvenile Dam Passage Survival; and (3) calculated Juvenile Dam Passage Survival. The survival of each Plan Species shall be determined by the Coordinating Committee using one of these metrics, with subsequent evaluations implemented as appropriate, per the following guidelines. If the Combined Adult and Juvenile Project Survival cannot be measured, then Juvenile Project Survival shall be measured as the next best alternative until adult survival measurement is possible.

If Juvenile Project Survival for each Plan Species is measured to be greater than or equal to 93%, then the District will proceed to Phase III (Standard Achieved). The Juvenile Project Survival Standard is 93%. If Juvenile Project Survival is measured at less than 93% but greater than or equal to 91%, then the District will proceed to Phase III (Provisional Review). If Juvenile Project Survival is measured at less than 91%, then the District will proceed to Phase II (Additional Tools).

If Juvenile Project Survival cannot be measured, then Juvenile Dam Passage Survival shall be measured as the next best alternative until project measurement is possible. The Juvenile Dam Passage Survival standard is 95%.

For some Plan Species such as sockeye and sub-yearling chinook where measurement of Juvenile Dam Passage Survival and Juvenile Project Survival is not yet possible, the Juvenile Dam Passage Survival Standard will be calculated based on the best available information (including the proportion of fish utilizing specific passage routes and the use of off-site information), as determined by the Coordinating Committee. This calculation will consider the same elements as measured Juvenile Dam Passage Survival, except that off-site information may be used where site-specific information is lacking.

5.2.3 Methodologies. The survival standards set forth in Section 5 "Passage Survival Plan" shall be measured using the best available technology and study designs approved by the Coordinating Committee. Current methodologies are summarized in Supporting Document D "Briefing Paper Estimating Survival of Anadromous Fish through the Mid-Columbia PUD Hydropower Projects". These methodologies are not exclusive, and may be updated based on new information or techniques.

A valid study is one in which the study design, implementation, and criteria are determined to have been met by the Coordinating Committee, and one in which the study took place during Representative Flow Conditions and normal project operating conditions consistent with the approved study design. The Coordinating Committee will evaluate each study after it is completed to see if previously agreed-to criteria are met. All studies will be evaluated for quality control. If the Committee agrees that critical criteria were violated, then the study will not be included in the overall average over the

three years of testing, and an additional year of testing will take place. In the event that the additional year's test is invalid, the Coordinating Committee will decide how to address the requirement for three years of testing.

Survival studies shall be measured at a ninety-five percent (95%) confidence level, with a standard error of the estimate that shall be not more than plus or minus 2.5% (i.e. 5% error). A study result meeting this precision level will automatically be included in the three-year average, unless the study is determined to be invalid by the Coordinating Committee for other reasons. If, however, a study is considered to have met all other testing protocols, and the Coordinating Committee agrees, it may be included in the calculation of the three-year average so long as the standard error around the point estimate does not exceed plus or minus 3.5%. This decision is not subject to Dispute Resolution.

Point estimates of survival measurements from the three years of studies shall be averaged (arithmetic mean). The point estimate of the average will be used to compare against the pertinent survival standard. If the averaged point estimates equals or exceeds the survival standard, then the standard has been achieved. If the average of the 3 years of survival measurements is no more than 0.5 percent below the survival standard, the Coordinating Committee may decide whether an additional year of study is appropriate. If an additional year of study is undertaken, the study result (if valid) will be included in the calculation of the arithmetic mean.

5.3 Phased Implementation of Measures to Achieve the Survival Standards. The survival standards contained in this Section 5 "Passage Survival Plan" will be achieved in three phases. Under Phase I, the District shall implement the "Phase I Plan to Achieve the Survival Standards" set forth in Section 5.3.1. Studies will be conducted to determine the survival rates beginning in 2004 and lasting for three years, unless additional years of studies are agreed to by the Coordinating Committee. Following the completion of the three-year studies, the Coordinating Committee will determine whether the pertinent survival standards have been achieved. Depending on the results of this determination, the District will either proceed to Phase II (if the applicable survival standard has not been achieved) or Phase III (if the applicable survival standard has been achieved). Phase III also includes steps designed to address gaps in the available information. Juvenile survival studies conducted during Phase I may result in different phase designations for each of the plan species. For example, the District may move to: Phase II (Additional Tools); Phase III (Standard Achieved); Phase III (Provisional Review); or to Phase III (Additional Juvenile Studies) as described in Figure 1, depending on the survival results for individual plan species. If the Coordinating Committee cannot agree on Phase designation, the Coordinating Committee may agree to require an additional year of study to resolve the disagreement, or a Party may institute Section 11 "Dispute Resolution" to determine the Phase designation or address the need for Additional Tools during the period of measurement and evaluation.

5.3.1 Phase I Testing. Assuming that the final bypass construction is completed by the 2003 juvenile migration, the District will use the first year of the operation (2003) of the juvenile bypass system to identify operational and maintenance modifications that may be needed. The District will conduct a pilot study, estimating the parameters that will be used in future survival studies. The District will begin testing the applicable survival standard in 2004.

Beginning in 2004, the District proposes to use acoustic tag technology to measure Juvenile Dam Passage Survival or Juvenile Project Survival. Current coordination between the District, consultants, NMFS Science Center, and the USGS Biological Research Division is ongoing to design and develop the acoustic tag survival methodology. The results of this effort will then be presented to the Coordinating Committee before study implementation for approval. Between 2004 and 2006, chinook yearlings will be tested. Steelhead tests will begin between 2004 and 2006 as determined by the Coordinating Committee. Sockeye and sub-yearling chinook will be tested if technology exists, or will be calculated as discussed above if not measured by the end of Phase I testing.

5.3.2 Phase II (Additional Tools). If the Coordinating Committee has determined, based on Phase I monitoring and evaluation or Phase III periodic monitoring, that Juvenile Project Survival is less than 91% or Juvenile Dam Passage Survival (measured or calculated) is less than 95%, the District shall move to Phase II for that Plan Species.

(Phase II Additional Tools). If measurement and evaluation concludes that the survival standard(s) being evaluated are not achieved, the Coordinating Committee shall decide on additional Tools for the District to implement in order to achieve the survival standard(s) being evaluated using the following criteria: Likelihood of biological success; Time required to implement; and Cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness. Until the survival standard(s) being evaluated are achieved, the Parties shall continue to implement Phase II (Additional Tools) for the standard and for each Plan Species that is not meeting the pertinent survival standard, except as set forth in Section 2.4 “Impossibility”. The Coordinating Committee will determine the number of valid studies (not to exceed three years) necessary to make a phase determination following the implementation of Additional Tools.

5.3.3 Phase III (Standard Achieved or Provisional Review or Additional Juvenile Studies). The District proceeds to Phase III upon a determination by the Coordinating Committee that the District has (1) verified compliance with the Combined Adult and Juvenile Survival or measured Juvenile Project Survival (Standard Achieved), (2) has evaluated Juvenile Project Survival at less than 93% but greater than or equal to 91% (Provisional Review), or (3) has measured or calculated 95% Juvenile Dam Passage Survival (Additional Juvenile Studies). In short, Phase III indicates that the appropriate standard has either been achieved or is likely to have been achieved and provides additional or periodic monitoring to ensure that survival of the Plan Species remains in

compliance with the survival standards in this Section 5 "Passage Survival Plan" for the term of the Agreement.

(Phase III Standard Achieved). The District shall proceed to Phase III (Standard Achieved) following measurement and evaluation that indicate that either the 91% Combined Adult and Juvenile Survival Standard or 93% Juvenile Project Survival is being achieved. In this case, the District shall re-evaluate survival under the applicable standard every 10 years. Representative species shall be picked by the Coordinating Committee. This re-evaluation will occur over one year and be included in the pertinent average for that particular species. If the survival standard is met, then Phase III (Standard Achieved) status will remain. If the survival standard is not met, then an additional year of testing will occur. If the survival standard remains unmet over three years of re-evaluation, then Phase II designation will take affect for the representative species, and the Coordinating Committee shall re-evaluate the survival of other Plan Species, as appropriate. If the survival standard has been exceeded, the Coordinating Committee shall reduce spill for the next juvenile migration so that the survival standard is achieved, but not exceeded; provided that, if multiple species are migrating at the same time, the Coordinating Committee cannot reduce spill during a time at which a reduction would prevent another species from achieving the survival standard (see Example 1 below).

> Example 1. Steelhead and sockeye migrate during the spring but at different times. Steelhead and sockeye will likely require different levels of spill. It could be possible to reduce spill during the portion of the steelhead migration that does not overlap with sockeye so that the survival standard for steelhead is achieved during this portion of its migration. But, during the period where the sockeye migration overlaps with the steelhead migration, the spill needs of sockeye control the amount of spill provided at the Project. It is accepted by the District that this greater level of spill will result in steelhead exceeding the survival standard during the period of the steelhead migration where steelhead and sockeye are migrating together. The increase in steelhead survival during this period of combined migration will not result in a reduction of spill during the portions of the steelhead migration where steelhead are migrating alone so that the average survival of steelhead throughout their migration achieves the survival standard.

If spill is reduced, the Coordinating Committee shall oversee additional one to three years of testing to confirm achievement of the survival standard under the new operations.

(Phase III Provisional Review.) The District shall proceed to Phase III (Provisional Review) when Juvenile Project Survival studies indicate that Plan Species survival is less than 93% but greater than or equal to 91%. Provisional Review allows the District a one time (plan species specific) five-year period to implement additional measures or conduct additional juvenile or additional adult survival studies to more accurately determine whether the pertinent survival standard is being achieved. If at the end of this period Juvenile Project Survival is still less than 93% but greater than or equal to 91% and the Combined Adult and Juvenile Survival Studies are inconclusive, then the District will move to Phase II (Additional Tools). When the Provisional Review Studies indicate that the Combined Adult and Juvenile Survival estimates are greater than or equal to 91% or when the Juvenile Project Survival Studies indicate that survival is greater than or equal to 93% then the District shall proceed to Phase III (Standard

Achieved). If the Provisional Review Studies indicate that the 95% Juvenile Dam Passage Survival Standard has been achieved through direct measurement or calculation, then the District shall proceed to Phase III (Additional Juvenile Studies).

(Phase III Additional Juvenile Studies). The District shall proceed to Phase III (Additional Juvenile Studies) when Juvenile Dam Passage Survival studies or Juvenile Dam Passage calculations indicate that Juvenile Dam Passage Survival is greater than or equal to 95%. Because measurement or calculation of Juvenile Dam Passage Survival does not address juvenile mortality in the pool or the indirect effects of juvenile project passage, the District will evaluate either the 91% Combined Adult and Juvenile Project Survival or the 93% Juvenile Project Survival as determined appropriate by the Coordinating Committee. If at any time during Phase III (Additional Juvenile Studies), the Coordinating Committee approves the use of new survival methodologies, the District will have five years to conduct the appropriate evaluations. The Parties will then proceed based upon the results of these new studies. This re-evaluation will occur over one year. If the survival standard is met, then Phase III (Standard Achieved) status will remain. The Coordinating Committee will determine the number of valid studies (not to exceed three years) necessary to make a phase determination following the implementation of Additional Tools.

5.4 Phase 1 Plan to Achieve Survival Standards. The District shall implement the following activities starting in 2002 and continuing until at least the conclusion of Phase I studies.

5.4.1 Juvenile Measures

a. Adjustment Period. During the 2002 juvenile migration, the District shall operate its prototype bypass system as set forth in Section 5.4.1(b) below, provide the spill as set forth in Section 5.4.1 (c) below, and provide the predator control as set forth in Section 5.4.1 (d) below.

In December of 2001, the District has pending before FERC an application to amend its license for the Project to install a permanent bypass system. Upon construction of the final bypass for the 2003 juvenile migration as scheduled, the District will operate the bypass, provide spill, and provide predator control as it did in 2002. In order to obtain information about the newly constructed bypass, in 2003 the District shall also conduct a fish passage efficiency study of the bypass system for each Plan Species. The Coordinating Committee shall approve the study plan.

Upon completion of the 2003 fish passage efficiency study and before March 1, 2004, operation of the bypass and spill for the 2004, 2005 and 2006 juvenile migrations will be decided by the District as follows, unless the Coordinating Committee approves a more accurate method for adjusting the operation of the bypass and spill, if a species' 2003 bypass FPE is less than or greater than the historic total FPE for chinook yearlings (see Table 1 "Historic Total FPE for Chinook Yearlings"), then spill for that species will be adjusted to cover 95% of the migration as follows:

$$\frac{\text{(historic total FPE for chinook yearling) – (bypass FPE}_{species})}{\text{spill efficiency}_{species}}$$

b. Bypass. The District will continue to operate the juvenile salmonid bypass system at Rocky Reach Dam to meet the criteria set out below. The District shall operate the bypass system continuously between April 1 and August 31. Operation of the bypass system outside the specified dates above (either before April 1 or after August 31) will occur when it can be demonstrated it is necessary to encompass 95% of the juvenile migration of a Plan Species. The basis for making this determination shall be based on periodic fish capture information from the bypass system in addition to video counts from 1995-2001, or other empirical information agreed to by the Coordinating Committee. Additional run timing information and species composition monitoring shall be conducted once every 10 years in order to verify that a significant component (greater than 5%) of the juvenile emigration is not present outside the normal bypass operating period (April 1 through August 31) and to verify that the operations established by the Coordinating Committee are adequately protecting 95% of the spring and summer migrations of juvenile Plan Species. Turbine units 1 and 2 will be given high operating preference for project operations during the juvenile salmonid migration (note - "split-station" service needs dictate at least one turbine unit from units 5-11 must operate to maintain plant safety when flows allow only two units to run).

c. Spill. For the 2002 and 2003 juvenile migrations, spill will supplement the bypass system as set forth below. For the 2004, 2005, and 2006 juvenile migrations, spill will supplement the bypass system, as necessary to achieve the fish passage efficiency required by Section 5.4.1 (a) above. For the 2007 juvenile migration and beyond, spill will supplement the bypass system as necessary to achieve the survival standards as set forth in Section 5.3 "Phased Implementation of Measures to Achieve the Survival Standards"(see also Figure 1 "Survival Standard Decision Matrix").

In the spring 2002 and 2003, the District will spill fifteen percent of the Daily Estimated Flow during a period coinciding with the 95% passage of each spring migrating Plan Species' juvenile migration. However, spring spill shall be increased to twenty-five percent of the Daily Estimated Flow during the period coinciding with the passage of the juvenile sockeye salmon migration, provided that, twenty-five percent spill not exceed twenty-one (21) days in duration. The Coordinating Committee shall decide when sockeye spill starts and ends. Spring spill shall begin no later than April 20th of each year, but the date may be adjusted by the Coordinating Committee based upon in-season migration information. Spring spill shall generally end no later than June 15th of each year, but the date may be adjusted by the Coordinating Committee based upon in-season migration information.

In the summer 2002 and 2003, the District will spill fifteen percent of the Daily Estimated Flow during a period coinciding with the 95% passage of the sub-yearling chinook juvenile migration. Summer spill shall begin no later than July 1st of each year, but the date may be adjusted by the Coordinating Committee based upon in-season migration information. Summer spill shall generally end no later than August 15th of each

year, but the date may be adjusted by the Coordinating Committee based upon in-season migration information. The Coordinating Committee shall investigate the need for a spill efficiency study in the summer of 2003. The Coordinating Committee shall also investigate the potential for changing spill operations to utilize the agreed to spill levels more efficiently.

d. Predator Control. The District will conduct control efforts for both northern pikeminnow and piscivorous bird populations for the protection of juvenile Plan Species. Northern pikeminnow will be primarily controlled by utilizing anglers at the dam. Northern pikeminnow tend to congregate in the Tailrace and anglers will exploit this population during the spring and summer months. The pikeminnow removal program may also be expanded to include not only the dam itself, but also the whole reservoir. This may be accomplished by implementing a bounty reward program and using sport anglers to assist in our control efforts. Long lines and trapping may also be utilized to supplement the dam angling and further exploit the pikeminnow population. Piscivorous bird populations, which include, Caspian terns, double-crested cormorants, and various gull species will be hazed. Hazing techniques may include elaborate wire arrays in the tailrace to deter foraging, propane cannons, various pyrotechnics, and lethal control when necessary. This program will continue to run during the juvenile outmigration.

5.4.2 Adult Measures. The District shall emphasize adult project passage Measures in order to give high priority to adult survival in the achievement of 91% Combined Adult and Juvenile Project Survival for each Plan Species. To accomplish this, the District shall implement at least the following Tools:

a. The District shall use best efforts to maintain and operate adult passage systems at the Project according to criteria developed through the Coordinating Committee and as provided in the DFOP.

b. Areas within the adult fish passage systems which are identified by the Coordinating Committee as either continuously out of criteria or where significant delay occurs (as it relates the biological fitness of the adult Plan Species) shall be addressed as soon as feasible.

c. The District shall use best efforts to eliminate identified sources of adult injury and mortality during adult migration through the Dam.

d. By the end of Phase I, the District shall identify adult fallback rates at the Dam. This evaluation will include the magnitude of voluntary and involuntary fallback, will assess how ladder trapping, project operations, the influence of the Turtle Rock Fish Hatchery, and the Wenatchee River have upon observed rates of fallback. This assessment will also determine the biological significance of these fallback events on the overall fitness of adult Plan Species. If the observed rates of adult fallback and steelhead kelt loss are determined to make a significant difference in meeting the relevant survival standard, then the Coordinating Committee shall determine the most cost effective

methods to protect adult fallbacks and steelhead kelts at the Dam, and the District shall immediately implement the agreed to Measures. Reduction in fallback rates, mortalities and protection of kelts shall be factored into juvenile bypass and adult passage development and implementation and into Project operation decisions. Before the District is asked to implement additional operation of the bypass system or other measures for kelts or fallbacks, there will need to be a high level of certainty that these Measures will make a significant difference in meeting the relevant survival standard.

e. The Parties to this Agreement recognize that current technology does not allow for a precise estimate of hydroelectric project induced mortality to adult salmonids. Until adult survival studies can accurately differentiate between natural and hydro-project inducted mortality, the District shall use the best available technology to conduct, on a periodic basis, adult passage verification studies toward the diagnosis of adult loss, injury and delay at Rocky Reach Dam. Prior to the completion of adult survival studies, compensation for adult mortality shall be assumed completely fulfilled by the District's contribution to the Tributary Fund. Following the completion of adult survival studies, should adult survival rates fall below 98% but the Combined Adult and Juvenile survival rate be maintained above 91%, additional hatchery compensation for that portion of adult losses that exceeds 2%, toward a maximum contribution of 7% hatchery funding and 2% tributary funding, would be utilized to satisfy NNI compensation requirements for each Plan Species.

f. Pursuant to the 2000 Biological Opinion for the Federal Columbia River Power System (the "Bi-Op"), federal action agencies are required to conduct a comprehensive evaluation to assess adult survival at federal dams. The Bi-Op sets forth a series of evaluation methods to be employed. The Coordinating Committee should review the information and techniques utilized in those studies and evaluate their potential for accurately measuring Combined Adult and Juvenile Project Survival. The Coordinating Committee should also evaluate technologies found at the federal dams to increase adult survival for possible implementation at the Project. Based upon those evaluations, the District shall implement as necessary technologies appropriate for the Project.

SECTION 6 RESERVOIR HABITAT AND WATER QUALITY

6.1 When making land use or related permit decisions on Project owned lands that affect reservoir habitat, the District shall consider the cumulative impact effects in order to meet the conservation objectives of the Agreement, requirements of the FERC license, and other applicable laws and regulations. The District further agrees to notify and consider comments from the Parties to the Agreement regarding any land use permit application on Project owned lands.

6.2 The District shall notify all applicants for District permits to use or occupy Project lands or water that such use or occupancy may result in incidental take of species listed as endangered or threatened under the ESA, requiring advance authorization from NMFS or USFWS.

6.3 The Parties recognize that there are potential water quality issues (temperature and dissolved gas) related to cumulative hydropower operations in the Columbia River. The Parties will work together to address water quality issues.

SECTION 7 TRIBUTARY CONSERVATION PLAN

7.1 Tributary Plan. The Tributary Conservation Plan ("Tributary Plan") consists of this Agreement and is supported by Supporting Document A "Tributary Plan, Project Selection, Implementation, and Evaluation", and Supporting Document B "Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers". The Parties recognize that Supporting Documents A and B do not by themselves create contractual obligations.

7.2 Purpose. Under the Tributary Plan, the District shall provide a Plan Species Account to fund projects for the protection and restoration of Plan Species' habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat and Wenatchee River watersheds, in order to compensate for two percent of Unavoidable Project Mortality; provided that the Parties shall not be required to actually measure whether the Tributary Plan compensates for two percent Unavoidable Project Mortality. The Tributary Committee shall make sure that an appropriate amount of projects are chosen above the Rocky Reach Tailrace.

7.3 Tributary Committee

7.3.1 Establishment of Committee. There shall be a Tributary Committee composed of one (1) representative of each Party, provided that an entity eligible to appoint a representative to the Tributary Committee is not required to appoint a representative, and further provided that, representatives from USFWS shall participate in a non-voting, ex-officio capacity unless they otherwise state in writing, and further provided that, the Power Purchasers may participate as a non-voting observer through a single representative, whom they will designate from time to time. The Tributary Committee may select other expert entities, such as land and water trusts/conservancy groups to serve as additional, non-voting members of the Tributary Committee. Each entity eligible to appoint a representative to the Tributary Committee shall provide all other eligible entities with written notice of its designated representative. The Tributary Committee is charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Plan.

7.3.2 Meetings. The Tributary Committee shall meet not less than twice per year at times determined by the Tributary Committee. Additionally, the Tributary Committee may meet whenever requested by any two-(2) members following notice.

7.3.3 Meeting Notice. The Chair of the Tributary Committee shall provide all committee members with a minimum of ten- (10) day's advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

7.3.4 Voting. Except as set forth in Section 7.4.2 "Prohibited Use of Account", the Tributary Committee shall act by unanimous vote of those members present in person or by phone for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Tributary Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Tributary Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Tributary Committee. A Party may invoke this right only once per delayed item. If the Tributary Committee cannot reach agreement, then upon request of any Party, that issue shall be referred to the Coordinating Committee.

7.3.5 Chair of Tributary Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Tributary Committee. The Chair of the Tributary Committee shall have the same responsibilities and authorities with regard to the Tributary Committee as the Chair of the Coordinating Committee has with regard to the Coordinating Committee. At least every three years, the Tributary Committee shall evaluate the performance of the Chair of the Tributary Committee.

7.4 Plan Species Account.

7.4.1 Establishment of Account. The District shall establish a Plan Species Account in accordance with applicable provisions of Washington State law and this Agreement. Interest earned on the funds in the Plan Species Account shall remain in the Plan Species Account. The Parties to this Agreement may audit the District's records relating to the Account during normal business hours following reasonable notice. The Tributary Committee shall select projects and approve project budgets from the Plan Species Account by joint written request of all members of the Tributary Committee. The Tributary Committee shall act in strict accordance with Section 7.4.2 "Prohibited Use of Account".

7.4.2 Prohibited Uses of Account. No money from the Plan Species Account shall be used to enforce compliance with this Agreement. Members of the Tributary Committee and their expenses shall not be compensated through the Plan Species Account. Administrative costs, staffing and consultants, reports and brochures, landowner assistance and public education costs collectively shall not exceed $80,000 in 1998 dollars in any given year without the unanimous vote of the Tributary Committee.

7.4.3 Reports. At least annually, the District shall provide financial reports of Plan Species Account activity to the Tributary Committee.

7.4.4 Ownership of Assets. Determinations regarding ownership of real and personal property purchased with funds from the Plan Species Account shall be made by the Tributary Committee. Title may be held by the District, by a resource agency or tribe or by a land or water conservancy group, as determined by the Tributary Committee. Unless the Tributary Committee determines that there is a compelling reason for ownership by another entity, the District shall have the right to hold title. All real property purchased shall include permanent deed restrictions to assure protection and conservation of habitat.

7.4.5 Account Status Upon Termination. Upon the Agreement's termination, (1) the District's unspent advance contributions to the Plan Species Account shall be promptly released to the District, (2) if funds remain in the Plan Species Account after the return of the District's advance contributions, then the Tributary Committee shall remain in existence and continue to operate according to the terms of this Agreement until the funds in the Plan Species Account are exhausted, and (3) all real and personal property which the District holds title shall remain its property.

7.5 Plan Species Account Funding

7.5.1 While this Agreement remains in effect, the District shall contribute $229,800, in 1998 dollars, annually to the Plan Species Account. By joint written request, the JFP and American Rivers, Inc.'s representatives to the Tributary Committee may elect for the District to contribute, in advance, any of the annual payments to be made during the first fifteen years of the Agreement, provided that, (1) each annual payment shall be adjusted by the District for inflation based upon a nationally recognized index, (2) the total adjusted amount shall be reduced to present value by the actual discount rate applicable to the District, and reduced by the District's actual cost of financing, and (3) each election shall be for a minimum of three annual payments.

7.5.2 The first installment is due within ninety- (90) days of the Effective Date of the Agreement. The rest of the installments are due by the 31st day of January each year thereafter. The dollar figures shall be adjusted for inflation on the 1st day of January each year based upon the "Consumer Price Index for all Urban Consumers" for the Seattle/Tacoma area, published by the U.S. Department of Labor, Bureau of Labor Statistics. If said index is discontinued or becomes unavailable, a comparable index suitable to the Tributary Committee shall be substituted.

7.6 Tributary Assessment Program. The District shall provide support for a tributary assessment program separate from the Plan Species Account. The tributary assessment program will be utilized to monitor and evaluate the relative performance of projects approved by the Tributary Committee and directly funded by the initial contribution to the Plan Species Account. It is not the intent of the tributary assessment program to measure whether the Plan Species Account has provided a 2% increase in survival for Plan Species. Instead, the program has been established to ensure that the dollars allocated to the Plan species Account are utilized in an effective and efficient manner. The District shall develop, in coordination with and subject to an approval by the

Tributary Committee, the measurement protocols for the tributary assessment program. The Tributary Committee may choose to either evaluate the relative merits of each project or it may choose to evaluate an aggregation of projects provided that the total cost associated with the tributary assessment program does not exceed $200,000 (not subject to inflation adjustment).

7.7 Project Selection.

7.7.1 Geographic Area and Types of Projects. The Tributary Committee shall select projects and approve budgets for expenditure from the Plan Species Account for the following: (1) Any action, structure, facility, program or measure (referred to herein generally as "projects") intended to further the purpose of the Tributary Plan for Plan Species. Projects shall be chosen based upon the guidelines set forth in Supporting Document A "Tributary Plan Project Selection, Implementation, and Evaluation" and Supporting Document B "Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers". Projects shall not be implemented outside the area specified in Section 7.2 "Purpose". High priority shall be given to the acquisition of land or interests in land such as conservation easements or water rights or interests in water such as dry year lease options; (2) Studies, implementation, monitoring, evaluation, and legal expenses associated with any project financed from the Plan Species Account; and (3) Prior approved administrative expenses associated with the Plan Species Account.

7.7.2 Coordination With Other Conservation Plans. Whenever feasible, projects selected by the Tributary Committee shall take into consideration and be coordinated with other conservation plans or programs. Whenever feasible, the Tributary Committee shall cost-share with other programs, seek matching funds, and "piggy-back" programs onto other habitat efforts.

7.7.3 Conflict of Interest. After full written disclosure of any potential conflict of interest, which shall appear in the minutes of the Tributary Committee and prior to project approval, the Tributary Committee may approve a project that may benefit a person or entity related to a committee member, or an entity which appointed the committee member.

SECTION 8 HATCHERY COMPENSATION PLAN

8.1 Hatchery Objectives

8.1.1 The District shall provide hatchery compensation for Plan Species (spring chinook salmon, summer chinook salmon, fall chinook salmon, sockeye salmon, coho salmon upstream of Rock Island Dam origin, and summer steelhead). This compensation may include Measures to increase the off-site survival of naturally spawning fish or their progeny.

8.1.2 The District shall implement the specific elements of the hatchery program consistent with overall objectives of rebuilding natural populations and achieving NNI. Species specific hatchery programs objectives developed by the JFP may include

contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest.

8.2 Hatchery Committee.

8.2.1 Establishment of the Committee. There shall be a Hatchery Committee composed of one (1) representative of each Party, provided that a Party is not required to appoint a representative and further provided that the Power Purchasers may participate as a non-voting observer through a single representative whom they will designate from time to time. A Party shall provide all other Parties with written notice of its designated representative.

8.2.2 Responsibilities. The Hatchery Committee shall oversee development of recommendations for implementation of the hatchery elements of the Agreement that the District is responsible for funding. This includes overseeing the implementation of improvements, monitoring and evaluation relevant to the District's hatchery programs, as identified in the Hatchery Compensation Plan, the Permit and this Agreement. Hatchery Committee decisions shall be based upon: Likelihood of biological success; Time required to implement; and Cost-effectiveness of solutions. The Hatchery Committee shall also coordinate in-season information sharing and shall discuss unresolved issues.

8.2.3 Meetings. The Hatchery Committee shall meet twice per year or whenever requested by any two-(2) members following notice.

8.2.4 Meeting Notice. The Chair of the Hatchery Committee shall provide all committee members with a minimum of ten- (10) day's advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

8.2.5 Voting. The Hatchery Committee shall act by unanimous vote of those members present in person or by phone for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Hatchery Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Hatchery Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Hatchery Committee. A Party may invoke this right only once per delayed item. If the Hatchery Committee cannot reach agreement, then upon request of any Party, that issue shall be referred to the Coordinating Committee.

8.2.6 Chair of Hatchery Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Hatchery Committee. The Chair of the Hatchery Committee shall have the same responsibilities and authorities with regard to the Hatchery Committee as the Chair of the Coordinating Committee has with

regard to the Coordinating Committee. At least every three years, the Hatchery Committee shall evaluate the performance of the Chair of the Hatchery Committee.

8.3 Hatchery Operations. The District or its designated agents shall operate the hatchery facilities according to the terms of this Section 8 "Hatchery Compensation Plan", the ESA Section 10 permit(s), and in consultation with the Hatchery Committee.

8.4 Hatchery Production Commitments.

8.4.1 Hatchery Agreements. The District may enter into agreements with other entities for the rearing, release, monitoring and evaluation and research of hatchery obligations. The Hatchery Committee must approve any proposed agreements or trades of production. However, it is the District's responsibility to ensure that their obligations under Section 8 (Hatchery Compensation Plan) are satisfied.

8.4.2 Calculation of Hatchery Levels. The District shall provide the funding and capacity required of the District to meet the 7% hatchery compensation level necessary to achieve NNI for all Plan Species. As set forth below, the initial estimated hatchery production capacities for Plan Species needed to compensate for Unavoidable Project Mortality are based on average adult returns of Plan Species for a baseline period, a 7% compensation requirement, and baseline adult to smolt survival rates for existing mid-Columbia River hatcheries. Juvenile Project Survival estimates, when available, will be used to adjust hatchery based compensation programs. However, should adult survival rates fall below 98% but the Combined Adult and Juvenile survival rates is maintained above 91%, additional hatchery compensation for adult losses, toward a maximum contribution of 7% hatchery compensation, would be utilized to provide compensation for Unavoidable Project Mortality. The rationale for determining the initial capacity requirement is supported by Supporting Document C, "Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Program". The Parties recognize that Supporting Document C is a supporting document and does not by itself, create contractual obligations.

8.4.3 Periodic Adjustment of District Hatchery Levels. Hatchery production levels, except for original inundation mitigation, shall be adjusted in 2013 and every 10 years thereafter as is required to adjust for changes in the average adult returns of Plan Species and for changes in the adult-to-smolt survival rate, and for changes to smolt-to-adult survival rate from the hatchery production facilities, considering methodologies described in the BAMP. The Hatchery Committee will be responsible for determining program adjustments considering the methodology described in BAMP and providing recommended implementation plans to the District. The District will be responsible for funding the implementation plan.

a. Coho. Hatchery compensation for Methow River coho will be assessed in 2006 following the development of a continuing coho hatchery program and/or the establishment of a Threshold Population of naturally reproducing coho in the Methow Basin (by an entity other than the District and occurring outside this Agreement). The Hatchery Committee shall determine whether a hatchery program and/or, naturally

reproducing population of coho is present in the Methow Basin. Should the Hatchery Committee determine that such a program or population exists, then (1) the Hatchery Committee shall determine the most appropriate means to satisfy the 7% hatchery compensation requirement for Methow Basin coho, and (2) the District shall have the next juvenile migration to adjust juvenile protection Measures to accommodate Methow Basin coho. Thereafter, Coordinating Committee shall determine the number of valid studies (not to exceed three years) necessary to make a juvenile phase determination. Programs to meet NNI for Methow Basin coho may include but are not limited to: (1) provide operation and maintenance funding in the amount equivalent to 7% project passage loss, or (2) provide funding for acclimation or adult collection facilities both in the amount equivalent to 7% juvenile passage loss at the Project. The programs selected to achieve NNI for Methow Basin coho will utilize an interim value of project survival, based upon a Juvenile Project Survival estimate of 93%, until juvenile project survival studies can be conducted on Methow Basin coho.

b. Okanogan Basin Spring Chinook. Hatchery compensation for Okanogan Basin spring chinook will be assessed in 2007 following the development of a continuing spring chinook hatchery program and/or the establishment of a Threshold Population of naturally reproducing spring chinook in the Okanogan watershed (by an entity other than the District and occurring outside this Agreement). The Hatchery Committee shall determine whether a hatchery program and/or naturally reproducing population of spring chinook is present in the Okanogan Basin. Should the Hatchery Committee determine that such a program or population exists, then the Hatchery Committee shall determine the most appropriate means to satisfy the 7% hatchery compensation requirement for Okanogan Basin spring chinook. Programs to meet the 7% hatchery requirement for Okanogan Basin spring chinook may include but not be limited to: (1) operation and maintenance funding in the amount equivalent to 7% project passage loss or (2) replace project passage losses of hatchery spring chinook with annual releases of equivalent numbers of yearling summer chinook into the Okanogan River Basin or (3) provide funding for acclimation or provide funding for adult collection facilities in the amount equivalent to 7% juvenile passage loss at the Rocky Reach Project. The programs selected to achieve NNI for Okanogan Basin spring chinook will utilize an interim value of project survival, based upon a Juvenile Project Survival estimate of 93%, until project survival studies can be conducted on Okanogan Basin yearling chinook.

8.4.4 Initial Hatchery Program Levels. The District will continue to fund the operation and maintenance of the Rocky Reach Fish Hatchery and a portion of Chelan Fish Hatchery, a portion of the production in excess of 7% currently provided by the Rock Island Hatchery Complex, and other facilities necessary to meet production levels. The Parties agree that the initial production commitments to be provided by the District to satisfy 7% Unavoidable Project Mortality and compensation for original inundation are satisfied with production as follows below (See Table 2 for initial production levels, and production levels necessary to achieve 7% Unavoidable Project Mortality). The initial production levels will be maintained until 2013 unless otherwise agreed to by the Hatchery Committee.

a. Spring chinook: 7,500 pounds at about 12 fish per pound (90,000 fish); (the Hatchery Committee will determine if this commitment can be met through either the Okanogan Spring chinook program (see above), or another program (such as utilizing extra space in the Methow Hatchery) and, until 2013, 9,600 pounds at about 15 fish per pound (144,000 fish) at the Methow Hatchery (50% of proportion raised for Rock Island hatchery program). (The intent of the initial production program is to maintain current production levels of fish reared for the District at the Public Utility District No. 1 of Douglas County, Washington ("Douglas PUD") owned Methow Hatchery through a contractual agreement between Douglas PUD and the District).

b. Steelhead: 5,800 pounds at about 6 fish per pound (35,000 fish, plus 27,500 pounds (165,000 fish) for original inundation losses;

c. Summer/Fall chinook: 20,000 pounds of yearling summer/fall chinook at about 10 fish per pound (200,000 fish); plus 40,500 pounds of sub-yearling summer/fall chinook at about 40 fish per pound (1,620,000) for inundation and, until 2013, 20,000 pounds at about 10 fish per pound (200,000 fish, a portion of which can be used for studies) at the Carlton Pond (50% of proportion raised for Rock Island hatchery program). (The intent of the initial production program is to maintain current production levels of fish reared for Douglas PUD at the District owned Carlton Pond through a contractual agreement between Douglas PUD and the District).

d. Sockeye: 15,000 pounds at about 20 fish per pound (300,000 fish). Options for long term production of sockeye will be explored by the Hatchery Committee and will be implemented by the District as soon as reasonably practical.

8.5 Monitoring and Evaluation.

8.5.1 The Hatchery Committee shall develop a five-year monitoring and evaluation plan for the hatchery program that is updated every five years (see also Section 8.6 "Program Review"). The first monitoring and evaluation plan shall be completed by the Hatchery Committee within one year of the Effective Date of this Agreement. Existing monitoring and evaluation programs shall continue until replaced by the Hatchery Committee.

8.5.2 The Parties agree that over the duration of this Agreement new information and technologies that are developed will be considered and utilized in the monitoring and evaluation of the hatchery program. The District shall fund hatchery program monitoring and evaluation consistent with this Agreement, the general objectives and guidelines listed for each Plan Species in the BAMP and as determined by the Hatchery Committee.

8.5.3 The Hatchery Committee shall plan and the District implement a study (related to the District's production program) to investigate the natural spawning success of hatchery reared steelhead relative to wild steelhead. The Hatchery Committee shall coordinate the study with the Wells and Rock Island hatchery committees.

8.6 Program Modification.

8.6.1 Hatchery program modifications shall make efficient use of existing facilities owned by the District or cooperating entities including adult collection, acclimation, and hatchery facilities, provided that the existing facility or the existing facility as modified is compatible with and does not compromise ongoing programs. The District in consultation with the Hatchery Committee shall make reasonable efforts to implement program modifications when needed to achieve overall and specific program objectives. Program modifications may include changes to facilities, release methods, and rearing strategies necessary to achieve NNI as determined by the monitoring and evaluation program.

8.6.2 In December 2001, it is recognized that current monitoring and evaluation programs have identified alternative rearing strategies to be addressed as soon as reasonably possible. These alternative strategies include: the ability to hold steelhead adults on river water prior to spawning; and ability to rear and acclimate steelhead juveniles on Columbia or tributary waters. The District will make every reasonable effort to complete program modifications as soon as reasonably possible following agreement with the Hatchery Committee.

8.6.3 NMFS shall have the opportunity to seek hatchery program modifications (that do not change 7% program levels) but are otherwise necessary to address emergency effects of a hatchery program on listed Permit Species. Such program modifications shall be supported by a minimum of two years of field data from the river or stream in question. Other information documenting a significant and adverse effect on the productivity of listed Permit Species from other rivers can be considered, but only if applicable to the listed Permit Species and stream in question. Any proposal to modify a program will be documented in a memorandum from the Regional Administrator to the Hatchery Committee summarizing the problem, and then followed by up to six months of Hatchery Committee evaluation. The Parties recognize that initially a portion of the production contemplated in this Agreement will be for purposes of supplementation of Plan Species or re-establishing runs in areas from which they have been extirpated. In the event the concerns raised in this Section 8.6.3 involve the use of such a program, NMFS agrees to take the program design and intent into account in reaching any conclusions regarding the need for emergency modifications.

8.7 Program Review. As part of the five year review set forth in Section 8.4 "Monitoring and Evaluation" the Hatchery Committee shall look back comprehensively at the previous five year plan to help prepare the next five year plan. In 2013 as part of the comprehensive review and every ten years thereafter, the hatchery program will undergo a program review incorporating new information from the monitoring and evaluation program. This program review will determine if adult-to-smolt and smolt-to adult survival standard, and hatchery program goals, and objectives as defined in this document and the Section 10 of the ESA permits have been met or sufficient progress is being made towards their achievement. This review shall include a determination of whether hatchery production objectives are being achieved and a review to identify adjustments to the monitoring and evaluation programs. The Hatchery Committee shall

be responsible for conducting the hatchery program review, and developing a summary report. The Hatchery Committee shall be responsible for recommending alternative plans to the District in the event that program objectives as defined above are not being met or needed modifications to the monitoring and evaluation have been identified. The Hatchery Committee shall be responsible for developing and the District funding implementation plans.

8.8 Changed Hatchery Policies under ESA.

8.8.1 Except in 2013 and every ten years thereafter, NMFS will refrain from applying hatchery policy decisions that would preclude the 7% hatchery levels (as adjusted) from being achieved. During 2013 and every 10 years thereafter (at the time of the program review), if NMFS proposes hatchery policy decisions that would preclude the 7% hatchery levels (as adjusted) from being achieved, NMFS will (a) propose application of the policies to the Hatchery Committee and seek agreement, (b) propose a revised hatchery program consistent with the principles of NNI and an expeditious transition plan from the existing hatchery program to the revised hatchery program, (c) if agreement is not possible discuss the application of the policies with the Coordinating Committee and then with the Policy Committee, if necessary, and (d) if agreement is still not possible then allow elevation to the Administrator of NMFS. The Parties recognize that initially a portion of the production contemplated in this Agreement will be for purposes of supplementation of Plan Species or re-establishing runs in areas from which they have been extirpated. NMFS agrees to take the program design and intent into account in reaching any conclusions.

8.8.2 Through 2013, facility modifications are based on monitoring and evaluation and may not reflect changes in NMFS hatchery policy. During 2013 and every 10 years thereafter (at the time of the program review), facility modifications can also reflect changes in ESA policy with the understanding that a reasonable period of time will be provided to complete the modifications. The 2013 date for achievement of NNI in Section 3.1 will be adjusted if necessary to reflect the time needed to complete such modifications (as determined by the Hatchery Committee).

8.9 New Hatchery Facilities. Before being required to construct new hatchery facilities, the Hatchery Committee shall make efficient use of existing or modified facilities owned by the District or entities consenting to the use of their facilities, including adult collection, acclimation and hatchery facilities, provided that existing or as modified facility use is compatible with and does not compromise ongoing programs.

SECTION 9 ASSURANCES

9.1 Release, Satisfaction and Covenant Not to Sue.

9.1.1 The Parties, within the limits of their authority, shall from the date of construction of the Project to the Effective Date of this Agreement, release, waive, discharge the District and the District's predecessors, commissioners, agents, representatives, employees, and signatory power purchasers from any and all claims,

demands, obligations, promises, liabilities, actions, damages and causes of action of any kind concerning impact of the Project on Plan Species except for the obligation to provide compensation for original construction impacts of the Project implemented through the hatchery component of this Agreement. This release, waiver, and discharge shall not transfer any of the above listed District liabilities or obligations to any other entity.

9.1.2 Provided that the District is in full compliance with its Permit, this Agreement, and its FERC project license provisions relating to Plan Species, each Party agrees not to institute any action under ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act against the District and its signatory power purchasers related to impacts of the Project on Plan Species from the date this Agreement becomes effective through the date this Agreement terminates.

9.1.3 Termination of this Agreement or withdrawal of a Party shall have no effect upon the release provided for in Section 9.1.1.

9.1.4 This Agreement does not affect, limit or address the imposition of annual charges under the Federal Power Act, or the right of any party in any proceeding or forum to request annual charges.

9.2 Re-Licensing.

9.2.1 With respect to Plan Species, the Parties agree to be supportive of the District's long-term license application(s) to the FERC filed during the term of this Agreement for the time period addressed in this Agreement, provided that the District has adhered to the terms and conditions of this Agreement, the Permit, and the FERC license provisions relating to Plan Species, as well as any future terms, conditions, and obligations agreed upon by the Parties hereto or imposed upon the District by the FERC. To the extent that the District has met such terms and conditions, the Parties agree that the District is a competent license holder with respect to its obligations to Plan Species. If the fifty (50)-year term of this Agreement will expire during a long-term license, any Party may advocate for license conditions that take effect after this Agreement expires.

9.2.2 This Agreement shall constitute the Parties' terms, conditions and recommendations for Plan Species under Sections 10(a), 10(j) and 18 of the Federal Power Act, and the Fish and Wildlife Coordination Act, provided that, NMFS and USFWS maintain the right to reserve their authorities under Section 18 of the Federal Power Act on the condition that such reserved authority may be exercised only in the event that this Agreement terminates, provided further that, the Parties as part of their terms, conditions and recommendations under Section 10(a) of the Federal Power Act may request that Plan Species protection or mitigation measures contained in a competing license application be included as a condition of the District's new long term license.

9.2.3 Notwithstanding Sections 9.2.2 and 9.7 "Drawdowns/Dam Removal/Non-Power Operations", this Agreement does not limit the participation of any Party in any FERC proceeding to assert: (1) any condition for resources and other aspects of the District's license other than for Plan Species, and (2) to assert conditions for Plan Species to implement this Agreement.

9.3 Limitation of Reopening. During the term of this Agreement the Parties shall not invoke or rely on any re-opener clause set forth in any FERC license applicable to the Project for the purpose of obtaining additional measures or changes in project structures or operations for Plan Species, except as set forth in Sections 9.2.2 and 9.2.3.

9.4 Additional Measures. This Agreement sets out certain actions, responsibilities, and duties with regard to Plan Species to be carried out by the District and by the JFP to satisfy the legal requirements imposed under the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act. This Agreement is not intended to prohibit the Parties from opposing or recommending actions in reference to (1) Project modifications such as pool raises and additional power houses, and (2) activities not related to Project operations that could adversely affect Plan Species. The Parties recognize that various of the JFP have governmental rights, duties, and responsibilities as well as possible rights of action under statutes, regulations, and treaties that are not covered by this Agreement. This Agreement does not limit or affect the ability or right of a Party to take any action under any such law, regulation, or treaties. However, the Party shall use reasonable efforts to exercise their rights and authority under such statutes, regulations or treaties (consistent with their duties and responsibilities under those statutes, regulations and treaties) in a manner that allows this Agreement to be fulfilled.

9.5 Title 77 RCW. Provided the District is in compliance with the Agreement, the Permit, and the FERC license provisions relating to Plan Species, WDFW shall not request additional protection or mitigation for Plan Species under Title 77 RCW as now exists or as may be amended, unless WDFW is required to take such action by statute.

9.6 Cooperation in Studies/Approval/Permits. The Parties shall cooperate with the District in conducting studies and in obtaining any approvals or permits which may be required for implementation of this Agreement.

9.7 Drawdowns/Dam Removal/Non-Power Operations. With respect to Plan Species under the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, each Party during the term of this Agreement will not advocate for or support additional or different fish protection measures or changes in Project structures or operations other than those set forth in this Agreement. For example, the Parties will not advocate or support partial or complete drawdowns, partial or complete dam removal, and partial or complete non-power operations. However, this Agreement does not preclude: spillway or

Tailrace modifications; spill; structural modifications and concrete removal (holes in Dam) to accommodate bypass; structural modifications to accommodate adult passage facility improvements; and future consideration of additional measures that may include reservoir elevation changes if all Parties agree. The Parties agree to work within this Agreement to address any issues that may arise in the future concerning Plan Species.

9.8 Stipulation of Plan Species. Each Party stipulates that the performance of the District's obligations under this Agreement, its Permit, and its FERC license will adequately and equitably conserve, protect, and mitigate Plan Species pursuant to the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act as those Plan Species are affected by the Project through the term of the Agreement.

9.9 Vernita Bar. Nothing in this Agreement is intended to affect the protection of Plan Species in the Hanford Reach or the Vernita Bar Agreement, as it exists now or may be modified in the future.

9.10 Non-Plan Species. Non-Plan Species are not addressed in this Agreement.

SECTION 10 ENDANGERED SPECIES ACT

10.1 Permit Issuance.

10.1.1 NMFS issuance of a Permit to the District assures the District that based upon the best scientific and commercial data available and after careful consideration of all comments received, NMFS has found that with respect to all Permit Species that: (i) any take of a Permit Species by the District under this Agreement will be incidental to the carrying out of otherwise lawful activities; (ii) under this Agreement the District will, to the maximum extent practicable, minimize and mitigate any incidental take of Permit Species; (iii) the District has sufficient financial resources to adequately fund its affirmative obligations under this Agreement; (iv) as long as the actions required by this Agreement to minimize/mitigate incidental take are implemented, any incidental take of a Permit Species will not appreciably reduce the likelihood of the survival and recovery of such species in the wild; and (v) other measures and assurances required by NMFS as being necessary or appropriate are included in this Agreement. The hatchery permits are addressed in Section 10.1.4.

10.1.2 After opportunity for public comment, compliance with NEPA and concurrent with the Effective Date of this Agreement, NMFS will issue a Permit to the District pursuant to Section 10(a)(1)(B) of the ESA to authorize any incidental take of listed Permit Species which may result from the District's otherwise lawful operation of the Project, conducted in accordance with this Agreement and the Permit, and NMFS will issue necessary hatchery Permits (incidental and direct). In addition, the Permit shall authorize any incidental take of listed Permit Species which may result from the District's otherwise lawful operation of the hatchery facilities required by this

Agreement, conducted in accordance with this Agreement and the Permit. The Permit and this Agreement shall remain in full force and effect for a period of fifty-(50) years from the Effective Date, or until revocation of the Permit under Section 10.4 "Permit Suspension, Revocation and Re-Instatement", or the District or NMFS' withdraws under Section 2.1 "Enough Already", whichever occurs sooner. Amendments to the Permit or this Agreement shall remain in effect for the then-remaining term of this Agreement or until revocation under Section 10.4 "Permit Suspension, Revocation and Re-Instatement", whichever occurs sooner. Withdrawal from this Agreement pursuant to Section 2 "Withdrawal From Agreement" and revocation of the Permit is not limited by the no surprises regulation. The Permit shall incorporate by reference the no surprises rule set forth in 50 CFR 222.307(g) (2001). This Agreement provides for changed circumstances and the mitigation measures to respond to changed circumstances. Any circumstance relating to Permit Species not addressed by this Agreement is an Unforeseen Circumstance.

10.1.3 The Permit shall authorize the District to incidentally take Permit Species that are listed under the ESA, to the extent that such incidental take of such species would otherwise be prohibited under Section 9 of the ESA, and its implementing regulations, or pursuant to a rule promulgated under Section 4(d) of the ESA, and to the extent that the take is incidental to the District's lawful operation of the Project, subject to the condition that the District must fully comply with all requirements of this Agreement and the Permit. The Permit will be immediately effective upon issuance for Permit Species currently listed under the ESA. The Permit will become effective for currently unlisted Permit Species upon any future listing of such species under the ESA.

10.1.4 In the event that an additional or amended Section 10 permit is required for the implementation of any aspect of the Tributary Conservation Plan or Hatchery Compensation Plan, the NMFS shall expedite the processing of such permits or amendments. The hatchery Permits (direct and incidental) will initially be issued to authorized take through 2013. Beginning in 2013 and every ten (10)-years thereafter, the District or its agent shall submit to NMFS hatchery Permit applications incorporating changes to the Hatchery Program identified in the ten (10)-year program reviews (see Section 8.7 "Program Review").

10.2 Permit Monitoring. Upon issuance of the Permit, the implementation thereof, including each of the terms of this Agreement shall be monitored and evaluated as provided for in Section 5 "Passage Survival Plan". Any reports the FERC should require regarding this Agreement shall be provided to the NMFS at the time such reports are provided to the FERC.

10.3 Permit Modification.

10.3.1 The Permit issued to the District, shall be amended in conformance with the provisions 50 CFR 222. 306(a) (2001) through 222. 306(c) (2001), provided, that if said regulations are modified the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

10.3.2 This Agreement provides for on-going, active and adaptive management activities. Adaptive management provides for on going modification of management practices to respond to new information and scientific development. Adaptive management will yield prescriptions that may vary over time. Such changes are provided for in this Agreement and do not require modification of the Agreement or amendment of the Permit, provided, that such changes will not result in a level of incidental take in excess of that otherwise allowed by this Agreement and the Permit.

10.4 Permit Suspension, Revocation and Re-Instatement. Except as set forth in Section 2.1 "Enough Already", the Permit shall be suspended, revoked and re-instated in conformance with the provisions of 50 CFR 220. 306(d) (2001) and 50 CFR 222. 306(e) (2001), provided, that if said regulations are modified the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

10.5 Early Termination Mitigation. If the Permit is terminated early and de-listing has not occurred, NMFS may require the District to mitigate for any past incidental take of Permit Species that has not been sufficiently mitigated prior to the date of termination. Such mitigation may require the District to continue relevant mitigation measures of the Agreement for some or all of the period, which would have been covered by the Permit. NMFS agrees that the District may invoke the dispute resolution procedures of this Agreement to pursue resolution of any disagreement concerning the necessity or amount of such additional mitigation, NMFS reserves any authority it may have under the ESA or its regulations regarding additional mitigation. So long as the District meets and continues to meet the survival standard, its Tributary Plan funding obligations, and its Hatchery Plan funding and capacity obligations early termination mitigation shall not apply to the District.

10.6 Funding. In its current financial position, the District has sufficient assets to secure funding for its affirmative obligations under the Agreement. To ensure notification of any material change in the financial position of the District during the term of the Permit, the District will provide the NMFS with a copy of its annual report each year of the Permit.

10.7 USFWS. USFWS does not exercise ESA authority over Permit Species.

SECTION 11 DISPUTE RESOLUTION

11.1 Stages of Dispute Resolution.

11.1.1 Stage 1: Coordinating Committee. Any dispute regarding this Agreement shall first be referred to the respective committee dealing with that issue (the Coordinating Committee is the committee of default). That committee shall have twenty- (20) days within which to resolve the dispute. If at the end of twenty- (20) days there is no resolution any Party may request that the dispute proceed to Section 11.1.2 "Stage 2:

Policy Committee." However, Tributary Committee and Hatchery Committee disputes must first proceed to the Coordinating Committee, before the Policy Committee is triggered.

11.1.2 Stage 2: Policy Committee. Following the completion of Stage 1, the Chair of the Coordinating Committee or any Party may refer the dispute to the Policy Committee. The Chair of the Coordinating Committee shall chair all meetings of the Policy Committee. The Policy Committee shall have thirty- (30) days, following the referral, to convene and consider the dispute. The Chair of the Coordinating Committee shall provide advance written notice of all meetings. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

Each Party shall designate a policy representative who shall be available to participate on the Policy Committee. Any Party that fails to name a Policy Committee representative or to have its Policy Committee representative participate in the Policy Committee shall waive that Party's right to object to the resolution of the dispute by the Policy Committee.

The Policy Committee shall act by unanimous vote of those members present in person or by phone for the vote and shall develop its own rules of process, provided, that the Policy Committee shall ensure that all Parties are sent notice of all Policy Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Coordinating Committee who may delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties. A Party may invoke this right only once per delayed item.

11.1.3 Options following Stage 2. If there is no resolution of a matter following completion of Stage 1 and 2 of this Procedure, then any Party may pursue any other right they might otherwise have. The inability of the Coordinating Committee and Policy Committee to make a decision shall be considered a dispute. The Parties are encouraged to resolve disputes through alternative dispute resolution.

11.2 Implementation of Settlement Dispute. If the Procedure results in a settlement of the dispute then: (1) the Parties shall implement, consistent with the terms of the settlement, all aspects of the settlement that can lawfully be implemented without FERC approval, or the approval of another federal agency; and (2) where FERC or other federal agency approval is needed before some or all of the settlement can be implemented, all settling Parties shall jointly present the resolution of the dispute to FERC or the appropriate federal agency for approval.

11.3 No Intent to Create Jurisdiction. The Parties agree that this Agreement is not intended to create jurisdiction in any court.

SECTION 12 MISCELLANEOUS

12.1 Conflict Between Agreement and Appendix. In the event of a conflict between this Agreement and an appendix to this Agreement, this Agreement shall control and the Parties shall cause the appendix in conflict to be revised accordingly.

12.2 Amendment of Agreement. This Agreement may be amended or modified only with the written consent of the Parties, provided that, Parties who withdraw from the Agreement do not need to, and have no right to, approve any amendments or modifications, provided further, that this Agreement provides for on-going, active and adaptive management activities. Adaptive management provides for ongoing modification of management practices to respond to new information and scientific developments. Adaptive management will yield prescriptions that may vary over time. Such changes are provided for in this Agreement and do not require modification of the Agreement or amendment of the Permit, provided that such changes will not result in a level of incidental take in excess of that otherwise allowed by this Agreement or modify the provisions set out in Section 3 "Survival Standards and Allocation of Responsibility for No Net Impact", further provided, that unless otherwise agreed to by the Parties NNI applies only to the identified Plan Species on the date this Agreement became effective originally.

12.3 Notices. Except as set forth in Sections 1.2.2 "Upon Completion of Regulatory Reviews," 2.6 "Withdrawal of Another Party" and 2.7 "Conditions Precedent to Withdrawal" all written notices to be given pursuant to this Agreement shall be mailed by first-class mail, postage prepaid to each Party. Parties shall inform all Parties by written notice in the event of a change of address. Notices shall be deemed to be given three- (3) days after the date of mailing.

12.4 Waiver of Default. Any waiver at any time by any Party hereto of any right with respect to any other Party with respect to any matter arising in connection with this Agreement shall not be considered a waiver with respect to any subsequent default or matter.

12.5 Integrated Agreement. All previous communications between the Parties, either verbal or written, with reference to the subject matter of this Agreement are superseded by the terms and provisions of this Agreement, and once executed, this Agreement and its examples, figures, tables and appendices shall constitute the entire agreement between the Parties, provided, that titles to sections and sub-sections thereof are for the assistance of the reader and are not part of the Agreement.

12.6 Benefit and Assignment. This Agreement shall be binding upon and inure to the benefit of the Parties hereto and their successors and assigns provided, no interest, right, or obligation under this Agreement shall be transferred or assigned by any Party hereto to any other Party or to any third party without the written consent of all other Parties, except by a Party: (1) to any person or entity into which or with which the Party making the assignment or transfer is merged or consolidated or to which such Party transfers

substantially all of its assets, (2) to any person or entity that wholly owns, is wholly owned by, or is wholly owned in common with, the Party making the assignment or transfer, provided that, the assignee is bound by the terms of this Agreement and applies for and receives an incidental take permit for listed Plan Species.

12.7 Force Majeure. For purposes of this Agreement, a "*force majeure*" is defined as causes beyond the reasonable control of, and without the fault or negligence of, the District or any entity controlled by the District, including its contractors and subcontractors. Economic hardship shall not constitute *force majeure* under this Agreement.

In the event that the District is wholly or partially prevented from performing obligations under this Agreement because of a *force majeure* event, the District shall be excused from whatever performance is affected by such *force majeure* event to the extent so affected, and such failure to perform shall not be considered a material breach. Nothing in this Section shall be deemed to authorize the District to violate the ESA or render the standards and objectives of this Agreement unobtainable. The suspension of performance shall be no greater in scope and no longer in duration than is required by the *force majeure.*

The District shall notify the other Parties to this Agreement in writing within seven- (7) calendar days after a *force majeure* event. Such notice shall: identify the event causing the delay or anticipated delay; estimate the anticipated length of delay; state the measures taken or to be taken to minimize the delay; and estimate the timetable for implementation of the measures. The District shall have the burden of demonstrating by a preponderance of evidence that delay is warranted by a *force majeure*.

The District shall use a good faith effort to avoid and mitigate the effects of the delay and remedy its inability to perform. A *force majeure* event may require use of the adaptive management provisions of this Agreement in remedying the effects of the *force majeure* event. When there is a delay in performance of a requirement under this Agreement that is attributable to a *force majeure*, the time period for performance of that requirement shall be reasonably extended as determined by the Coordinating Committee. When the District is able to resume performance of its obligation, the District shall give the other Parties written notice to that effect.

12.8 Appropriations. Implementation of this Agreement by the JFP is subject to the availability of appropriated funds. Nothing in this Agreement will be construed by the Parties to require the obligation, appropriation, or expenditure of any money from federal, state or tribal governments. The Parties acknowledge that the JFP will not be required under this Agreement to expend any of its appropriated funds unless and until an authorized official of that agency or government affirmatively acts to commit to such expenditures as evidenced in writing.

12.9 Legal Authority. Each Party to this Agreement hereby represents and acknowledges that it has legal authority to execute this Agreement and is fully bound by the terms hereof. NMFS is authorized to enter into this Agreement pursuant to the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

12.10 Execution. This Agreement may be executed in counterparts. A copy with all original executed signature pages affixed shall constitute the original Agreement. The date of execution shall be the date of the final Party's signature. Upon execution of this Agreement by the Parties, this Agreement shall be submitted to the Secretary of Interior or her designee for any approval, to the extent required by 25 U.S.C. § 81.

12.11 Indian Tribal or Treaty Reserved Rights. Nothing in this Agreement is intended to nor shall it in any way abridge, limit, diminish, abrogate, adjudicate, or resolve any Indian right reserved or protected in any treaty, executive order, statute or court decree. This Section shall be deemed to modify each and every Section of this Agreement as if it is set out separately in each Section.

12.12 No Precedent/Compromise of Disputed Claims. The conditions described and measures proposed to rectify them set forth in this Agreement are fact specific and uniquely tied to the circumstances currently existing at the Project. The Parties agree that the conditions existing here and the proposed actions to deal with them are not intended to in any way establish a precedent or be interpreted as the position of any party in any proceeding not dealing specifically with the terms of this Agreement. Further, the Parties acknowledge that this Agreement is a compromise of disputed claims for which each Party provided consideration to the other as contemplated under Federal Rule of Evidence 408, and will not be used by any Party in a manner inconsistent with the provisions of Federal Rule of Evidence 408.

12.13 U.S. v. Oregon. Nothing in this Agreement is intended by the signatories who are parties to the continuing jurisdiction case of U.S. v. Oregon, 302 F.Supp. 899 (D. OR 1969), to change the jurisdiction of that court or the parties positions therein.

SECTION 13 DEFINITIONS

Capitalized terms are defined as follows:

13.1 "Agreement" means this document, examples, figures, Tables 1 and 2, and Appendices A through C. This Agreement is supported by Supporting Documents A through E but does not incorporate these documents.

13.2 "BAMP" means Document C "Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Program".

13.3 “Combined Adult and Juvenile Project Survival” means that 91% of each Plan Species (juvenile and adult combined) survive Project effects when migrating through the Project’s reservoir, Forebay, Dam and Tailrace including direct, indirect, and delayed mortality whenever it may occur and can be measured (as it relates to the Project) given the available mark-recapture technology.

13.4 “DFOP” means the Detailed Fishway Operating Plan. DFOP is attached hereto as Appendix A “Detailed Fishway Operating Plan” and incorporated herein by this reference.

13.5 “Daily Estimated Flow” means the Bonneville Power Administration’s estimate of the next day’s flow. However, actual flows will be tracked by the District and compared to the estimated flows. Spill will be adjusted based upon the comparison of the actual flows with the estimated flows in order to provide the required amount of spill. Spill will be shaped in steps as agreed to by the Coordinating Committee.

13.6 “Dam” means the concrete structure impounding the Columbia River.

13.7 “ESA” means the Endangered Species Act, 16 U.S.C. ss 1531 through 1543, as amended, and it’s implementing regulations.

13.8 “Essential Fish Habitat Provisions of the Magnuson-Stevens Fishery Conservation and Management Act” means the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1801 et seq., as amended by the Sustainable Fisheries Act and as may be amended, and its implementing regulations.

13.9 “Federal Power Act” means the Federal Power Act, 16 U.S.C. §§ 791a - 828c, as amended, and its implementing regulations.

13.10 “FERC” means the Federal Energy Regulatory Commission or its successor.

13.11 “Fish and Wildlife Coordination Act” means the Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-668c, as amended, and its implementing regulations.

13.12 “Forebay” means the body of water represented in the drawing (which is approximately 500 feet upstream of the Dam), which is attached hereto as Appendix B “Forebay and Tailrace Diagram” and incorporated herein by this reference.

13.13 “Juvenile Dam Passage Survival” means that 95% of each juvenile Plan Species over 95% of each species migration survive Projects effects when migrating through the Project’s Forebay, Dam and Tailrace including direct, indirect and delayed mortality where ever it may occur and can be measured (as it relates to the Project), given the available mark-recapture technology.

13.14 “Juvenile Project Survival” refers to the measurement of survival for juvenile Plan Species over 95% of each species migrating from tributary mouths and through the

Project's reservoir, Forebay, Dam and Tailrace including direct, indirect and delayed mortality, where ever it may occur and can be measured (as it relates to the Project) given the available mark-recapture technology.

13.15 "Juvenile Project Survival Standard" refers to a surrogate measurement of the Combined Adult and Juvenile Survival Standard. If Juvenile Project Survival for each Plan Species is measured to be greater than or equal to 93%, then the District will be assigned to Phase III (Standard Achieved). If Juvenile Project Survival is measured at less than 93% but greater than or equal to 91%, then the District will be assigned to Phase III (Provisional Review). If Juvenile Project Survival is measured at less than 91%, then the District will be assigned to Phase II (Interim Tools).

13.16 "Measures" means any action, structure, facility, or program (on-site or off-site) intended to improve the survival of Plan Species, except those prohibited in Section 9.7 "Drawdowns/Dam Removal/Non-Power Operation". Measures do not include fish transportation unless otherwise agreed by the Coordinating Committee.

13.17 "Pacific Northwest Electric Power Planning and Conservation Act" means the Pacific Northwest Electric Power Planning and Conservation Act, 16 U.S.C. §§ 839 - 839h, 16 U.S.C. §§ 839 - 839h, as amended, and its implementing regulations.

13.18 "Permit" shall mean permit(s) issued to the District by NMFS pursuant to Section 10 of the ESA to authorize take of Permit Species which may result from the District's or its agent's implementation of this Agreement.

13.19 "Permit Species" means all Plan Species except coho salmon (*Oncorhynchus kisutch*). Permit Species do not include coho salmon (*O. kisutch*) since wild coho salmon are extirpated from the Mid-Columbia Region and therefore not protected by the ESA.

13.20 "Plan Species" means spring, summer and fall chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*).

13.21 "Power Purchasers" means Puget Sound Energy, Inc. Portland General Electric, Avista Corp., Colockum Transmission Company, Inc., and PacifiCorp for the term of their existing long-term power sales contracts with the District.

13.22 "Project" means the Rocky Reach Hydroelectric Project owned and operated by the Public Utility District No. 1 of Chelan County, Washington pursuant to FERC Project Number 2145. The geographic boundaries of the Project (reservoir, Forebay, Dam and Tailrace) are defined in exhibit "K" of the Project's FERC license.

13.23 "RCW" means Revised Code of Washington.

13.24 "Representative Flow Conditions" means that the flow of the Columbia River measured at Grand Coulee Dam during the study is between 205,381 (spring)/164,905 (summer) cubic feet per second and 100,523 (spring)/76,318 (summer) cubic feet per second. These flows bound the ten percent to ninety percent range on the flow duration curve attached as Appendix C "Flow Duration Curve". Studies conducted when flow is within this ten percent to ninety percent range (values above) are automatically included in the three-year average as long as the study is otherwise valid. However, when studies are conducted when river flow is between 220,597 (spring)/180,607 (summer) cubic feet per second and 90,152 (spring)/63,291 (summer) cubic feet per second, the Coordinating Committee shall decide whether the study is included in the three year average. This decision is not subject to dispute resolution. These flows bound the five percent to 10 percent range and the ninety to ninety-five percent range on the flow duration curve attached as Appendix C "Flow Duration Curve". The flow duration curve was created by compiling the flows coming out of Grand Coulee Dam. Starting as part of the 2013 comprehensive review, and every ten years thereafter, the Coordinating Committee shall update the flow duration curve and the river flow amounts contained in this definition.

13.25 "Spill" means the passage of water through spill gates.

13.26 "TDG" means total dissolved gas.

13.27 "Tailrace" means the body of water represented in the drawing (which is approximately 1000 feet downstream of the Dam), which is attached hereto as Appendix B "Forebay and Tailrace Diagram" and incorporated herein by this reference.

13.28 "Threshold Population" refers to a naturally reproducing population that contains a five-year average of greater than 500 adults as assessed at Wells Dam and is composed of a population that is reproductively isolated from other populations of the same species".

13.29 "Tools" means any action, structure, facility or program (on-site only) at the Project, except those prohibited in Section 9.7 "Drawdowns/Dam Removal/Non-Power Operation" that are intended to improve the survival of Plan Species migrating through the Project. Tools do not include fish transportation unless otherwise agreed by the Coordinating Committee. This term is a sub-set of Measures.

13.30 "Unavoidable Project Mortality" refers to the assumed 9% mortality caused by the Project to Plan Species that is compensated through the tributary and hatchery programs

13.31 "Unforeseen Circumstance" is defined by 50 CFR 222.102 (2001), and implemented according to 50 CFR 222.307(g) (2001). If these regulations are modified, the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

IN WITNESS WHEREOF, the Parties hereto execute this Agreement as of the date last signed below.

Dated April 1, 2002

PUBLIC UTILITY DISTRICT NO. 1 OF
CHELAN COUNTY, WASHINGTON

By Charles J. Hosken
(signature)

Charles J. Hosken
(print name)

GENERAL MANAGER
(Title)

Address for Notice:

Public Utility District No. 1 of
Chelan County, Washington
327 N. Wenatchee Avenue
P.O. Box 1231
Wenatchee, WA 98801

Attn: General Manager

Dated 4/5/02

NATIONAL MARINE FISHERIES SERVICE

By _____
(signature)

D. Robert Lohn
(print name)

Regional Administrator
(Title)

Address for Notice:
National Marine Fisheries Service, Regional Office
7600 Sand Point Way NE, Bin C15700, Bldg 1
Seattle WA 98115-0070

Dated 4/10/2002

UNITED STATES FISH AND WILDLIFE SERVICE

By Rowan W Gould
(signature)

Rowan W Gould
(print name)

Deputy Regional Director
(Title)

Address for Notice:
Project Leader
US Fish and Wildlife Service
Eastern Washington Ecological
Services Office
32 C Street NW
P.O. Box 848
Ephrata, WA 98823

Dated 4/2/2002

WASHINGTON DEPARTMENT OF
FISH AND WILDLIFE

By _____
(signature)

Dr. Jeffrey P. Koenings
(print name)

Director
(Title)

Address for Notice:
Washington Department of Fish & Wildlife
600 Capitol Way North
Olympia, WA 98501-1091

Dated April 4, 2002

CONFEDERATED TRIBES OF
THE COLVILLE RESERVATION

By Colleen F. Cawston.
(signature)

Colleen F. Cawston
(print name)

Chair, Colville Business Council
(Title)

Address for Notice:
P.O. Box 150
Nespelem, WA 99155

Anadromous Fish Agreement and Habitat Conservation Plan, Rocky Reach Hydroelectric Project, FERC License No. 2145

Originally signed by Public Utility District No. 1 of Chelan County, United States Fish and Wildlife Service, NOAA Fisheries Service, Washington Department of Fish and Wildlife, and Confederated Tribes of the Colville Reservation in April 2002, and approved by the Federal Energy Regulatory Commission on June 21, 2004.

Dated April 24, 2005

CONFEDERATED TRIBES AND BANDS
OF THE YAKAMA NATION

By _____
(signature)

Jerry Meninick
(print name)

Chairman-Yakama Tribal Council
(Title)

Address for Notice:

_____

_____

_____

Dated _____

AMERICAN RIVERS, INC., a Washington
D.C., nonprofit corporation

By _____
(signature)

_____
(print name)

_____
(Title)

Address for Notice:

_____
_____
_____
_____
_____

Table 1

Summary of Route Specific Passage Studies at Rocky Reach (RRE) Dam Acoustic Tag and Radio Telemetry Information

Tool	Project	Species (rearing)	Year	Spill %	PH	Spillway	Bypass	Total	Proj. FPE	Spill Eff.	Report
Radio telemetry	RRE	Sum/Fall Chin 1 (ROR)	1998	0.156	0.533	0.075	0.392	1.000	0.467	0.481	English et al. (1998)[1]
Radio telemetry	RRE	Sum/Fall Chin 1 (ROR)	1999	0.153	0.579	0.157	0.263	0.999	0.420	1.026	English et al. (1999)[2]
Radio telemetry	RRE	Sum/Fall Chin 1 (ROR)	2000	0.193	0.537	0.179	0.284	1.000	0.463	0.927	English et al. (2000)[3]
Acoustic tags	RRE	Sum/Fall Chin 1 (ROR)	2000	0.193	0.476	0.140	0.384	1.000	0.524	0.725	Steig et al. (2001)[4]
		Average Project Fish Passage Efficiency for Sum/Fall Chin 1 at RRE =							**0.469**		

Note:

[1]Petersen Index Estimates / 5.5% of fish guided through units 1&2 included in bypass estimate.

[2]Petersen Index Estimates / 2.9% of fish guided through units 1&2 included in bypass estimate.

[3]Petersen Index Estimates / 5.3% of fish guided through units 1&2 included in bypass estimate.

[4]HTI monitored Units 1-11, spillway and surface collectors 1 and 2; fish tagged with acoustic tags.

Table 2

HCP Production Commitments for Rocky Reach Project

Species	Initial Production Levels: Original Inundation[1]	Initial Production Levels: Passage Losses[2]	Initial Production Levels: Total	Calculated 7% Production Levels[3]	Rearing Facility
Spring chinook				90,000	New program
		144,000	144,000		Methow
Steelhead	165,000	35,000	200,000	30,000	EB, TR, CF
Summer/fall chinook[4]					
yearlings		400,000	400,000	200,000	EB, RRA, TR
sub-yearlings	1,620,000		1,620,000		EB, RRA, TR
Sockeye				300,000	New program

EB=Eastbank
TR=Turtle Rock
CF=Chelan Falls
RRA=Rocky Reach Annex

[1] Compensates for original inundation by the Project. These amounts are not subject to recalculation, and are provided in addition to the levels necessary to compensate for Unavoidable Project Mortality.
[2] Agreed to production levels to compensate for Unavoidable Project Mortality. These hatchery levels are greater than that required to compensate for 7% Unavoidable Project Mortality. These hatchery levels will be produced from the Effective Date of the Agreement through 2013. These amounts are subject to recalculation every 10 years beginning in 2013.
[3] These are the hatchery levels that are required to compensate for 7% Unavoidable Project Mortality. Original inundation levels must be produced in addition to the hatchery levels in this column.
[4] There is potential for program shifts from sub-yearling production to more yearling production.

APPENDIX A
Detailed Fishway Operation Plan (DFOP)

ADULT FISH PASSAGE INFORMATION

The location of adult fish passage facilities is shown on Figure 2 "Rocky Reach Dam General Site Plan". This information may be out of date and will be reviewed and updated as appropriate by the Coordinating Committee.

ADULT PASSAGE FACILITIES

The adult passage facilities at Rocky Reach Dam consist of a fishway on the powerhouse side with right and left powerhouse entrances, a powerhouse collection channel, a spillway transportation channel and a main spillway entrance. The left powerhouse entrance is located at mid-dam between the powerhouse and spillway. The fishway includes a counting station on the right bank. The system includes pumped and gravity auxiliary water supplies.

Construction activities and associated modification in operations have potential for impact on adult passage at Rocky Reach Dam. Construction schedules and activities will be reviewed in advance to limit this potential. Activities which have a high probability of affecting passage will be scheduled during nighttime hours.

ADULT MIGRATION TIMING

For operation and maintenance purposes, the primary fish passage season is considered to be April through November. Primary passage periods by species are:

Spring Chinook	April 18 - June 23
Summer Chinook	June 24 - September 1
Fall Chinook	September 2 - November
Steelhead	April - March
Coho	August - November
Sockeye	Late June - August 15

OPERATING CRITERIA FOR ADULT PASSAGE

SPILL MANAGEMENT FOR ADULT PASSAGE

1. Spill not provided for juvenile passage will be shaped to avoid delay of upstream migrants according to agencies, tribes, and PUD agreement.

2. Spill shaping requests are based on the tribes and agencies objective of achieving 100% passage efficiency without delay.

Spilling Schedule for Rocky Reach Dam, Est. 1984. (Openings in feet)

Gate Number												Total
1	2	3	4	5	6	7	8	9	10	11	12	
						(2)		2				
					(2)		2					
	(2)		2		2		2					
	(2)		2		2		2					
	2		2	(2)	2	2	2					12
	2	(2)	2	2	2	2	2					
	2	(2)	2	2	2	2	2					
	2	2	2	3	(3)	2	2					
	2	2	3	3	3	(3)	2					
	2	2	3	(4)	3	3	3					20
	2	(3)	3	4	4	3	3					
	2	3	4	(5)	4	3	3					
	2	3	4	5	4	4	(4)					
	2	3	5	5	(5)	4	4					
	2	3	5	(6)	5	5	4					30
	2	3	5	6	(6)	5	5					
	2	4	5	6	(7)	5	5					
	2	4	6	6	7	(6)	5					
	2	4	6	6	(8)	6	6					
	2	4	6	7	8	(7)	6					40
	2	5	(7)	7	8	7	6					
	2	5	7	7	9	(8)	6					
	2	5	(8)	8	9	8	6					
	(3)	5	8	9	9	8	6					
	3	6	8	9	(10)	8	6					50
	3	6	8	10	10	(9)	6					
	3	6	9	10	(11)	9	6					
	3	(7)	9	11	11	9	6					
	3	7	10	11	11	(10)	6					
	3	7	11	(12)	11	10	6					60

Circled values indicate opening one foot less than value. For example:

(2) means 0 or 2 foot opening
(3) means 2 or 3 foot opening

OPERATING STANDARDS FOR ADULT PASSAGE FACILITIES
Reviewed February 1990

Adult Fishway

Water depth over weirs: 1.0 to 1.2 ft.

Transportation Channel (Between Entrances and Ladder)

Transportation velocity: A transportation velocity of 1.5 to 4.0 feet per second (prefer 2.0 fps) shall be maintained in all channels and the lower ends of the fish ladders which are below the tailwater.

Entrances

General: Head 1.0 ft. minimum

Right Powerhouse Entrance: Rotary gate openings at RPE1 and RPE2 shall be fully open.

Left Powerhouse Entrance: LPE1 and LPE3 shall be continuously open.

Submerged weir crest elevation for the following tailwater elevations shall be at or below:

Tailwater El.	Submerged Weir Crest El.
615.0	603.5
620.0	606.5

Orifice Entrances: The following 6 orifice entrances shall be open: CC1, CC2, CC3, CC16, CC18, CC20

Main Spillway Entrance (MSE): Open May 1 - October 31. One gate permanently closed. One gate permanently open.

Submerged weir crest elevations for the following tailwater elevations shall be at or below:

Tailwater El.	Submerged Weir Crest El.
Below 621.5	604.5
625.0	605.3

Turbine No. 11 Operation

Turbine No. 11 loading will be reduced or discontinued completely during daylight hours from May 1 through October 31 of each year, during periods when the powerhouse is not fully loaded. This will improve adult passage at the left powerhouse entrances.

Trashracks

Visible buildups of debris shall be removed immediately from ladder exit and attraction water intake trashracks.

Visible buildups of debris shall be cleaned immediately from picketed leads at the counting window.

Staff Gauges and Water Level Indicators

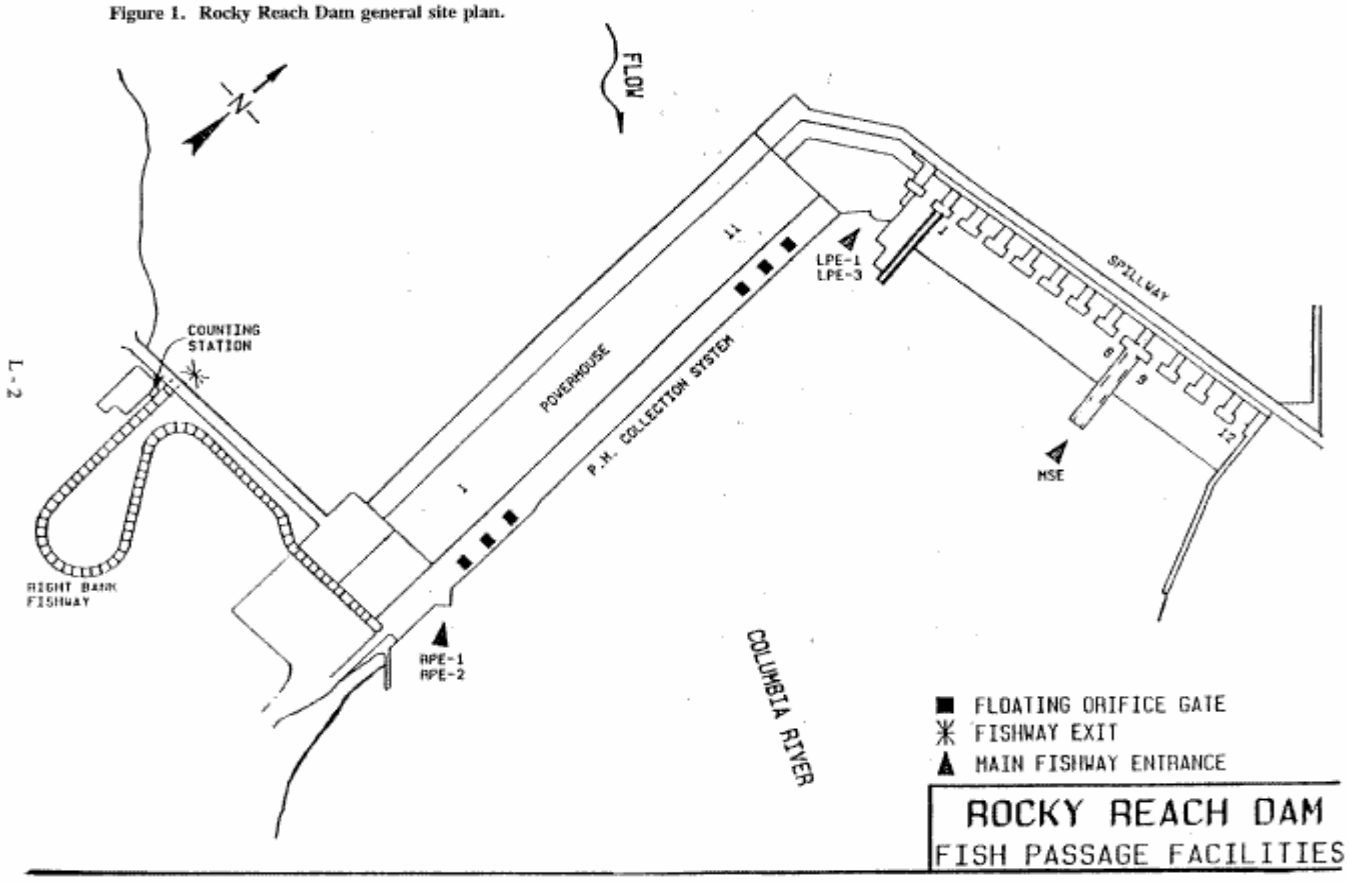
Shall be readable at all water levels encountered during passage periods.

Staff gauges or water level indicators shall be located upstream and downstream from entrances, and at a convenient location for viewing along the ladder.

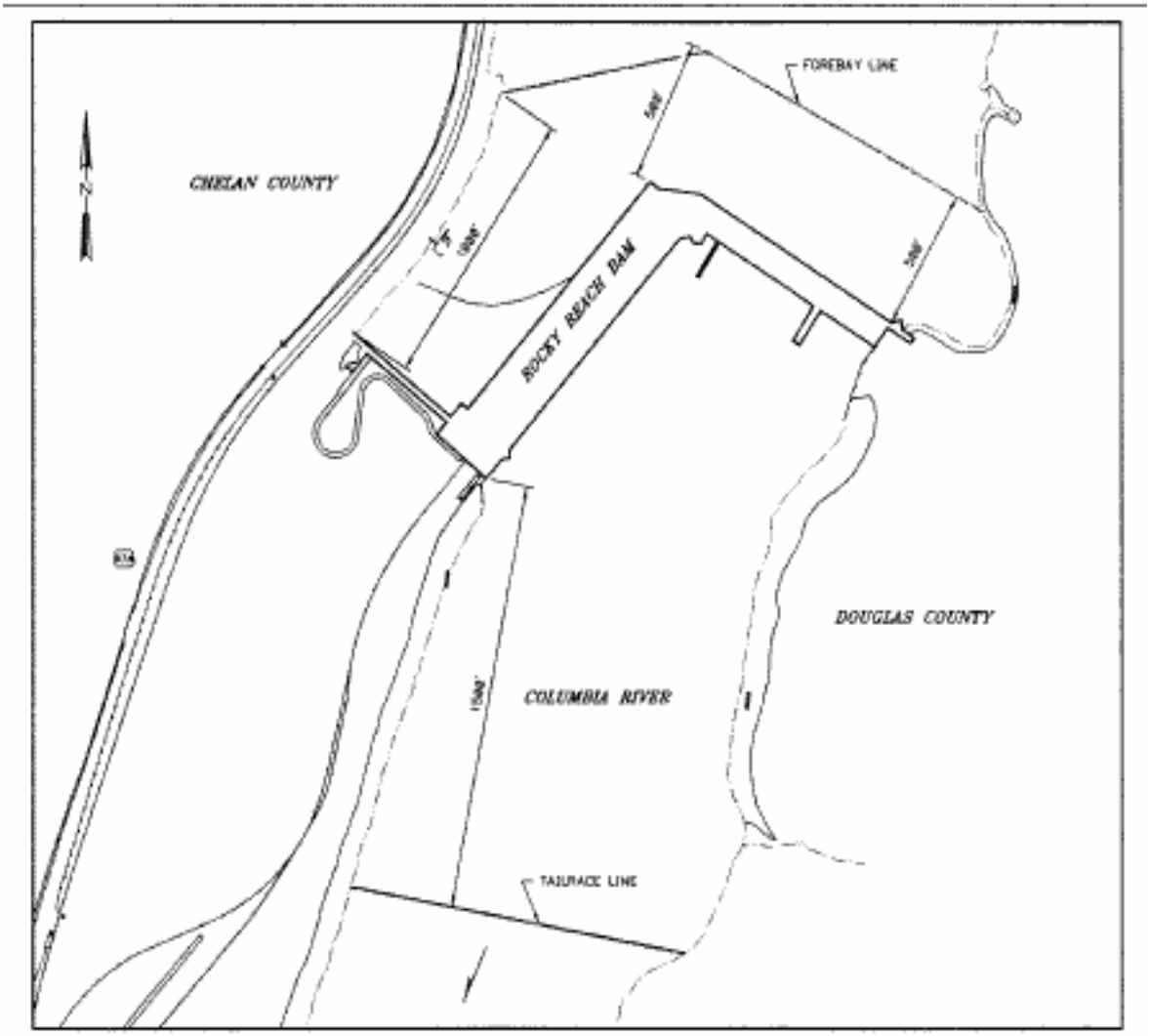
Staff gauges or water level indicators shall be consistent with panel board water surface readings in the fishway room.

Water level indicators shall be maintained such that they are in continuous operation.

Figure 2 “Rocky Reach General Site Plan”



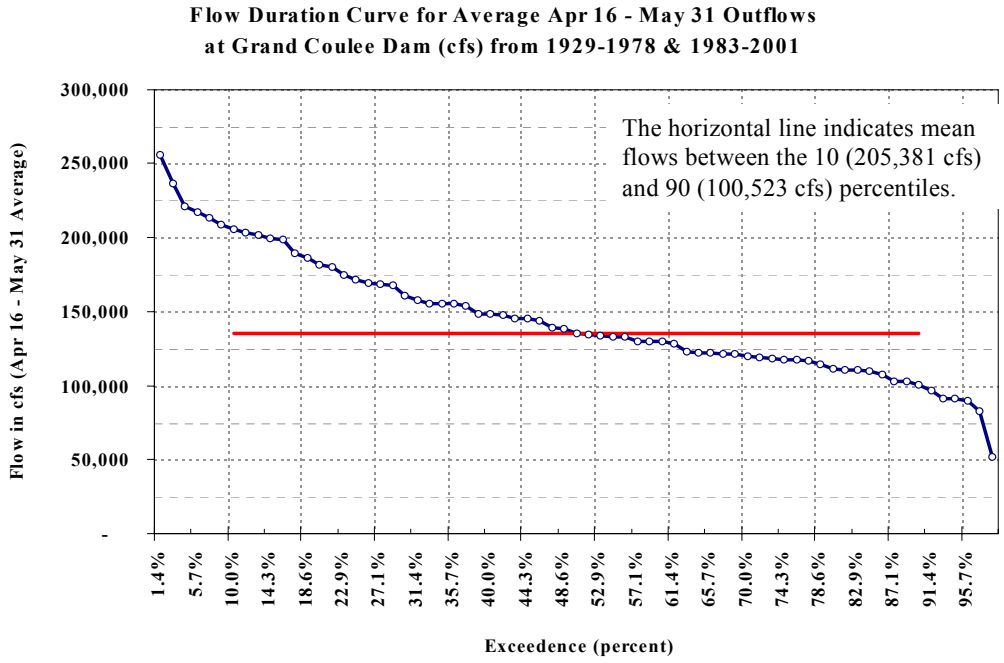
APPENDIX B
Forebay and Tailrace Diagram

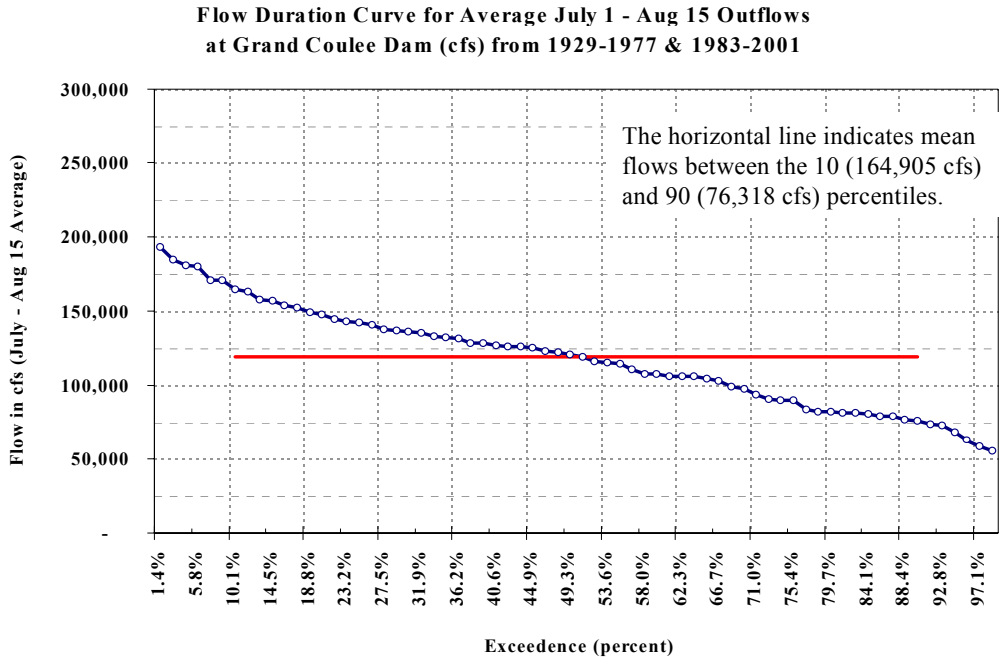


ROCKY REACH TAILRACE AND FOREBAY

APPENDIX C

Flow Duration Curve





Key Flow Exceedence Values:

Modeled Outflows at Grand Coulee Dam (1929-1978 record) and Actual Data (1983-2001) from DART.

Summary Table of BPA modeling (1929-1978) and actual flow data (1983-2001).				**Summary Table of BPA modeling (1929-1977) and actual flow data (1983-2001).**		
Spring Flows		Apr16-May31		Summer Flows		Jul1-Aug15
Rank	Percentile	Mean Flows		Rank	Percentile	Mean Flows
1	1.4%	255,259		1	1.4%	192,888
7	**10.0%**	**205,381**		**7**	**10.1%**	**164,905**
18	25.7%	169,289		18	26.1%	140,831
35	50.0%	135,423		35	50.7%	119,087
53	75.7%	117,402		52	75.4%	90,010
63	**90.0%**	**100,523**		**62**	**89.9%**	**76,318**
69	98.6%	51,389		68	98.6%	55,388

NOTE:	1929-1978 data from BPA model results under 00FSH-26, Base Case - 1995 FCRPS biop operations
	1978 data is not included in the Jul 1 - Aug 15 period because Aug., 1979 is not included in the period of record.
	1979-1982 water years are not included: they are not part of the modeled record and operations were not representative.
	1983-2001 water years are observed flows after NWPP Act was implemented (from Columbia River DART website).

Representative Flow Conditions

	% Exceedence	Spring Flow (kcfs	% Exceedence	Summer Flow (kcfs)
05 Percent	4.30%	220,597	4.30%	180,607
10 Percent	10.00%	205,381	10.10%	164.905
90 Percent	90.00%	100,523	89.,9%	76,318
95%	95.70%	90,152	95.70%	63,291

LIST OF SUPPORTING DOCUMENTS

Supporting Document A	Tributary Plan, Project Selection, Implementation, and Evaluation (1998)
Supporting Document B	Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers (1998)
Supporting Document C	Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Programs (1998)
Supporting Document D	Briefing Paper Estimating Survival of Anadromous Fish through the Mid-Columiba PUD Hydropower Projects (2002)
Supporting Document E	Rocky Reach Background Biology (1998)

Supporting Documents can be obtained by contacting Public Utility District No. 1 of Chelan County, Washington at 509-663-8121 or the National Marine Fisheries Service web site at <http://www.nwr.noaa.gov/1hydrop/hydroweb/ferchcps.html>

APPENDIX B: 2016 ROCKY REACH TDG OPERATIONAL PLAN

2016 Rocky Reach Operational Plan

for Total Dissolved Gas During Fish-spill Season

April 1 through August 31

(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

APPENDIX C: 2016 OPERATIONS PLAN

2016 OPERATIONS PLAN

LICENSE ARTICLE 402

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

March 30, 2016

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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TERMS AND ABREVIATIONS

401 Certification	water quality certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
CCT	Confederated Tribes of the Colville Reservation
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
fps	feet per second
GAP	Gas Abatement Plan
GBT	gas bubble trauma
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
HPU	hydraulic pumping unit
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
LPEs	left powerhouse entrances
License	FERC license for Rocky Reach
MCHCA	Mid-Columbia Hourly Coordination Agreement
MSE	Main spillway entrance
NMFS	National Marine Fisheries Service
NNI	No Net Impact
Project	Rocky Reach Hydroelectric Project
RPE	right powerhouse entrance
RRFF	Rocky Reach Fish Forum
Settlement Agreement	2006 Rocky Reach Comprehensive Settlement Agreement
TDG	total dissolved gas
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
YN	Confederated Tribes and Bands of the Yakama Nation

EXECUTIVE SUMMARY

As required by the Federal Energy Regulatory Commission's (FERC's) License Order, Article 402, for the Rocky Reach Hydroelectric Project No. 2145 (Project), issued February 19, 2009, this Operations Plan describes: (1) fisheries- and water quality-related operating criteria for the project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (2) fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (3) provides an annual schedule for operation and inspection of these facilities.

The turbines at Rocky Reach are operated as needed to produce electricity and do not have an operation season or schedule. However, during the juvenile fish migration season (April 1 through August 31), Public Utility District No. 1 of Chelan County (Chelan PUD) will prioritize the dispatch of generating units to achieve peak plant operating efficiency as follows: 1, 2, 3, 5, 4, 6, 7, 8, 9, 10, 11 and turbine units 1 and 2 will operate at a soft-limit of 12 to 12.5 thousand feet per second (kcfs) each.

The Rocky Reach Juvenile Fish Bypass System (JBS) will operate continuously from April 1 to August 31 of each year. Operations outside these dates can occur if it is deemed necessary to encompass 95 percent of the juvenile salmon migration based on discussion with the Rocky Reach Habitat Conservation Plan Coordinating Committee (HCP CC).

The Project will provide spill for juvenile salmonid passage to cover 95 percent of the juvenile summer Chinook migration (see Table 4-2, specifically Chinook subyearling) in accordance with the criteria set forth by the HCP CC. Spill levels and durations are correlated with operations necessary for meeting the Habitat Conservation Plan (HCP) juvenile survival standards and the specific passage studies designed to measure attainment of Project survival standards.

Chelan PUD will continue to monitor total dissolved gas (TDG) to evaluate compliance with state water quality criteria.

Adult fishways will be operated from March 1 to December 31 each year. If more time is required to complete critical fishway maintenance during the annual fishway overhaul period (January and February), the fishway outage may begin in December and be extended into March with the agreement of the HCP CC.

SECTION 1: INTRODUCTION

The Rocky Reach Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). Chelan PUD received a new license (License) from the Federal Energy Regulatory Commission (FERC) on February 19, 2009, authorizing Chelan PUD to operate the Project dam and powerhouse for a period of 43 years.

The Project consists of a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The dam consists of:

- a forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- a powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- a spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate;
- two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide;
- an east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet and;
- Dryden weir and Tumwater dams' fish ladders and trapping facilities. (These facilities are located some distance away from the Project on the Wenatchee River).

The Rocky Reach Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. One entrance is located between spillway bays 8 and 9, a second entrance is at the center of the dam adjacent to powerhouse unit 11, and a third entrance is at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also six submerged orifice entrances in operation; three at each end of the powerhouse. Fish pass from the entrances into fish collection and transportation channels, which converge to guide fish to a pool and weir fish ladder. There is a counting station at the fishway exit located near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cubic feet per second (cfs). A gravity intake provides additional attraction water for the spillway entrance. The juvenile fish bypass system (bypass system) includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

On February 19, 2009, FERC issued its Order on Offer of Settlement and Issuing New License for the Rocky Reach Hydroelectric Project for a term of 43 years to Chelan PUD (License ends February 1, 2052). Article 402 of the License order, *Operations Plan*, requires the following:

> *Within six months of the issuance date of the license and by February 15 each year thereafter, the licensee shall file for Commission approval an operations plan. The plan shall include, but not be limited to, the following: (a) descriptions of fisheries- and water quality-related operating criteria for the project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (b) descriptions of fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (c) an annual schedule for operation and inspection of these facilities.*

The licensee shall prepare the plan after consultation with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Environmental Quality (sic, Washington State Department of Ecology), the Confederated Tribes of the Umatilla Reservation, the Confederated Tribes of the Colville Indian Reservation, and the Confederated Tribes and Bands of the Yakama Nation. The licensee shall include with the plan, copies of comments and recommendations on the completed plan after it has been prepared and provided to the above entities, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the plan is approved by the Commission. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

To comply with Article 402 of the License, Chelan PUD includes its annual Fish Spill Plan with the filing of the annual Operations Plan. The annual filing date of the Operations Plan was revised from February 15 to March 30, to better coincide with development and required HCP CC approval of the annual Fish Spill Plan.

On December 8, 2009, FERC approved and modified the 2009 (first) Operations Plan and on December 3, 2010 approved the 2010 Operations Plan. This document constitutes Chelan PUD's eighth Operations Plan, and is substantially the same as the 2015 Operations Plan. Changes made to the 2016 Operations Plan are limited to specifics associated with the Juvenile Fish Bypass Operations Plan and Fish Spill Plan.

The License requires the continued implementation of the HCP and associated Anadromous Fish Agreement, which was incorporated into the License by Ordering Paragraphs E and F. The License also includes several provisions of the 2006 Rocky Reach Comprehensive Settlement Agreement (Settlement Agreement). It is from this document that the Rocky Reach Fish Forum (RRFF) is established to work with Chelan PUD in implementation of Chapters 2, 3, 4, 5, and 6 of the Comprehensive Plan, relating to Water Quality, White Sturgeon (Acipenser transmontanus), Bull Trout (Salvelinus confluentus), Pacific Lamprey (Entosphenus tridentatus), and Resident Fish, respectively. The RRFF shall also assist Chelan PUD in coordinating Chelan PUD's work plans and efforts with the HCP CC through joint membership and/or other such arrangements as the RRFF and the HCP CC may mutually devise.

The operations of the Project with regards to upstream and downstream fish passage are guided by the terms and conditions of the HCP. The HCP is a 50 year agreement, ending in 2052, to protect four species (five stocks) of anadromous salmonids by implementing a combination of fish bypass systems, spill, off-site hatchery programs and evaluations, and habitat restoration work conducted in mid-Columbia tributary streams. This agreement was enacted by Chelan PUD with the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes and Bands of the Yakama Nation (YN), and the Confederated Tribes of the Colville Reservation (CCT). The HCP describes the year round Project operations necessary to protect Endangered Species Act (ESA) listed Upper Columbia River steelhead (*Oncorhynchus mykiss*) and Upper Columbia spring Chinook (*O. tshawytscha*) as well as non-listed late-run (summer/fall) Chinook salmon (*O. tshawytscha*), sockeye salmon (*O. nerka*), and coho salmon (*O. kisutch*) (collectively referred to as "Plan Species"). A HCP CC, consisting of one member from each of the signing Parties, oversees the implementation of the HCP. The HCP CC will be used as the primary means of consultation between Chelan PUD and the other parties in connection with the conduct of studies and the implementation of measures set forth in the HCP.

The operation of the Project with respect to water quality is guided by the terms in the Washington State Department of Ecology's (Ecology) 401 Certification, which has been included as Appendix A of the License.

This Operations Plan provides details of operations and procedures necessary to safely pass fish through the Project facilities to meet the standards agreed upon in the HCP. Additionally, this Operations Plan provides the details of operations and procedures that are taken to meet water quality standards, particularly with relation to operations of the spillway to meet both fish passage requirements and abatement of TDG resulting from spillway operations. Table 1-1 provides a schedule of Project operations for fisheries and water quality purposes at Rocky Reach.

The Operations Plan will be revised as necessary by Chelan PUD to incorporate changes to Project operations and maintenance as a result of new facilities, changes in operational procedures, or information gained from evaluations. Future revisions may incorporate changes adopted through ESA consultations or through agreement of the HCP CC and RRFF.

Table 1-1. Dates of Project Operations for Fisheries and Water Quality Purposes.

Project Name	Start Date	End Date
Juvenile Fish Bypass System Operation	April 1	August 31
Juvenile Fish Bypass Evaluation (Species composition, fish condition evaluation)	April 1	August 31
Juvenile Fish Bypass Maintenance	Sept. 1	March 31
Summer Fish Spill* (subyearling Chinook)	May/June	August*
Dissolved Gas Monitoring	Year round	
Adult Fishway Operation**	March 1	Dec. 31
Adult Fishway Maintenance**	Jan. 2	March 1
*Start and end * dates may vary according to in-season run-timing for each species. **Months of fishway operation and maintenance may vary according to scope of maintenance work for a given year.		

1.1 Emergency Deviations from the Operations Plan

Operational emergencies may occur that could require projects to deviate temporarily from the Operations Plan. To the extent possible, these deviations will be conducted to minimize impacts to fish and TDG and will be coordinated with the RRFF and HCP CC. Normally, coordination occurs prior to an action. However, if an emergency situation requires immediate attention, coordination will occur as soon as possible after the action.

Chelan PUD will file a report with FERC within 10 days of any emergency situation that requires a temporary deviation from this Operations Plan. The report will describe the emergency situation, the operational changes implemented as a result of the emergency, a schedule for resuming normal operation, and adverse environmental impacts associated with the emergency conditions, and any comments from the RRFF or the HCP CC.

Additionally, when emergency deviations from the Operations Plan occur, any adverse environmental effects including increased TDG levels, gas bubble trauma (GBT) or fish mortality; will be reported to Ecology's Central Regional Office, Water Quality Program.

1.2 System Load Shaping

The Project is a participant in the Mid-Columbia Hourly Coordination Agreement (MCHCA). The MCHCA operates the seven dams from Grand Coulee through the Priest Rapids Dam to meet system load requests while minimizing the reductions in head that could result if the projects were operated independently, using active storage in their reservoirs to meet individual loads. Efficient load following is accomplished by matching daily load requests to the movement of water released from Grand Coulee as it passes sequentially through the downstream projects, while maintaining the forebays of these projects as near full as possible. Limitations to operations flexibility at any of the projects with active storage result in greater fluctuations in discharge and forebay elevation at the remaining coordinated projects.

The MCHCA is also an important tool used to minimize spill (and resultant TDG levels) and headwater losses during special operations, including fish survival studies, spill gate testing, and repair and maintenance of turbine generating units at each of the projects.

To the extent it reduces TDG, Chelan PUD will avoid spill by continuing to participate in the MCHCA, or any successor agreement to which Chelan PUD is a party.

1.3 Adaptive Management Approach to Fishery Operations

The adaptive management approach that is used to direct Project fishery operations is clearly defined in the Rocky Reach Settlement Agreement, Page 4:

> *"Adaptive Management" is an iterative and rigorous process used to improve decision-making in the face of uncertainty. In the context of the Rocky Reach relicensing, it is intended to improve the management of natural resources affected by ongoing Project operations, in order to achieve desired goals and objectives as effectively and efficiently as possible, within the provisions of this Agreement. The process has seven steps:*
>
> *a) Develop initial hypotheses regarding any ongoing Project impacts and potential remedial measures;*
>
> *b) Develop goals and objectives for addressing any such impacts;*
>
> *c) Develop and implement appropriate and reasonable measures in accordance with an established schedule;*
>
> *d) Develop or identify monitoring and evaluation methodologies for determining whether such goals and objectives have been achieved;*
>
> *e) Monitor and evaluate the implementation of such measures and their effectiveness toward achieving such goals and objectives;*
>
> *f) Review monitoring and evaluation efforts; and*
>
> *g) Confirm that such goals and objectives have been achieved or, if not achieved, evaluate additional or revised measures, including those previously considered in the Comprehensive Plan, and implement any additional or revised appropriate and reasonable measures, or explain why such goals and objectives cannot be achieved. If such goals and objectives have not been achieved, the RRFF may reevaluate and revise such goals and objectives.*

The HCP is a programmatic approach developed by Chelan PUD and the fisheries agencies and tribes for reducing and eliminating the effects of the Project on salmon and steelhead. The objective of the HCP is to achieve No Net Impact (NNI) for each Plan Species (spring, summer and fall Chinook salmon, sockeye salmon, coho salmon, and steelhead) affected by the Project on the schedule set out in the HCP and to

maintain the same for the duration of the HCP. NNI consists of two components: 1) 91 percent combined adult and juvenile fish project survival achieved by Project improvement measures implemented within the geographic area of the Project, 2) 9 percent compensation for unavoidable project mortality provided through hatchery and tributary programs, with seven percent compensation provided through hatchery programs and two percent compensation provided through tributary programs. The Parties intend these actions to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of Plan Species. Adaptive management, as detailed in the HCP, provides for on-going modification of management practices to respond to new information and scientific development. Adaptive management will yield prescriptions that may vary over time.

The Settlement Agreement includes management plans that include goals and a process for developing protection, mitigation, and enhancement measures for species not covered by the HCP (white sturgeon, Pacific lamprey, bull trout, and resident fish species).

SECTION 2: DESCRIPTION OF TURBINE OPERATING CRITERIA AND PROTOCOLS

2.1 Turbine Operations

The powerhouse contains 11 vertical-axis turbines. The turbines incorporate many fish-friendly design features, including minimal gaps between each blade's leading edge and the hub. At rated capacity and head, units 1 through 7 discharge 14,600 cfs each and units 8 through 11 discharge 17,200 cfs each.

Generally, the turbines are operated as needed for producing electricity and do not have an operation season or schedule. However, during the juvenile fish migration season, Chelan PUD will prioritize the dispatch of generating units to promote optimal fish guidance efficiency of the Bypass System, with unit priority for starts and stops, as 1, 2, 3, 5, 4, 6, 7, 8, 9, 10, and 11. During juvenile fish passage season (April 1 through August 31) turbine units 1 and 2 will operate at a soft-limit of 12 to 12.5 kcfs each to minimize high velocities at the vertical barrier screens in those two turbine units subsequent diversion into the JBS.

2.2 Turbine Operation and Inspection Schedule

Operation of the turbines at the Project is automated, including decisions to start, stop and adjust the output of the 11 generating units to achieve maximum efficiency. The Project's automated functions are backed up with around the clock on duty plant operators who monitor operations and can override computer control if needed.

Turbines are inspected as necessary based on hours operated and other associated stresses. To the extent possible, maintenance of priority units will be scheduled outside of fish passage periods. Because units 1 and 2 provide attraction water flows they are important components of the bypass system; long-term outages of the two units will be avoided during the juvenile fish passage season.

Additionally, to minimize TDG uptake in the tailrace, Chelan PUD will, to the extent practicable, avoid maintenance outages during the high flow periods. When possible, maintenance will be scheduled based on predicted flows.

2.3 Unit Outages

Units C-9 and C-11 are running in an interim repaired status. C-8 has been off line since January 21st of 2015, completion of repairs is scheduled for October of 2016. C-10 became unavailable due to coil failures on June 24th of 2015. Repairs are estimated to be completed by April of 2016.
The remaining large units will follow as listed below.

- Expected final repair schedule:

  - ~ Unit C-9 January 9, 2017 through February 11, 2018
  - ~ Unit C-11 February 12, 2018 through April 17, 2019
  - ~ Unit C-10 April 18, 2019 through May 21, 2020

Additionally unit C-5 will be removed from service to perform routine overhaul maintenance as well as installation of a new exciter and governor control upgrades. It will be removed from service July 11, 2016 and return to service September, 2016.

SECTION 3: JUVENILE FISH BYPASS SYSTEM (JBS)

3.1 Facilities Description

Following more than 15 years of testing and prototype operation, Chelan PUD constructed the permanent JBS in 2002 and began operation of that system at Rocky Reach in 2003 to guide migrating fish before they enter the powerhouse and divert them downstream past the dam. The bypass system is a key component of the HCP signed by Chelan PUD, NMFS, USFWS, WDFW, CCT, and the YN to meet HCP juvenile fish survival standards.

The juvenile fish passage facilities at the Project consist of three parts: a surface collector, an intake screen system in units 1 and 2, and a bypass conduit, which includes a juvenile fish sampling facility.

For a more detailed discussion of bypass system operations, please see Appendix A: 2016 Rocky Reach Juvenile Fish Bypass Operations Plan.

3.1.1 Surface Collection System

The surface collector attracts the majority of the migrating juvenile fish into the bypass conduit. The surface collector is located in the forebay of the Rocky Reach powerhouse adjacent to the forebay wall, service bay, and turbine units 1, 2, and 3. The surface collector structure comprises three major sub-parts: the entrance, the de-watering structure, and the pump station. Trash racks, trash handling system and screen cleaners are provided to facilitate management of debris. The migrating fish pass over two surface collector control gates and are delivered to the bypass conduit by way of the surface collector weir box.

3.1.2 Intake Screen System

Studies indicate the second most likely path for migrating juvenile fish is through the turbine intakes for units C1 and C2. The intake screen system is designed to divert the majority of these fish and safely move them to the bypass conduit.

The intake screen system extends from the turbine intakes, up the gatewell slots, and into the gatewells of turbine units 1 and 2. The intake screen system consists of diversion and vertical barrier screens and 12 weir boxes (two boxes per intake slot, three slots per unit, and two units). The fish are guided by diversion screens in each intake, are routed up the gate well slot along the vertical barrier screens, and then pass over slide gates into the weir boxes. At normal forebay elevation (703 to 707 ft normal operating range), a total of 120 cfs flows through each weir box. Flow from each of these weir boxes is directed into the gatewell collection piping and routed to the bypass conduit which consists of a combination of flumes and large diameter pipes.

3.1.3 Bypass Conduit

The bypass conduit is a combination of flumes and large diameter pipes and is designed to collect 240 cfs from the surface collector and 120 cfs from the intake screen system. Transport pipes from the surface collector and intake screen system penetrate the forebay wall at two separate locations and merge at a junction just south of the intake screen system pipe's exit from the forebay wall. The bypass conduit is 4,600 feet long and ranges from 90 to 108 inches in diameter. The bypass conduit originates south of the forebay wall and service bay and proceeds north along the tailrace deck. The bypass conduit then curves to the east across the center dam area and continues along the spillway to the Eastbank area. As soon as the bypass conduit reaches the east bank, it curves to the south and runs along the top of the bank, until it finally swings to the southwest for its last 500 feet. The bypass conduit terminates with an outfall structure. The velocity at the outfall terminus is 26 feet per second (fps) with impact velocities ranging from 40 to 48 fps depending on the tailrace elevation.

3.1.4 Juvenile Fish Sampling Facility

The juvenile fish sampling facility is comprised of a sampling screen, sampling flume, adult fish separator and return pipe, juvenile fish flume, raceway, and support building. The sampling screen is designed to be deployed into and retracted from the bypass conduit by large hydraulic cylinders. When deployed, the sampling screen will divert 20 to 25 cfs from the bypass conduit flow; this flow is then reduced to four cfs. Adult fish are separated automatically from the juvenile fish. Adults are returned to the bypass conduit by means of the adult fish return pipe; juvenile fish fall between the bars of a separator and are delivered to the raceway by way of a flume. Juvenile fish are processed at the support building and returned to the bypass conduit or transported to other sites if needed for studies.

3.2 Operating Criteria and Protocol

3.2.1 Operation Schedule

The bypass system will operate continuously from April 1 to August 31, but may be extended as determined by the HCP CC beyond August 31. Operations outside these dates may occur if it is deemed necessary to encompass 95 percent of the juvenile salmon and steelhead run based on decisions by the HCP CC.

3.2.2 Operation Procedures

The bypass system has been designed to provide fish guidance and bypass at river flows ranging from 0 to 425 kcfs, forebay elevations ranging from 703 to 707 feet, and tailwater elevations ranging from 609 to 636 feet. The surface collector is operated to maintain a constant velocity of 2.85 feet per second at the entrance. At a normal forebay elevation of 703-707 feet, approximately 6,000 cfs is drawn into the entrance. After flowing through two dewatering channels, the 6,000 cfs is reduced to a bypass flow of 240 cfs at normal forebay elevation. A series of 36 screen cleaners sequentially remove debris from the surface collector dewatering screens. The diversion and vertical barrier screens in turbine units 1 and 2 will be cleaned routinely with a mobile intake screen cleaner. Cleaning will occur frequently enough to maintain the proper differential across the vertical barrier screens and to prevent descale/injury of migrating juvenile fish. Debris buildup will be monitored with a camera mounted to the screen cleaner; this monitoring will enable the cleaning schedule to be adjusted based on the debris load in the river. Slide gate settings (associated with weir boxes and the intake screen system) are controlled automatically to maintain a flow of 120 cfs from the gatewell depending on forebay elevation. Contingencies are in place to manually operate any of the automatic systems, if the need arises.

3.2.3 Service Interruptions

The JBS is taken out of operation at the end of the juvenile fish bypass season (i.e. after August 31) for fall/winter shutdown and annual maintenance. The JBS may also be removed from service due to unforeseen emergency repairs during the fish migration season. A fisheries biologist will be on-site for coordination and oversight of any maintenance activities during the April 1 to August 31 operating season.

3.3 Inspection and Maintenance Schedule

3.3.1 Juvenile Fish Bypass Daily Inspection Check List (100 degrees)

Chelan PUD has developed a Juvenile Fish Bypass Daily Inspection Check List (Check List) (Appendix B) for days when air temperatures exceed 100 degrees. Implementation of this Check List begins on April 1. The Check List must be performed by the end of each shift each day when temperatures are at or exceed 100 degrees. All hydraulic hoses and their associated cylinders and hydraulic pumping units (HPUs) will be inspected for leaks. Hoses will be inspected for signs of cracking or abrasions on the hose jackets, bulging, kinking, or any signs of imminent failure.

3.3.2 Scheduled Maintenance

Scheduled maintenance of the bypass system will occur in the off-season, which typically runs from September through March of each year. At this time, the various systems that comprise the JBS will be inspected; worn and/or broken parts will be repaired or replaced.

In 2015, Chelan PUD completed hydraulic hose replacements on the JBS at the bypass conduit and sampling facility. Additional hydraulic hose replacement in the headgate slot of C-2 will be replaced in the fall of 2016.

Additionally, Chelan PUD will begin a 7-year replacement cycle for the hoses remaining on the system that were not hard plumbed.

3.3.3 Unscheduled Maintenance

If unscheduled maintenance will cause an outage of the bypass system during the juvenile fish migration season, Chelan PUD's biologists will inform the HCP CC of the problem. If the problem is an emergency and immediate action must be taken, then the HCP CC will be informed as soon as possible. If the problem is not an emergency, but serious enough that action will need to be taken during the migration season, Chelan PUD will coordinate efforts with the HCP CC.

SECTION 4: DESCRIPTION OF SPILLWAY OPERATING CRITERIA AND PROTOCOL

The Project's gated spillway allows regulation of flows and headwater levels in the Project reservoir. The spillway structure is oriented roughly perpendicular to the flow of the river. The spillway section consists of twelve 50 foot wide bays separated by 10 foot wide piers. The crest of the ogee spillway section is at elevation 650 feet. Flow through each bay is controlled by a 58 foot high radial gate. Each gate is operated by a stationary hoist and is equipped for remote operation from the control room in the Project powerhouse.

Spillway releases to pass water in excess of turbine capability for load requirements, or for fish passage, are controlled by computer. The Project's automated functions are backed up with around the clock, on duty plant operators who monitor operations and can override computer control if needed. When the headwater level exceeds operator set maximum points, gates are automatically opened to pass the excess flow.

Spill gates are opened to create a tailrace pattern of turbulent water, the edges of which lead toward the adult fishway entrances. This spill pattern was designed to provide favorable guidance conditions for adult migrant salmon and steelhead. This spill pattern and alternate patterns were tested and it was determined this pattern was as good as, if not better than the alternate patterns (Schneider and Wilhelms, 2005). The same pattern (Table 4-1) 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.

During fish passage spill operations, the sequence and amounts of gate opening can also be adjusted to maximize the effectiveness of the water being spilled, both for juvenile fish passage and adult fish attraction. Based on the daily spill memo sent by the Chelan PUD Spill Coordinator by 5:00 PM., the plant operators input into the system the volume of spill, start time, and end time requested. On occasion the daily spill volumes are revised later in the day based on flows from Grand Coulee and Chief Joseph dams. The computer then determines, based on the program, which gates to open and how far.

For spill other than designated fish passage spill, the gates can be operated either automatically with the above mentioned program or manually.

Table 4-1. Spilling Schedule for Rocky Reach Dam. (Openings are in feet)

Total Feet of Gate Open	Gate 2	Gate 3	Gate 4	Gate 5	Gate 6	Gate 7	Gate 8	Estimated flow in cfs
2							2	4334
3							3	6501
4					2		2	8668
5					2		3	10835
6					3		3	13002
7			2		2		3	15169
8			2		3		3	17336
9			3		3		3	19476
10	2		2		3		3	21640
11	2		3		3		3	23804
12	2		3		3	2	2	25968
13	2		3		3	2	3	28132
14	2		3		3	3	3	30296
15	2		3	2	3	2	3	32460
16	2		3	2	3	3	3	34624
17	2		3	3	3	3	3	36788
18	2	2	3	3	2	3	3	38124
19	2	2	3	3	3	3	3	40242
20	2	2	3	4	3	3	3	42360
21	2	3	3	4	3	3	3	44478
22	2	3	3	4	4	3	3	46596
23	2	3	3	5	4	3	3	48714
24	2	3	4	5	4	3	3	50832
25	2	3	4	5	4	4	3	52950
26	2	3	4	5	4	4	4	55068
27	2	3	5	5	4	4	4	57186
28	2	3	5	5	5	4	4	59304
29	2	3	5	5	5	5	4	61422
30	2	3	5	6	5	5	4	63540
31	2	3	5	6	5	5	5	65658
32	2	3	5	6	6	5	5	67776
33	2	4	5	6	6	5	5	69894
34	2	4	5	6	7	5	5	72012
35	2	4	6	6	7	5	5	74130
36	2	4	6	6	7	6	5	76248
37	2	4	6	6	7	6	6	78366
38	2	4	6	6	8	6	6	80484
39	2	4	6	7	8	6	6	82602

Total Feet of Gate Open	Gate 2	Gate 3	Gate 4	Gate 5	Gate 6	Gate 7	Gate 8	Estimated flow in cfs
40	2	4	6	7	8	7	6	84720
41	2	5	6	7	8	7	6	86838
42	2	5	7	7	8	7	6	88956
43	2	5	7	7	9	7	6	91074
44	2	5	7	7	9	8	6	93192
45	2	5	7	8	9	8	6	95310
46	2	5	8	8	9	8	6	97428
47	2	5	8	9	9	8	6	99546
48	3	5	8	9	9	8	6	101664
49	3	6	8	9	9	8	6	103782
50	3	6	8	9	10	8	6	105900
51	3	6	8	10	10	8	6	108018
52	3	6	8	10	10	9	6	110136
53	3	6	9	10	10	9	6	112254
54	3	6	9	10	11	9	6	114372
55	3	6	9	11	11	9	6	116490
56	3	7	9	11	11	9	6	118608
57	3	7	10	11	11	9	6	120726
58	3	7	10	11	11	10	6	122844
59	3	7	11	11	11	10	6	124962
60	3	7	11	12	11	10	6	127080
61	4	7	11	12	11	10	6	129198
62	4	8	11	12	11	10	6	131316
63	5	8	11	12	11	10	6	133434
64	5	8	11	12	11	11	6	135552
65	6	9	11	12	11	11	6	137670
66	6	9	11	12	11	11	6	139788
67	7	9	11	12	11	11	6	141906
68	7	9	12	12	11	11	6	144024
69	8	9	12	12	11	11	6	146142
70	8	10	12	12	11	11	6	148260
71	9	10	12	12	11	11	6	150378
72	9	11	12	12	11	11	6	152496
73	9	11	12	12	12	11	6	154614
74	9	11	12	12	12	12	6	156732
75	9	12	12	12	12	12	6	158850
76	9	12	13	12	12	12	6	160968
77	9	12	13	13	12	12	6	163086
78	9	12	13	13	13	12	6	165204

Total Feet of Gate Open	Gate 2	Gate 3	Gate 4	Gate 5	Gate 6	Gate 7	Gate 8	Estimated flow in cfs
79	9	13	13	13	13	12	6	167322
80	9	13	13	13	13	13	6	169440
81	10	13	13	13	13	13	6	171558
82	10	13	14	13	13	13	6	173676
83	10	13	14	14	13	13	6	175794
84	10	13	14	14	14	13	6	177912
85	10	14	14	14	14	13	6	180030
86	10	14	14	14	14	14	6	182148
87	11	14	14	14	14	14	6	184266
88	11	14	15	14	14	14	6	186384
89	11	14	15	15	14	14	6	188502
90	11	14	15	15	15	14	6	190620
91	11	15	15	15	15	14	6	192738
92	11	15	15	15	15	15	6	194856
93	12	15	15	15	15	15	6	196974
94	12	15	16	15	15	15	6	199092
95	12	15	16	16	15	15	6	201210
96	12	15	16	16	16	15	6	203328
97	12	16	16	16	16	15	6	205446
98	12	16	16	16	16	16	6	207564
99	12	16	16	16	16	16	7	209682
100	12	16	16	16	16	16	8	211800
101	12	16	17	16	16	16	8	213918
102	12	16	17	17	16	16	8	216036
103	12	16	17	17	17	16	8	218154
104	12	17	17	17	17	16	8	220272
105	12	17	17	17	17	17	8	222390
106	13	17	17	17	17	17	8	224508
107	13	17	18	17	17	17	8	226626
108	13	17	18	18	17	17	8	228744
109	13	17	18	18	18	17	8	230862
110	13	18	18	18	18	17	8	232980
111	13	18	18	18	18	18	8	235098
112	14	18	18	18	18	18	8	237216
113	14	18	19	18	18	18	8	239334
114	14	18	19	19	18	18	8	241452
115	14	18	19	19	19	18	8	243570
116	14	19	19	19	19	18	8	245688
117	14	19	19	19	19	19	8	247806

Total Feet of Gate Open	Gate 2	Gate 3	Gate 4	Gate 5	Gate 6	Gate 7	Gate 8	Estimated flow in cfs
118	15	19	19	19	19	19	8	249924
119	15	19	20	19	19	19	8	252042
120	15	19	20	20	19	19	8	254160
121	15	19	20	20	20	19	8	256278
122	15	20	20	20	20	19	8	258396
123	15	20	20	20	20	20	8	260514
124	15	20	20	20	20	20	9	262632
125	15	20	20	20	20	20	10	264750
126	15	20	21	20	20	20	10	266868
127	15	20	21	21	20	20	10	268986
128	15	20	21	21	21	20	10	271104
129	15	21	21	21	21	20	10	273222
130	15	21	21	21	21	21	10	275340
131	16	21	21	21	21	21	10	277458
132	16	21	22	21	21	21	10	279576
133	16	21	22	22	21	21	10	281694
134	16	21	22	22	22	21	10	283812
135	16	22	22	22	22	21	10	285930
136	16	22	22	22	22	22	10	288048
137	17	22	22	22	22	22	10	290166
138	17	22	23	22	22	22	10	292284
139	17	22	23	23	22	22	10	294402
140	17	22	23	23	23	22	10	296520
141	17	23	23	23	23	22	10	298638
142	17	23	23	23	23	23	10	300756
143	18	23	23	23	23	23	10	302874
144	18	23	24	23	23	23	10	304992
145	18	23	24	24	23	23	10	307110
146	18	23	24	24	24	23	10	309228
147	18	24	24	24	24	23	10	311346

Notes:

1) The estimated flow values are only an estimate. Flow values are dependent on actual headwater (and possibly how far the gate is open).
2) The table only accounts for gates that are under SCADA control (2-8).
3) Other gates could be opened manually, which would change total flow.

4.1 Fish Passage Spill Program

Since 2003, the University of Washington has been contracted to provide Chelan PUD with run-timing predictions for spring and summer out migrating salmon and steelhead using the Program RealTime juvenile fish run-time forecasting model. Program RealTime provides daily forecasts and cumulative passage percentiles for steelhead, yearling Chinook, sockeye, and subyearling Chinook at both Rocky Reach and Rock Island dams. The program enables the Chelan PUD to better predict the date when a selected percentage of these species will pass each project and to determine when to initiate spring and summer fish spill. The program utilizes daily fish counts from the juvenile fish sampling facility at Rocky Reach and the bypass trap at Rock Island. Estimates of the program's forecast error in daily run projections will be calculated and displayed with the daily predictions at the University of Washington's Columbia Basin Research website page, "Inseason Forecasts Methods and Information[1]".

Spill will be provided for subyearling (summer) Chinook salmon passage to cover 95 percent of the run at each of the projects in accordance with the criteria set forth in the HCP. Spill levels and durations are correlated with operations necessary for meeting the HCP juvenile fish survival standards and the specific passage studies designed to measure attainment.

Table 4-2. Mean Historical Juvenile Fish Run-timing at Rocky Reach Dam, (Columbia Basin Research website[1]).

Species	Passage Dates						
	First	*5%*	*10%*	*50%*	*90%*	*95%*	*Last*
Chinook Yearling	4/01	4/20	4/26	5/12	5/26	5/29	8/4
Steelhead	4/2	4/28	4/30	5/10	5/24	5/30	8/22
Sockeye	4/8	5/10	5/12	5/17	5/23	5/25	8/14
Chinook Subyearling	5/24	6/3	6/6	7/5	8/2	8/10	9/21

Appendix C provides information on annual operations related to the spillways, including annual juvenile fish spill program details.

4.2 Operation and Inspection Schedule

Spillways are operated on the schedule outlined above when spilling solely for juvenile fish passage. Spill required for other reasons, such as passing inflows in excess of powerhouse capacity or generation requirements may occur on an as-needed basis throughout the year, but rarely outside of the May to July snowmelt period. Inspections generally occur between May and October every year and are coordinated with spill requirements.

[1].The website for the University of Washington, School of Aquatic & Fishery Sciences, Columbia Basin Research, Inseason Forecasts for the Snake and Columbia Rivers is currently located at http://www.cbr.washington.edu/inseason/.

4.3 TDG Monitoring and Control

The state water quality criteria TDG is 110 percent of saturation at ambient temperature and pressure, except when inflows to the Project exceed the seven-day, 10-year average maximum flow level (7Q10). During the juvenile salmon passage season (April 1 through August 31), Ecology establishes a special fish passage water quality standards exemption for the Snake and Columbia rivers to aid in fish passage over hydroelectric dams when consistent with an Ecology approved Gas Abatement Plan (GAP). Per the exemption, TDG must not exceed an average of 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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. Additionally, a maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

Chelan PUD operates the Project in a manner to avoid spill as much as possible, while meeting the juvenile fish passage and survival standards set forth in the HCP and Fish Management Plans. When spilling for fish or due to excess inflow or generation needs, the spillway is operated using gate settings that have been shown to limit TDG production and meet fish passage requirements (Schneider and Wilhelms, 2005). These gate settings are is consistent with Section 5.4(1)(b) of the 401 Certification, which states "manage spill toward meeting state water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and Fish Management Plans….."

Under the Operational Plan for TDG (Appendix D), the Project's operations personnel will monitor the TDG levels hourly. If the previous six-hour average TDG level in the tailrace at the bypass outfall is at or above 120 percent, or the instantaneous TDG level is at or above 125 percent, the voluntary spill volume will be reduced by three kcfs, or as necessary to achieve an instantaneous TDG level below 120 percent. The new spill volume will be monitored for an hour. If the next six-hour average TDG level is not less than 120 percent, the spill will be reduced by another two kcfs and monitored for an hour. The cycle continues, with the spill level reduced by two kcfs until the average TDG level of the previous six-hour period is less than 120 percent and remains at less than 120 percent through the next full hour. If the instantaneous TDG drops below 118 percent for one full hour, the spill will be increased by two kcfs and monitored. The objective is to maintain as much of the spill level scheduled for fish passage operations as possible, without exceeding the tailrace TDG numeric criteria.

If the TDG level in the forebay of Rock Island Dam exceeds 115 percent, the Rock Island operations personnel will notify Rocky Reach operations personnel immediately. If the TDG level in the Rock Island forebay is greater than 115 percent and the TDG level in the forebay of Rocky Reach is less than 115 percent, the voluntary spill volume at Rocky Reach will be reduced by three kcfs for two hours. If, after two hours of reduced spill, the Rock Island forebay TDG levels are still above 115 percent, the spill will be reduced another two kcfs. If, subsequently, the instantaneous TDG level in the forebay of Rock Island is less than 113 percent, spill will be increased to the level necessary to comply with the TDG level of 115 percent. Since the TDG level in the Rock Island forebay is affected by mixing of powerhouse flows with spillway flows at the Rocky Reach Project, Project operations personnel may develop additional protocols to adjust spill levels based on changes in powerhouse flow levels.

To track Project compliance during fish spill (April 1 through August 31) and non-fish (September 1 through March 31) seasons, Chelan PUD monitors TDG levels at three locations: one in the forebay of Rocky Reach Dam, one in the tailrace of the dam; and one in the forebay Rock Island Dam (the next downstream project). TDG levels are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the United States Army Corps of Engineers (USACE), Columbia River Basin Water Management Division on an hourly basis and posted on their site on their website. The data can be found

on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data[2].

During the non-fish spill season Chelan PUD utilizes the standard spill pattern (gates 2 through 8) as necessary. Chelan PUD has no defined mechanism, other than operating generating resources to minimize spill, of achieving 110 percent during non-fish spill periods. Chelan PUD minimizes spill outside of juvenile fish passage times by participating in the MCHCA, and by careful planning of turbine unit outages and other activities to avoid reducing hydraulic capacity of the powerhouse during time periods when inflows to the Project are highest.

[2]. The website for the United States Army Corps of Engineers, Columbia River Basin Water Management Division, Rocky Reach Dam, Water Quality Data, TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/#RRDW Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.

SECTION 5: ADULT FISHWAYS

5.1 Facilities Description

Adult fish facilities provide upstream passage for both anadromous and native resident fish species at the Project. These facilities consist of a fishway with two right powerhouse entrances (RPEs) and two left powerhouse entrances (LPEs), powerhouse collection and transportation channels, a spillway tunnel, a middle spillway entrance (MSE), and a fish ladder. The LPEs are located at mid-dam between the powerhouse and spillway. The RPEs are located on the south end of the powerhouse. The fishway includes a counting station on the right bank of the river.

The adult fish passage facilities include three turbine-driven propeller-type pumps that supply attraction water from the tailwater of the Project for the powerhouse fishway entrances, the spillway entrance, and the six orifice gates that are operated along the powerhouse collection channel. Additional gravity-flow water can be supplied at the MSE to maintain the agreed upon criteria for that entrance. The collection, left powerhouse, and spillway channels merge in the junction pool area, which transitions into the transportation channel that guides fish to the lower end of the fish ladder. The fish ladder exit is located on the right bank of the river.

Construction activities and associated modification in operations have potential for impact on adult fish passage at the Project. Construction schedules and activities will be reviewed in advance to limit this potential. Activities that have a high probability of affecting passage will be scheduled during nighttime hours. However, activities will be scheduled to minimize potential effects to adult Pacific lamprey passage.

5.2 Operations Schedule

For operation and maintenance purposes, the primary fish passage season is considered to be April through November. Primary passage periods by species are included in Table 5-1. Adult fish facilities will be operated from March 1 to December 31 each year. If more time is required to complete critical fishway maintenance during the annual fishway overhaul period, the fishway outage may encompass the month of December in addition to January and February. Chelan PUD will notify the HCP CC as soon as possible in the process and request the additional time. Chelan PUD's annual goal is to have the fishway back in service by March 1. If unforeseen events or circumstances arise during the maintenance period which could extend the fishway outage beyond March 1, Chelan PUD will again notify the HCP CC and request an extension beyond March 1.

Table 5-1. Primary Adult Salmonid Passage Periods by Species at Rocky Reach Dam.

Species	Passage Period
Spring Chinook*	Mid-April to mid-late June
Summer Chinook*	Mid-late June to early September
Fall Chinook*	Early September to November
Steelhead	April to March
Coho	September to November
Sockeye	Late June to early September
* For accounting purposes and based on historical run timing, the spring Chinook run occurs from April 15 to June 23, summer Chinook from June 24 to September 1, and fall Chinook from September 2 to November 15.	

5.3 Operation Criteria

Below are the operation criteria for Rocky Reach Dam fish facilities.

a. **Adult fishway**: Water depth over weirs will be maintained at 1.0 to 1.2 feet.
b. **Transportation Channel (Between trifurcation pool and ladder)**: A transportation velocity of 1.5 to 4.0 feet per second (fps) (preferably 2.0 fps) shall be maintained in the channel and the lower end of the fish ladder which is below tailwater elevation.
c. **Entrances**:
   1. General: A 1.0-foot minimum head will be maintained.
   2. RPE: Rotary gates at RPE1 and RPE2 shall be fully open.
   3. LPE: LPE1 and LPE3 shall be continuously open.

      Submerged weir crest elevation at the RPEs and LPEs for the following tailwater elevations shall be at or below:

Tailwater Elevation (ft)	*Submerged[1] Weir Crest Elevation (ft)*
615.0	*603.5*
620.0	*606.5*

      During periods of high tailwater (elev. 621.0 or above) the gates are set to maintain a depth of 10-12 feet.

   4. Orifice Entrances: The following six orifice entrances shall be open: CC1, CC2, CC3, CC16, CC18, and CC20.
   5. MSE: Open May 1 through October 31. One gate (MSE 1) is permanently closed. One gate (MSE 2) is permanently open.
      Submerged weir crest elevations at MSE 2 for the following tailwater elevations shall be at or below:

Tailwater Elevation (ft)	*Submerged Weir Crest Elevation (ft)*
621.5	*604.5*
625.0	*605.3*

d. Trashracks:
   1. Ladder Exit and Attraction Water Intake Trashracks: Visible buildup of debris shall be removed immediately.
   2. Picketed Leads at Counting Window: Visible buildup of debris shall be removed immediately.

e. Staff Gauges and Water Level Indicators:
   1. Gauges and indicators shall be readable at all water levels encountered during passage periods.
   2. Staff gauges or water level indicators shall be located upstream and downstream from entrances, and at a convenient location for viewing along the fishway.
   3. Staff gauges and/or water level indicators shall be consistent with panel board water surface readings in the fishway control room.
   4. Water level indicators shall be maintained such that they are in continuous operation.

[1]During periods of high tailwater (elev. 621.0 or above) it has been found that to keep a 1-foot differential at the LPEs and RPEs, gate depths cannot be set at the elevation listed. The depth that the gates are set at is generally between 10.0 and 12.0 feet. This has been coordinated with the Fish Passage Center.

5.4 Dewatering and Fish Handling

The Project's adult fish facilities are dewatered for annual maintenance during the maintenance season (approximately January 2 to March 1). On rare occasions, dewatering has been needed during the fish migration season to address emergency repairs. Although every effort is made to allow fish to leave the facilities volitionally, rescue and evacuation of some fish is typically required.

To facilitate volitional exiting by fish, the upper fishway section is dewatered three to four days ahead of the lower fishway. Orifice gates and ladder entrances in the lower fishway will remain open during this time, so that fish are able to leave the facility.

When fish evacuation is necessary, a Project biologist and a lead Fishway attendant will be on site to coordinate and oversee fish salvage and handling. They will ensure that proper procedures are followed, and the equipment needed to safely evacuate the fish is on hand. The Project biologist will determine where the rescued fish are to be returned to the river. The release location may be closest to the point of rescue, which is usually the tailrace. However, adult salmon, steelhead, and lamprey will be released in the forebay.

The evacuation of fish that are listed as threatened or endangered is a priority. However, the goal is to successfully relocate all fish to the river in good physical condition.

5.5 Inspection and Reporting

Chelan PUD's fishway attendants conduct two walk-throughs of the Rocky Reach fishway per day. A daily report is logged using information from the morning walk-through. The adult fish passage facilities are also inspected monthly by WDFW personnel. The Fish Passage Center (FPC) provides monthly reports covering inspections by WDFW as well as a year-end report.

5.6 Maintenance

Scheduled maintenance for the adult fishway will occur in the off-season from January 2 to March 1. The annual list of items that are checked is noted in Appendix E. Fishway attendants also record additional punch list items to address as they discover them throughout the fish passage season.

If unscheduled maintenance must occur during the fish passage season that results in the need for an outage of the attraction water system, the HCP CC will be consulted. Historically, nighttime outages have been preferred. However, potential effects of nighttime outages to adult Pacific lamprey passage will be considered, prior to initiating unscheduled maintenance activities, to the greatest extent practicable.

SECTION 6: DRYDEN AND TUMWATER FISHWAYS AND TRAPS

The Dryden and Tumwater dams are located at river miles 17.6 and 32, on the Wenatchee River, respectively. The Wenatchee River is a tributary of the Columbia River, with the confluence located approximately 5.3 miles downstream of Rocky Reach Dam. The Dryden and Tumwater facilities are owned and operated by Chelan PUD.

Chelan PUD uses the fish ladders and traps at these facilities to provide passage and to collect broodstock for its salmon and steelhead hatchery program, which is required pursuant to the HCP and used for the Rock Island project. This is the only connection between these fish ladders/trapping facilities and the Rocky Reach Project, and they serve no other purpose related to the Rocky Reach Project. However, because ongoing activities at these facilities are required by the License as mandated by USFWS' incidental take statement, the fish ladders and trapping facilities at Dryden and Tumwater have been made Project facilities through Ordering Paragraph (B)(2) and Article 204 of the License.

6.1 Dryden Fishway and Trap

At Dryden left and right bank fishways, the start of fishway operations and operations in general are based on river flows and the need for alternative fish passage routes. At Dryden left bank fishway, the fishway is opened for fish passage when river flow declines below six kcfs (headgates are removed). At Dryden right bank, the threshold is also six kcfs. The fishway attendants may open the fishways during slightly higher flows, if they observe that fish are beginning to have difficulty in migrating over the spillway (due to a declining hydrograph). The fishways remain in continuous operation throughout the year. When river flow reaches six kcfs or greater, head gates are deployed, at the discretion of the fishway attendants, to prevent the influx of sand and sediment.

The Dryden fish traps operate from July 1 through the end of November (or until the required number of coho and steelhead/Chinook are collected for the Yakama Nation and Eastbank Hatchery's broodstock programs, respectively). Both traps are operated continuously on a weekly basis, Sunday night through Friday afternoon. WDFW personnel operate the traps from July through August. Yakama Nation personnel operate the traps from September through November. Adult summer Chinook, steelhead and coho are collected at the Dryden fish traps.

6.1.1 Inspection and Maintenance

Site visits for operation vary throughout the operating year, from as few as three times per week to twice daily visits. Inspections of the ladder (including fishway hydraulics), attraction water intake screens, trashracks, and staff gauges are conducted during these site visits. Daily monitoring of weather and river flow conditions is necessary to determine when additional site visits are required to keep the facility operating within the established criteria.

Initial maintenance (prior to start-up) occurs before trapping operations commence in the summer. In addition, PUD mechanics normally conduct an annual structural inspection in the late spring. Winterization of the trapping facilities is conducted immediately following the conclusion of fish trapping operations for the year. The general purpose of winterization is to protect the facilities from freezing temperatures and damage due to ice formation.

6.2 Tumwater Fishway and Trap

The Tumwater fishway operates year round, with the exception of 1) the annual overhaul period (generally one week in February), and 2) river flow of 10 kcfs or greater at which point head gates are deployed. WDFW, the Yakama Nation, and USFWS trap adult steelhead, spring Chinook, summer Chinook, sockeye, and coho from mid to late-February through mid-December (or until weather

conditions prohibit trap operations). During this period, the trap is collecting fish 24 hours per day, seven days per week from approximately mid-February to 15 July and from 1 September until mid-December. From 16 July to 31 August, the trap is operated three days/week for up to 16 hours/day (not to exceed 48 hours per week). From mid-February until 31 May, the trap is passively operated, i.e. fish are removed from the trap hopper by WDFW personnel one to two times per day. As the numbers of spring Chinook increase (approximately late May), the trap is actively operated, and fish continually processed, with WDFW personnel on site from dawn to dusk (1 June to 15 July). If the median passage time through both PIT tag antennas in the middle fishway is greater than 48 hours, trapping will cease and fish will be allowed to exit via the upper fishway, bypassing the trap. As steelhead numbers decrease in the winter (late November/early December), the trap is passively operated until freezing temperatures bring an end to trap operations. From approximately mid-December to mid-February, no trapping operations occur. Fish move through the fishway and are captured on video.

6.2.1 Inspection and Maintenance

Site visits for operation vary throughout the operating year, from as few as three times per week to daily visits. Inspections of the ladder (including fishway hydraulics), attraction water intake screens, trashracks, staff gauges, fishway entrance gates, and pump intake and fish trap screens are conducted during these site visits. Daily monitoring of weather and river flow conditions is necessary to determine when additional site visits are required to keep the facility operating within the established criteria.

An annual inspection of the fish trapping facilities is performed during the fishway overhaul period in February.

SECTION 7: REFERENCES

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APPENDIX A: 2016 Rocky Reach Juvenile Fish Bypass System Operations Plan

2016 Rocky Reach Juvenile Fish Bypass System Operations Plan

Final Plan

Prepared By:

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January 2016

Introduction

The Public Utility District of Chelan County (District) constructed and installed a permanent fish bypass system (FBS) in 2002/2003. The bypass system is designed to guide juvenile salmon and steelhead away from turbine intakes at Rocky Reach Dam. The system consists of one surface collector entrance (SC) and the intake screen (IS) system in turbine units 1 and 2. Please refer to Mosey (2004) for a detailed description of the bypass production system.

Studies and data collection at the Rocky Reach FBS fall under one of two general categories "Standard Operations" or "Special Operations" for bypass evaluations. Activities and data collection under standard operations include day to day sampling of run-of-river (ROR) fish to evaluate run timing, species composition, and fish condition after passage. Special operations may include additional sampling time to supply fish for marked fish releases.

2016 Evaluation Requirements

Run-of-river fish collected at the Juvenile Sampling Facility (JSF) to evaluate and provide fish for the following:

1. Run timing of target species:
    a. Provide standardized juvenile capture rate data to supplement Program RealTime (UW) run-timing predictions
    b. Guide decisions about initiating summer fish spill

2. Fish species composition:
    a. Guide decisions about starting or stopping spill
        i. Currently summer fish spill occurs at Rocky Reach (9% of the daily average river flow).

3. Origin of fish stocks and identification of marked individuals:
    a. PIT tags
    b. Fin clips

4. Fish condition:
    a. Ensure that the bypass system remains safe for migrating juvenile salmon and steelhead by evaluating:
        i. Descale: 20% or more scale loss on either side
        ii. Injury: Scratches, bruises, or hemorrhages
        iii. Mortality: Any fish dead on arrival to sampling facility

2016 Study Methods

For more information about the study methods please refer to Mosey (2004).

Standard Operations:

1. Sampling Periods (1 April to 31 August):
    a. Monday through Sunday
    b. Collections Times

i. 30 minute maximum **(or)**
    i. 0800-0830
    ii. 0900-0930
    iii. 1000-1030
    iv. 1100-1130
ii. Target number of fish
    i. 350 spring species
    ii. 125 summer species

2. Fish Condition:
    a. First 100 fish of each species are examined for condition:
        i. Descale
        ii. Injury
        iii. Mortality

3. Species Composition:
    a. ROR fish collected are enumerated by species
    b. Collect data for Program RealTime to determine start and end of spill
    c. Currently summer fish spill occurs at Rocky Reach.

4. Origin of fish stocks and identification of marked individuals:
    a. PIT tags
    b. Fin clips

Special Operations:

1. Marked Fish Releases (Prior 1 April):
    a. Prior to the 1 April system start-up, hatchery yearling Chinook will be used for marked fish releases to determine if the JFBS is causing descale, injury, or mortality.
        i. Releases will be conducted with hatchery summer chinook prior to the 1 April start date to determine if the JFBS is working properly and to help isolate potential sources of descale, injury, and mortality.
        ii. Fish (n = 100/release) of varying sizes will be randomly selected from hatchery chinook. Only those with no scale loss or injury will be marked.
        iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system and into both intake screens in units C1 and C2.
        iv. If potential problems are identified, resolve problems by 1 April system start-up.

2. Marked Fish Releases (1 April to 31 August):
    a. A phased approach will be used to evaluate the descaling rate, injury rate, and mortality rate of fish passing through the bypass system. We

developed a sampling protocol and threshold percentages (Table 1) for descale, injury and mortality that will trigger study phases.

b. Identify "ambient" rates of descale, injury and mortality.
c. Once the ambient rate is estimated and if further sampling shows descale problems continuing at 5%, (3% for injury, 2% for mortality) *above* ambient level for three consecutive samples.
    i. If variable rates of descale, injury or mortality do occur between species, then collection of yearling chinook, sockeye, or steelhead may be necessary for marked releases.
    ii. Fish (n = 100/release) of varying sizes will be randomly selected at the juvenile facility and only those migrants with no scale loss or injury will be marked.
    iii. Marked fish will be systematically released at locations upstream of the sampling screen in the bypass system until the problem area is isolated.
d. Identify circumstances when we would refer to the HCP Coordinating Committee.
e. The District will consult with the Coordinating Committee if any abnormal fish conditions (within values outlined in Table 1) are observed in the sample population.

Table 1. Flow diagram of phased approach and threshold values for conducting marked-fish releases in the *juvenile bypass system at Rocky Reach Dam (Skalski and Townsend 2003)*

	Phase 1		**Phase 2**		**Phase 3**		**Phase 4**
Threshold		**5% initl**		**A*+5%**		**A*+15%**	
Descale	Index sampling for for descale rate	→	Mark-releases to est. ambient descale	→	In-system mark-releases to isolate descale problem	→	refer to HCP Coord. Comm.
Threshold		**3% initl**		**A*+3%**		**A*+10%**	
Injury	Index sampling for for inury rate	→	Mark-releases to est. ambient injury	→	In-system mark-releases to isolate injury problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.
Threshold		**2% initl**		**A*+2%**		**A*+4%**	
Mortality	Index sampling for for mortality rate	→	Mark-releases to est ambient mortality	→	In-system mark-releases to isolate mortality problem	→	Temp. bypass shutdown refer to HCP Coord. Comm.

A* = Ambient percentage

3. Collection of Bull Trout:
    a. Document:
        i. Fork Length and weight measurements
        ii. Condition (descale, injury, or mortality)

b. Allow to recover, then release

Daily Protocol for Fish Collection

Standard Operations:

1. Deploy sampling screen at beginning of each hour (0800, 0900, 1000, 1100 hours).
2. Using direct enumeration to count fish entering the sampling facility
3. Collect for 30 minutes **or** until approximately 350 spring migrants/125 summer migrants have been collected, whichever comes first. RETRACT SCREEN IF 200 TO 300 FISH ARE COLLECTED IN FIRST TWO MINUTES.
4. Retract screen when time period or target number of fish has been reached.
5. Determine species composition of all collected fish in the hourly sample.
6. Scan/examine each fish for PIT tags, fin clips, and acoustic tags.
7. Evaluate fish condition (first 100 fish per species).
8. If needed, collect and hold fish for marked releases (Special Operations).
9. Return to step 1 for next sample period. After the 1100 hour sample, go to step 11.
10. See Special Operations
11. Allow anesthetized fish (examined for species composition and fish condition) to recover in the facility's holding tank for at least 1.5 hours.

Special Operations:

1. If fish are collected for marked fish releases, verify that the required number of target species has been set aside from the four sample periods.
2. If the required number of fish are not collected by the 1100 hour sample period, deploy the sampling screen and repeat steps 2 and 4 under standard operations.
3. Scan/check all anesthetized fish for PIT and acoustic tags.
4. Collect and hold the fish at the facility for transport and/or marking (marked fish releases).
5. Determine species composition for any remaining anesthetized fish and scan for PIT tags.
6. After fish have been collected to meet study needs, estimate the number of fish remaining in the raceway (by species to the extent practical), record the number, and immediately release the fish back into the bypass pipe.
7. Return to step 11 under Standard Operations.

Contingencies:

1. If, after start-up of the bypass system, we encounter any unforeseen problem(s) with fish collection, we will immediately consult with the HCP Coordinating Committee on how to correct the problem(s).
2. If we accumulate many fish during a collection period (e.g. just after a hatchery release), we will only handle/sample the number of fish needed to satisfy the study requirements and then immediately release the remaining fish back into the bypass pipe.

3. If we accumulate many fish during each "index" sample period, we will only evaluate species composition in the first three periods. In the final period, we will evaluate descale and injury, regardless of the number of fish. However, we will be attentive to any injury or descale that may be present among the fish in each of the first three periods. We need to allow enough time (between samples) to gather all species composition information, so that we have representative information on daily passage.

Diversion Screen and Trashrack Cleaning (Units 1 and 2):
During the last week of March, the trashracks in front of Units 1 and 2 (six intakes total) will be cleaned by divers and clammed to remove any dislodged debris. The trash rack cleaning will be repeated as differentials increase across the racks due to debris load. A mid-season cleaning will be scheduled in June. Starting 1 April, the vertical barrier and diversion screens (IS system) will be cleaned one to two times per week or as needed with an automated screen cleaner. Careful observation of trash build up will also be monitored and the screens will be cleaned on a more regular basis if warranted. Frequency of the cleanings may increase depending on debris load during spring run-off and aquatic plant load in the summer. The District will log each screen cleaning, and in the event of high descaling/injury in a single sample, the vertical barrier and diversion screens will be inspected prior to releasing marked fish.

Discussion

The 2016 biological studies at Rocky Reach will encompass the following: 1) a continuing evaluation of the juvenile bypass system, and 2) a daily sampling program to monitor fish passage for run timing. Representatives of various research agencies and the HCP Coordinating Committee will be consulted about the development of detailed study plans and protocols. A time line showing important activities and deadlines for these activities has been developed and is presented in Table 2.

Table 2. Tasks and deadlines for the Rocky Reach 2016 biological evaluations.

Task	Deadline
Present 2016 study plan to Committee	**Winter 2015-2016**
Committee discussion/comments on study plan	**Jan. 27, 2016-Mar. 24, 2016**
Pre-season JFB operations testing (marked fish releases prior to 1 April)	March 15, 2016-March 31, 2016
Begin biological evaluation of JFB	April 1, 2016
Complete 2016 biological evaluation	August 31, 2016
Present 2016 evaluation report to Committee	**December 31, 2016**
Committee comments on 2016 report	**February 1, 2017**
Present 2016 report to Committee	March 1, 2017

****Tasks printed in bold text require action by the HCP Coordinating Committee.**

References

Mosey, T. R., S. L. Hemstrom, and J. R. Skalski. 2004. Study Plan for the Biological Evaluation for the Rocky Reach Fish Bypass System-2004. Chelan County Public Utility District, Wenatchee, Washington.

APPENDIX B: Juvenile Fish Bypass Daily Inspection Checklist (100 Degrees)

CHELAN COUNTY HYDRO	**SITE RECORD SHEET** RR - JFBDICL - 001	
PROJECT: LOCATION:	REFERENCE DRAWINGS:	REVISION 1
ITEM NO.		PAGE 1 of 3

Juvenile Fish Bypass Daily Inspection Check List (100 degrees)

This daily inspection check list must be performed by the end of each shift each day when temperatures are at or exceed 100 degrees. Inspect ALL hydraulic hoses and their associated cylinders and HPUs for leaks and check off when completed. On the hoses, look for signs of cracking or abrasions on the hose jackets. Look for bulging, kinking or any signs of imminent failure. Make notes of any areas of concern.

The completed sheets need to turned in to the Rocky Reach Operations Superintendent immediately for review. Complete SRS (Site Record Sheets) will be scanned and linked to the annual JFB operations admin work order.

Trash rakes and Trash racks

1.2.2.	North trash rake cylinders and hoses	___	Note: _____
	North trash rake HPU	___	Note: _____
1.2.4.	South trash rake cylinders and hoses	___	Note: _____
	South trash rake HPU	___	Note: _____

Trash Handling System

1.3.1.	Local Control panel and Hydraulic Cabinet	___	Note: _____
1.3.2.	Trash pusher cylinder and hoses	___	Note: _____
1.3.3.	Trash hopper lift cylinder and hoses	___	Note: _____

Screen Cleaners

2.2.1.	SC LCP 1, cylinders and hoses	___	Note: _____
2.2.2.	SC LCP 2, cylinders and hoses	___	Note: _____
2.2.3.	SC LCP 3, cylinders and hoses	___	Note: _____
2.2.4.	SC LCP 4, cylinders and hoses	___	Note: _____
2.2.5.	SC LCP 5, cylinders and hoses	___	Note: _____
2.2.6.	SC LCP 6, cylinders and hoses	___	Note: _____
2.2.7.	SC LCP 7, cylinders and hoses	___	Note: _____
2.2.8.	SC LCP 8, cylinders and hoses	___	Note: _____
2.2.9.	SC LCP 9, cylinders and hoses	___	Note: _____
2.2.10.	SC LCP 10, cylinders and hoses	___	Note: _____
2.2.11.	SC LCP 11, cylinders and hoses	___	Note: _____
2.2.12.	SC LCP 12, cylinders and hoses	___	Note: _____
2.2.13.	SC LCP 13, cylinders and hoses	___	Note: _____
2.2.14.	SC LCP 14, cylinders and hoses	___	Note: _____
2.2.15.	SC LCP 15, cylinders and hoses	___	Note: _____
2.2.16.	SC LCP 16, cylinders and hoses	___	Note: _____

CHELAN COUNTY PUD HYDRO	**SITE RECORD SHEET** RR - JFBDICL - 001	
PROJECT: LOCATION:	REFERENCE DRAWINGS:	REVISION 1
ITEM NO.		PAGE 2 of 3

Juvenile Fish Bypass Daily Inspection Check List (100 degrees)

SC Hydraulic Pressure Units and Control Gates

2.3.1.	SC HPU 1	___	Note: _____
2.3.2.	SC HPU 2	___	Note: _____
2.4.	SC Control Gates and Weirbox Flush Gate Hoses	___	Note: _____
2.4.1.	GC LCP 1	___	Note: _____
2.4.2.	SC North Control Gate Cylinder and Hoses	___	Note: _____
2.4.3.	SC South Control Gate Cylinder and Hoses	___	Note: _____
2.4.4.	Weir Box Flushing Gate	___	Note: _____
2.7.	SC Ring Follower Gates	___	Note: _____
2.7.1.	GC LCP 2 (Also controls for the IS Ring Follower)	___	Note: _____
2.7.2.	SC RFG guard gate	___	Note: _____
2.7.3.	SC RFG service gate	___	Note: _____
2.8.	SC Bypass Control Gate	___	Note: _____
2.8.1.	GC LCP 3	___	Note: _____
2.8.2.	SC Bypass Control Gate	___	Note: _____
2.9.	SC Fish Screen Gate	___	Note: _____
2.9.1.	GC LCP 5 (Also controls for IS Fish Screen Gate)	___	Note: _____
2.9.2.	SC Fish Screen Gate	___	Note: _____
2.9.3.	IS Fish Screen Gate	___	Note: _____

IS Barrier Screens (C-1)

4.3.2.	VBS Upper Panels and Hoists	___	Note: _____
4.4.	C1 Weir Boxes and Weir Gates	___	Note: _____
4.5.	C1 Knife Gates	___	Note: _____

IS Barrier Screens (C-2)

5.3.2.	VBS Upper Panels and Hoists	___	Note: _____
5.4.	C2 Weir Boxes and Weir Gates	___	Note: _____
5.5.	C2 Knife Gates	___	Note: _____

Intake Screens - Joint Systems

6.1.	IS Hydraulic Pressure Unit	___	Note: _____
6.5.	IS Ring Follower Gate (Controls are in SC system)	___	Note: _____
6.6.	IS Bypass Control Gate	___	Note: _____
6.6.1.	GC LCP 4	___	Note: _____
6.6.2.	IS bypass control gate and operator	___	Note: _____

CHELAN COUNTY PUD HYDRO	**SITE RECORD SHEET** RR - JFBDICL - 001	
PROJECT: LOCATION:	REFERENCE DRAWINGS:	REVISION 1
ITEM NO.		PAGE 3 of 3

Juvenile Fish Bypass Daily Inspection Check List (100 degrees)

Sampling Facility

8.1.	Power Supply	___	Note: _____
8.2.	Sampling Screen	___	Note: _____
8.2.1.	SS LCP 1	___	Note: _____
8.2.3.	Screen lift System	___	Note: _____
8.3.	Sampling Screen Cleaner	___	Note: _____
8.3.1.	SS-LCP 2	___	Note: _____
8.3.2.	SS Cleaner Mechanical System	___	Note: _____
8.4.	Sampling Screen Radial Gate	___	Note: _____
8.4.1.	SS-LCP 3	___	Note: _____
8.5.	Adult Separator and Gates	___	Note: _____
8.5.1.	Adult Separator Structure and Screen	___	Note: _____
8.5.2.	SF Gate G1	___	Note: _____
8.5.3.	SF Gate G2	___	Note: _____
8.5.4.	SF Gate G3	___	Note: _____
8.9.4.	Hydraulic Pressure Unit	___	Note: _____

Inspector(s):	Date:
Operations Superintendent:	Date:

APPENDIX C: 2016 Fish Spill Plan

2016 Fish Spill Plan

Rock Island and Rocky Reach Dams

Public Utility District No. 1 of Chelan County

Prepared By:

Thad Mosey
Fisheries Biologist

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

Final
January 29, 2016

Introduction and Summary

In 2016, Public Utility No. 1 of Chelan County (Chelan PUD) will implement spill operations for fish passage at the Rock Island and Rocky Reach and projects. Spill timing and spill percentages are specified by the anadromous Habitat Conservation Plans (HCP) for each respective project. Chelan PUD conducted juvenile project survival studies from 2002 through 2011 at Rocky Reach and Rock Island under varying spill levels in order to achieve HCP survival standards. The Rock Island Project completed multiple survival studies over a nine year period (17 total studies) for spring migrating Plan Species (yearling Chinook, steelhead, sockeye), first using a 20 percent spill level, then a 10 percent spill level. Rock Island will continue to spill 10 percent of day average flow during the spring outmigration period through at least year 2020. Rocky Reach completed its suite of HCP survival studies for spring migrating Plan Species in 2011 (14 studies), under spill and no-spill operation at the dam. HCP juvenile survival standards were achieved for species tested with a no spill operation (yearling Chinook, steelhead, sockeye). Project spill levels are summarized in Tables 2 and 4 of this plan. Chelan PUD holds valid Incidental Take Statements (ITS) from National Oceanic and Atmospheric Administration Fisheries (NOAA) and the United States Fish and Wildlife Service (USFWS) for HCP fish spill operations at Rocky Reach and Rock Island dams.

For the 2016 juvenile outmigration, Chelan PUD will operate the Rocky Reach juvenile fish bypass system (JFBS) starting 1 April for the spring juvenile outmigration of yearling Chinook, steelhead, and sockeye. Spring spill at Rocky Reach Dam will consist of hydraulic spill for reservoir control only. HCP Project survival standards were achieved with bypass-only operations. During the subyearling Chinook outmigration in 2016, Rocky Reach will spill 9 percent of day average river flow for a duration covering 95 percent of subyearling outmigration past the dam.

At Rock Island Dam in 2016, Chelan PUD will operate the Project with a 10 percent day-average spill level for the spring outmigration period. Rock Island has also completed HCP spring Plan Species survival testing for all Plan Species with a 10 percent spill level at the dam and has achieved juvenile survival standards for yearling Chinook, steelhead and sockeye and combined adult-juvenile survival for all three species.

During the summer period in 2016, Rock Island Dam will spill 20 percent of the day-average river flow for the outmigration of subyearling (summer) Chinook. Spill is the primary means of juvenile salmon and steelhead passage at Rock Island per Section 5.4.1(a) of the Rock Island HCP. Spring and summer spill will cover 95 percent of the juvenile fish outmigration for yearling/subyearling Chinook, steelhead, and sockeye in 2016.

Rocky Reach Spring Juvenile Fish Bypass Operations

Rocky Reach will operate its JFBS continuously through the spring outmigration period, beginning 1 April 2016. Daily index sampling (for steelhead, yearling Chinook, and sockeye) will be performed at the bypass sampling facility to estimate the outmigration percentiles for each species through the spring period. During "index sampling" each day, a total of four 30-minute samples (Table 1) will be taken beginning at the top of each hour, 0800 to 1100 hours. Spring spill for fish passage is not required at Rocky Reach in addition to the JFBS operation, but periods of forced spill may occur under high river flows. Some level of forced spill (river flow above 201 kcfs turbine capacity) normally occurs at Rocky Reach in the spring. Over the past 20 years, forced spill has occurred approximately 28 percent of all hours, April through June.

Sampling protocols at the Rocky Reach bypass system in 2016 will remain consistent with those used in 2004-2015. Daily sampling in spring and summer periods (Monday through Sunday) will use four 30-minute "index periods" at 0800, 0900, 1000, and 1100 hours (Table 1). The sample target for each 30-minute sample will be 350 smolts during the spring period (yearling Chinook, steelhead, and sockeye combined), and 125 smolts for summer period (subyearling Chinook). If the number of fish collected in the bypass sampling raceway is estimated to reach the maximum number prior to completion of the 30-minute sample, the sampling screen will be retracted from the bypass conduit, and the number of fish collected in the shortened sample period will be proportionately expanded to the entire 30-minute period.

Table 1. Index sampling times at the Rocky Reach juvenile fish bypass and the number of smolts per sample. Sample times and sample targets have remained consistent since 2004.

Time	Sample Duration	Number of Smolts	Day of Week
08:00-08:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
09:00-09:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
10:00-10:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday
11:00-11:30	30 minutes*	350 (spring) 125 (summer)	Monday-Sunday

*Sample duration may be less than 30 minutes if smolt numbers are met prior to full 30 minute sample time

Rocky Reach 2016 Summer Spill Operations

Rocky Reach Dam will spill 9 percent of the estimated day average river flow for the subyearling Chinook outmigration (Table 2). Spill will commence in late May to early June upon arrival of subyearling Chinook smolts in the Rocky Reach bypass samples. Juvenile run-timing information at Rocky Reach will be used to estimate subyearling Chinook passage percentiles (from the University of Washington's Program RealTime run forecaster) and guide spill operations to cover 95 percent of the summer outmigration. Actual subyearling counts in combination with juvenile passage estimates from the University of Washington's Program RealTime run forecaster will determine start and stop dates for the summer spill program.

The HCP guidelines for starting and ending summer spill at Rocky Reach are as follows:

1. Summer spill will start at midnight no later than the day on which the estimated 1-percentile passage point is reached, as indicated by Program RealTime run-forecast model. Subyearling Chinook will be defined as any Chinook having a fork length from 76 to 150 mm.

2. Summer spill season will generally end no later than 15 August, but not until subyearling index counts from the juvenile bypass sampling facility are 0.3 percent or less of the cumulative run for three out of any five consecutive days (same protocol used 2004-2015) and Program RealTime is estimating that the 95th percentile passage point has been reached. In addition, spill operations must cover at least 95% of the subyearling outmigration

Diel Spill Shaping at Rocky Reach and Rock Island Dams

Daily spill volumes will be shaped within each 24-hour period at Rocky Reach Dam during the summer spill period, and at Rock Island Dam during both spring and summer spill periods (Tables 2 and 4).

Spill-shaping attempts to optimize spill water volume to maximize spill passage effectiveness for smolts. The diel spill shape functions to provide either higher or lower spill volume during periods of either higher or lower fish passage. Spill-shaping is based on the observed diel (24-hour) passage distributions of smolts at each project during spring and summer (Steig et al. 2009, Steig et al. 2010, Skalski et al. 2008, Skalski et al. 2010, Skalski et al. 2011, Skalski et al. 2012). The different spill percentages and time blocks are shaped such that the summation of water volume from all time blocks within the day equals the volume of water that would have been spilled under a constant, unshaped spill level (i.e. spill at 9 percent day-average river flow at Rocky Reach with no shaping). The hourly spill shape in 2016 will remain consistent with previous years, 2004-2015.

Table 2. Fish spill percentages and spill shape for the Rocky Reach spill program, 2016.

Project	Season	Daily Spill Average	Within-Day Spill Levels	Duration (# of hours each day)	Time of Day	Spill Shape %
Rocky Reach	Spring	none	--	--	--	--
Rocky Reach	Summer*	9%	Med	1	00:00-01:00	9.0%
			Low	6	01:00-07:00	6.0%
			Med	2	07:00-09:00	9.0%
			High	6	09:00-15:00	12.0%
			Med	9	15:00-00:00	9.0%

*Spill for subyearling Chinook

2016 Run-Timing Predictions

Chelan PUD contracts with the University of Washington (UW) to provide run-timing predictions and year-end observed values for spring and summer out-migrating percentiles for salmon and steelhead. UW's Program RealTime run-time forecasting model is used for this purpose. Program Real-Time provides daily forecasts and cumulative passage percentiles for steelhead, yearling/subyearling Chinook and sockeye at both Rocky Reach and Rock Island dams. This program enables Chelan PUD to better predict the time when a selected percentage of these species will arrive, and when a given percentage of any stock has passed. The program utilizes daily fish counts from the Rocky Reach bypass sampling facility and the juvenile fish bypass trap at Rock Island Dam. Estimates of passage percentiles are generated with the model's forecast error and are displayed with the daily predictions at:

http://www.cbr.washington.edu/crisprt/

Historic Run Timing

Estimated mean passage dates (first percentile to the 95th percentile) for each species at Rocky Reach and Rock Island dams are summarized in Table 3. Run-timing dates are estimated from daily index sample counts at the Rocky Reach JFBS (2004-2015), and from the Rock Island bypass trap, (2002-2015). At Rocky Reach Dam, the subyearling Chinook run generally begins the first week of June, with the one-percentile passage date on 31 May (mean date for years 2004-2015). Rocky Reach subyearling passage reaches the 95th percentile, on average, around 8 August (2004-20l5, range: 21 July to 24 August).

Rock Island Dam juvenile salmon and steelhead sampling from the Smolt Monitoring Program (SMP; 2002-2015) indicates that the first percentile (one-percent passage) mean passage date for combined spring migrants (yearling Chinook, steelhead, and sockeye) occurs around 18 April (Table 3). The latest spring spill start date for Rock Island Dam per the HCP is 17 April. The summer outmigration of subyearling Chinook smolts at Rock Island Dam generally begins in early June (although fry are encountered earlier), and on average, reaches the 95th percentile passage point around 7 August (range: 22 July to 19 August, 2002-2015).

Table 3. Spill percentages, bypass operation dates, and mean passage percentile dates (2002-2015) for the 1st and 95th percentile passage points for HCP spring and summer outmigrants at Rocky Reach and Rock Island dams.

Rocky Reach	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	0% Spring	0% Spring	0% Spring	9% Summer
1st, 95th percentile Passage Dates	4/17, 5/30	4/16, 5/29	5/6, 5/25	5/31, 8/8
RR Bypass Operating?	Yes 4/1 – 8/31	Yes 4/1 – 8/31	Yes 4/1 – 8/31	Yes 4/1 – 8/31
Rock Island	**steelhead**	**yearling Chinook**	**sockeye**	**subyearling Chinook**
Percent Spill	10% Spring	10% Spring	10% Spring	20% Summer
1st, 95th percentile Passage Dates	4/22, 6/8	4/15, 6/4	4/17, 6/8	6/2, 8/7
RI Bypass Trap Operation	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31	4/1 - 8/31

Source - Rock Island: http://www.cbr.washington.edu/crisprt/index_midcol2_pi.html
Source- Rocky Reach: http://www.cbr.washington.edu/crisprt/index_midcol2_che.html

Rock Island 2016 Spring Spill Operations

In 2016, Rock Island Dam will spill 10 percent of the estimated day average river flow starting no later than 17 April and will end spill after 95 percent of spring outmigrants have passed the dam (usually the first week of June), with spill being provided for at least 95% of the spring species outmigration. Spill volume will be shaped to maximize spill efficiency (Table 4). Chelan PUD personnel will operate the Rock Island bypass trap, an upper Columbia SMP site, continuously from 1 April through 31 August (seven days per week) to provide daily smolt counts. Index counts will provide the basis to determine the start and end of the spring and summer outmigration periods. The HCP guidelines to start and end the spring spill program at Rock Island Dam are as follows:

1. The Rock Island spring spill program will begin when the daily smolt passage index count exceeds 400 fish for more than 3 days (this corresponds to the approximately 5 percent passage date), or no later than 17-April, as outlined in Section 5.4.1. (a) of the Rock Island HCP.

2. Rock Island spring spill will end 1) following completion of the spring outmigration (95 percent passage point), and 2) when subyearling (summer) Chinook have arrived at the Project.

Rock Island 2016 Summer Spill Operations

Rock Island will spill 20 percent of the estimated daily average river flow for a duration covering 95 percent of the summer outmigration of subyearling Chinook. Daily smolt counts from the Rock Island bypass trap will inform decisions on when to start and stop spill. The HCP guidelines to start and stop summer spill at Rock Island Dam are outlined as follows:

1. Rock Island summer spill in 2016 will begin immediately after completion of the spring spill. The summer spill level will be 20 percent of day average flow, shaped to increase spill efficiency. Spill will continue for a duration covering 95 percent of the subyearling Chinook outmigration.

2. Summer spill will generally end no later than 15 August, or when subyearling Chinook counts from the Rock Island trap are 0.3 percent or less of the cumulative run total for three out of any five consecutive days, and UW's Program RealTime is estimating 95 percent run completion (same protocol used in 2004-2015).

Table 4. Spill percentages and hourly spill shape for the Rock Island spring and summer fish spill program, 2016.

Project/Season	Daily Spill Average	With-in Day Spill Levels	Duration (# of hours each day)	Time of Day	Spill Shape %
Rock Island Spring*	10%	High	4	0000-0400	12.5
		Med	3	0400-0700	10.0
		Low	5	0700-1200	6.0
		Med	8	1200-2000	10.0
		High	4	2000-2400	12.5
Rock Island Summer**	20%	High	1	0000-0100	23.0
		Med	1	0100-0200	19.0
		low	8	0200-1000	15.0
		Med	1	1000-1100	19.0
		High	13	1100-2400	23.0

*Spring spill for yearling Chinook, steelhead, and sockeye; **summer spill for subyearling Chinook.

Spill Program Communication

Chelan PUD's fish spill coordinator will notify the HCPCC not less than once per week when fish passage numbers indicate that specific triggers for starting or stopping spill are likely to occur in the immediate future. Chelan PUD will notify the HCPCC regarding any unforeseen issues that pertain to the spill program as the season progresses. Communications with the HCPCC on spill information will generally be made by email, pre-scheduled conference calls, and HCPCC monthly meetings.

Literature Cited

Skalski, J.R., R.L. Townsend, T.W. Steig, and P.A. Nealson. 2012. Survival, Diel Passage, and Migration Dynamics of Yearling Chinook Salmon Smolts at Rocky Reach Dam in 2011. Prepared for Public Utility District of Chelan County, Wenatchee, WA. Columbia Basin Research School of Aquatic and Fishery Sciences, University of Washington. Final Report, January 2012.

Skalski, J.R., R.L. Townsend, T.W. Steig, and P.A. Nealson. 2011. Survival, Diel Passage, and Migration Dynamics of Yearling Chinook Salmon Smolts at Rocky Reach Dam in 2010. Prepared for Public Utility District No. 1 of Chelan County, Wenatchee, WA. Columbia Basin Research School of Aquatic and Fishery Sciences, University of Washington. Final Report, February, 2011.

Skalski, J.R., R.L. Townsend, T.W. Steig, and P.A. Nealson. 2010. Survival, Diel Passage, and Migration Dynamics of Sockeye Smolts at Rocky Reach Dam in 2009. Prepared for Public Utility District No. 1 of Chelan County, Wenatchee, WA. Columbia Basin Research School of Aquatic and Fishery Sciences, University of Washington. Final Report, January, 2010.

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Steig, T.W., P.A. Nealson, K.K. Kumagai, B.J. Rowdon, J.R. Selleck and C. Tunnicliffe. 2009. Route specific passage of juvenile Chinook, sockeye and steelhead salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2009. Draft report for Chelan County Public Utility District No. 1, Wenatchee, WA, by Hydroacoustic Technology, Inc. Seattle, WA.

Steig, T.W., P.A. Nealson, K.K. Kumagai, B.J. Rowdon, J.R. Selleck and C. Tunnicliffe. 2010. Route specific passage of yearling Chinook and steelhead salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2010. Draft report for Chelan County Public Utility District No. 1, Wenatchee, WA, by Hydroacoustic Technology, Inc. Seattle, WA.

APPENDIX D: 2016 Rocky Reach Operational Plan for Total Dissolved Gas During Fish Spill Season

2016 Rocky Reach Operational Plan
for Total Dissolved Gas During Fish Spill Season
April 1 through August 31

(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwatercontrol)

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

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

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

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

APPENDIX E: Annual Maintenance List for Rocky Reach Fishway

2016 ROCKY REACH ANNUAL FISH LADDER OVERHAUL

Annual Overhaul List:

a. Perform maintenance on gate and hoist motors.
b. Inspect and repair/replace any damaged or missing aluminum diffuser grating.
c. Clean and test fishway annunciators.
d. Replace burned-out tunnel lamps.
e. Check and clean/repair attraction water intake screens.
f. Check and clean traveling screens.
g. Inspect fishway gates and repair as needed.
h. Inspect fishway attraction water system which includes:
    1. Inspect turbine pumps A, B, and C.
    2. Check clearances on lower guide bearings.
    3. Check clearance runner crown and stay ring bore.
    4. Inspect carbon seals.
    5. Inspect each actuator for each butterfly valve on a yearly, rotational basis.
i. Inspect fishway-traveling screens:
    1. Clean debris from traveling screen area.
    2. Inspect penstock intake chamber.
    3. Inspect and replace bearings as needed.
    4. Inspect sprockets and shaft bushings.
j. Fishway flap and wing gates:
    1. Inspect and repair flap gates (if needed).
    2. Inspect seals and indicator rods.
    3. Inspect wing gates.
    4. Inspect the actuators for the gates.
k. Fishway regulating gates and picket weir:
    1. Inspect control valves and hoses at the middle spillway entrance (MSE).
    2. Inspect and replace cables on MSE regulating gate.
    3. Inspect left powerhouse entrance (LPE) regulating gates.
    4. Clean, inspect and repair picket barrier regulating gate hoist.
    5. Drain, check operation, and clean CS-S1 (valve that controls make-up water in the upper fishway).
l. Put attraction water system turbine pumps through dry runs and test alarms.
m. Clean stilling wells and check operation of orifice valves.
n. Clean and polish fish counting window.

APPENDIX F: Consultation with Stakeholders

Article 402 of the Project License requires that Chelan PUD prepare the Operations Plan:

> *"…after consultation with National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service, Washington Department of Fish Wildlife, Washington Department of Environmental Quality [Ecology], the Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Colville Indian Reservation, and the Confederated Tribes and Bands of the Yakama Nation. The licensee shall include with the plan, copies of comments and recommendations on the completed plan after it has been prepared and provided to the above entities, and specific descriptions of how the above entities' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the above entities to comment and to make recommendations before filing the plan with the Commission."*

The following individuals were sent draft copies for review on February 8, 2016, for a 30 day comment period. Chelan PUD did not receive any comments during the 30 day comment period.

NAME	***AGENCY***
Bob Rose	Confederated Tribes and Bands of the Yakama Indian Nation
Scott Carlon	National Marine Fisheries Service
Aaron Jackson	Confederated Tribes of the Umatilla Indian Reservation
Patrick Verhey	Washington Department of Fish and Wildlife
Kirk Truscott	Confederated Tribe of the Colville Reservation
Mark Peterschmidt	Washington Department of Ecology
Steve Lewis	U.S. Fish and Wildlife Service

From:	Steinmetz, Marcie
To:	"rosb@yakamafish-nsn.gov"; "scott.carlon@noaa.gov"; "aaronjackson@ctuir.org"; "Verhey, Patrick M (DFW)"; "Lewis, Stephen"; "Peterschmidt, Mark F. (ECY)"; "Jason.McLellan@colvilletribes.com"
Cc:	Sokolowski, Rosana; Osborn, Jeff; Smith, Michelle; Bitterman, Deborah; Keller, Lance
Subject:	Draft 2016 Rocky Reach Operations Plan
Date:	Monday, February 08, 2016 10:27:00 AM
Attachments:	2016 DRAFT Operations Compliance Monitoring Plan.docx

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

To: Bob Rose, Confederated Tribes and Bands of the Yakama Indian Nation
Scott Carlon, National Marine Fisheries Service
Aaron Jackson, Confederated Tribes of the Umatilla Indian Reservation
Patrick Verhey, Washington Department of Fish and Wildlife
Jason McLellan, Confederated Tribe of the Colville Reservation
Mark Peterschmidt, Washington Department of Ecology
Steve Lewis, US Fish and Wildlife Service

From: Marcie Steinmetz, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145
License Article 402 – Draft 2016 Operations Plan

In accordance with Article 402 of the Rocky Reach License, Chelan PUD requests your review and comments on the attached Draft 2016 Rocky Reach Operations Plan.

Please submit your comments on or before 5:00 p.m., March 8, 2016 to me via email at Marcie.steinmetz@chelanpud.org.

Pursuant to a FERC-approved revised submittal date, Chelan PUD will file the Operations Plan with FERC by March 30, 2016.
All received comment letters will be appended to the final plan with a description of how each comment or recommendation was incorporated in the plan, or, if the licensee does not adopt a recommendation, the filing with the FERC will include the licensee's reasons, based on project-specific information for not adopting such recommendation.

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

Thank you,

Marcie Steinmetz | **Water Resource Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

APPENDIX D: 2010 QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN
Rocky Reach Water Quality Monitoring and Reporting

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

February 19, 2010

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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DISTRIBUTION LIST

Chelan PUD
- Steve Hays
- Dan Garrison
- Michelle Smith
- Keith Truscott

Ecology
- Charlie McKinney
- Jon Merz
- Pat Irle

Rocky Reach Fish Forum

ACRONYMS AND ABBREVIATIONS LIST

cfs	cubic feet per second
Chelan PUD	Public Utility District Number 1 of Chelan County
CRO	Central Region Office of Ecology
CWA	Clean Water Act
DO	dissolved oxygen
DQO	data quality objectives
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
kcfs	thousands of cubic feet per second
mg/L	milligrams per liter
mmHg	millimeters of mercury
MQO	measurement quality objective
N/A	not applicable
NIST	National Institute of Standards and Technology
PI	PI System® from OSIsoft®
Project	Rocky Reach Hydroelectric Project
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	standard method
SOP	standard operating procedure
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WAS	Watershed Assessment Section
WQA	Water Quality Assessment

SECTION 1: BACKGROUND

The Rocky Reach Hydroelectric Project is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project's installed capacity under the license is 865.76 megawatts.

This Federal Energy Regulatory Commission (FERC) licensed Project includes a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The Project consists of:

- A forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- A powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- A spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate; with a combined hydraulic capacity of 980 kcfs;
- Two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide; and
- An east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet.

The Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. These are located between spillway bays 8 and 9, at the center of the dam adjacent to powerhouse unit 11, and at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also several submerged orifice entrances at each end of the powerhouse. Fish pass from the entrances into fish collection channels, which converge to guide fish to a pool and weir fish ladder with a counting station at the fishway exit that is near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cfs and a gravity intake provides attraction water for the spillway entrance. The juvenile fish bypass system includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

Figure 1-1: Project Location

The water quality monitoring program described in this Quality Assurance Project Plan (QAPP) is necessary to fulfill the requirements set forth by the Washington State Department of Ecology (Ecology) in the Section 401 water quality certification (401 Certification), Order No. 3155 issued on March 17, 2006, and incorporated into the License by Ordering Paragraph (D) on February 19, 2009. The 401 Certification incorporates, by reference, the Water Quality Management Plan, which is Chapter 2 of the Comprehensive Plan, Attachment B to the Settlement Agreement. This QAPP was prepared in accordance with the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology, 1993).

To accomplish these measures in accordance with the 401 Certification, the Public Utility District Number 1 of Chelan County (Chelan PUD) will monitor and evaluate total dissolved gas (TDG) in the Project forebay and tailrace (401 Certification, Section 5.4(1)(a)), water temperature in the Project forebay, tailrace, juvenile bypass system, and adult fishway (401 Certification, Section 5.5); and temperature, dissolved oxygen (DO) concentrations, and pH in selected macrophyte beds in the Reservoir (401Certification, Section 5.6). In addition, Chelan PUD will prepare and implement a study of gas bubble trauma (GBT). This QAPP is designed to describe the proposed sampling, monitoring and assessment methods, and subsequent reporting requirements.

In addition to the above mentioned monitoring, Chelan PUD will monitor TDG in the Rock Island forebay. This location is not included in Section 5.4(1)(a) of the 401Certification; however, Chelan PUD is required to report data from this location as per Section 5.4(4) of the 401 Certification.

Chelan PUD plans to coordinate the macrophyte bed monitoring with required resident fish monitoring (as per Chapter 6 of the Comprehensive Plan), which, because additional time is needed to prepare a study plan for the GBT study, will not be conducted until after 2010. These studies will be included in a subsequent annual QAPP update/revision. For these reasons, macrophyte bed monitoring and the GBT study will not be described in this QAPP.

Using the data collected in the first five years of the New License, Chelan PUD will run the CE-QUAL-W2 model to evaluate Project compliance with numeric temperature criteria. An additional QAPP will be drafted to address the modeling effort.

It is necessary to note that some of the monitoring described in this QAPP may not be conducted if unsafe conditions exist. At this time it is not possible to know if unsafe conditions exist, and if so, whether they are temporary or permanent. If permanently unsafe conditions exist, Chelan PUD will consult with Ecology to determine an appropriate alternative.

1.1 REGULATORY FRAMEWORK

1.1.1 Total Dissolved Gas

Washington Administrative Code (WAC) 173-201A-200(1)(f)) establishes, and Ecology administers, Washington state water quality standards for TDG during the non-fish and fish-spill seasons . The current

standard for TDG (in percent saturation) during the non-fish spill season (September 1 through March 31) is 110% for any hourly measurement.

For projects on the Snake and Columbia rivers, the current standard for TDG (in percent saturation) during the fish-spill season (generally assumed to fall between April 1 through August 31) is 120% in the tailrace of the dam spilling water for fish and 115% in the forebay of the next downstream dam, based on the average of the 12 highest consecutive hourly readings in a 24-hour period. A one-hour, 125% maximum standard for TDG also applies throughout the Project during the fish-spill season.

Prior to 2008, the method used to calculate the daily TDG compliance value during the fish-spill season was based on the average of the 12 highest hourly values in a 24-hour period, starting at 0100 hours and ending at 2359 hours. This method was based on Ecology's 1997 Water Quality Standards. In Ecology's 2006 revision to the Water Quality Standards the method for calculating the TDG compliance value was changed to the 12 highest consecutive hourly readings in a 24-hr period.

The revision did not define how to implement the new standard so on April 2, 2008 Ecology sent a letter to all Columbia and Snake river dam operators requesting the use of a rolling average method for calculating the 12 highest consecutive hourly TDG readings in a 24-hour period, beginning at 0100 hours (Ecology 2008). Using a rolling average that begins at 0100 hours results in counting the hours 1400 hours through 2359 hours 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 based on the same group of hours.

This "double-counting" of some of the hourly TDG values could potentially lead to critical management decisions that alter operational or physical characteristics of a particular hydroelectric project. Because there is not yet a formally established method to address this "double counting" issue, in 2009 Chelan PUD followed the methodology below to address such:

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.

Use of the above methodology allowed for the monitoring of consecutive hours while eliminating "double counting". Chelan PUD understands and appreciates the need for consist compliance monitoring and reporting throughout the basin and will modify or replace the methodology described above at such time as Ecology provides an approved method.

1.1.2 Water Temperature

WAC 173-201A-602 designates the section of the Columbia River within the Project as a "salmonid spawning, rearing, and migration" water body (formerly Class A) and therefore water temperature must

remain below 17.5°C, as measured by the 7-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.

1.1.3 Dissolved Oxygen and pH

The water quality criteria for DO within the Project require that DO be greater than 8.0 milligrams per liter (mg/L). When DO is lower than the criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(f)).

WAC 173-201A-200(1)(g) provides that pH shall be within the range of 6.5 to 8.5 units with a human-caused variation within the above range of less than 0.5 units.

1.2 HISTORICAL WATER QUALITY INFORMATION

The Columbia River at the Project is designated under current Washington State water quality standards as a "salmonid spawning, rearing, and migration" water body (formerly Class A). Water quality of this designation must meet or exceed the requirements for all or substantially all uses. The characteristic uses for the Project segment of the Columbia River include propagation of fish and wildlife (including salmonid species), water supply (domestic, irrigation, industrial), recreation, navigation and commerce (including power generation).

The Reservoir meets water quality standards numeric criteria for DO, pH, turbidity, and fecal coliform (Chelan PUD, 2004; Table 7 in PDEA). The mid-Columbia River, including the Reservoir is currently listed as impaired for TDG and water temperature with five sites on or near the Reservoir per the 2002/2004 candidate list (Section 303(d) of the Clean Water Act (CWA)). At times, water comes into the Reservoir with temperatures or TDG levels that exceed the numeric criteria. The existence of the Project does have the potential to increase water temperatures during the summer due to the effects of the Reservoir on total water surface area and increased travel time of water moving through the Reservoir. Spill operations at the Project can increase TDG levels in the Columbia River below the Project.

Chelan PUD has conducted water quality surveys within Rocky Reach Hydroelectric Project reservoir targeting specific water quality concerns; some of these studies include annual monitoring over multiple years. In coordination with the US Army Corps of Engineers, Chelan PUD has monitored water temperature at the fishway since 1965 and TDG in the forebay since 1982. More intensive monitoring of temperature and TDG was initiated in 1996. The monitoring data sets consist of daily temperature only (1965 - 1981), hourly temperature and TDG in the forebay (April - August, 1982 - present), and hourly TDG and temperature below the tailrace of the Rocky Reach Hydroelectric Project dam (April – August, 1997 - present). TDG monitoring with improved equipment and calibration procedures during the spring and summer seasons was initiated in 1995 for the forebay and 1997 for the tailrace (McDonald and Priest, 1997; Koehler and McDonald, 1997, 1998).

Douglas PUD has conducted comparable studies at Wells Hydroelectric Project dam, which are the headwaters to the Rocky Reach Hydroelectric Project reservoir. Transparency data are available for both the Rocky Reach Hydroelectric Project dam forebay and the Wells Hydroelectric Project dam forebay (1993 – present) from secchi disk readings from the fishways.

The Rocky Reach Project generally has no adverse effect on the objectives and narrative requirements of the water quality standards. The Project and the Reservoir maintain the water quality, habitat and accessibility necessary to support all the existing beneficial and designated uses included in the standards (WAC 173-201A). These uses include primary contact recreation; aesthetic enjoyment; sports fishing; boating; water supply for domestic, industrial, and agricultural uses; and fish and wildlife habitat, including habitat for spawning, rearing and migration of cold –water salmonid species. The Reservoir has clean, clear water with high water transparency, very low fecal coliform content, and high DO concentrations.

SECTION 2: PROJECT DESCRIPTION

According to the 401 Certification, monitoring, assessment, and reporting are required. Each will be discussed in this QAPP.

The goal of the QAPP is to determine compliance with Washington's numeric water quality criteria (WAC 173-201A). This QAPP was prepared to guide Chelan PUD in this effort. If criteria are not being met, subsequent goals may include identifying any impacts due to ongoing Project operations on the regulated parameters; and determining and implementing any reasonable and feasible solutions to exceedances.

The following are the monitoring requirements of the Rocky Reach 401 Certification. Chelan PUD must:

- Maintain two fixed monitoring stations at Rocky Reach Dam to monitor TDG levels annually from April through August, one in the forebay and one in the tailrace for the term of the New License;
- Monitor hourly water temperatures in the forebay and tailrace annually from April through October for the term of the New License;
- Monitor water temperatures in the juvenile fish bypass system and upstream fishway for one year;
- Monitor DO, temperature, and pH in shallow water habitats, including macrophyte beds, in the Reservoir for one year; and
- Prepare and implement a study of Gas Bubble Trauma.

The reporting of these data includes submitting:

- In year 5 of the effective date of the New License, a report summarizing the results of all TDG studies performed to date, and describing whether compliance with numeric criteria has been attained;
- A Gas Abatement Plan to Ecology for review and approval by April of the year of implementation;
- An annual report to Ecology in an approved format that includes the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, spill levels, and biological effects of GBT;
- Hourly TDG information to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible;
- An annual report to Ecology in an approved format that includes a data assessment of compliance with state water quality criteria, summaries of the data, and a list of any water quality exceedances; and
- Immediate reports to Ecology's Spills Response Program of any spills into state waters, spills onto land where contaminants could potentially drain into state waters, or cause fish kills or any other significant water quality problems.

SECTION 3: ORGANIZATION AND SCHEDULE

This section includes key personnel assigned to the project and an associated organizational chart, and time schedules for field operations, project deliverables, budgeting, and funding information.

3.1 KEY PERSONNEL

This project is to be conducted primarily by Chelan PUD personnel, with assistance as needed, to expedite the process, reduce costs, or improve quality (if needed). All personnel conducting work will have sufficient skills and experience to complete the necessary tasks at a high level of quality. This plan has been designed by Chelan PUD, and is anticipated to be conducted by the personnel outlined in Table 3-1:.

Table 3-1: Key Personnel

Personnel	Responsibility
Waikele Hampton	*Chelan PUD Environmental Permit Coordinator / Project Manager*. Lead responsible for project management, jointly responsible for report generation, data interpretation, field sampling methodology development, and sampling and monitoring.
Steven Hays	*Chelan PUD Fish and Wildlife Senior Advisor*. Jointly responsible for report generation and/or review, data interpretation, and field sampling methodology development. Senior technical review for all reports.
Michelle Smith	*Chelan PUD Licensing and Natural Resource Compliance Manager*. Responsible for QAPP and report review and approval, and funding approval.
Rosana Sokolowski	*Chelan PUD Licensing & Compliance Coordinator*. Responsible for administrative support of QAPP, sampling, data entry, and reporting.
Debby Bitterman	*Chelan PUD Administrative Assistant.* Responsible for administrative support of QAPP.
Charlie McKinney	*Ecology WQ Section Manager, Central Regional Office (CRO).* Oversees Ecology participation regarding 401 certification and Settlement Agreement.
Jon Merz	*Ecology Watershed Unit Supervisor, CRO.* Provides Ecology staff to assist PUD in compliance with 401 Certification and Settlement Agreement. Reviews Ecology work documents.
Patricia Irle	*Ecology Hydropower Projects Manager, CRO.* Lead responsible for tracking compliance with terms of 401 Certification and Settlement Agreement. Includes review of reports and the QAPP and assistance in meeting other requirements as defined in the 401 certification and Settlement Agreement.
To be determined (may be contracted out)	*Field sampler.* Responsible for field activities (including equipment maintenance), documentation and health and safety during field operations. Jointly responsible for report generation as needed.
Kris Pomianek	*Community Outreach Advisor.* Responsible for website creation and maintenance.
Jeff Mettler	*Power Management, P.I. Interface person.* Responsible for providing assistance with data management and recovery.
Ron Franklin	*Health and Safety Officer*. Responsible for overall aspects of health and safety for the QAPP project work.

3.2 SCHEDULE

The schedules below will be closely managed to ensure that no deadlines are missed, or parameter reporting requirements overlooked, unless a Force Majeure event arises, as provided in the Rocky Reach Settlement Agreement.

3.2.1 Monitoring Schedule

The schedule that will be followed has been developed from the requirements stated in the 401 Certification.

Table 3-2: Monitoring Schedule

Parameter	Monitoring Schedule	Comments
TDG	Annually Hourly April-August	Monitors located in the forebay and tailrace of Rocky Reach and in the forebay of Rock Island.
Spill as a surrogate for TDG	Hourly (This will be necessary only during spill events outside of the fish spill season.)	Data collected during the fish spill season will be used to further refine the linear regression developed by Schneider and Wilhelms (2005)
Temperature	Annually, Hourly April - October	Forebay and tailrace
Temperature	Hourly for one year	Juvenile bypass and upstream fishway
Macrophyte beds (temp, DO, pH)	Frequency is TBD; one-year study	This study will be conducted at a later date (likely in 2011)[1]
GBT	TBD	This study will be conducted at a later date (no sooner than 2011)

[1] ***Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for a side-by-side look at macrophyte bed water quality conditions and fish presence/use.***

3.2.2 Reporting Schedule

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

Chelan PUD will report exceedances of the water quality criteria within 48 hours to Ecology's CRO. Note that it may not be possible to provide temperature exceedances that are based on shifts in the temperature from natural because modeling is required to determine this type of exceedance.

3.3 BUDGET AND FUNDING

A preliminary budget has been developed to aid in planning for this work. For the sake of the initial budget, it is assumed that the forebay and tailrace temperature and TDG data will be collected real-time and the remainder of the temperature data will be logged and downloaded monthly or quarterly.
Chelan PUD will fund the monitoring and reporting described herein. These funds will be made available internally earmarked well in advance of the initiation of the monitoring (likely a minimum of two years prior) to ensure sufficient funding is provided.

SECTION 4: DATA QUALITY OBJECTIVES (DQO)

The primary objective for collecting data is to track compliance with water quality standards. The purpose of the QAPP is to identify the methods and standards used to make that determination/decision. Data quality objectives (DQOs) are statistical statements of the level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. They describe what data are needed, and how the data will be used to address the concerns being investigated. The DQOs also establish numeric limits that ensure the data collected are of sufficient quality and quantity for data user applications.

The overall DQO is to ensure that data of known and acceptable quality are provided. Proper execution of each task will yield consistent results that are representative of the media and conditions measured. All data will be calculated and reported in conventional units to allow comparability of the data. There are two types of DQOs, including decision quality objectives and measurement quality objectives (MQOs).

The acquired data will be used to characterize the water quality of the Rocky Reach Reservoir and tailrace. Decision quality objectives to obtain this information are to:

- Generate scientific data of sufficient quality to withstand scientific and legal scrutiny.
- Gather and develop data in accordance with procedures appropriate for its intended use.
- Conduct all methods/procedures specified for this project in compliance with Ecology requirements for environmental investigations.

To ensure that the MQOs of the monitoring effort are within the limits of the work, specific criteria for data parameters have been established as appropriate.

4.1 DECISION QUALITY OBJECTIVES

For this effort, the data collection must be designed in such a manner that the results can be used to determine if the water quality criteria have been met; therefore, quality objectives at the level of the decision are required. These objectives will be met by carefully determining the number of measurements taken to represent a given condition. The Sampling Process Design (Section 5.0) addresses the requirements of the decision quality objectives.

The success of obtaining these objectives can be measured by ensuring that the representativeness, completeness and comparability are controlled. Each is described below.

4.1.1 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. For this investigation, representativeness is a qualitative parameter that is primarily concerned with proper design of the sampling program, and can be best satisfied by ensuring that the monitoring locations are properly located with a sufficient number of data collected.

4.1.2 Comparability

The comparability criterion is a qualitative characteristic that expresses the confidence with which one data set can be compared to another. Principal comparability issues are field sampling techniques, and standardized concentration units and reporting formats. Data comparability is achieved using standard

field sampling techniques and measuring methods; however, comparability is limited by the other MQOs because only when precision and bias (accuracy) are known can data sets be compared with confidence.

4.1.3 Completeness

Completeness is defined as the percentage of valid analytical determinations compared to the total number of determinations. A reasonable completeness goal is 90 percent. Typical field or electronics problems may result in completeness of less than 100 percent. Completeness will be evaluated and documented throughout all monitoring, and corrective actions taken as warranted on a case-by-case basis.

4.2 MEASUREMENT QUALITY OBJECTIVES (MQOS)

The term "data quality" refers to the level of uncertainty associated with a particular data set. Data quality associated with environmental measurement is a function of the sampling plan rationale and procedures used to collect the samples, as well as the monitoring methods and instrumentation used in making the measurements. Uncertainty cannot be eliminated entirely from environmental data. However, quality assurance (QA) programs effective in measuring uncertainty in data are employed to monitor and control deviation from the desired DQOs. Sources of uncertainty that can be traced to the sampling component are poor sampling plan design, incorrect sample handling, faulty sample transportation (if applicable), and inconsistent use of standard operating procedures (SOPs). The most common sources of uncertainty that can be traced to the analytical component of the total measurement system are calibration and contamination (i.e. equipment not "resetting" or fully equilibrating in a new sampling location).

One of the primary goals of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible, and that the methodology employed is actually measuring the parameters in an acceptable manner.

For the field measurements to be conducted under this QAPP (temperature and TDG) MQOs can be specified. Each of the MQOs that pertain to this QAPP is further discussed below. The goals for this effort are outlined in Table 4-1:**.**

Table 4-1: MQOs

Parameter	Smallest Reference Level for Decision Making	Range of Instrument	Precision (Duplicate Samples)	Bias/ Accuracy	Sensitivity/ Resolution
Temperature	0.3°C	-5 to 50°C	20% RPD or ±0.05 units, whichever is least	± 0.1°C	0.01°C
TDG	1% saturation	400 – 1,300 mmHg	N/A	±0.1 % of span	1 mmHg

RPD = relative percent difference
TDG = total dissolved gas
mmHg = millimeters of mercury

4.2.1 Precision

Precision is a measure of the reproducibility of an analysis or set of analyses under a given set of conditions, and generally refers to the distribution of a set of reported values about the mean. The overall precision of a sampling event has both a sampling and an analytical component. The precision provides transparency into presence of random error such as field sampling procedures, handling, and data collection/analysis method. A reduction of precision could be introduced to this work in several ways including using equipment that is not sensitive enough (see Sensitivity below), collecting measurements over a large spatial or temporal regime, using a wide range of types of equipment, etc. A means of determining the precision of a measurement is to conduct duplicate sampling (e.g. making the same measurement in the same location at approximately the same time with the same type of equipment) and looking at the variability in results.

4.2.2 Bias

Bias (otherwise known as accuracy) is the difference between the population mean and the true value of the parameter being measured. Bias in measurements obtained under this QAPP may be introduced by faults in the sampling design (e.g. all of the temperature measurements collected in one location that is not indicative of the mixed flow or strata of interest), inability to measure all forms of the parameter of interest (e.g. inability of a thermometer to reach a temperature regime needed due to physical obstacles), improper or insufficient calibration of instrumentation and/or equipment. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

4.2.3 Sensitivity

Sensitivity denotes the rate at which the analytical response varies with the concentration of the parameter being measured, or the lowest concentration of a parameter that can be detected (often referred to as "resolution" for water quality equipment). For this work, equipment must be selected that provides tight enough tolerances to ensure that the data collected are described to the necessary precision. For example, if water criterion for temperature is concerned with a temperature shift of greater than 0.3 degrees Celsius, then the equipment should be able to measure the water temperature with sensitivity less than 0.3 degrees Celsius, preferably by an order of magnitude. Often, the accuracy is much larger than the resolution. If this is the case, the accuracy is the smallest verifiable value reported by the instrument.

SECTION 5: SAMPLING PROCESS DESIGN

The sampling process design includes the parameters of interest, the measurement location and the frequency of monitoring. The goal of the sampling process design is to ensure that the quality objectives for this effort can be met. The 401 Certification has outlined the requirements for the parameters, frequency, basic location, and schedule of sampling (see Table 5-1).

Table 5-1: Monitoring Parameters, Locations, Frequency, and Criteria

Parameter	Location(s)	Frequency	Metric	Standards
Temperature	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-October	degrees Celsius	17.5[1]
Temperature	Juvenile Fish Bypass, Adult Fishway	Hourly for one year	degrees Celsius	17.5[1]
TDG	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-August	% Saturation	120% in tailrace 115% of forebay (as per special fish passage criteria) 110% during outside of fish spill season

[1] When a water body's temperature is warmer than the criteria (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F).
When the background condition of the water is cooler than the criteria, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge); and
(B) Incremental temperature increases resulting from the combined effect of all nonpoint source activities in the water body must not, at any time, exceed 2.8°C (5.04°F).

5.1 MONITORING LOCATION AND DEPTH

The general locations for measurements have been identified in the 401 Certification and are more specifically define below. These locations are included in Table 5-1.

5.1.1 Forebay and Tailrace TDG and Temperature

Annual hourly TDG and temperature data will be measured at Chelan PUD's existing fixed monitoring stations, located in the forebay and tailrace of the Project, as well as in the forebay of the Rock Island Project. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of either the TDG or temperature readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rocky Reach forebay fixed monitoring station is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station is located approximately 0.38 mile downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is

east of mid-channel, and is minimally impacted by powerhouse flows when the project is passing water over the spillway (Schneider and Wilhelms, 2005). See Figure 5-1:.

The Rock Island forebay fixed monitoring station is affixed to the project, located on the west side of the river, near the right bank fishway and Powerhouse 2 (Figure 5-2:). The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations.

Figure 5-1: Locations of the Forebay and Tailrace Fixed Monitoring Stations at Rocky Reach.

Figure 5-2: Location of the Rock Island Forebay Fixed Monitoring Station.

5.1.2 Juvenile Bypass System Temperature

Downloadable data loggers will be deployed in the juvenile bypass system where gatewell water enters the system and at the juvenile sampling facility. Chelan PUD has not yet determined precisely how these instruments will be mounted in the bypass system, but it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

A data logger previously deployed in the entrance to the system will also be used to monitor temperature data in the juvenile fish bypass system.

5.1.3 Upstream Fishway Temperature

Downloadable data loggers will be deployed in two locations of the upstream fishway. Two loggers will be installed at the exit of the fishway, at depths of 703' elevation and near the bottom of the exit to collect data from both shallow and deep portions of the water column. A third logger will be installed near the bottom of the ladder section above where pumped attraction water from the tailrace enters the fishway. Chelan PUD has not yet determined precisely how these instruments will be mounted in the fishway, but again, it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

SECTION 6: MONITORING PROCEDURES

The following sections present the monitoring procedures that will be used to implement the requirements of the 401 Certification.

6.1 FREQUENCY

Table 5-1 provides the frequency that each water quality parameter will be measured. These frequencies follow the requirements of the 401 Certification, which provide that forebay and tailrace TDG and temperature be monitored on an hourly basis, April to August and April to October, respectively. Hourly temperature monitoring in the juvenile bypass system and upstream fishway will be initiated upon approval of this QAPP and will be conducted for one year, unless Ecology determines, in consultation with the Rocky Reach Fish Forum, that additional monitoring is necessary.

6.2 EQUIPMENT

Forebay and tailrace temperature and TDG data will be collected using instruments that can immediately transmit the data to Chelan PUD headquarters, allowing for real-time data recording. The fishway and juvenile fish bypass temperature data will be collected using a logging device that can be downloaded on a monthly or quarterly basis.

All temperature monitoring equipment will be of sufficient quality to meet the MQOs (Table 4-1:). The monitoring equipment will be Hydrolab's DataSondes or MiniSondes, or Hobo Water Temperature Pro Data Logger, or equivalent. Specifications for all types of equipment described herein are provided in Appendix A. Any of these types of monitoring equipment are referred to as merely equipment in the following discussion.

TDG will be measured using Hydrolab DataSondes or MiniSondes, which use a pressure transducer mounted behind a rigid gas-permeable silicone membrane to measure amount of total dissolved gaseous compounds dissolved in a liquid. The measurement quality objectives, range, precision, accuracy, and resolution of the TDG sensor are provided in Table 4.1. (See Appendix A for Equipment Specifications). TDG will be measured in mmHg and then converted to percent saturation using barometric pressure measurements recorded by a certified barometer located at the project. The conversion equation is as follows:

TDG in percent saturation = (TDG mmHg/barometric pressured mmHg) x 100

To the extent possible, sampling methods will follow protocol established by Hydrolab (or alternative manufacturer), the most current version of the Ecology Field Sampling and Measurements Protocols for the Watershed Assessment Section (Ecology, 1993), and this QAPP.

SECTION 7: QUALITY CONTROL

Field sampling and measurement protocols will follow those described in the Watershed Assessment Section (WAS) protocol manual (Ecology, 1993). Prior to deployment, instruments will be calibrated in a lab and the calibration verified by side-by-side readings. Specific quality control for each parameter measurement is described as follows.

7.1 TEMPERATURE QUALITY CONTROL

For all field-deployed equipment, a pre-and post-calibrated protocol will be conducted in accordance with the manufacturer's recommendations to document instrument bias and performance at representative temperatures. The accuracy of the field thermometers (data loggers and real-time equipment) will be maintained by a two-point comparison between the field equipment and a certified reference thermometer. This comparison will be made prior to and after logger deployment, and at a minimum of annually for real-time equipment. The certified reference thermometer to be used will have a National Institute of Standards and Technology (NIST) Traceable certification. If the mean difference between the NIST-certified thermometer and the field equipment differs by more than the manufacturer's reported specifications during the pre-study calibration, then the thermometer of interest (Sonde or logger) will not be deployed.

Additionally, each month or quarter when the data are downloaded from the loggers Chelan PUD staff will inspect the equipment to ensure it has not been damaged, has sufficient battery power (with the exception of equipment that does not show battery life, which will be replaced prior to expected battery failure), shows no signs of biofouling, and is generally in good condition. It will be cleaned as needed and replaced if damaged. The real-time equipment will be inspected and maintained in accordance with the manufacturer's recommendations.

7.2 TDG QUALITY CONTROL

Calibration and maintenance of the individual sensors of the Hydrolab® multi-probes will continue to follow the manufactures recommendations and regionally accepted methods used by other resource agencies conducting similar monitoring programs, such as the USGS, U.S. Army Corps of Engineers, and other mid-Columbia River Dam operators. The general calibration, maintenance, and deployment methods for the multi-probes also follow regionally accepted methods.

SECTION 8: DATA MANAGEMENT PROCEDURES

Data management will vary depending on whether it is transmitted in real-time or logged and downloaded periodically. The data that are collected in real-time will be automated to be transmitted directly into Chelan PUD's P.I. system as they are collected. This data management system is used on a regular basis across the Chelan PUD to manage power, flows, temperatures and many other parameters. Data that are logged and downloaded monthly or quarterly will be manually added to the P.I. system for consistent ease of availability and safe, archived keeping.

The reported data are anticipated to include the location of collection, the time of collection (by the interval determined if real-time), hourly data (averaged over the hour if more than one reading is collected per hour), and the date of collection.

SECTION 9: ADAPTIVE MANAGEMENT

The 401 Certification incorporates by reference Adaptive Management as defined in the Settlement Agreement. Additionally, conditions within the 401 Certification set forth Adaptive Management processes and measures to achieve full compliance with standards and constitute a water quality attainment plan under WAC 173-201A-510(5). Under Adaptive Management, it may be necessary to revise/modify sampling procedures/locations, as necessary to ensure quality data collection.

SECTION 10: AUDITS AND REPORTS

A process is needed to ensure that the QAPP is implemented correctly, that the quality of the data is acceptable, and that corrective actions are implemented in a timely manner.

10.1 AUDITS

In order to assure that the proper measurement procedures are taking place and to determine if changes in the procedures are needed, two forms of audits will be conducted: field audits and reporting audits, each of which is discussed below.

10.1.1 Field Audits

Once per year the project manager will accompany or oversee Chelan PUD water quality field staff (or contractor) in the field to monitor and audit all field activities including calibrations, maintenance, and multi-probe deployment methods, and safety activities. The auditor will focus on ensuring that all SOPs are followed, calibrations are conducted in compliance with manufacturers' specifications when applicable, and this QAPP is followed. The auditor will provide a brief write up of their observations including any deviations from QAPP and whether it should be changed or the process in the field needs to be addressed. The project manager will be responsible for ensuring that, if needed, any corrective actions meet Ecology and FERC approval, and that each corrective action is implemented. A subsequent audit may be required to ensure that the change has been successfully implemented.

10.1.2 Reporting Audits

It is the responsibility of the Chelan PUD to ensure that all of the reporting requirements of the 401 Certification have been met. The project manager and Licensing and Compliance Coordinator will be responsible for keeping track of the mandated reporting and confirming that it has been met. Specifically, the project manager will access the website monthly or quarterly, as appropriate, to check that the necessary data are present, legible and correct. Additionally, the project manager will review the annual reports to make sure that the data presented are accurate, and verifiable (see Section 12). Any deviations from requirements will be rectified and Ecology will be notified of the deviation and corrective action.

10.2 REPORTS

Reporting will be conducted in a variety of ways, which will depend primarily on the frequency of monitoring.

10.2.1 Periodic Updates

Data collected will be evaluated and flagged to indicate any water quality exceedances and measures taken by the Chelan PUD to address the exceedances. The Chelan PUD will report exceedances of the water quality criteria within 48 hours to the Ecology CRO.

10.2.2 Annual Reports

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and

measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). Presentation of the TDG monitoring results in the annual report should include the following:

- Flow during the preceding year (cfs over time);
- Spill during the preceding year (cfs and duration);
- Reasons for spill;
- TDG levels during spill (hourly);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP; and
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG standards.

This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

SECTION 11: DATA REVIEW, VERIFICATION, AND QUALITY ASSESSMENT

Data will be downloaded from the meters or the P.I. system to a spreadsheet and reviewed for outliers and values not conforming to the MQOs. If the objectives have not been met, the project manager will decide how to qualify the data and how the data should be used in the analysis or whether the data should be rejected. As appropriate, the project manager will assign additional data qualifiers where necessary or reject data from further use. Data that is rejected from further use will be recorded in a deleted data database with a description of why the data was rejected, as well as any adjustments needed to correct the reason for the data rejection. These deleted data will then be presented in the annual water quality monitoring report under the QA/QC sections.

Data completeness will be adequate if monitoring is completed with data meeting the MQOs at least 85 percent of the time. A lower rate of data completeness may be acceptable, which will be determined in an overall review of data. All data meeting MQOs will be used.

The results analyses will be evaluated for compliance with acceptance criteria. This evaluation will include collection of temperature data for subsequent modeling, and a statistical evaluation of other data to the numeric criteria. It is anticipated that the average and variance of all data will be assessed to determine the frequency that any numeric water quality criteria have been exceeded, if any. Once the data have been reviewed, verified, and validated, the project manager will determine if the data are of usable quality to make decisions for which the study was designed.

SECTION 12: REFERENCES

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APPENDIX A: SPECIFICATIONS FOR PROPOSED EQUIPMENT

HYDROLAB®
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THE WORLD LEADER IN MULTI-PARAMETER WATER QUALITY MONITORING INSTRUMENTATION

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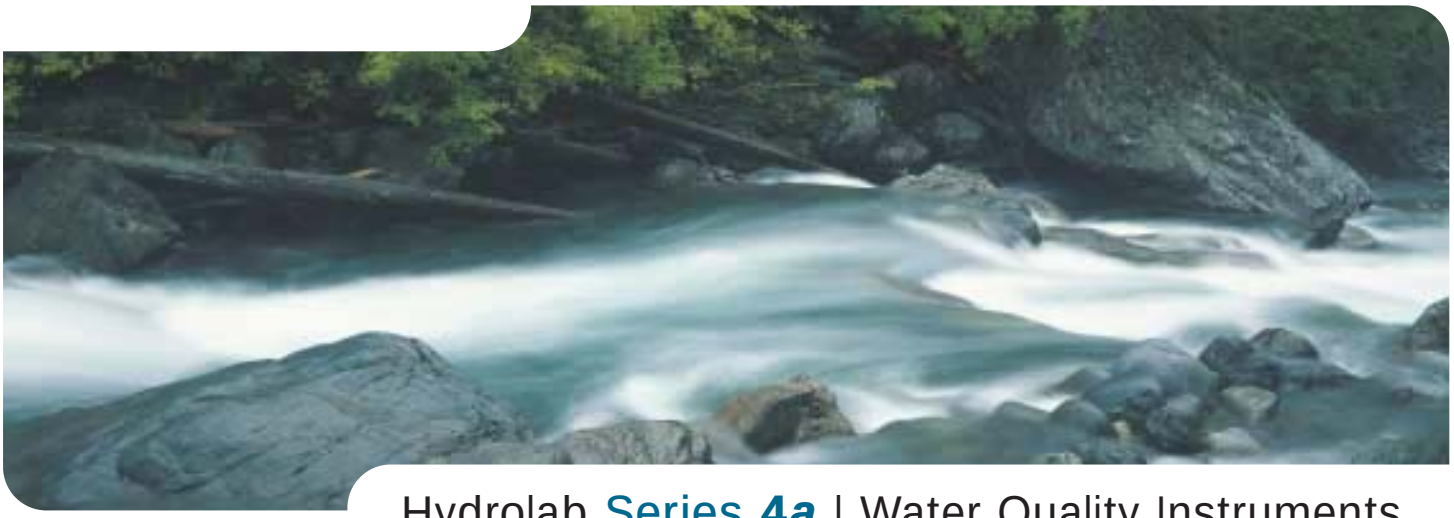

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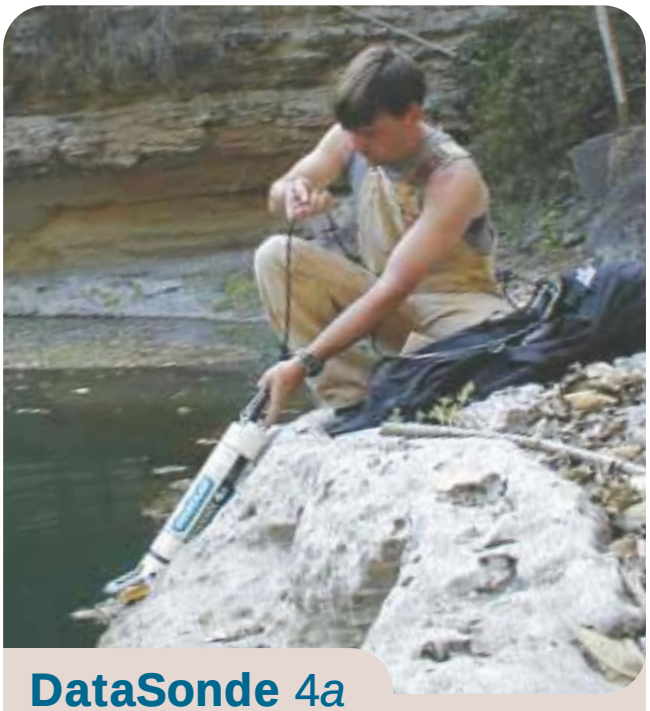
> *The Series 4a continues that tradition with several enhancements that provide you with even greater value.*
> *Now, as part of Hach Company, you can expect continuous innovation from Hydrolab, now and into the future!*

*Both the **DataSonde 4a** and the **MiniSonde 4a** are well suited for profiling and spot-checking applications, and are available with battery packs and memory to use for long-term monitoring. Data can be downloaded to the **Surveyor 4a** or a PC.*



DataSonde 4a

> Seven built-in expansion ports
> Designed for in-situ and flow-through applications
> Measures up to 15 parameters
> Excellent long-term deployment capability

MiniSonde 4a

> Four built-in expansion ports
> 1.75" diameter housing – ideal for ground water monitoring, portability, and limited space environments
> Measures up to 10 parameters

Series **4a** water quality instruments provide the best long-term value: > Easy to use and maintain

Surveyor 4a

- Rugged, waterproof (NEMA 6) case with hand strap
- Displays parameters in real-time or stores data automatically (up to 375,000 measurements)
- Data presented in real-time graphical form or tabular format
- Optional GPS and barometric pressure

Hydras3 LT

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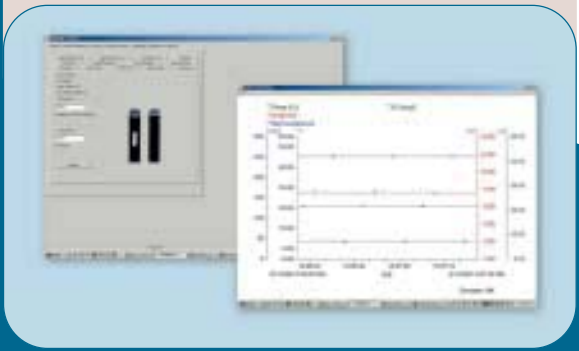
- Real-time multiparameter time series graphs *and* vertical profiling
- Simple calibration of any parameter
- Set-up data logging runs in a snap
- One click download for field data collection
- Simultaneous, multiple probe download capability
- Available for free download at www.hydrolab.com



*Superior **Sensor** Technology*

At the heart of the Series 4a instruments is Hydrolab's superior sensor technology. Advanced design and sensor technology make these instruments the most reliable in the field. The Series 4a features watertight sensors based on superior technology to produce instruments that are longer lasting, more reliable, less expensive, and easier to maintain. This means lower operating costs in the long run, and better value for you.

*The **DataSonde 4a** and **MiniSonde 4a** system, proven during years of field testing, provides the following advantages:*

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> Superior sensor technology > Unsurpassed reliability > Guaranteed after-sale support

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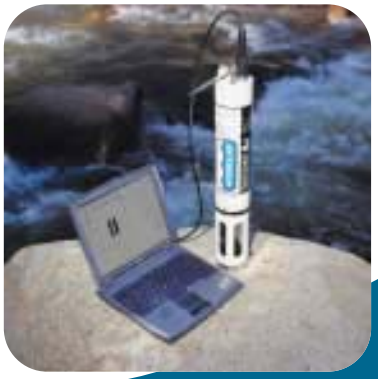
Engineered for dependable performance and durability in the field, Series 4*a* water quality instruments by Hydrolab can measure up to 15 parameters at once. These rugged instruments offer the highest long-term value, providing you years of reliable water quality data.

The three components of Hydrolab's Series 4*a* product line are the DataSonde 4*a*, MiniSonde 4*a* and Surveyor 4*a*. These instruments come with a two-year warranty – the best you'll find in the industry.



- > Configured to fit your specific need
- > Profiling or long-term deployment
- > Surface or ground water
- > Remote or attended monitoring

Hydrolab Series 4*a*: DataSonde 4*a* | MiniSonde 4*a* | Surveyor 4*a*

- Temperature
- Conductivity
- Dissolved Oxygen
- Rebuildable pH
- ORP
- 4-Beam Turbidity
- Self-Cleaning Turbidity
- Level & Depth
- Chlorophyll a
- Blue-Green Algae
- Rhodamine WT
- Li-Cor® Ambient Light
- Ammonium/Ammonia
- Nitrate
- Chloride
- GPS
- Barometric Pressure
- Transmissivity
- Total Dissolved Gas

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hydrolab.com

Lit. No. HY04 Rev. 5
G42 Printed in U.S.A.

TYPICAL PERFORMANCE SPECIFICATIONS

	RANGE	ACCURACY	RESOLUTION	AVAILABLE INSTRUMENT *
Temperature	-5 to 50° C	±0.10° C	0.01° C	D, M
Specific Conductance	0 to 100 mS/cm	±1% of reading; ±0.001 mS/cm	4 digits	D, M
pH	0 to 14 units	±0.2 units	0.01 units	D, M
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L at ≤ 20 mg/L ±0.6 mg/L at > 20 mg/L	0.01 mg/L	D, M
ORP	-999 to 999 mV	±20 mV	1 mV	D, M
Depth Vented Level 0-25 m 0-100 m 0-200 m	0 to 10 m 0 to 25 m 0 to 100 m 0 to 200 m	±0.003 m ±0.05 m ±0.05 m ±0.1 m	0.001 m 0.01 m 0.01 m 0.1 m	D, M D, M D, M D, M
Salinity	0 to 70 ppt	±0.2 ppt	0.01 ppt	D, M
4-Beam Turbidity	0 to 1000 NTU	±5% of reading; ±1 NTU	0.1 NTU (<100 NTU) 1 NTU (≥100 NTU)	D
Self-Cleaning Turbidity	0 to 3000 NTU	±1%, up to 100 NTU ±3%, 100-400 NTU ±5%, 400-3000 NTU	0.1, up to 400 NTU 1.0, 400-3000 NTU	D, M
Ammonium/Ammonia	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Nitrate	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Chloride	0.5 to 18,000 mg/L	Greater of ±5% of reading or ±2 mg/L (typical)	4 digits	D, M
Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg	D, M
Ambient Light	0 to 10,000 µmol $s^{-1}m^{-2}$	±5% of reading or ±1 µmol $s^{-1}m^{-2}$	1 µmol $s^{-1}m^{-2}$	D
Chlorophyll *a*	0 to 500 µg/L 0 to 50 µg/L 0 to 5 µg/L	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 µg/L	D, M
Rhodamine WT	0 to 1000 ppb 0 to 100 ppb 0 to 10 ppb	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 ppb	D, M
Blue-Green Algae	100 to 2,000,000 cells/mL 100 to 200,000 100 to 20,000	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 cells/mL	D, M
Barometric Pressure	500 to 850 mmHg	±10 mmHg	0.1 mmHg	S
Global Positioning System	-90 to 90° Latitude -18 to 180° Longitude	25 m CEP (50%) without SA and DGPS 2 m CEP (50%) with DGPS	0.1”	S

* D = DataSonde 4*a* M = MiniSonde 4*a* S = Surveyor 4*a*

INSTRUMENT SPECIFICATIONS

Computer Interface	RS-232, SDI-12
Memory	DataSonde 4*a* – 120,000 measurements MiniSonde 4*a* – 120,000 measurements Surveyor 4*a* – 375,000 measurements
Battery Supply	DataSonde 4*a* – 8 C batteries MiniSonde 4*a* – 8 AA batteries Surveyor 4*a* – rechargeable nickel metal hydride
Typical Battery Life (1-hour intervals)	DataSonde 4*a* – 313 days MiniSonde 4*a* – 114 days Surveyor 4*a* – 12-16 hours
Operating Temperature	-5 to 50° C
Maximum Depth	DataSonde 4*a* & MiniSonde 4*a* – 225 m
Size	DataSonde 4*a*: Outer diameter – 3.5”/8.9 cm; Length – 23”/58.4 cm; Weight – 7.4 lbs/3.35 kg MiniSonde 4*a*: Outer diameter – 1.75”/4.4 cm; Length – 21”/53.3 cm; Weight – 2.2 lbs/1.0 kg with extended battery pack: 29.5”/74.9 cm, Weight – 2.9 lbs/1.3 kg Surveyor 4*a*: 11x4x5”/27.9x10.2x3.8 cm, Weight – 2 lbs/0.9 kg

Hydrolab

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fax (970) 461-3921
hydrolab.com

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BENEFITS & SPECIFICATIONS

- Uses a pH glass sensor
- Both feature a single refillable, flowing junction reference electrode OR optional low ionic strength electrode
- Standard reference electrode is more reliable, lasts longer, is easily maintained, and refills in seconds
- Reference electrode is maintained and refilled independently of pH and/or ORP
- Two-year warranty

pH SENSOR

Range	0 to 14 pH units
Accuracy	±0.2 units
Resolution	0.01 units

ORP SENSOR

Range	-999 to 999 mV
Accuracy	±20 mV
Resolution	1 mV

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HYDROLAB®
A HACH COMPANY BRAND

BENEFITS & SPECIFICATIONS

DISSOLVED OXYGEN SENSOR

- Uses field-proven Clark Cell technology
- Provides a continuous steady-state reading
- Low maintenance – no need to recondition the sensor
- Two-year warranty

Range	0 to 50 mg/L
Accuracy	±0.2 mg/L for 20 mg/L or less ±0.6 mg/L for over 20 mg/L
Resolution	0.01 mg/L

SPECIFIC CONDUCTANCE SENSOR

- Hydrolab uses the four graphite electrode cell methodology:
  - Increases sample exchange
  - Open cell design provides more reliable data
  - Reduces measurement error due to fouling and air bubbles (bubbles rise above the electrodes out of the way and debris and sediment fall below)
  - Easily maintained without damaging electrodes
  - Resists corrosion
- Also measures salinity, resistivity, and TDS
- Two-year warranty

Range	0 to 100 mS/cm
Accuracy	±1% of reading, ±0.001 mS/cm
Resolution	4 digits

SAMPLE CIRCULATOR

Only Hydrolab offers a sample circulator for more reliable readings. The DataSonde 4*a* and MiniSonde 4*a* integrated sample circulator facilitates fast, accurate, steady-state dissolved oxygen measurements. Other sensors receive similar benefits.

- Creates a flow of water past the sensors
- Provides “sufficient sample flow across membrane surface” in accordance with Standard Methods Article 4500-OG
- Reduces response time – important to detect moving contaminant plumes or movement within water column
- Reduces sensor fouling – sweeps away inert debris and biological growth
- Allows deployment in any environment, even in poorly mixed areas

Hydrolab

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HOBO® Water Temp Pro

AWARD-WINNING TECHNOLOGY AE50 HOBO® WEATHER STATION HOBO® WATER TEMP PRO

Size/Weight: 11.4 x 3.0 cm (4.5" X 1.19") with 6.4 mm (0.25") hole in mounting bail
42 grams (1.5 oz)

$110

The durable HOBO Water Temp Pro has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. A temperature-compensated real time clock provides better than ± 1 minute per month time accuracy. Designed with a durable streamlined case for extended deployment in fresh or salt water up to 50°C, the Water Temp Pro is equipped with an infrared (IR) interface for data offload in the field, even when the logger is wet.

Key Specifications

Measurement Range: 0° to 50°C (32°F to 122°F) in water (nonfreezing); –20°C to 70°C (-4°F to 158°F) in air

Waterproof: To 120 m (400 ft)

Accuracy: ±0.2°C at 0 to 50°C (± 0.36°F at 32° to 122°F)

Resolution: 0.02°C at 25°C (0.04°F at 77°F)

Time accuracy: Better than ±1 minute per month

Capacity: 21,580 12-bit measurements

CE Compliant with all relevant directives in the European Union (EU)

Bp BoxCar®Pro-compatible

Features

Accurate:
12-bit resolution and precision sensor for ±0.2°C accuracy at 0° to 50°C (±0.36°F accuracy at 32°F to 122°F)
Includes a NIST-traceable accuracy certificate at room temperature
Real-time clock for better than ±1 minute per month time accuracy

Easy to Use:
High-speed infrared (IR) interface offloads full logger <30 seconds
Programmable start time/date
User-selectable sampling interval: 1 second to 9 hours
Uses popular BoxCar® Pro 4.3+ for system launch and data retrieval

Reliable:
Factory-replaceable battery lasts 6 years (typical); temperature extremes will reduce battery life
Battery level indication at launch
Offload data, check logger and battery status while logging using BoxCar Pro
Non-volatile EEPROM memory retains measurements even if battery fails
Blinking LED confirms operation with option to suppress signal during logging
UV-stable plastic for long-term immersion in fresh or salt water*
Rugged, streamlined case design withstands years of use in stream conditions
Rated for use up to 50°C in water, 70°C in air
The dark gray case blends in, minimizing chances of tampering
Optional protective boot for high water flow, flooding, or conditions with debris *(see pg. 38)*

Detailed Specifications

Response Time: 5 minutes in water, 12 minutes in air moving 2 m/sec, typical to 90%
Memory modes: Stop when full or Wrap-around when full
Data offload: Readout full logger in < 30 seconds while logging or when stopped
Buoyancy: +13 grams (0.5 oz) (fresh water at 25°C); +17 grams (0.6 oz) with optional boot
Battery : One 3.6 V Lithium, factory replaceable ONLY
Battery Life: 6 years typical, temperature extremes reduce battery life
Drop proof to 1.5 m (5')
Note: NIST-traceable certification at additional temperature points is also available through Onset at additional cost.

The HOBO Water Temp Pro received an AE50 award for product innovation from the American Society of Agricultural Engineer's Resource *magazine.*

** Not for prolonged exposure to chlorinated water.*

IR Basestation for HOBO® Water Temp Pro

Operating Range: 0° to 40°C (32° to 104°F) 0 to 95% RH
Size/Weight: 3.2 x 6.4 x 1.5 cm (1.3 x 2.5 x 0.6 in.); 54 g (2.0 oz)

$60

The Infrared (IR) Basestation is required for communications between the HOBO Water Temp Pro and the PC. Simply place the logger 4 to 5 inches away from an IR Basestation (connected to a PC) within the 30° angle of view to read out the Water Temp Pro. The IR Basestation requires a 9-pin serial port in the PC. For use with USB port, see USB-to-Serial Adapter (pg 43). The Water Temp Pro is not compatible with IR ports on PCs or laptops.

Note: The IR Basestation is not waterproof.

HOBO Water Temp Pro Ordering

Description	Part No.	Qty. 1-9	10-99	100+
HOBO Water Temp Pro	H20-001	$110	$102	$94
IR Basestation	BST-IR	$60	$56	$51
Protective boot—black	BOOT-BLK	$15	$14	$13
Protective boot—white	BOOT-WHT	$15	$14	$13
Factory replacement battery service		$35		
Replacement caps				
Cap for Water Temp Pro (without Boot)	85-CAPLUG-H20	$2		
Cap for Boot-BLK	85-CAPLUG-H20-B	$2		
Cap for Boot-WHT	85-CAPLUG-H20-W	$2		
Software				
BoxCar Pro 4.3 Starter Kit (Windows®)	BCP4.3-ON	$95	$88	$81

Note: A BoxCar Pro Starter Kit and IR Base Station are required to operate the HOBO Water Temp Pro. Each starter kit includes software, computer interface cable and software manual. See page 42 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

underwater

StowAway® TidbiT®

$119

Small size: approx.
3.0 x 4.1 x 1.7 cm thick
(1.2 x 1.6 x 0.65"); 23 gm (0.8 oz)

The StowAway TidbiT is Onset's smallest data logger and is widely used for monitoring temperatures in streams, lakes, oceans, and soils. Small size, rugged case and alarm indication also make this a popular choice for monitoring conditions in shipping applications.

Key Specifications

Ideal for underwater applications up to 30° C

StowAway TidbiT: Model TBI32-05+37

Range†: -4° to 37°C (24° to 99°F)
Accuracy: ±0.2° at 20°C (±0.4° at 70°F)
Resolution: 0.16° at 20°C (0.29° at 70°F)

StowAway TidbiT: Model TBI32-20+50

Range†: -20° to 50°C (-4° to 122°F)
Accuracy: ±0.4°at 20°C (±0.8° at 70°F)
Resolution: 0.3°C at 20°C (0.6° at 70°F)

Capacity: 32,520 measurements

† *Specified range is narrower than nominal range due to precision calibration process. Using TidbiT Temp loggers in wet environments (>90% RH) over 86°F (30°C) for extended periods of more than 8 weeks cumulative may lead to premature failure. For applications over 30°C, use the HOBO Water Temp Pro (pg 35).*
Note: For Onset's lowest cost underwater temperature monitoring solutions, see HOBO Pendant Temp (pg 17). For depths greater than 300m see HOBO Stainless Temp (pg 18).

Features and Specifications

Waterproof to 300 m (1000 feet)
IR communications and Optic Shuttle for readout when wet—even underwater!
Programmable start time/date or triggered start on location with Optic Coupler or magnet
Small Size and Alarm Indication
5-year, non-replaceable battery (typical use*)
NIST-traceable temperature accuracy certificate available
Multiple sampling with minimum, maximum or averaging
Mounting tab
Time accuracy: ±1 minute per week at 20°C (68°F)
Memory modes: Stop when full, Wrap-around when full
Response time in water: 5 minutes (typical to 90%)
Response time in air moving 1m/second: 20 minutes

** 16 three-month deployments in water (35° to 80°F) with 4 minute or longer intervals (no multiple sampling)*

Optic Shuttle™

$199

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x 1.0" thick)
without coupler; 28.35 g (1 oz)

The pocket-sized Optic Shuttle provides a convenient way to readout and relaunch TidbiT data loggers and bring the data back to your host PC.

Features and Specifications

Waterproof to 15 psi (30 feet)
128K capacity enough for 4 full 32K loggers
Data offload time from logger: 6 minutes typical from 32K logger
Data readout time to PC: 3 minutes typical for complete offload
TidbiT Coupler and Optic Coupler included
Uploads the same data to a PC as if the data were read out directly from the logger
6 year factory-replaceable battery (typical)

Optic Base Station™

$80

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x .95" thick)
without coupler; 56.7 g (2 oz)

The Optic Base Station is used to communicate between the host computer and either a StowAway TidbiT data logger or an Optic Shuttle. An Optic Coupler and TidbiT Coupler for connecting the base station to loggers are also included.

StowAway TidbiT Ordering

Description	Part No.	Qty. 1-9	10-99	100+
32K StowAway TidbiT				
(-4° to 37°C)	TBI32-05+37	$119	$110	$101
(-20° to 50°C)	TBI32-20+50	$119	$110	$101
Optic Base Station for TidbiT	DSA	$80	$74	$68
Optic Shuttle for TidbiT	DTA128B	$199	$183	$169
Software				
BoxCar Pro 4.3 Starter Kit (Windows)	BCP4.3-ON	$95	$88	$81
BoxCar 3.7 Starter Kit (Windows)	BC3.7-ON	$20	$19	$17

Note: A BoxCar Pro 4.3 or BoxCar 3.7 starter kit and an Optic Base Station are required to operate the TidbiT loggers. Each starter kit includes software, computer interface cable and software manual. The Optic Base Station includes an Optic Base Station, Optic Coupler and TidbiT Coupler. See pages 42-43 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

B BoxCar®-compatible

Bp BoxCar®Pro-compatible

CE Compliant with all relevant directives in the European Union (EU)

APPENDIX B: CONSULTATION RECORD

B.1 Comments Letters Received

Email From Patricia Irle
Received January 1, 2010

Hi, Kelee -

I've attached a copy of the draft QAPP with some comments. However, I think it would be helpful if you could address the comments below, and submit it for another review. At that time, I'll send Section 4 to our in-house expert… (I think he needs some of the following information to do a thorough job…)

General comments:

1) TDG. How will determine whether TDG standards are being met during non-fish-spill season?
2) Temperature. QAPP notes (page 3) that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.
3) Temperature in the bypass. How do you expect to apply the standard here?
4) Please include all sampling locations.

Thanks!
Pat
(509) 454-7864

B.2 Response to Comments

Date	Section	Agency Comment	Chelan PUD Response
1/5/10	General	How will Chelan PUD determine whether TDG standards are being met during non-fish-spill season?	As per Section 5.4 (1)(a) of the 401 Certification which states: "Outside of the fish spill season, Chelan PUD may use spill as a surrogate for TDG levels," Chelan PUD will use spill as a surrogate for TDG levels outside the fish spill season. This use of spill as a surrogate for TDG levels is made possible by a linear regression developed by Schneider and Wilhelms (2005). Chelan PUD will continue to refine said regression using data collected during the April – August fish spill season.
		Temperature in the bypass. How do you expect to apply the standard here?	Monitoring will confirm whether temperatures in the bypass system increase from the entrance (forebay) to exit (sampling facility). Any observed temperature increases will be evaluated to determine impact on Columbia River temperatures.
		Please include all sampling locations.	Forebay and tailrace TDG and temperature locations have been identified in Section 5.1.1. Juvenile bypass temperature collection locations are stated in Section 5.1.2. Fishway temperature locations are stated in Section 5.1.3.
	Section 1 3rd paragraph	Says three, then lists four groups….	Language has been revised in response to comment.
	Section 1	QAPP notes that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.	This may be a misinterpretation of what is written. As per Section 5.5(1)(b) of the 401 Certification, "Chelan PUD will collect or compile meteorological and water temperature data, including hourly water temperature data from the Wells Dam tailrace, for at least the first 5 years of New License; such data shall be of sufficient quality to meet technical peer review group standards for running the model." As stated previously in the Section and in the 401, Chelan PUD will collect temperature data in the forebay, fishways, juvenile bypass, and tailrace, as well as use data collected at Wells Dam.
	Table 3-2	"This study will be conducted at a later date (no sooner than 2011)." Why not?	Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for concurrent analyses of macrophyte bed water quality conditions and fish presence/use. Note added to the table to clarify this.
	Table 5-1	Regarding standards column: This does not make sense in terms of the two locations identified.	Chelan PUD does not fully understand your comment, as these *are* the numeric criteria, but the table has been revised to clarify.
	5.1.1 1st Paragraph	Note that there is a slight temperature gradient. Please discuss how this may affect the results.	The monitoring device is located deep enough in the water column to not be effected by near surface temperature gradients. Language has been added to the section in response to comment.
	5.1.1 2nd Paragraph	Can you cite the study?	Citation added.
	5.1.1 3rd Paragraph	Explain how this will affect the accuracy of the TDG results…	The monitoring device is located below the depth at which bubbles form on the membrane; therefore, no effect in accuracy is expected. Language has been added to the section in response to comment.

Date	Section	Agency Comment	Chelan PUD Response
	5.1.2 1st Paragraph	This should be part of this report.	Language revised in response to comment.
	5.1.2 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	5.1.3 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	Section 9	I don't know that we need this. If the project changes, it will require changes to the overall objectives. Why include here?	Chelan PUD does not intend to change any projects. This adaptive management section is intended to addresses the potential need to revise/modify procedures/locations to ensure quality data collection. The language in this section has been revised in an attempt to clarify the intent of the section.
	Section 9 3rd Paragraph	This, then, isn't adaptive management…. And shouldn't be in this section.	Paragraph deleted.
	General	Suggested grammatical, formatting, etc revisions.	Chelan PUD appreciates your time and effort in making these suggestions. The suggested changes have been accepted as appropriate.
2/4/10	Section 1	Our primary concern is with regard to collecting data for a future computer temperature model run. It is stated (page 3) that an additional QAPP will be drafted to address this modeling effort. Because the model is to be run based in the first five years of data, it is critical that a QAPP be prepared immediately, to address collection of this data. Please include a data for completing that QAPP.	This is a valid point. Water temperature data to be used in the model is addressed in this QAPP; however, we agree it is necessary to draft a second QAPP that addresses the climatic data that will be used in the model. In order to proceed with the additional QAPP, Chelan PUD feels it is necessary to work collaboratively with Ecology to decide what climatic data sources should be used in this effort. Once that is determined, we can proceed with the drafting of the climatic data QAPP. Because we do not have an anticipated completion date for the second QAPP, we have not added/revised language in this QAPP to address this comment.
		The draft document describes two annual reports that will be sent to Ecology as part of this QAPP; one due in April, one in December (see pages 9 and 25 of the report). It is not clear which document will include the results and analysis for the 110% standards. Please clarify.	Clarifying language added in response to comment. Please note that the December submittal will address TDG only. This report will be appended to the March 1 submittal that is to address all parameters addressed in this QAPP.
	Table 3-2	It is indicated that spill as a surrogate for TDG will collected hourly. A minor suggestion: for consistency, could you move the comment "This will be necessary only during spill events outside of the fish season" into the second column?	Table revised in response to comment.
	Table 3-2	TDG: You should be monitoring or compiling information at each of three sites: forebay and tailrace of Rocky Reach, and forebay of Rock Island. Please clarify.	Table revised in response to comment.
	Table 5-1	TDG: Please include Rock Island forebay in the table under "Locations". And, 110% under "standards".	Table revised in response to comment.

APPENDIX E: 2015 TOTAL DISSOLVED GAS ANNUAL REPORT

2015
TOTAL DISSOLVED GAS ANNUAL REPORT

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145
and
ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

December 4, 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABBREIATIONS

7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
CCT	Confederated Tribes of the Colville Reservation
Chelan PUD	Public Utility District No. 1 of Chelan County
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
Grant PUD	Public Utility District No. 2 of Grant County
GBT	gas bubble trauma
HCP	Anadromous Fish Agreement and Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
msl	mean sea level
NMFS	National Marine Fisheries Service
project	Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RM	river mile
RRFF	Rocky Reach Fish Forum
SCADA	supervisory control and data acquisition
standards	Washington State water quality standards
TDG	total dissolved gas
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQC	water quality certification
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual report to summarize the results of the 2015 total dissolved gas (TDG) monitoring, associated spill, biological monitoring and gas abatement methods during the fish-spill period (April 1 through August 31) within the Rocky Reach and Rock Island Hydroelectric Projects.

Over the course of the 2015 fish-spill season, there were no exceedances of the total dissolved gas (TDG) numeric criteria in either the forebays or tailrace of Rocky Reach and Rock Island dams, nor at the forebay of Wanapum Dam.

Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 71.6% of average at Rocky Reach, and 73% of average at Rock Island dams) over the entire fish-spill season.

In 2015, spill events at Rocky Reach Dam were involuntary April 1 through May 31 and both voluntary and involuntary June 1 through August 7 (summer fish-spill period). Between June 1 and the end of summer fish-spill on August 7, 98% of the total volume spilled was voluntary, while 2% was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 14 with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates on August 12.

To achieve the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of 9% of daily average river flow at the Rocky Reach Dam for a duration covering 95% of the subyearling outmigration during the summer of 2015. The summer spill program for subyearling passage began on June 1 and ended on August 11. Percent daily river flow spilled during the summer period was 9%.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Project. Spring fish-spill of 10% of total river flow began on April 16 and was continued through May 31. During the spring fish-spill period, 10% of total river flow was spilled. Of that 10%, 100% of it was voluntary spill for fish. Rock Island fish-spill increased to 20% upon onset of the summer outmigration of subyearling Chinook salmon. Summer spill began on June 1 and continued through August 11. During the summer fish-spill period, 20% of total river flow was spilled. Of that 20% of total river flow, 100% of it was voluntary spill for fish

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of gas bubble trauma (GBT) between April 17 and July 16, 2015. During 2015 monitoring, 2,650 smolts were examined for GBT. Of these, 10, or 0.38%, showed signs of GBT.

In 2015, Chelan PUD implemented gas abatement measures as outlined in the Washington State Department of Ecology (Ecology) 401 Water Quality Certification (WQC) (Ecology, 2006). Chelan PUD will continue to closely monitor TDG levels during the fish-spill season, while implementing the abatement measures outlined in Ecology's approved Gas Abatement Plans (GAP), the WQC (Ecology, 2006), and the Rocky Reach Hydroelectric Project Quality Assurance Project Plan (QAPP) (Chelan PUD, 2010b).

SECTION 2: *INTRODUCTION*

2.1 Report Organization

Specific requirements of this annual report are listed below as defined in Appendix A of the Federal Energy Regulatory Commission (FERC) License Order (FERC, 2009), Section 5.4(4) of the WQC (Ecology, 2006).

5.4(4). Total Dissolved Gas Annual Report

a) Flow over the preceding year (cubic feet per second over time)
b) Spill over the preceding year (cubic feet per second and duration)
c) Reasons for spill (e.g., for fish, turbine down time)
d) TDG levels during spill (hourly)
e) Summary of TDG exceedances and what was done to correct the excedances
f) Results of the fish passage efficiency (FPE) studies and survival per the Habitat Conservation Plan (HCP)
g) Analysis of monitoring data for confirmation or refinement of the regression equations in the Water Quality Management Plan (WQMP) (Table 2-7Analysis of the TDG monitoring in comparison to the regression equations use to predict compliance with the TDG numeric criteria
h) All monitoring and studies performed for TDG control and abatement

Chelan PUD has prepared this annual report to address the requirements of the WQC. The following Sections of the report specifically address the listed requirements for the fish-spill period as follows:

Section 1 – Project Description	• Project description • fixed monitoring stations • regulatory framework • HCP results
Section 2 – Operations	• Flow • Spill • Fish-spill programs
Section 3 – Results	• Monitoring results o TDG o biological (gas bubble trauma or GBT) o regression analysis o discussion of exceedances
Section 4 – Abatement measures and Corrective Actions	• Abatement measures • Corrective actions
Section 5 - Conclusions	• Summary

2.2 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. The Rocky Reach and Rock Island projects are located in mid-Washington State on the mainstem of the Columbia River and are owned and operated by Chelan PUD. This area is 59 river miles (RM), from the forebay of Rocky Reach Dam (RM 474) downstream to the forebay of Wanapum Dam (RM 415) owned and operated by the Public Utility District No. 1 of Grant County (Figure 1-1). There are 21 RM between Rocky Reach and Rock Island dams and 38 RM between Rock Island and Wanapum dams.

*2.2.1 **Rocky Reach Project Description***

The powerhouse at Rocky Reach Dam contains a total of 11 vertical axis-generating units and is situated on the west half of the river parallel to the flow. The spillway houses 12 individually opening 170-ton tainter gates arranged on the east half of the river, perpendicular to the river flow (Figure 1-2). The normal maximum reservoir water surface elevation is 707 feet with an average tailrace water surface elevation of 618 feet, providing a gross head of 89 feet. The depth of the stilling basin immediately downstream of the project is approximately 40 feet at average tail water elevation.

In 2003, Chelan PUD began operation of the juvenile bypass system (JBS), which continues to be the primary juvenile non-turbine passage route at Rocky Reach Dam. Testing completed during the first year of operation enabled Chelan PUD to determine the juvenile guidance efficiency of the JBS and estimate the level of spill necessary to meet the HCP survival standards. Voluntary spill is used at Rocky Reach Dam to supplement the effectiveness of the JBS, when needed, to maintain survival goals of the HCP (See Section 2.3 for details). Due to the effectiveness of the JBS, Chelan PUD has reduced or eliminated 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 JBS. During the subyearling Chinook migration (generally mid-June to mid/late August), a spill level of 9% of daily flow (reduced from 15%) has been provided.

The 2015 fish-spill program at Rocky Reach Dam was managed to maximize fish passage, maintain HCP requirements, minimize voluntary spill, and still stay within the terms of Ecology's TDG fish-spill water quality criteria. Voluntary spill levels were managed in real time as detailed in the TDG Operational Plan (Appendix A) for Rocky Reach Dam.

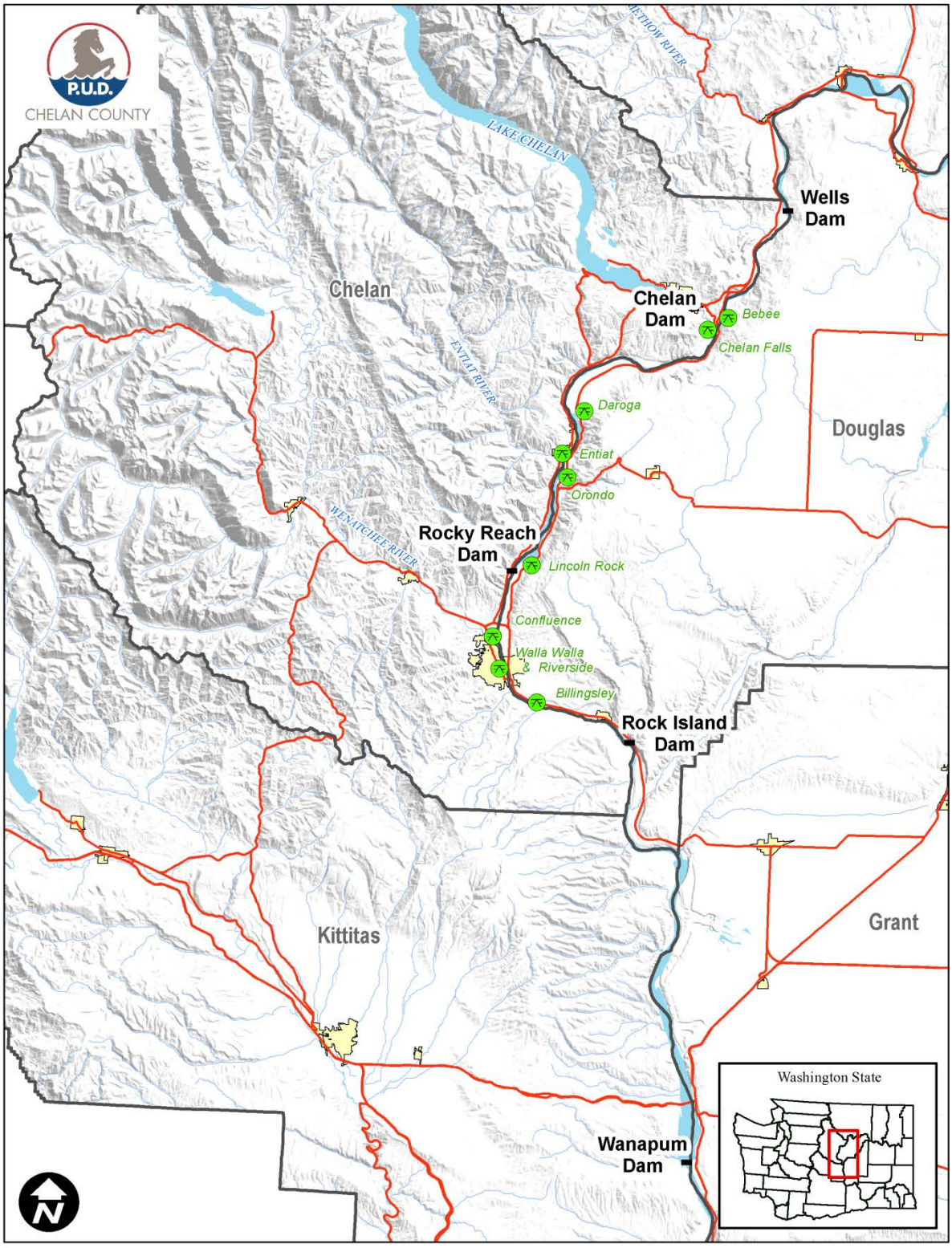

Figure 2-1: Project Location

2.2.2 ***Rock Island Project Description***

The 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. The spillway is 1,184 feet 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 or cfs) surface spill for fish bypass. The normal maximum reservoir elevation of Rock Island project is 613 feet with a tailrace elevation of 572 feet, with a total head of 41 feet. Tailrace bathymetry below Rock Island is complex, and ranges in elevation from approximately 580 feet below bays 21-23 to approximately 520 feet below Bay 1. Chelan PUD has installed the following three TDG abatement structures at Rock Island:

1. Notched gates

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

2. Spill deflector in Bay 16

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

3. Three over/under gates

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

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

2.3 Fixed Monitoring Stations

In accordance with Section 5.4.1(a) of the 401 WQC (Ecology, 2006), Chelan PUD currently operates and maintains four fixed-site water quality monitoring stations (FMS) that record barometric pressure (millimeters of mercury (mm/Hg)), TDG % saturation, and temperature (degrees Celsius). Barometric pressure, TDG percentage saturation, and temperature are recorded

at 15-minute intervals, throughout the year in accordance with Chelan PUD's Ecology and the FERC approved QAPP (Chelan PUD, 2010b).

TDG data enables plant operators to adjust spill volumes to maintain gas levels to reduce the likelihood of exceeding the TDG criteria. These 15-minute intervals are averaged into hourly readings for use in compiling daily and 12-hour averages. All hourly data are forwarded to Chelan PUD headquarters building and then onto the United States Army Corps of Engineers (USACE) Reservoir Control Center and posted at their site on the World Wide Web: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/.

Each Chelan PUD FMS is equipped with a Hydrolab® Minisonde® 5, enclosed in a submerged conduit (Figures 1-2 through 1-4). These Hydrolab® Minisonde® 5's or probes are connected to an automated system that allows Chelan PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. Probes are maintained and calibrated as outlined in the QAPP.

Forebay FMS were located at fixed sites on the upstream face of Rocky Reach and Rock Island dams (Figures 1-2 and 1-3, respectively). The probes were lowered down a conduit, secured to the upstream face of each project, and submerged to a depth of approximately 15 feet.

Tailrace monitoring stations are located downstream of both projects. The Rocky Reach Dam monitoring station is located approximately one third of a mile downstream of the spillway on the JBS outfall (Figure 1-2), as required by the 401 WQC (Ecology, 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 Total Maximum Daily Load (TMDL).

No bridge or other permanent in-water structure is available downriver of Rock Island Dam on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the project on the eastern shoreline (Figure 1-4). This FMS has two means of deploying the probe; scaffolding that holds a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold. The fixed pipe was installed August 25, 2014 due to the extreme fluctuations of the Rock Island Dam tailrace as a result of the Wanapum Reservoir drawdown emergency.

Figure 2-2: Rocky Reach Dam, forebay, tailrace and fixed monitoring stations.

Figure 2-3: Rock Island Dam, forebay fixed monitoring station.

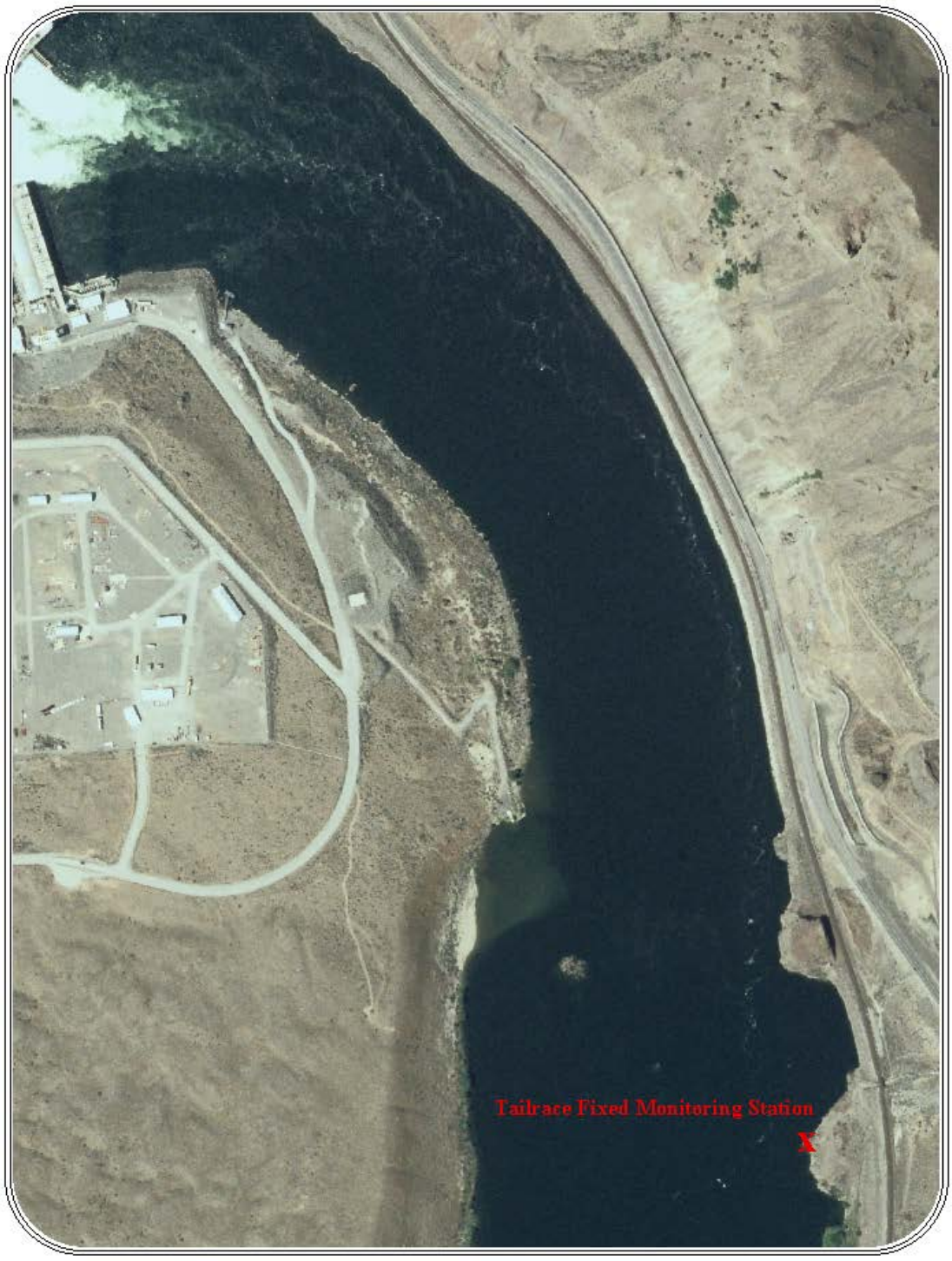

Figure 2-4: Rock Island Dam, tailrace fixed monitoring station.

2.4 Regulatory Framework

The Washington State water quality numeric criteria for TDG (Washington Administrative Code (WAC) 173-201A-200(1)(f)) address standards for the surface waters of Washington State. Under the water quality standards (standards), TDG shall not exceed 110% 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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110%) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers, there are three separate standards with regard to the TDG exemption: 1) in the tailrace of a dam, TDG shall not exceed 125% as measured in any one hour period and 2) TDG shall not exceed 120% in the tailrace of a dam and shall not exceed 115% in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period).

It is important to note that the TDG water quality standards identified above are intended to help protect aquatic life designated uses within the project. This includes Ecology's allowance of higher TDG levels during the fish-spill season, which allow dams to spill water to help achieve juvenile salmonid passage performance standards.

Specific passage performance or survival standards for the project are outlined in the HCP for the Rocky Reach Project. Specifically, the HCP provides that Chelan PUD achieve and maintain combined adult and juvenile project survival. The combined adult juvenile survival standard is 91%. The 91% standard is composed of 98% adult project passage survival and 93% juvenile project survival.

Chelan PUD is currently in Phase III - Standards Achieved. This means that the 91% adult-juvenile combined survival standard is achieved for the spring migrating HCP species; sockeye and spring Chinook salmon, and steelhead. Summer/fall subyearling Chinook salmon are in Phase III - Additional Juvenile Studies, due to limitations on acoustic tag technology for subyearlings and the unpredictable migration behavior of these Upper Columbia River subyearling Chinook salmon. Coho salmon, the last HCP species, is in Phase III - Standards Achieved - Interim.

Achieving the survival standards as described above and in addition to meeting TDG numeric criteria as outlined in WAC 173-201A-200(1)(f), are an integral part of meeting the water quality standards as described in the project's 401 WQC (Ecology, 2006).

*2.4.1 **7Q10 Flows***

Section 5.4.1(b) of the 401 WQC (Ecology, 2006) and WAC 173-201A-200(f)(i) state that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for Rocky Reach Dam was calculated to be 252 thousand cubic feet per second (kcfs), and 264 kcfs at Rock Island Dam.

2.4.2 ***Daily Total Dissolved Gas Compliance Value Calculation Method***

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

On May 21, 2008, Ecology requested, via memo, that all Columbia and Snake River dam operators use a rolling average method for calculating the twelve highest consecutive hourly TDG readings in a twenty-four hour period, beginning at 0100 hours, based on Ecology's 2006 revised water quality standards (Ecology, 2008). Using a rolling average method that begins at 0100 hours results in counting the hours 1400 through 2359 twice: in the average calculations on the day they occur and on the next reporting day. As a result, a TDG water quality standard exceedance may be indicated on two separate days based on the same group of hours. For the 2015 fish-spill period, there were no TDG exceedances and therefore, no double counting occurred.

SECTION 3: *OPERATIONS*

3.1 Description of 2015 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2015 fish-spill season was compared to the 10-year average of mean daily discharge from 2005-2014, as measured at Rocky Reach (Figure 2-1) and Rock Island dams (Figure 2-2). Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 71.6% of average at Rocky Reach, and 73% of average at Rock Island dams) over the entire fish-spill season.

Average flow for all months during the spill season was lower than the monthly 10-year average at both projects. The maximum hourly flows observed at Rocky Reach and Rock Island dams during the spill season were 138 kcfs and 147 kcfs, respectively, on April 3. Of the 153 days during the spill season (April 1 through August 31), there were no instances where the daily average flows exceeded the 7Q10 value at Rocky Reach or Rock Island dams.

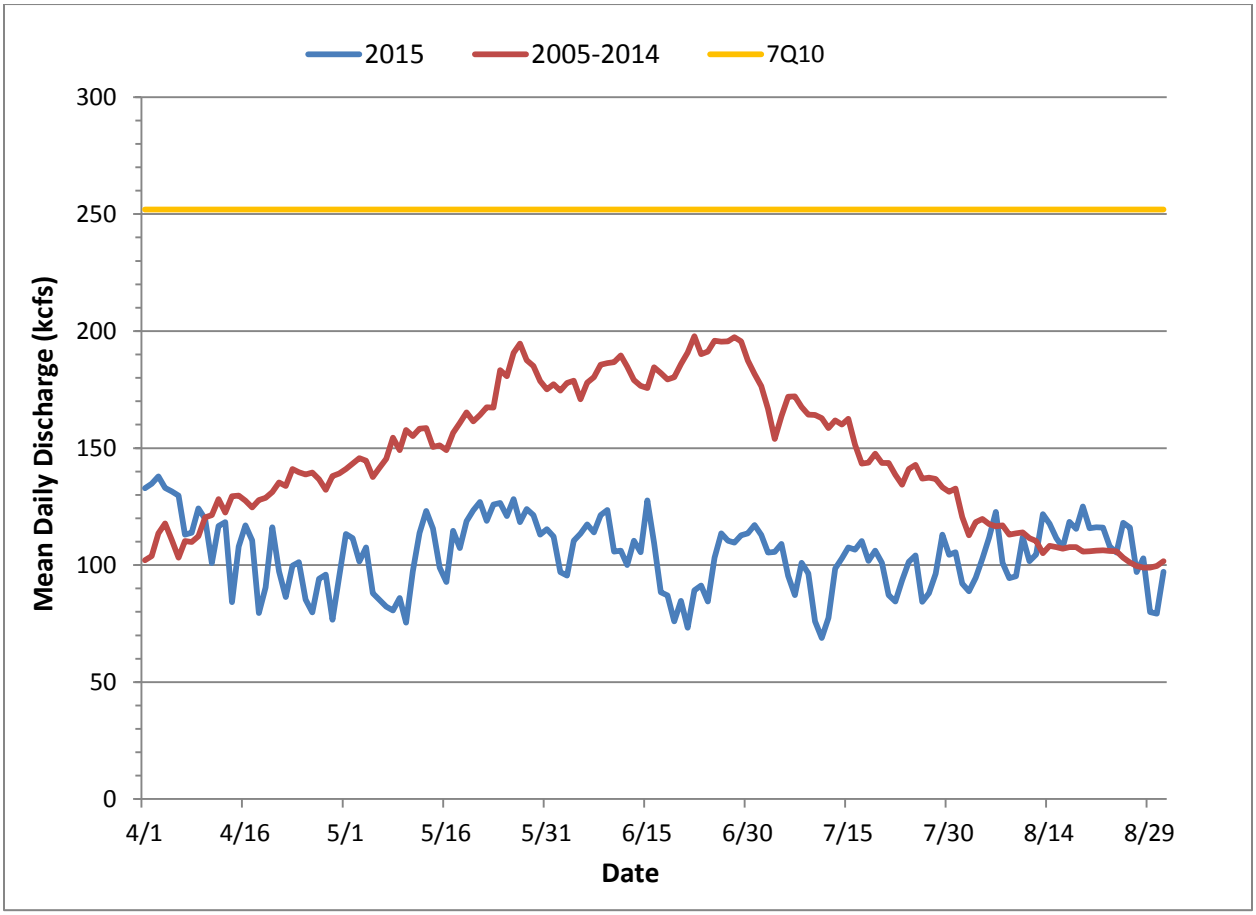

Figure 3-1: Comparison of 2015 vs. previous 10-year average (2005-2015) of mean daily discharge at Rocky Reach Dam.

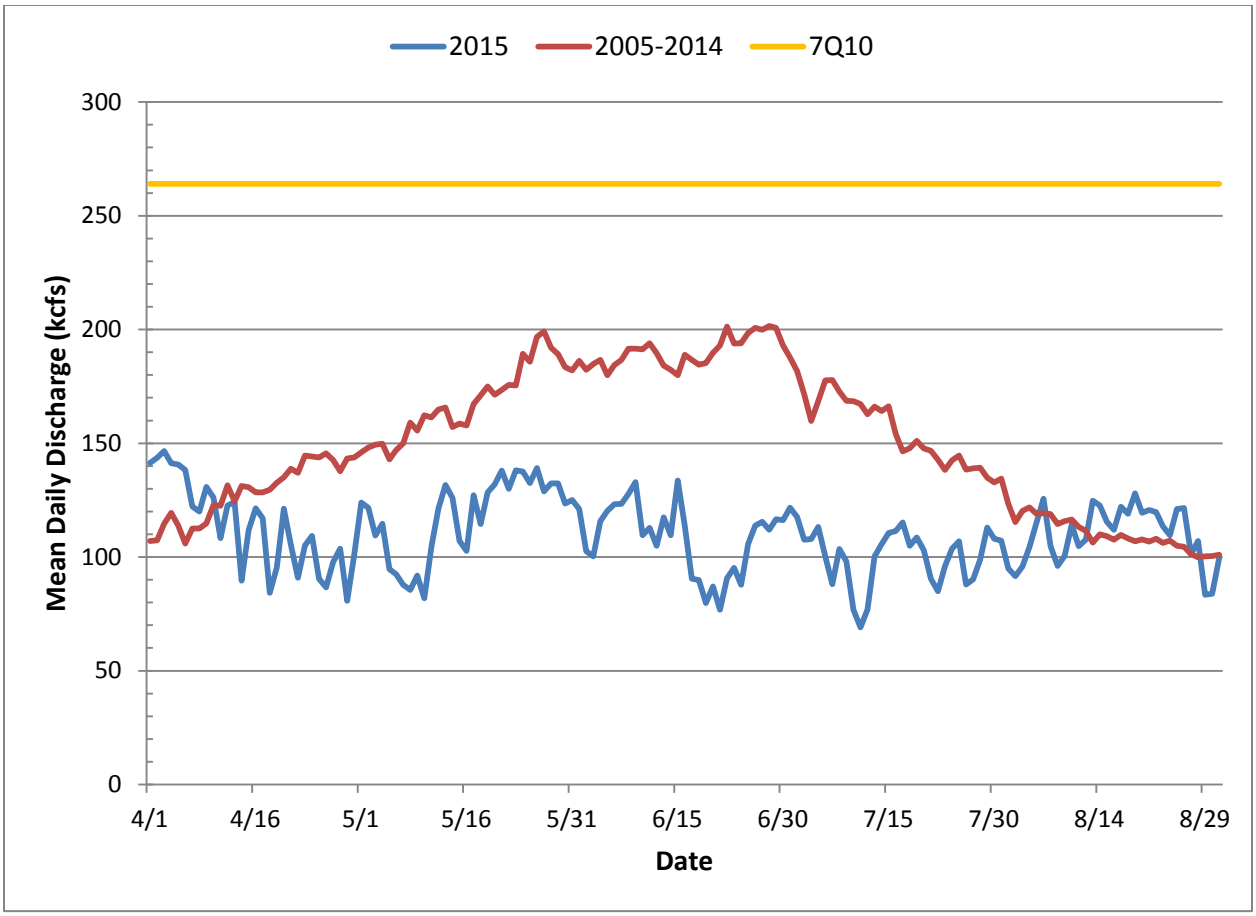

Figure 3-2: Comparison of 2015 vs. previous 10-year average (2005-2014) of mean daily discharge at Rock Island Dam.

3.2 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 Rock Island Dam are also instructed to inform the operators at Rocky Reach Dam when the Rock Island Dam forebay TDG level exceeds 115%. Since implementation of this plan, the number of TDG exceedances in the tailrace of each project has been reduced.

*3.2.1 **Rocky Reach Dam***

The standard spill configuration used at Rocky Reach Dam uses gates 2 through 8 with a minimum discharge per spill bay of about four 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 through 12 are used only in high flow conditions when gates 2 through 8 cannot pass enough water. The standard spill pattern is deviated from only when needed during high flow and spill events.

3.2.2 ***Rock Island Dam***

Spill at Rock Island Dam is provided to cover 95% of the juvenile outmigration for steelhead, and sockeye, yearling and subyearling Chinook salmon.

Optimizing spill efficiency and reducing TDG levels has been a key task for Chelan PUD at Rock Island Dam. To accomplish this task, nine of the 32 spill gates have been modified with notches (notched spill gate) in the upper section of the spill gate, in order to provide efficient spill that also provides high juvenile salmonid passage survival. In addition to notched spill gates, three spill gates have been modified to pass spill over one gate and under another, termed over/under spill gates, effectively passing juvenile fish and reducing TDG levels in the tailrace associated with spill.

3.2.2.1 Existing Spill Plan

The existing juvenile fish-spill plan at Rock Island Dam is implemented for normal forebay and tail water elevations. The usual operating range for the Rock Island Dam forebay is 612 ft to 613 feet mean sea level (msl) and tail water is 570 feet. Spill for juvenile fish passage is provided between the first of April and up to the end of August each year.

Notched spill gates are numbers 1, 16, 18, 24, 26, and 29. These gates can be opened or closed sequentially by the operators using electric hoists. Over/under spill gates are numbers 30, 31, and 32. Once these gates are installed prior to the start of spring fish-spill season, they remain open until the close of the season. A mechanic crew installs the gates (in their operating configuration) with a crane, so the operators themselves cannot sequentially open or close the over/under gates as they do with the notched gates. As a result, Rock Island Dam can spill no less than 7.2 kcfs (total discharge for the three gates) from the date of installation (late March/early April) to the date of removal (late August/early September). Sequencing of the notched and over/under spill gates vary from year to year depending upon inflows, headwater control, and any scheduled maintenance of the gates.

3.3 Fish-Spill Programs

Specific survival standards for the project are outlined in the HCP for the Rocky Reach and Rock Island projects. Chelan PUD is required to meet and maintain survival standards for fish migrating through the projects. Reservoir and dam passage survival are the key components of project survival. Chelan PUD uses a different combination of tools to facilitate fish passage at the Rocky Reach and Rock Island dams because of each dam's unique features. At Rocky Reach Dam, passage is facilitated by the JBS, which is the primary method to increase juvenile dam passage survival. The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.

At Rock Island Dam, spill is still the preferred method of moving fish past the dam, with most of the spill being passed through the modified notched spill gates. Results of survival studies

conducted at Rock Island Dam 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 Dam remains at 20% of the daily average flow.

The fish-spill programs implemented by Chelan PUD at each project are dictated by the timing and duration of each species of outmigration. In the spring, generally mid-April through early- June, yearling Chinook salmon, steelhead and sockeye migrate past the projects, while subyearling Chinook salmon migrate during the summer, generally mid-June to mid/late-August. Appendix B contains the specific 2015 Fish-Spill Season Memoranda announcing the spring and summer fish-spill periods.

During the spring of 2015, Chelan PUD operated the JBS exclusively with no voluntary spill for yearling Chinook salmon, steelhead, and sockeye passage. Spring fish-spill began at Rock Island Dam on April 16, 2015 at 0001 hours and ended May 31, 2015 at 2400 hours (see Appendix D).

Summer fish-spill began on June 1, 2015 at 0001 hours immediately following the end of the spring fish-spill season and continued through 2400 hours on August 7, 2015 at Rocky Reach and August 11, 2015 at Rock Island dams (see Appendix B). Tables 2-1 and 2-2 provide a summary of the 2015 fish-spill for Rocky Reach and Rock Island dams respectively.

Table 3-1: Summary of fish-spill operations at Rocky Reach Dam.

Rocky Reach Dam			
Date	**Juvenile Fish Passage Program**	**Quantity**	**Notes**
1–Apr	JBS Operation Began		Operated exclusively with no fish-spill during the spring (April 1 – May 31)[1]
1–June	Summer Spill Initiated	9% of daily average river flow	Spill for sub-yearling (summer) Chinook salmon
7–Aug	End of summer spill		
31–Aug	JBS Operation Ended		
Notes: [1] The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.			

Table 3-2: Summary of fish-spill operations at Rock Island Dam.

Rock Island Dam		
Date	**Juvenile Fish Passage Program**	**Quantity**
1-Apr	Fish Bypass Operation Began	
16-Apr	Spring Spill Initiated	10% daily average river flow
31-May	End of Spring Spill	
1-June	Start of Summer Spill	20% of daily average river flow
11-Aug	End of Summer Spill	
31-Aug	Fish Bypass Operation Ended	

3.4 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 may 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

Tables 2-3 and 2-4 show the monthly averages for river flow, total spill, fish-spill, and other spill for the Rocky Reach and Rock Island dams.

Table 3-3: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2015.

Month	**Average Flow kcfs**	**Average Spill kcfs**	**Spill Purpose**					
			Fish-Spill			**Other**		
			Spill kcfs	**% of flow**	**% of Total Spill**	**Spill kcfs**	**% of flow**	**% of Total Spill**
April	107.4	0.5	0.0	0.0	0.0	0.5	0.4	100.0
May	108.9	0.3	0.0	0.0	0.0	0.3	0.2	100.0
June	103.6	9.6	9.5	9.2	99.0	0.1	0.1	1.0
July	98.4	8.5	8.4	8.5	98.4	0.1	0.1	1.6
August	106.2	2.9	2.1	2.0	72.3	0.8	0.8	27.7

Table 3-4: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2015.

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish-Spill			Other		
			Spill kcfs	% of flow	% of Total Spill	Spill kcfs	% of flow	% of Total Spill
April	113.7	5.2	5.2	4.5	100.0	0.0	0.0	0.0
May	117.3	11.5	11.5	9.8	100.0	0.0	0.0	0.0
June	107.5	21.3	21.3	19.8	100.0	0.0	0.0	0.0
July	100.2	19.3	19.3	19.2	100.0	0.0	0.0	0.0
August	109.5	7.5	7.5	6.9	100.0	0.0	0.0	0.0

3.4.1 ***Voluntary and Involuntary Spill***

In 2015, spill events at Rocky Reach Dam were involuntary (forced) April 1 through May 31 and both voluntary and involuntary June 1 through August 7 (summer fish-spill period). Between June 1 and the end of summer fish-spill on August 7, 98% of the total volume spilled was voluntary, while 2% was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 14, with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates on August 12.

To achieve HCP passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of 9% of daily average river flow at the Rocky Reach Dam for a duration covering 95% of the subyearling outmigration during the summer of 2015. The summer spill program for subyearling passage began on June 1 and ended on August 11. Percent daily river flow spilled during the summer period was 9%.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Hydroelectric Project. Spring fish-spill of 10% began on April 16 and was continued through May 31. During the spring fish-spill period, 10% of total river flow was spilled. Of that 10%, 100% of it was voluntary spill for fish. Rock Island Dam fish-spill increased to 20% upon onset of the summer outmigration of subyearling Chinook. Summer spill began on June 1 and continued through August 11. During the summer fish-spill period, 20% of total river flow was spilled. Of that 20%, 100% of it was voluntary spill for fish

SECTION 4: *RESULTS*

The following sections describe the 2015 fish-spill season flow characteristics compared to the previous ten-year average, the 2015 fish-spill season programs, the 2015 biological TDG monitoring results, and the TDG data for the fish-spill season.

4.1 Biological Evaluations

The following sections provide a summary of fisheries management and results from GBT monitoring. Note that no survival studies were conducted in 2015.

No survival studies on spring migrants (yearling Chinook and sockeye salmon and steelhead) were conducted in 2015 as HCP survival standards have been achieved for all three species at both projects. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for summer/fall subyearling Chinook have been conducted since 2004.

4.1.1 Gas Bubble Trauma Monitoring

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach Project WQC (Ecology, 2006) requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. On April 21, 2014, Chelan PUD received a letter from Ecology postponing the GBT monitoring until such a time as is determined to be appropriate by Ecology. Ecology is currently evaluating the need for future GBT studies below Rocky Reach Dam. Currently, Chelan PUD conducts a Smolt Monitoring Program at Rock Island Dam.

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of GBT between April 17 and July 16, 2015. 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, the sample was changed from yearling to subyearling Chinook salmon when the subyearling Chinook salmon collection exceeded the yearling Chinook salmon collection. A random sample of up to 100 subyearling was examined two days per week. Examinations followed FPC standardized procedure as outlined by FPC (2009). During 2015 monitoring, 2,650 smolts were examined for GBT. Of these, 10, or 0.38%, showed signs of GBT. Table 3-1 provides the summary results of 2015 GBT monitoring.

Table 4-1: Number salmon and steelhead smolts examined for external signs of GBT of at Rock Island Dam in 2015.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		N	%	N	%	N	%
Chinook yearling	846	4	0.47%	4	0.47%	0	0.00%
Steelhead	642	2	0.31%	2	0.31%	0	0.00%
Chinook Sub-yearling	1,162	4	0.34%	4	0.34%	0	0.00%
Total	*2,650*	*10*	*0.38%*	*10*	*0.38%*	*0*	*0.00%*

4.2 Data Evaluation and Analyses

Data collection, quality assurance/quality controls (QA/QC), and analyses of TDG values were conducted in accordance with the QAPP for the FMS (Chelan PUD, 2010b). For this report, hourly TDG data recorded during 2015 were analyzed for apparent exceedances of current water quality standards. TDG values are rounded to the nearest number for example; 115.2 is rounded to 115, 115.5 is rounded to 116.

All of the TDG probes used during 2015 were calibrated and maintained in accordance with the methods and schedules described in the QAPP (Chelan PUD, 2010b). TDG probes that did not pass calibration tests were sent back to the manufacture for repair and/or replaced prior to deployment. Calibration reports are included in Appendix C of this report. Suspect or clearly erroneous TDG values were omitted from the analysis, but are included, as well as explanation for omission, in Appendix D of this report.

The data QA/QC issues during 2015 were related to the following issues; program upgrades, communication errors, and/or down time during calibration. Overall, data loss for Chelan PUD operated FMS during the 2015 fish-spill season was 38 hourly readings or 0.26% of the total available data collection hours. Table 3-2 displays the number of TDG values that were omitted from the dataset due to QA/QC issues during the 2015 fish-spill season.

Table 4-2: Overview of total dissolved gas data set during 2015 fish-spill season April 1 through August 31.

Location	Available data hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
RRFB	3,672	2	0.05
RRTR	3,672	3	0.08
RIFB	3,672	13	0.35
RITR	3,672	20	0.54
Total	*14,688*	*38*	*0.26*

Note: RRFB = Rocky Reach Dam Forebay, RRTR = Rocky Reach Dam Tailrace, RIFB = Rock Island Dam Forebay, RITR = Rock Island Dam Tailrace.
[1]See Appendix D for dates, times, and circumstances relating to omitted/lost data

4.3 Total Dissolved Gas Monitoring During the Fish-Spill Season

The following sections discuss the results of TDG monitoring from the 2015 fish-spill season within the project and at the Wanapum Dam forbay compliance point location. Specific sections of this document include TDG averages with associated figures for each FMS compliance point location, a breakdown of all TDG exceedances and possible explanations for those exceedances, and the connection between elevated TDG levels and involuntary spill during the 2015 fish-spill season. Summary values for all hourly average TDG measurements taken from each FMS during the 2015 fish-spill season are presented in Table 3-4 below.

Table 4-3: Summary of hourly averages total dissolved gas measurements from each FMS during the 2015 fish-spill season.

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
RRFB	04/01 – 08/31	108.1	1.9	102.4	111.1
RRTR	04/01 – 08/31	109.8	3.3	101.6	120.2
RIFB	04/01 – 08/31	108.0	2.2	101.8	115.3
RITR	04/01 – 08/31	111.7	3.4	101.9	119.4
WANF	04/01 – 08/31	109.5	2.8	102.3	115.0
Notes: Values represent % saturation RRFB = Rocky Reach Dam forebay, RRTR = Rocky Reach Dam tailrace, RIFB = Rock Island Dam forebay, RRTR = Rocky Reach Dam tailrace, WANF = Wanapum Dam forebay					

4.3.1 Total Dissolved Gas Averages

Total dissolved gas averages during the fish-spill season in Figures 3-1 through 3-9 display the average of the 12-highest consecutive hourly readings, spill vs. TDG, and a regression analysis of predicted TDG levels vs. actual TDG at Rocky Reach Dam tailrace. Figure 4-8 shows that actual 2015 TDG fish-spill data was lower than predicted regression equations in the WQMP, Table 2-7 (Chelan PUD, 2006). The average of the 12-highest consecutive hourly TDG readings from each day during the spring and summer fish-spill seasons from each FMS is presented in Appendix E of this report.

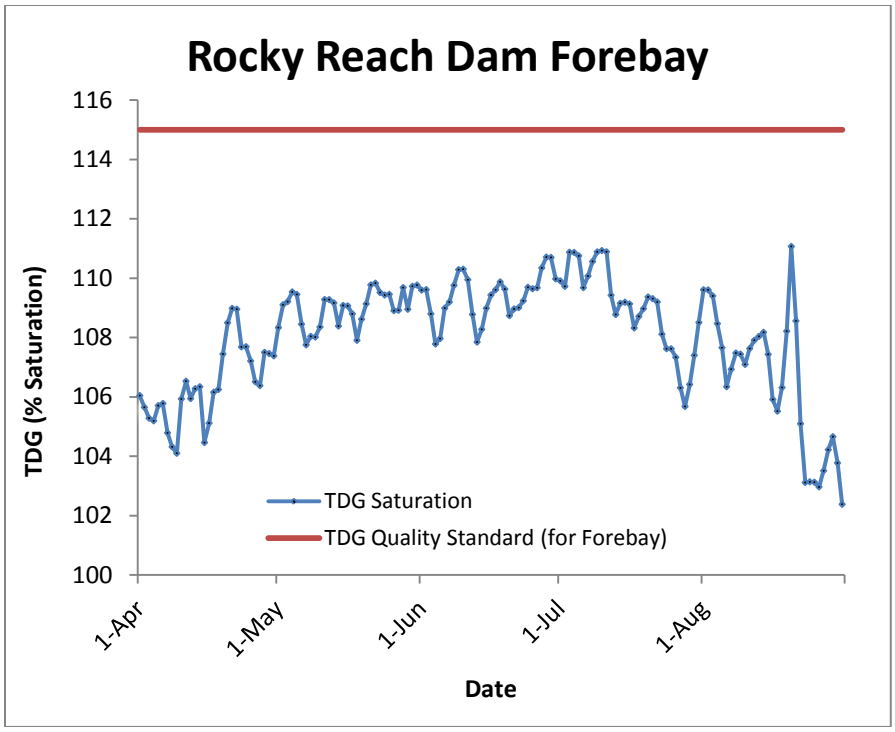

Figure 4-1: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam forebay FMS.

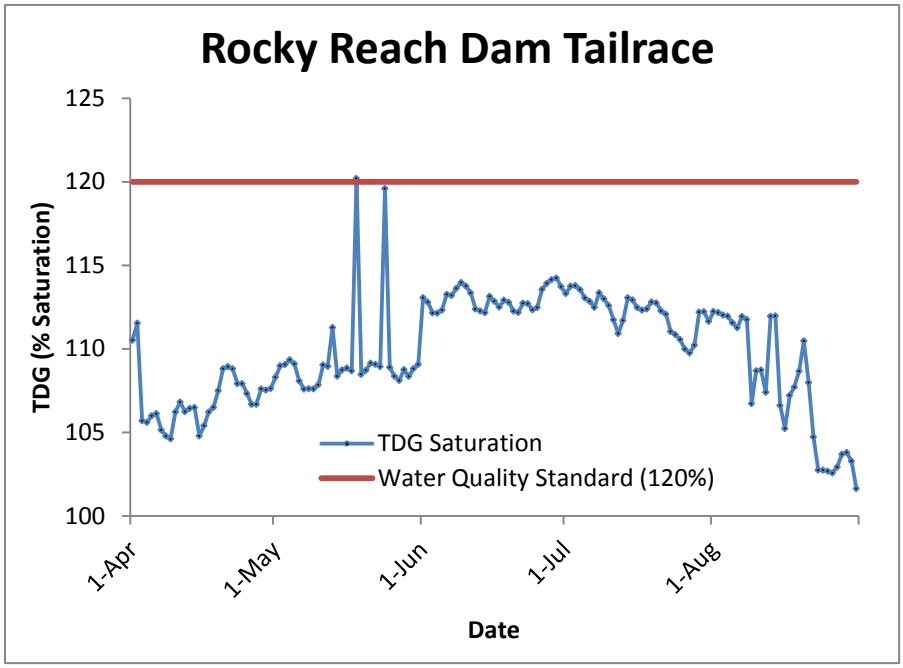

Figure 4-2: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam tailrace FMS.

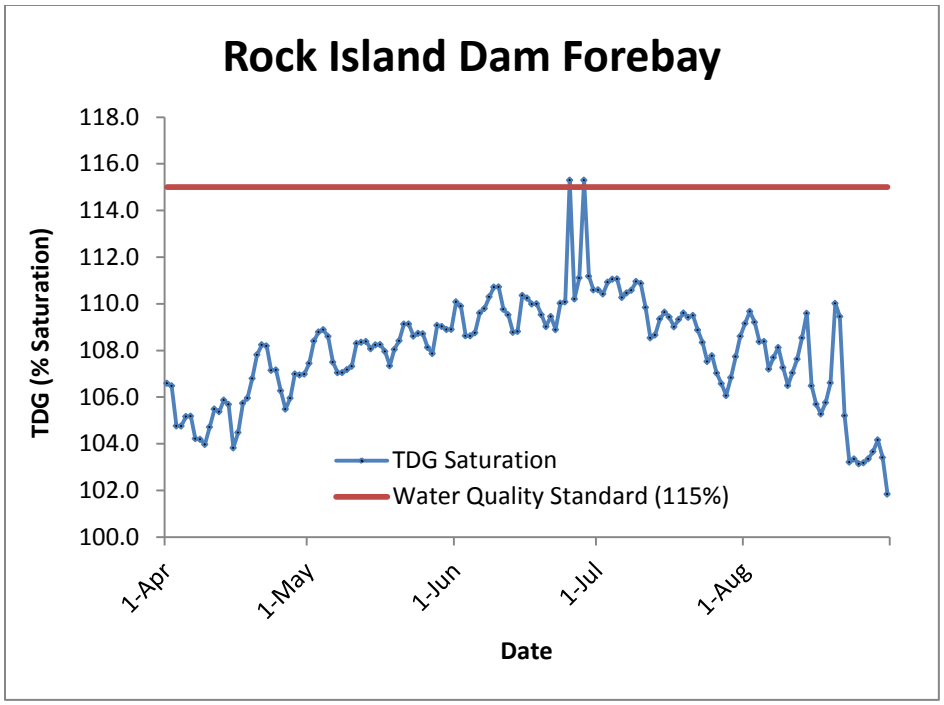

Figure 4-3: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rock Island Dam forebay FMS.

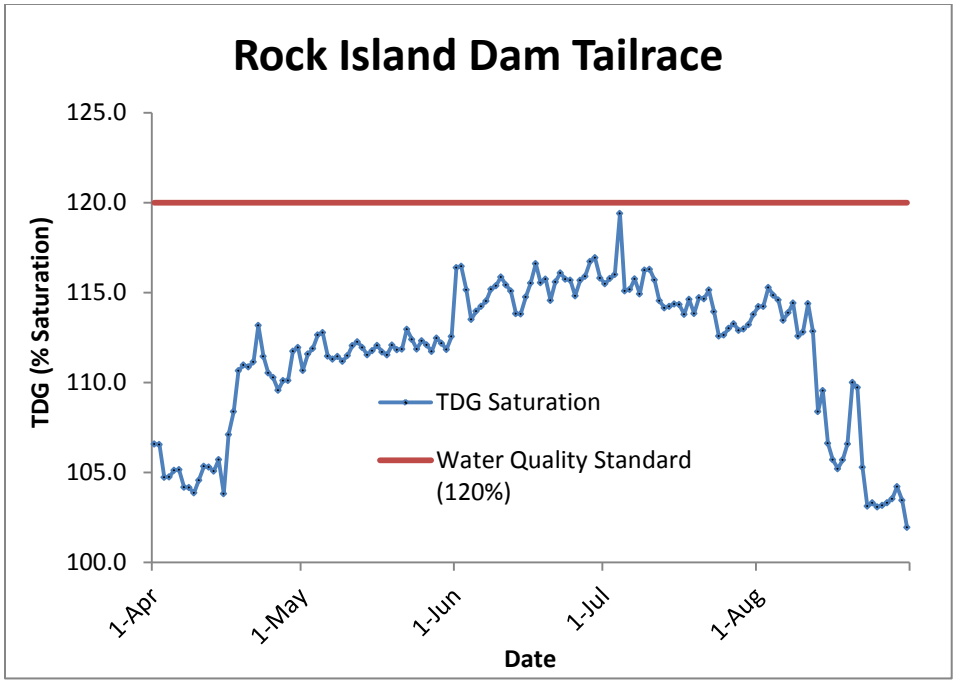

Figure 4-4: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rock Island Dam tailrace FMS.

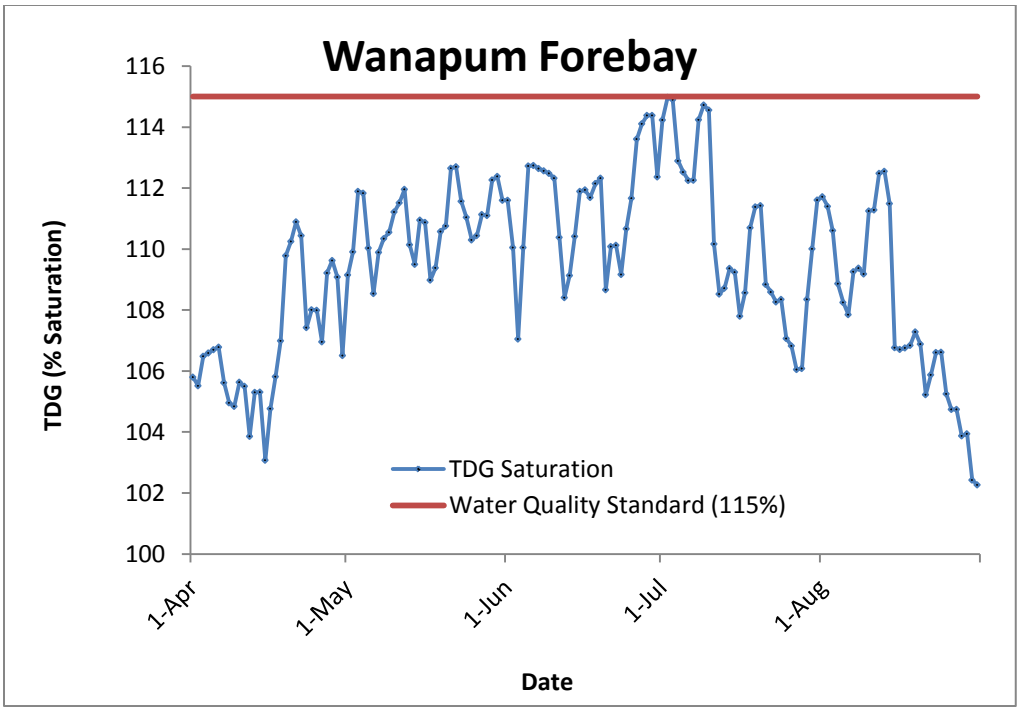

Figure 4-5: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Wanapum Dam forebay FMS.

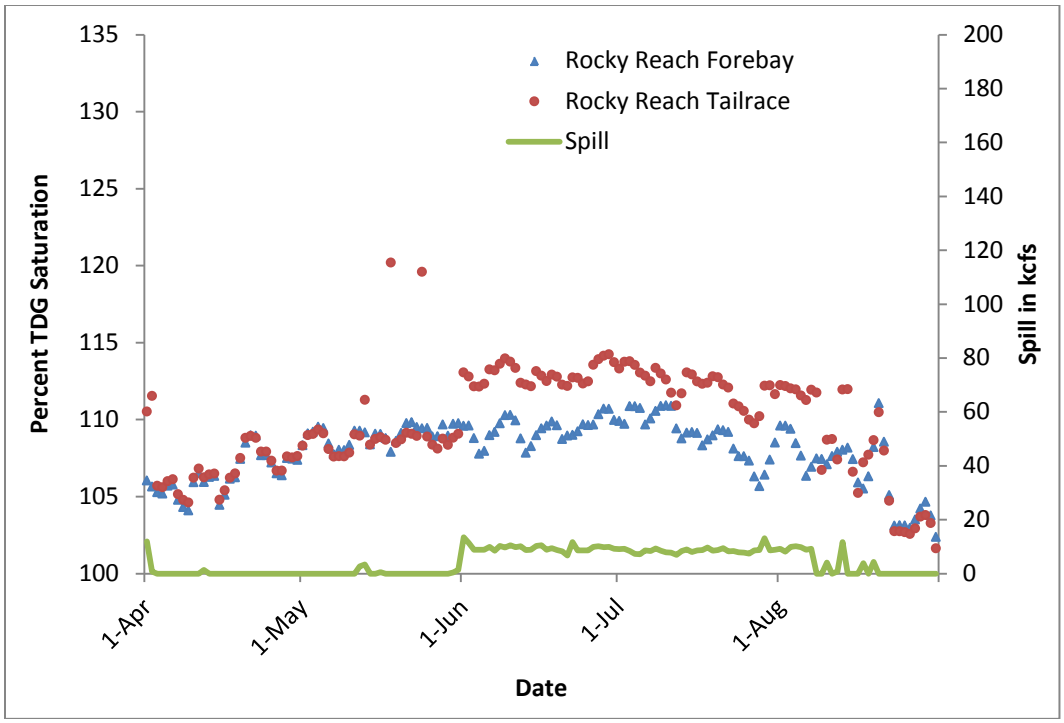

Figure 4-6: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam forebay and tailrace FMS.

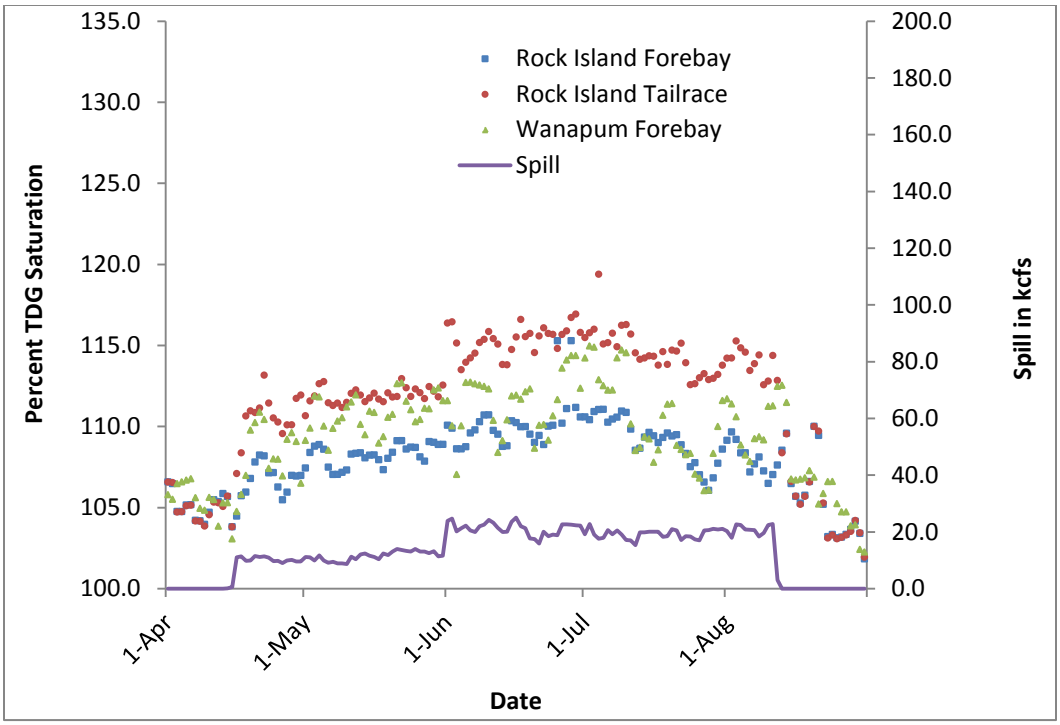

Figure 4-7: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Island Dam forebay and tailrace and the Wanapum Dam forebay FMS.

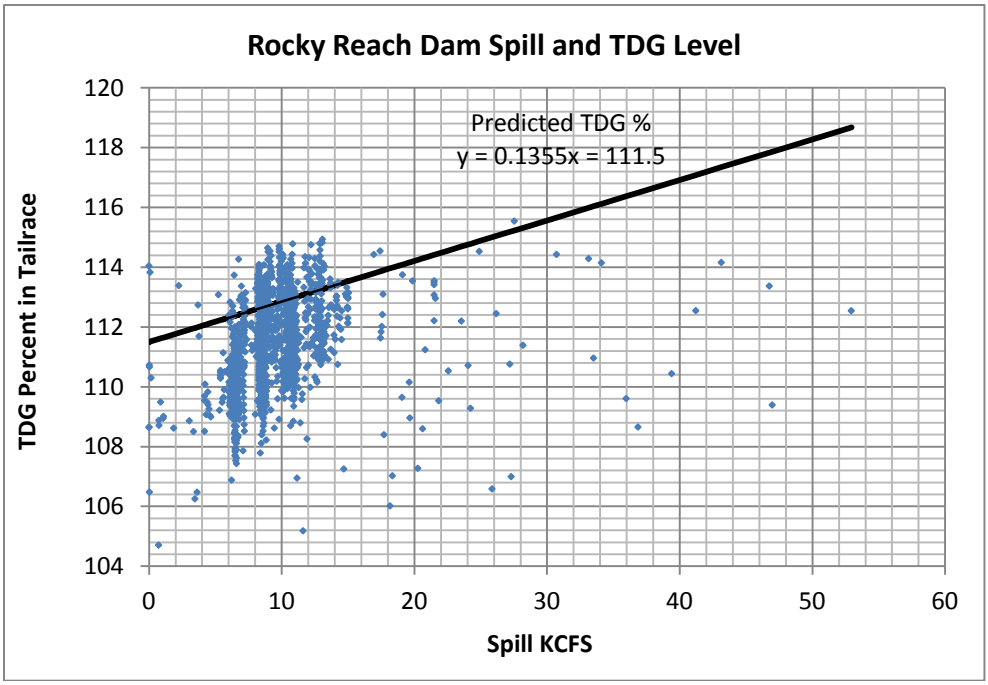

Figure 4-8: 2015 Rocky Reach Dam tailrace TDG % vs. predicted TDG %.

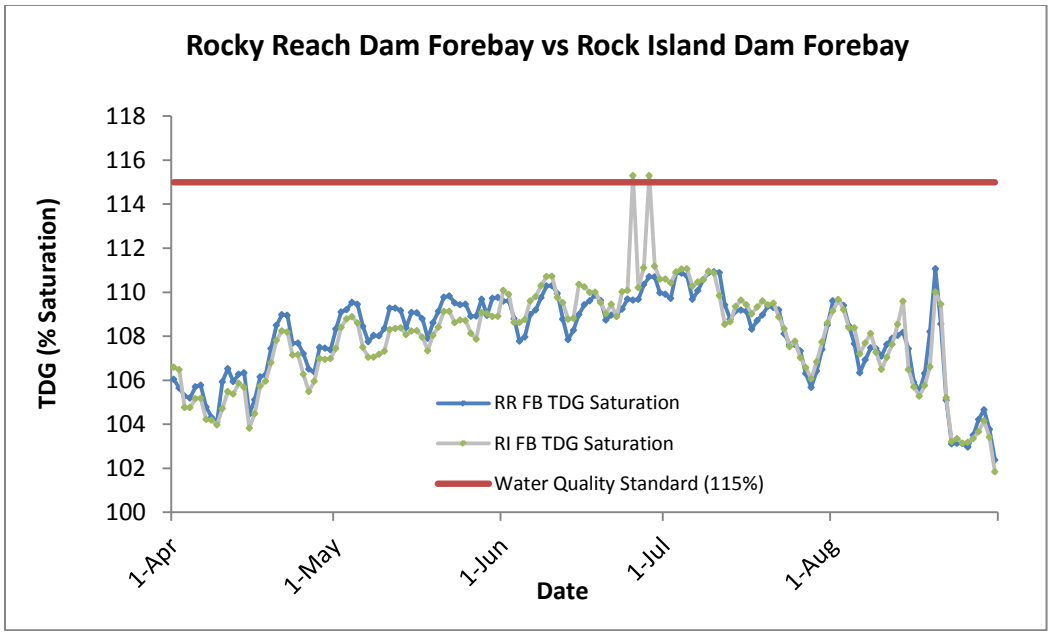

Figure 4-9: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach and Rock Island dam forebays FMS.

4.3.2 ***Total Dissolved Gas Exceedances***

During the 2015 fish-spill season, TDG levels never exceeded the current water quality standards as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD). All TDG data is presented in Appendix E of this report.

4.3.3 ***Discussion of Exceedances***

There were no exceedances of the numeric criteria for the Rocky Reach, Rock Island, and the forbay of Wanapum dams.

SECTION 5: *TOTAL DISSOLVED GAS ABATEMENT MEASURES AND CORRECTIVE ACTIONS IMPLEMENTED IN 2015*

5.1 Operational

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

5.1.1 Rocky Reach Project

Results of survival studies have allowed Chelan PUD to greatly reduce spill and eliminate for fish at Rocky Reach Dam. The JBS 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 2015 are shown in Table 4-1 below. The JBS continues to be the most efficient non-turbine route for fish passage and does not require spill for its operation.

Table 5-1: Rocky Reach Dam fish-spill Comparison 2003-2015.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
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% [2]
2005	Summer	10-Jun	15-Aug	67	9%
Total				**85.5**	
2006	Spring	2-May	1-Jun	19.0	0% / 24% [2]
2006	Summer	2-Jun	11-Aug	71	9%
Total				**90**	
2007	Spring	No Spill	No Spill	0	0%
2007	Summer	2-Jun	21-Aug	81	9%
Total				**81**	
2008	Spring	No Spill	No-Spill	0	0%
2008	Summer	8-Jun	31-Aug	81	9%
Total				**81**	
2009	Spring	No Spill	No Spill	0	0%
2009	Summer	10-Jun	31-Aug	78	9%
Total				**78**	
2010	Spring	No Spill	No Spill	0	0%
2010	Summer	9-Jun	20-Aug	73	9%
Total				**73**	
2011	Spring	No Spill	No Spill	0	0%

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2011	Summer	4-Jun	12-Aug	70	9%
Total				**70**	
2012	Spring	No Spill	No Spill	0	0%
2012	Summer	26-May	9-Aug	76	9%
Total				**76**	
2013	Spring	No Spill	No Spill	0	0%
2013	Summer	5-June	21-August	78	9%
Total				**78**	
2014	Spring	No Spill	No Spill	0	0%
2014	Summer	24-May	24 - August	93	9%
Total				**93**	
2015	Spring	No Spill	No Spill	0	0%
2015	Summer	1-June	11-August	73	9%
Total				**73**	**9%**

Notes: [1] Percentage of daily average river flow at Rocky Reach Dam. Two values in this column represents two different spill levels during the season (first value is the spill level for yearling Chinook and steelhead, second value is the spill level for sockeye.)
[2]24 days of on/off spill test for sockeye

The goal of the Rocky Reach Project GAP (Appendix E), approved by Ecology in April of 2015 is to implement measures to achieve compliance with the standards for TDG in the Columbia River at the project while continuing to meet the fish passage and survival standards set forth in the 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 A).
3. Minimized spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoided spill, to the extent practicable, by continuing to participate in the Hourly Coordination Agreement, to the extent it reduces TDG.
5. Maximized powerhouse discharge as appropriate up to 212 kcfs.
6. Continued the analysis of the three alternate spillway configurations that were tested in 2011 and 2012 (Chelan PUD, 2013b) to determine if any would be efficient at minimizing TDG. Chelan PUD is currently in the process of writing the program for gate operation in order to implement the flattened spill gate configuration during the non-fish-spill period.

5.1.2 ***Rock Island Project***

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 2015 are shown in Table 4-2 below.

Table 5-2: Rock Island Dam fish-spill comparison, 2003-2015.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2003	Spring	17-Apr	31-May	45	20%
2003	Summer	1-Jun	16-Aug	77	20%
Total				**122**	
2004	Spring	17-Apr	8-Jun	53	20%
2004	Summer	9-Jun	4-Aug	57	20%
Total				**110**	
2005	Spring	17-Apr	9-Jun	54	20%
2005	Summer	10-Jun	9-Aug	61	20%
Total				**115**	
2006	Spring	17-Apr	13-Jun	58	20%
2006	Summer	14-Jun	11-Aug	59	20%
Total				**117**	
2007	Spring	17-Apr	1-Jun	46	10%
2007	Summer	2-Jun	21-Aug	81	20%
Total				**127**	
2008	Spring	17-Apr	7-Jun	52	10%
2008	Summer	8-Jun	16-Aug	70	20%
Total				**122**	
2009	Spring	17-Apr	9-Jun	54	10%
2009	Summer	10-Jun	17-Aug	69	20%
Total				**123**	
2010	Spring	17-Apr	8-Jun	53	10%
2010	Summer	9-Jun	20-Aug	73	20%
Total				**126**	
2011	Spring	17-Apr	3-Jun	48	10%
2011	Summer	4-Jun	24-Aug	82	20%
Total				**130**	
2012	Spring	17-Apr	27-May	41	10%
2012	Summer	28-May	18-Aug	83	20%
Total				**124**	
2013	Spring	17-Apr	4-June	49	10%
2013	Summer	5-June	18-Aug	75	20%
Total				**124**	
2014	Spring	17-Apr	23 – May	37	10%
2014	Summer	24 - May	24 - Aug	93	20%
Total				**130**	

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2015	Spring	16-Apr	23 – May	46	10%
2015	Summer	1-Jun	11 - Aug	72	20%
Total				**128**	
Notes: Percentage of daily average river flow at Rock Island Dam					

The goal of the Rock Island Project GAP (Appendix G) approved by Ecology in April of 2015, 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 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 A).
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.

As well as the Hourly Coordination Agreement, Chelan PUD participates in various water quality forums. The USACE hosts a year-end TDG Monitoring and QA/QC meeting, at which presentations are made from the various agencies conducting TDG and other water quality monitoring within the Columbia River Basin. Topics include data completeness, quality, calibration results, new or improved monitoring methods, etc. Agencies presenting at this meeting included the United States Geological Services, USACE, other mid-Columbia River PUDs, and private consultants. Chelan PUD has participated in these yearend meetings.

Chelan PUD has also regularly attended the Transboundary Gas Group meetings since early in its history. Although the frequency of the Transboundary Gas Group meetings has lessened, Chelan PUD will attend the next scheduled meeting.

5.2 Structural

No structural modifications were made or utilized at Rocky Reach or Rock Island dams in 2015.

5.3 Corrective Actions

Actions taken to maintain/regain compliance with the TDG standards in 2015 included:

- Implementation of the TDG Operational Plan.

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

- Attempted to maximize turbine flows by setting minimum generation requirements, which included establishing a common methodology for setting minimum generation requirements specific to Rocky Reach and Rock Island dams for the management of TDG. Each dam's minimum generation requirements were then allocated to power purchasers that receive a percentage of the projects' output.

- Participation in regional spill/project operation meeting in the spring. This meeting brought together representatives from Natural Resources, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Administration (BPA) and the Corps. Discussions included topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resources requirements (e.g. Hanford Reach fall Chinook salmon flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.

- Implementation of the Spill Priority List which included, for example, having the Mid-Columbia project (i.e. Grant, Chelan, and Douglas PUDs) operators working to coordinate spill to reduce the overall TDG on the entire Columbia River system. The Columbia River Basin projects Spill Priority List provided guidance to federal river operators when there was insufficient generation request available to pass the needed amount of water through the Federal Columbia River Power System. A mechanism through hourly coordination was used to shift load from the non-federal projects to the federal projects (by mutual agreement) to reduce the amount of spill (and associated TDG levels) that would otherwise occur at the federal projects using the Spill Priority List. Although this measure may not have resulted in direct decreases in TDG at Chelan PUD's projects (and in some cases it may have increased TDG within Chelan PUD's project if spill was shifted to either Rocky Reach or Rock Island dams in order to reduce spill at another project within the system), it was meant to help mitigate high TDG levels throughout the entire Columbia River system.

- Preemptive spill can be used to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. The spill rate could be stabilized if a project's storage was used to absorb flow fluctuations from upstream projects. Generally, a target operation of one foot from the allowed maximum at each project could be used. When flows spike high, the storage could be used to lower the need for spill; when flows

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

SECTION 6: *CONCLUSIONS*

During the 2015 fish-spill season, TDG levels never exceeded the current numeric water quality standards as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD).

Chelan PUD will continue to closely monitor TDG levels during the fish-spill season in accordance with Ecology approved GAPs, the Rocky Reach Project 401 WQC (Ecology, 2006), and the Rocky Reach Project QAPP (Chelan PUD, 2010b).

SECTION 7: *LIST OF LITERATURE*

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APPENDIX A: 2015 TDG OPERATION PLANS

2015 Rocky Reach Operational Plan
for Total Dissolved Gas During Fish Spill Season
April 1 – August 31
(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

2015 Rock Island Operational Plan
for Total Dissolved Gas During Fish Spill Season
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, please contact Thad Mosey (661-4451) and Marcie Steinmetz (661-4186) immediately so they can determine the next steps to take.

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

APPENDIX B: FISH-SPILL MEMOS

From:	Pwr Mgt - Chelan Environmental
To:	Baker, Megan (Avista); Bill C. Key (NextEraEnergy); Caramanolis, Ath (Morgan Stanley); Esch, Steve (Avistacorp); Fee, Mike (Morgan Stanley); Follini, Robert (Avista); Frank, Jennifer (Avista); Johnson, Bill (Avista); Kikkert, Sabrina (Morgan Stanley); Killam, Ryan (Morgan Stanley); Locke, Kathy (Avista); Loder, David (NextEraEnergy); Lucas, John (Morgan Stanley); Mattern,Kim (Avista); Mymko, Ryan (Morgan Stanley); Neff, Christin S. (NexteraEnergy); Ohm, Jennifer (Avista); Patrick Maher (Avista); Silkworth, Steve (Avista); Spannagel, Dave (Avista); Ward, Suzette (Avista); West Power Trading; West Realtime (Constellation RT); Wilkinson, John (Morgan Stanley); Wilson, Craig (Avista); Wright, Jasper (Morgan Stanley); Constellation Wholesale Trading & Portfolio Operations; Brennan Mueller; Bryant, Tom; Buehn, Scott; "Cash.desk@powerex.com"; Fields, Willard; Gray, Jim; Netik, Irena (PSE); Jaspers, Janet; Taylor, Joe (Mid-C); "Joel Molander"; "Josh Jacobs"; Keller, Lance; Ken Finicle; Owen, Hugh; "Paul Wetherbee"; pwxrealtime; "Load Office PSE"; Pwr Mgt - Chelan Preschedule; RI Chief Operators; RI Senior Operators; "Salvador Avalos"; System Operations; Garrison, Dan; Cronrath, Chris W.; Myers, Devin P.; West, Todd; Hemstrom, Steven; Nystrom, Chris; Whitehall, Brad; Steinmetz, Marcie; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.
Subject:	Start of 2015 Spring Fish Spill at the Rock Island Project - Thursday, 16 April
Date:	Tuesday, April 14, 2015 4:18:12 PM
Importance:	High

Good Afternoon, Everyone.

The purpose of this email is to notify all of you that Rock Island Dam will begin spring fish spill on **Thursday, 16 April 2015, at 00:00 hours**. The daily spill percentage will be **10% of the day average river flow forecasted for the Project**.

Consistent with the past 12 years, spill will be "shaped" in hourly blocks within each 24-hour day to provide slightly more spill volume during periods when juvenile salmon are passing the dam, and less volume during hours with lower fish passage. The average spill rate of all blocks will equal 10% of day average river flow.

Spring spill normally continues through the end of May at 10%. Summer fish spill will be 20% of the day average flow and usually begins the first week of June.

Please call or send an email, if you have any questions regarding Rock Island's fish spill program for 2015.

Thank you.

Thad

Thad Mosey

Chelan County PUD

(509) 670-5594

ROCK ISLAND
FISH SPILL MEMORANDUM

To: Rock Island Operators and System Operators

From: Thad Mosey (Ext. 4451) cell: 670-5594

Date: May 31, 2015

Subject: Summer fish spill for June 1 - 2, 2015

Rock Island will spill an average of **20% of the daily average river flow** during summer 2015. Below are spill rates shaped by hourly blocks, and they sum to 20% of the total estimated daily average flow rate at Rock Island.

Rock Island Spill for smolt passage: **Monday and Tuesday, June 1 - 2, 2015**

Spill Type		Start Date	Start Time	Stop Date	Stop Time	Spill (Kcfs)	
Fish		6/1/15	0001	6/1/15	0100	28.3	
Fish		6/1/15	0100	6/1/15	0200	23.4	
Fish	**Mon**	6/1/15	0200	6/1/15	1000	17.5	
Fish		6/1/15	1000	6/1/15	1100	23.4	
Fish		6/1/15	1100	6/1/15	2400	28.3	day ave ***24.3***
Fish		6/2/15	0001	6/2/15	0100	29.2	
Fish		6/2/15	0100	6/2/15	0200	24.1	
Fish	**Tues**	6/2/15	0200	6/2/15	1000	17.5	
Fish		6/2/15	1000	6/2/15	1100	24.1	
Fish		6/2/15	1100	6/2/15	2400	29.2	day ave ***24.9***

2015 – RI Operators

Please use gates in the following sequence for fish spill and any additional forced spill: **32, 31, 30, 1, 26, 18, 24, 29, and 16.** If total spill volume exceeds capacity of the three over/under gates and six notched gates listed, please use the full gates located in bays **17, 19, 20, 22, 25, 7, and 8** in the sequence shown. If it is necessary to spill more water for headwater control than the gates listed above can handle, take whatever action is necessary to maintain plant safety.

If inflow is insufficient to maintain both headwater and spill, reduce generation as necessary, then call Thad Mosey (4451) or Lance Keller (4299) to get information on current spill balance and options. If you have questions, please call Thad at Ext. 4451, cell 670-5594, or home 782-2428. Thank you.

ROCKY REACH
FISH SPILL MEMORANDUM

To: Rocky Reach Operators, Energy Resources, and System Operators

From: Thad Mosey (Ext. 4451); Cell: 670-5594

Date: May 31, 2015

Subj: **Rocky Reach Summer Spill for June 1 and 2, 2015**

Summer spill at Rocky Reach for subyearling Chinook smolts is 9% of the daily average river flow. This spill level will be in place through the first part of August. Spill is shaped to aid passage of Chinook smolts.

Spill Type		Start Date	Start Time	Stop Date	Stop Time	Spill (kcfs)	
Fish		6/1/15	0000	6/1/15	0100	**10.6**	
Fish		6/1/15	0100	6/1/15	0700	**7.1**	
Fish	**Mon**	6/1/15	0700	6/1/15	0900	**10.6**	
Fish		6/1/15	0900	6/1/15	1500	**14.2**	
Fish		6/1/15	1500	6/1/15	2400	**10.6**	**day ave 10.6**
Fish		6/2/15	0000	6/2/15	0100	**11.1**	
Fish		6/2/15	0100	6/2/15	0700	**7.4**	
Fish	**Tues**	6/2/15	0700	6/2/15	0900	**11.1**	
Fish		6/2/15	0900	6/2/15	1500	**14.8**	
Fish		6/2/15	1500	6/2/15	2400	**11.1**	**day ave 11.1**

Please put fish spill, immediate replacement spill, or spill for headwater control at Rocky Reach Dam through spill gates in the “normal” pattern in the automated gate control program **using gates 7 – 2. If additional spill is necessary to maintain headwater control, use whatever additional gates are necessary to maintain Plant safety.**

If you have questions or comments, please call Thad Mosey at 509-661-4451, by cell phone 670-5594 or at home any time day or night, at 509-782-2428. Please call Thad (ext. 4451) or Lance Keller (ext. 4299) if you need assistance with any of the fish spill operations above. Thank you.

From:	Pwr Mgt - Chelan Environmental
To:	Hemstrom, Steven; All RR Operators; Buehn, Scott; Todd V; Jaspers, Janet; Taylor, Joe (Mid-C); Keller, Lance; Owen, Hugh; "Powerex"; pwxrealtime; Pwr Mgt - Chelan Preschedule; RR/Ch/Steh Management; System Operations; Slice Customers - Fish Spill; "Bob Huber"; Brennan Mueller; True, Bruce (PGN); jeff j; "Greg Lange"; Netik, Irena (PSE); "Joel Molander"; "Josh jacobs"; Ken Finicle; "Paul Wetherbee"; "Salvador Avalos"; "Simon Arlen"; "Steve Pope"; West, Todd; Lucas, Terry; "lrogers@gcpud.org"; "mehinge@gcpud.org"; "rrecten@gcpud.org"; Steinmetz, Marcie; Nystrom, Chris; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.
Cc:	Truscott, Keith; Smith, Jeff; Hays, Steve; Osborn, Jeff; Craig, Kimberlee
Subject:	Confirmation - Rocky Reach Dam will end fish spill at midnight tonight, 7 August
Date:	Friday, August 07, 2015 3:56:42 PM
Importance:	High

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at the Rocky Reach Project tonight, 7 August, at 2400 hours (midnight).

Please disregard the previously sent spill memo for 8 August.

Thank you.

Thad

From:	Pwr Mgt - Chelan Environmental
To:	Baker, Megan (Avista); Bill C. Key (NextEraEnergy); Caramanolis, Ath (Morgan Stanley); Esch, Steve (Avistacorp); Fee, Mike (Morgan Stanley); Follini, Robert (Avista); Frank, Jennifer (Avista); Johnson, Bill (Avista); Kikkert, Sabrina (Morgan Stanley); Killam, Ryan (Morgan Stanley); Locke, Kathy (Avista); Loder, David (NextEraEnergy); Lucas, John (Morgan Stanley); Mattern,Kim (Avista); Mymko, Ryan (Morgan Stanley); Neff, Christin S. (NexteraEnergy); Ohm, Jennifer (Avista); Patrick Maher (Avista); Silkworth, Steve (Avista); Spannagel, Dave (Avista); Ward, Suzette (Avista); West Power Trading; West Realtime (Constellation RT); Wilkinson, John (Morgan Stanley); Wilson, Craig (Avista); Wright, Jasper (Morgan Stanley); Constellation Wholesale Trading & Portfolio Operations; Brennan Mueller; Bryant, Tom; Buehn, Scott; "Cash.desk@powerex.com"; Fields, Willard; Gray, Jim; Netik, Irena (PSE); Jaspers, Janet; Taylor, Joe (Mid-C); "Joel Molander"; "Josh Jacobs"; Keller, Lance; Ken Finicle; Owen, Hugh; "Paul Wetherbee"; pwxrealtime; "Load Office PSE"; Pwr Mgt - Chelan Preschedule; RI Chief Operators; RI Senior Operators; "Salvador Avalos"; System Operations; Garrison, Dan; Cronrath, Chris W.; Myers, Devin P.; West, Todd; Hemstrom, Steven; Whitehall, Brad; Steinmetz, Marcie; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.; "PS_ATF@gcpud.org"; Truscott, Keith
Cc:	Truscott, Keith; Smith, Jeff; Hays, Steve; Osborn, Jeff; Craig, Kimberlee
Subject:	Confirmation - Rock Island Dam will end fish spill at midnight tonight, 11 August
Date:	Tuesday, August 11, 2015 3:44:59 PM
Importance:	High

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at the Rock Island Project tonight, 11 August, at 2400 hours (midnight).

Thank you.

Thad

APPENDIX C: CALIBRATION REPORTS

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 10:10
Departure Time: 11:00

Site:
RRDW

	FMS ID	65718		65718	
	Time	10:25		10:50	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		758.2	754		754
Temp ºC			4.0		4.0
TDGsat			97.2		99.7
TDG mmHg			733		752

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 20-Jan-15
BP Station: 758.2 mmHg
Time: 10:30

	Std	Initial	Final
Temperature ºC	3.89	4.0	N / C
TDG 100%	758.2	758	N / C
TDG 113%	858.2	858	N / C
TDG 126%	958.2	957	N / C
TDG 139%	1058.2	1057	N / C
Depth m	N/A		

Comments: 962/1133

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 11:05
Departure Time: 11:40

Site:
RRH

FMS ID	65720		65720	
Time	11:10		11:35	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	756.5	754	756.2	754
Temp ºC		4.0		4.0
TDGsat		95.6		97.5
TDG mmHg		721		735

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 20-Jan-15
BP Station: 756.5 mmHg
Time: 11:15

	Std	Initial	Final
Temperature ºC	4.20	4.3	N / C
TDG 100%	756.5	756	N / C
TDG 113%	856.5	856	N / C
TDG 126%	956.5	956	N / C
TDG 139%	1056.5	1056	N / C
Depth m	N/A		

Comments: 977/1164

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 13:25
Departure Time: 14:00

Site:
RIS

FMS ID	65719		65719	
Time	13:30		13:55	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	758.7	759	758.4	758
Temp ºC		4.1		4.1
TDGsat		96.4		98.2
TDG mmHg		732		744

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 20-Jan-15
BP Station: 758.3 mmHg
Time: 13:35

	Std	Initial	Final
Temperature ºC	4.09	4.2	N / C
TDG 100%	758.3	757	N / C
TDG 113%	858.3	857	N / C
TDG 126%	958.3	957	N / C
TDG 139%	1058.3	1057	N / C
Depth m	N/A		

Comments: 970/1140

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 14:20
Departure Time: 15:10

Site:
RIGW

FMS ID	65721		65721	
Time	14:25		15:00	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	758.5	758	758.1	758
Temp ºC		4.1		4.1
TDGsat		96.4		99.5
TDG mmHg		731		754

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 20-Jan-15
BP Station: 758.8 mmHg
Time: 14:35

	Std	Initial	Final
Temperature ºC	4.93	5.1	N / C
TDG 100%	758.8	759	N / C
TDG 113%	858.8	859	N / C
TDG 126%	958.8	959	N / C
TDG 139%	1058.8	1060	N / C
Depth m	N/A		

Comments: 957/1105

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 9:05
Departure Time: 9:55

Site:
RRDW

FMS ID	65718		65718	
Time	9:20		9:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	750.6	748	751.0	749
Temp ºC		5.7		5.2
TDGsat		104.9		106.3
TDG mmHg		785		796

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 16-Mar-15
Time: 9:25
BP Station: 750.7 mmHg

	Std	**Initial**	**Final**
Temperature ºC	5.99	6.1	N / C
TDG 100%	750.7	752	751
TDG 113%	850.7	853	851
TDG 126%	950.7	954	951
TDG 139%	1050.7	1055	1051
Depth m	N/A		

Comments: 960/1155; new TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 10:05
Departure Time: 10:40

Site:
RRH

	FMS ID	65720		65720	
	Time	10:10		10:30	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		749.3	749	749.0	749
Temp ºC			5.7		5.7
TDGsat			104.4		103.6
TDG mmHg			782		776

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 16-Mar-15
BP Station: 749 mmHg
Time: 10:15

	Std	Initial	Final
Temperature ºC	14.24	14.3	N / C
TDG 100%	749.0	751	749
TDG 113%	849	852	849
TDG 126%	949	953	949
TDG 139%	1049	1054	1049
Depth m	N/A		

Comments: 951/1165; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 11:20
Departure Time: 12:15

Site:
RIGW

FMS ID	65721		65721	
Time	11:30		12:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	752.7	754	752.4	754
Temp ºC		5.7		5.8
TDGsat		103.6		105.6
TDG mmHg		781		796

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 16-Mar-15
BP Station: 752.6 mmHg
Time: 11:35

	Std	**Initial**	**Final**
Temperature ºC	14.20	14.3	N / C
TDG 100%	752.6	756	753
TDG 113%	852.6	857	853
TDG 126%	952.6	958	953
TDG 139%	1052.6	1059	1053
Depth m	N/A		

Comments: 948/1141; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 13:05
Departure Time: 13:45

Site:
RIS

FMS ID	65719		65719	
Time	13:15		14:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	750.9	753	750.2	753
Temp ºC		5.8		5.8
TDGsat		103.7		105.6
TDG mmHg		781		795

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 16-Mar-15
Time: 13:20
BP Station: 750.8 mmHg

	Std	Initial	Final
Temperature ºC	6.38	6.5	N / C
TDG 100%	750.8	752	751
TDG 113%	850.8	853	851
TDG 126%	950.8	954	951
TDG 139%	1050.8	1055	1051
Depth m	N/A		

Comments: 942/1175; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 9:30
Departure Time: 10:20

Site:
RRDW

FMS ID	65718		65718	
Time	9:50		10:15	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.8	741	742.8	741
Temp ºC		7.4		7.4
TDGsat		105.7		106.9
TDG mmHg		783		792

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 13-Apr-15
BP Station: 742.8 mmHg
Time: 9:55

	Std	**Initial**	**Final**
Temperature ºC	7.20	7.3	N / C
TDG 100%	742.8	743	N / C
TDG 113%	842.8	843	N / C
TDG 126%	942.8	943	N / C
TDG 139%	1042.8	1043	N / C
Depth m	N/A		

Comments: 946/1163, New TDG membrane

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 10:25
Departure Time: 11:00

Site:
RRH

FMS ID	65720		65720	
Time	10:30		10:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.9	741	740.7	740
Temp ºC		7.3		7.3
TDGsat		105.3		104.3
TDG mmHg		780		772

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 13-Apr-15
Time: 10:40
BP Station: 740.9 mmHg

	Std	**Initial**	**Final**
Temperature ºC	7.40	7.5	N / C
TDG 100%	740.9	741	N / C
TDG 113%	840.9	840	N / C
TDG 126%	940.9	940	N / C
TDG 139%	1040.9	1040	N / C
Depth m	N/A		

Comments: 952/1169, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 11:30
Departure Time: 12:10

Site:
RIS

FMS ID	65719		65719	
Time	11:40		12:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.7	745	742.5	745
Temp ºC		7.3		7.3
TDGsat		104.6		106.3
TDG mmHg		779		792

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 13-Apr-15
BP Station: 742.5 mmHg
Time: 11:45

	Std	**Initial**	**Final**
Temperature ºC	7.29	7.4	N / C
TDG 100%	742.5	742	N / C
TDG 113%	842.5	843	N / C
TDG 126%	942.5	943	N / C
TDG 139%	1042.5	1042	N / C
Depth m	N/A		

Comments: 934/1149, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 12:30
Departure Time: 13:25

Site:
RIGW

FMS ID	65721		65721	
Time	12:35		13:20	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	742.5	744	741.9	744
Temp ºC		7.3		7.4
TDGsat		104.7		106.2
TDG mmHg		779		790

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 13-Apr-15
BP Station: 742.4 mmHg
Time: 12:45

	Std	Initial	Final
Temperature ºC	7.80	7.9	N / C
TDG 100%	742.4	743	N / C
TDG 113%	842.4	843	N / C
TDG 126%	942.4	943	N / C
TDG 139%	1042.4	1042	N / C
Depth m	N/A		

Comments: 940/1167, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 9:25
Departure Time: 10:25

Site:
RRDW

FMS ID	65718		65718	
Time	9:35		10:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.7	738		738
Temp ºC		10.9		10.9
TDGsat		109.5		107.5
TDG mmHg		808		793

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 12-May-15
BP Station: 740.2 mmHg
Time: 9:55

	Std	**Initial**	**Final**
Temperature ºC	11.05	11.2	N / C
TDG 100%	740.2	740	N / C
TDG 113%	840.2	841	N / C
TDG 126%	940.2	941	N / C
TDG 139%	1040.2	1041	N / C
Depth m	N/A		

Comments: 940

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 10:30
Departure Time: 11:05

Site:
RRH

FMS ID	65720		65720	
Time	10:35		11:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	738.4	738	738.3	738
Temp ºC		10.8		10.8
TDGsat		108.5		110.0
TDG mmHg		801		812

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 12-May-15
BP Station: 738.3 mmHg
Time: 10:40

	Std	Initial	Final
Temperature ºC	11.05	11.2	N / C
TDG 100%	738.3	739	N / C
TDG 113%	838.3	839	N / C
TDG 126%	938.3	939	N / C
TDG 139%	1038.3	1039	N / C
Depth m	N/A		

Comments: 934

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 11:35
Departure Time: 12:15

Site:
RIS

FMS ID	65719		65719	
Time	11:30		12:10	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.1	743		743
Temp ºC		11.0		11.0
TDGsat		107.1		108.6
TDG mmHg		796		807

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 12-May-15
BP Station: 740.6 mmHg
Time: 11:50

	Std	**Initial**	**Final**
Temperature ºC	11.30	11.5	N / C
TDG 100%	740.6	740	N / C
TDG 113%	840.6	840	N / C
TDG 126%	940.6	941	N / C
TDG 139%	1040.6	1041	N / C
Depth m	N/A		

Comments: 936

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 12:35
Departure Time: 13:20

Site:
RIGW

FMS ID	65721		65721	
Time	12:40		13:15	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	741.0	743	741.0	743
Temp ºC		11.0		10.9
TDGsat		107.8		109.8
TDG mmHg		801		816

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 12-May-15
BP Station: 741.3 mmHg
Time: 12:45

	Std	Initial	Final
Temperature ºC	10.94	11.1	N / C
TDG 100%	741.3	742	N / C
TDG 113%	841.3	842	N / C
TDG 126%	941.3	942	N / C
TDG 139%	1041.3	1042	N / C
Depth m	N/A		

Comments: 932

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 8:00
Departure Time: 8:35

Site:
RRDW

	FMS ID	65718		65718	
	Time	8:15		8:30	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		738.2	736	738.0	736
Temp ºC			15.6		15.6
TDGsat			111.8		112.4
TDG mmHg			823		827

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 10-Jun-15
BP Station: 738.2 mmHg
Time: 8:15

	Std	Initial	Final
Temperature ºC	16.09	16.2	N / C
TDG 100%	738.2	739	N / C
TDG 113%	838.2	839	N / C
TDG 126%	938.2	939	N / C
TDG 139%	1038.2	1039	N / C
Depth m	N/A		

Comments: 930

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 8:40
Departure Time: 9:15

Site:
RRH

	FMS ID	65720		65720	
	Time	8:50		9:10	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		736.1	736	736.1	736
Temp ºC			15.6		15.6
TDGsat			109.8		108.7
TDG mmHg			808		800

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 10-Jun-15
Time: 8:55
BP Station: 736.3 mmHg

	Std	Initial	Final
Temperature ºC	16.45	16.6	N / C
TDG 100%	736.3	737	N / C
TDG 113%	836.3	837	N / C
TDG 126%	936.3	937	N / C
TDG 139%	1036.3	1037	N / C
Depth m	N/A		

Comments: 929

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 10:00
Departure Time: 10:45

Site:
RIGW

FMS ID	65721		65721	
Time	10:10		10:35	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.2	741	739.0	741
Temp ºC		15.7		15.7
TDGsat		113.8		112.7
TDG mmHg		843		835

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 10-Jun-15
BP Station: 739.3 mmHg
Time: 10:15

	Std	**Initial**	**Final**
Temperature ºC	16.76	16.9	N / C
TDG 100%	739.3	741	739
TDG 113%	839.3	841	839
TDG 126%	939.3	941	939
TDG 139%	1039.3	1040	1039
Depth m	N/A		

Comments: 935

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 11:05
Departure Time: 11:35

Site:
RIS

FMS ID	65719		65719	
Time	11:15		11:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	737.9	740	737.9	740
Temp ºC		15.8		15.8
TDGsat		109.5		110.3
TDG mmHg		810		816

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 10-Jun-15
BP Station: 737.9 mmHg
Time: 11:20

	Std	Initial	Final
Temperature ºC	16.30	16.4	N / C
TDG 100%	737.9	738	N / C
TDG 113%	837.9	838	N / C
TDG 126%	937.9	938	N / C
TDG 139%	1037.9	1038	N / C
Depth m	N/A		

Comments: 922

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 9:00
Departure Time: 9:50

Site:
RRDW

FMS ID	65718		65718	
Time	9:25		9:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.2	738		738
Temp ºC		18.3		18.3
TDGsat		110.8		112.1
TDG mmHg		818		827

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 08-Jul-15
BP Station: 740.2 mmHg
Time: 9:30

	Std	Initial	Final
Temperature ºC	18.70	18.8	N / C
TDG 100%	740.2	741	N / C
TDG 113%	840.2	841	N / C
TDG 126%	940.2	941	N / C
TDG 139%	1040.2	1042	N / C
Depth m	N/A		

Comments: 942

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 9:55
Departure Time: 10:25

Site:
RRH

FMS ID	65720		65720	
Time	10:00		10:20	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	738.5	738	737.4	737
Temp ºC		18.3		18.3
TDGsat		108.9		109.9
TDG mmHg		804		810

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 08-Jul-15
BP Station: 738.3 mmHg
Time: 10:05

	Std	**Initial**	**Final**
Temperature ºC	18.79	18.9	N / C
TDG 100%	738.3	738	N / C
TDG 113%	838.3	838	N / C
TDG 126%	938.3	939	N / C
TDG 139%	1038.3	1039	N / C
Depth m	N/A		

Comments: 952

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 11:00
Departure Time: 11:45

Site:
RIS

FMS ID	65719		65719	
Time	11:05		11:25	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.1	742	740.0	742
Temp ºC		18.7		18.7
TDGsat		109.3		111.1
TDG mmHg		811		824

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 08-Jul-15
BP Station: 740 mmHg
Time: 11:10

	Std	**Initial**	**Final**
Temperature ºC	18.90	19.0	N / C
TDG 100%	740.0	739	N / C
TDG 113%	840	840	N / C
TDG 126%	940	940	N / C
TDG 139%	1040	1040	N / C
Depth m	N/A		

Comments: 932

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 12:00
Departure Time: 12:40

Site:
RIGW

FMS ID	65721		65721	
Time	12:15		12:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.2	742	739.4	741
Temp ºC		18.7		18.7
TDGsat		115.1		114.2
TDG mmHg		854		846

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 08-Jul-15
BP Station: 740.1 mmHg
Time: 12:20

	Std	Initial	Final
Temperature ºC	19.65	19.8	N / C
TDG 100%	740.1	739	N / C
TDG 113%	840.1	840	N / C
TDG 126%	940.1	940	N / C
TDG 139%	1040.1	1041	N / C
Depth m	N/A		

Comments: 929

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 7:55
Departure Time: 9:00

Site:
RRDW

FMS ID	65718		65718	
Time	8:25		8:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.4	741	742.3	740
Temp ºC		20.0		20.0
TDGsat		105.9		107.0
TDG mmHg		785		792

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 11-Aug-15
BP Station: 742.4 mmHg
Time: 8:30

	Std	**Initial**	**Final**
Temperature ºC	19.91	20.0	N / C
TDG 100%	742.4	743	742
TDG 113%	842.4	844	842
TDG 126%	942.4	945	942
TDG 139%	1042.4	1045	1042
Depth m	N/A		

Comments: 948

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 9:10
Departure Time: 9:45

Site:
RRH

FMS ID	65720		65720	
Time	9:20		9:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	740.5	740	740.5	740
Temp ºC		20.0		20.0
TDGsat		106.8		107.2
TDG mmHg		790		793

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 11-Aug-15
BP Station: 740.5 mmHg
Time: 9:25

	Std	Initial	Final
Temperature ºC	20.67	20.8	N / C
TDG 100%	740.5	741	741
TDG 113%	840.5	842	841
TDG 126%	940.5	942	941
TDG 139%	1040.5	1043	1041
Depth m	N/A		

Comments: 941

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 10:20
Departure Time: 10:55

Site:
RIS

FMS ID	65719		65719	
Time	10:30		10:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.8	745	742.8	745
Temp ºC		20.1		20.1
TDGsat		107.1		107.7
TDG mmHg		798		802

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 11-Aug-15
BP Station: 742.8 mmHg
Time: 10:35

	Std	**Initial**	**Final**
Temperature ºC	20.28	20.4	N / C
TDG 100%	742.8	742	743
TDG 113%	842.8	843	843
TDG 126%	942.8	944	943
TDG 139%	1042.8	1044	1043
Depth m	N/A		

Comments: 936

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 11:20
Departure Time: 12:05

Site:
RIGW

FMS ID	65721		65721	
Time	11:30		12:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.3	745	743.1	745
Temp ºC		20.1		20.1
TDGsat		111.8		113.2
TDG mmHg		833		843

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 11-Aug-15
BP Station: 743.3 mmHg
Time: 11:35

	Std	**Initial**	**Final**
Temperature ºC	20.74	20.9	N / C
TDG 100%	743.3	743	N / C
TDG 113%	843.3	843	N / C
TDG 126%	943.3	944	N / C
TDG 139%	1043.3	1044	N / C
Depth m	N/A		

Comments: 937

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 9:40
Departure Time: 10:40

Site:
RRDW

FMS ID	65718		65718	
Time	10:05		10:35	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	743.8	742	743.6	742
Temp ºC		18.6		18.6
TDGsat		100.4		102.3
TDG mmHg		745		759

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 09-Sep-15
BP Station: 743.6 mmHg
Time: 10:10

	Std	Initial	Final
Temperature ºC	18.69	18.8	N / C
TDG 100%	743.6	742	744
TDG 113%	843.6	842	844
TDG 126%	943.6	943	944
TDG 139%	1043.6	1043	1044
Depth m	N/A		

Comments: 949

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 10:55
Departure Time: 11:35

Site:
RRH

FMS ID	65720		65720	
Time	11:00		11:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	741.5	742	741.1	741
Temp ºC		18.7		18.6
TDGsat		101.5		103.2
TDG mmHg		753		765

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 09-Sep-15
BP Station: 741.3 mmHg
Time: 11:05

	Std	**Initial**	**Final**
Temperature ºC	18.75	18.8	N / C
TDG 100%	741.3	740	N / C
TDG 113%	841.3	840	N / C
TDG 126%	941.3	940	N / C
TDG 139%	1041.3	1041	N / C
Depth m	N/A		

Comments: 947

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 12:20
Departure Time: 13:15

Site:
RIS

FMS ID	65719		65719	
Time	12:30		13:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.3	746	743.0	746
Temp ºC		18.7		18.8
TDGsat		101.1		102.8
TDG mmHg		754		767

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 09-Sep-15
Time: 12:35
BP Station: 743.1 mmHg

	Std	Initial	Final
Temperature ºC	19.38	19.5	N / C
TDG 100%	743.1	746	742
TDG 113%	843.1	845	842
TDG 126%	943.1	945	943
TDG 139%	1043.1	1045	1043
Depth m	N/A		

Comments: 951

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 13:30
Departure Time: 15:00

Site:
RIGW

FMS ID	65721		65721	
Time	13:40		14:15	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	744.0	746	743.6	746
Temp ºC		18.7		18.7
TDGsat		101.2		102.8
TDG mmHg		755		767

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 09-Sep-15
BP Station: 743.8 mmHg
Time: 13:45

	Std	Initial	Final
Temperature ºC	19.87	20.0	N / C
TDG 100%	743.8	745	744
TDG 113%	843.8	846	843
TDG 126%	943.8	946	943
TDG 139%	1043.8	1047	1044
Depth m	N/A		

Comments: 935

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 9:15
Departure Time: 10:00

Site:
RRDW

FMS ID	65718		65718	
Time	9:35		9:55	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	748.7	747	748.5	747
Temp ºC		15.9		15.9
TDGsat		99.6		101.9
TDG mmHg		744		761

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 21-Oct-15
BP Station: 748.7 mmHg
Time: 9:40

	Std	Initial	Final
Temperature ºC	15.69	15.8	N / C
TDG 100%	748.7	750	N / C
TDG 113%	848.7	850	N / C
TDG 126%	948.7	950	N / C
TDG 139%	1048.7	1050	N / C
Depth m	N/A		

Comments: 956

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 10:10
Departure Time: 10:45

Site:
RRH

FMS ID	65720		65720	
Time	10:20		10:40	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	746.3	747	745.6	746
Temp ºC		15.9		15.9
TDGsat		98.9		98.8
TDG mmHg		739		737

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 21-Oct-15
BP Station: 746.3 mmHg
Time: 10:25

	Std	**Initial**	**Final**
Temperature ºC	15.81	15.9	N / C
TDG 100%	746.3	747	746
TDG 113%	846.3	848	846
TDG 126%	946.3	948	946
TDG 139%	1046.3	1048	1046
Depth m	N/A		

Comments: 950

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 11:15
Departure Time: 12:00

Site:
RIS

FMS ID	65719		65719	
Time	11:25		11:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.3	752	748.2	751
Temp ºC		15.9		15.9
TDGsat		97.9		99.9
TDG mmHg		736		750

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 21-Oct-15
BP Station: 748.3 mmHg
Time: 11:30

	Std	**Initial**	**Final**
Temperature ºC	15.52	15.7	N / C
TDG 100%	748.3	746	748
TDG 113%	848.3	847	848
TDG 126%	948.3	948	948
TDG 139%	1048.3	1048	1048
Depth m	N/A		

Comments: 944

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 12:20
Departure Time: 13:20

Site:
RIGW

FMS ID	65721		65721	
Time	12:30		13:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.9	751	748.6	750
Temp ºC		15.9		15.9
TDGsat		98.9		100.8
TDG mmHg		743		756

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 21-Oct-15
BP Station: 748.8 mmHg
Time: 12:35

	Std	Initial	Final
Temperature ºC	16.01	16.1	N / C
TDG 100%	748.8	747	749
TDG 113%	848.8	847	849
TDG 126%	948.8	948	949
TDG 139%	1048.8	1048	1049
Depth m	N/A		

Comments: 948

Report created October 28, 2015

APPENDIX D: 2015 DATA LOSSES

Hours of Data losses at Rocky Reach and Rock Island Dams during the fish-spill season

Date	Rocky Reach			Rock Island		
	Forebay	Tailrace	Reason	Forebay	Tailrace	Reason
4/13/2015		1	Calibration	1	1	Calibration
5/12/2015	1	1	Calibration	1	1	Calibration
5/28/2015					1	Server Patch
5/29/2015					1	Server Patch
6/10/2015	1	1	Calibration	3	5	Calibration and fuse blown on radio
6/15/2015				3	3	SCADA server down
8/3/2015					1	SCADA server down
8/11/2015				1	1	Calibration
8/12/2015					2	Data cable replacement
8/17/2015				4	4	Solar panel service
Total	**2**	**3**		**13**	**20**	

Notes:
Calibration = probe is taken off line while calibration occurs
Communication error = probe not communicating/downloading data
Server patch = Upgrades to the server
Site maintenance = while Chelan PUD was upgrading the carriage that holds the probe, it was disconnected
System Control and Data Acquisition (SCADA) server down = Chelan PUD's data server was down

APPENDIX E: 2015 DATA

Hourly Total Dissolved gas readings during the 2015 fish-spill season

Notes:
FONT = Exceedances of the water quality TDG numeric critera are in bold red. Note, all exceedances in the Rocky Reach Forebay are for the upstream Wells Dam Project. TDG is rounded to the nearest number: 115.2 is rounded to 115, therefore not in exceedance)
121.2 (119.6) = Instances of "double counting", value in parentheses represents the TDG value used to eliminate "double counting"
110.8 = Not counted toward exceedances because RR FB > 115 (for RI FB) or RI FB > 115 (for Wanapum FB).

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
1-Apr	106.0	105.7	106.3	110.5	109.7	115.6	106.6	105.6	108.4	106.6	105.6	108.2	105.8	105.9	12.0	0.0	132.4	142.0	8.9	0.0	11.82	0.00	0.00	0.00
2-Apr	105.7	104.9	105.7	111.5	106.4	111.6	106.5	105.3	106.5	106.6	105.3	106.5	105.5	105.6	0.7	0.0	134.5	143.0	0.5	0.0	1.33	0.00	0.00	0.00
3-Apr	105.3	104.8	105.3	105.7	105.1	105.5	104.8	104.6	105.0	104.7	104.6	104.9	106.5	106.8	0.0	0.0	136.3	146.8	0.0	0.0	0.00	0.00	0.00	0.00
4-Apr	105.2	104.9	105.4	105.6	105.2	105.9	104.8	104.4	104.9	104.8	104.4	104.9	106.6	107.2	0.0	0.0	132.5	140.7	0.0	0.0	0.00	0.00	0.00	0.00
5-Apr	105.7	105.4	105.9	106.0	105.8	106.3	105.2	104.9	105.3	105.1	104.9	105.2	106.7	107.0	0.0	0.0	131.2	141.3	0.0	0.0	0.00	0.00	0.00	0.00
6-Apr	105.8	105.0	105.8	106.1	105.4	106.2	105.2	104.4	105.1	105.2	104.5	105.1	106.8	106.9	0.0	0.0	129.1	137.9	0.0	0.0	0.00	0.00	0.00	0.00
7-Apr	104.8	104.4	104.7	105.2	104.8	105.0	104.2	104.0	104.4	104.2	104.0	104.3	105.6	105.5	0.0	0.0	111.9	121.2	0.0	0.0	0.00	0.00	0.00	0.00
8-Apr	104.3	103.9	104.2	104.8	104.4	104.7	104.2	103.6	104.0	104.2	103.6	103.9	105.0	105.3	0.0	0.0	112.9	121.0	0.0	0.0	0.00	0.00	0.00	0.00
9-Apr	104.1	103.8	104.2	104.6	104.4	104.9	104.0	103.4	104.2	103.9	103.4	104.1	104.8	105.4	0.0	0.0	123.4	131.3	0.0	0.0	0.00	0.00	0.00	0.00
10-Apr	105.9	105.1	106.5	106.2	105.5	107.1	104.7	104.2	105.1	104.6	104.1	104.9	105.6	106.1	0.0	0.0	119.2	126.8	0.0	0.0	0.00	0.00	0.00	0.00
11-Apr	106.5	106.2	106.8	106.8	106.5	107.0	105.5	105.3	105.7	105.3	105.2	105.6	105.5	105.1	0.0	0.0	100.4	107.4	0.0	0.0	0.00	0.00	0.00	0.00
12-Apr	105.9	105.0	105.5	106.2	105.7	108.4	105.4	104.7	105.6	105.3	104.7	105.5	103.9	103.8	1.3	0.0	115.5	124.1	1.1	0.0	1.05	0.00	0.00	0.00
13-Apr	106.3	105.6	106.6	106.4	106.0	106.8	105.9	105.1	106.9	105.1	102.2	106.0	105.3	105.9	0.0	0.0	117.4	122.7	0.0	0.0	0.00	0.00	0.00	0.00
14-Apr	106.3	105.0	106.2	106.5	105.3	106.3	105.7	104.0	105.2	105.7	104.2	105.5	105.3	104.8	0.0	0.1	84.0	89.3	0.0	0.2	0.00	0.00	0.06	0.00
15-Apr	104.5	103.8	104.1	104.8	104.3	104.6	103.8	103.5	104.2	103.8	103.5	104.0	103.1	103.6	0.0	0.5	109.6	113.8	0.0	0.4	0.00	0.00	0.04	0.04
16-Apr	105.1	104.4	105.5	105.4	104.8	105.9	104.5	103.8	104.8	107.1	106.6	108.0	104.8	105.4	0.0	11.1	116.5	120.4	0.0	9.6	0.00	0.00	10.98	11.00
17-Apr	106.2	105.7	106.4	106.2	105.9	106.5	105.7	105.1	106.1	108.4	107.7	109.6	105.8	107.1	0.0	11.4	107.9	115.5	0.0	10.6	0.00	0.00	11.50	11.50
18-Apr	106.2	106.0	106.4	106.5	106.3	106.8	106.0	105.3	106.4	110.7	109.6	112.9	107.0	108.6	0.0	9.8	78.3	85.2	0.0	13.1	0.00	0.00	9.81	9.80
19-Apr	107.4	106.8	107.8	107.5	106.9	107.9	106.8	106.4	107.1	111.0	110.1	113.6	109.8	111.5	0.0	9.9	90.5	96.2	0.0	12.0	0.00	0.00	9.81	9.81
20-Apr	108.5	107.9	108.8	108.8	108.2	109.4	107.8	107.3	108.1	110.9	110.0	111.8	110.3	110.6	0.0	11.6	116.2	122.3	0.0	10.4	0.00	0.00	11.57	11.56
21-Apr	109.0	108.8	109.2	108.9	108.7	109.2	108.2	107.8	108.8	111.1	110.7	114.5	110.9	111.9	0.0	11.2	95.8	102.7	0.0	14.9	0.00	0.00	11.31	11.30
22-Apr	109.0	107.7	108.5	108.8	107.7	108.1	108.2	106.4	107.3	113.2	110.9	115.0	110.4	108.3	0.0	11.4	86.5	92.3	0.0	16.5	0.00	0.00	11.37	11.36
23-Apr	107.7	107.5	107.9	107.9	107.7	108.2	107.1	106.8	107.3	111.5	110.2	114.1	107.4	108.2	0.0	10.9	100.2	105.7	0.0	11.9	0.00	0.00	10.99	10.99
24-Apr	107.7	107.2	107.5	107.9	107.4	107.7	107.2	106.2	106.9	110.5	109.2	112.0	108.0	108.3	0.0	9.8	99.6	107.9	0.0	10.1	0.00	0.00	9.83	9.82
25-Apr	107.2	106.7	107.1	107.3	106.9	107.2	106.3	105.6	106.1	110.3	109.3	111.6	108.0	107.7	0.0	9.9	86.3	92.2	0.0	11.5	0.00	0.00	9.82	9.81
26-Apr	106.5	105.7	106.1	106.7	105.9	106.3	105.5	104.9	105.2	109.6	107.9	110.1	107.0	107.1	0.0	9.1	79.1	85.9	0.0	10.8	0.00	0.00	9.02	9.01
27-Apr	106.4	106.0	106.6	106.7	106.3	107.0	106.0	105.5	106.2	110.1	109.1	112.1	109.2	111.0	0.0	9.9	95.1	99.1	0.0	11.3	0.00	0.00	9.83	9.83
28-Apr	107.5	107.1	107.7	107.6	107.3	107.8	107.0	106.5	107.3	110.1	109.7	111.9	109.6	111.0	0.0	10.1	93.8	102.0	0.0	11.1	0.00	0.00	10.14	10.14
29-Apr	107.5	106.9	107.3	107.5	106.7	107.0	107.0	105.8	106.2	111.7	109.8	113.4	109.1	106.8	0.0	9.6	76.2	80.8	0.0	13.1	0.00	0.00	9.51	9.51
30-Apr	107.4	107.0	107.6	107.6	107.1	107.8	107.0	106.3	107.7	111.9	110.2	115.5	106.5	107.6	0.0	9.6	95.8	103.3	0.0	14.6	0.00	0.00	9.48	9.49
1-May	108.3	107.8	108.6	108.3	107.8	108.5	107.4	107.2	107.7	110.7	109.9	111.4	109.1	109.9	0.0	11.1	112.0	122.4	0.0	9.9	0.01	0.00	11.73	11.06
2-May	109.1	108.8	109.3	109.0	108.6	109.3	108.4	107.6	108.8	111.6	110.5	112.8	109.9	110.7	0.0	11.1	111.2	120.4	0.0	10.3	0.00	0.00	10.47	10.46
3-May	109.2	109.0	109.4	109.1	108.7	109.6	108.8	108.2	109.1	111.9	111.0	113.1	111.9	113.3	0.0	9.9	101.3	109.2	0.0	9.5	0.00	0.00	9.84	9.83

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
4-May	109.5	109.2	109.8	109.4	109.0	109.5	108.9	108.4	109.2	112.6	111.7	113.8	111.8	111.9	0.0	11.8	106.5	114.4	0.0	11.4	0.00	0.00	11.75	11.75
5-May	109.5	108.7	109.0	109.1	108.3	108.7	108.6	107.4	107.7	112.8	110.8	113.5	110.0	108.8	0.0	10.0	86.7	93.9	0.0	11.8	0.00	0.00	10.05	10.04
6-May	108.4	107.7	108.2	108.1	107.4	107.9	107.5	106.9	107.3	111.5	109.7	114.5	108.5	108.8	0.0	9.2	83.6	90.7	0.0	14.4	0.00	0.00	9.06	9.04
7-May	107.8	107.2	108.1	107.6	106.9	107.5	107.0	106.8	107.2	111.3	110.4	113.8	109.9	111.6	0.0	9.5	81.3	87.6	0.0	12.7	0.00	0.00	9.51	9.50
8-May	108.0	107.6	108.4	107.6	107.2	107.8	107.1	106.7	107.2	111.5	109.9	114.5	110.3	110.3	0.0	8.9	80.4	85.5	0.0	14.7	0.00	0.00	9.02	9.00
9-May	108.0	107.4	108.0	107.6	107.1	107.6	107.2	106.8	107.4	111.2	109.6	112.6	110.5	111.1	0.0	8.9	85.7	91.9	0.0	11.3	0.00	0.00	9.02	9.01
10-May	108.4	107.9	109.2	107.9	107.4	108.1	107.3	107.1	107.7	111.5	110.1	113.2	111.2	112.3	0.0	8.7	75.1	80.4	0.0	12.0	0.00	0.00	8.68	8.68
11-May	109.3	108.9	109.7	109.0	108.6	109.5	108.3	107.9	108.6	112.1	111.4	114.2	111.5	112.8	0.0	11.3	96.7	104.1	0.0	15.0	0.00	0.00	11.27	11.27
12-May	109.3	108.8	109.2	109.0	108.8	110.7	108.4	107.6	108.2	112.3	110.6	114.3	112.0	111.5	2.6	10.4	114.1	122.6	2.7	10.9	1.63	0.00	10.33	10.32
13-May	109.2	108.8	109.3	111.3	109.8	114.8	108.4	107.9	110.5	111.9	111.3	114.1	110.1	110.3	3.4	12.1	121.6	130.8	3.4	11.3	4.63	0.00	12.09	12.09
14-May	108.4	108.2	108.5	108.4	108.1	108.5	108.1	107.4	108.3	111.5	111.1	112.9	109.5	110.2	0.0	12.4	115.4	126.4	0.0	10.9	0.00	0.00	12.53	12.52
15-May	109.1	108.8	109.5	108.7	108.5	109.1	108.2	107.8	108.6	111.8	111.5	113.2	111.0	112.0	0.0	11.6	97.3	109.0	0.0	11.1	0.07	0.00	11.77	11.78
16-May	109.1	108.8	109.3	108.9	108.6	109.5	108.3	107.6	108.2	112.1	111.1	113.6	110.9	109.7	0.6	11.2	93.7	102.5	0.4	12.6	0.28	0.00	11.05	11.04
17-May	108.8	107.6	108.0	108.7	107.7	108.2	108.0	106.7	107.6	111.7	109.5	112.1	109.0	109.5	0.0	10.4	111.4	125.1	0.0	9.2	0.00	0.00	10.43	10.43
18-May	107.9	107.6	108.0	120.2	107.2	107.9	107.3	106.9	107.7	111.5	110.9	114.4	109.4	110.2	0.0	12.4	106.0	116.0	0.0	11.9	0.00	0.00	12.38	12.39
19-May	108.6	108.2	108.8	108.5	107.9	108.7	108.0	107.3	108.6	112.1	110.8	116.2	110.6	110.8	0.0	11.9	117.0	125.9	0.0	13.6	0.00	0.00	11.72	11.73
20-May	109.1	108.7	109.5	108.7	108.3	109.0	108.4	107.8	108.8	111.8	111.1	113.1	110.8	111.3	0.0	13.1	122.7	131.6	0.0	11.6	0.00	0.00	13.23	13.23
21-May	109.8	109.5	110.0	109.1	108.9	109.4	109.1	108.5	109.7	111.9	111.6	112.6	112.7	114.5	0.0	14.0	127.0	138.6	0.0	10.9	0.00	0.00	13.30	13.30
22-May	109.8	109.5	109.8	109.1	108.8	109.4	109.1	108.4	109.1	113.0	111.9	114.4	112.7	113.0	0.0	13.6	118.7	129.7	0.0	10.9	0.00	0.00	13.62	13.61
23-May	109.5	109.0	109.4	108.9	108.6	109.1	108.6	108.0	108.8	112.4	111.4	112.8	111.6	113.3	0.0	13.3	125.7	137.9	0.0	10.0	0.00	0.00	13.26	13.26
24-May	109.4	109.2	109.8	119.6	108.7	109.2	108.7	108.1	109.2	111.9	111.6	112.5	111.0	110.8	0.0	13.1	125.2	137.5	0.0	9.7	0.00	0.00	13.16	13.16
25-May	109.5	108.9	109.3	108.9	108.3	108.7	108.7	107.9	108.5	112.3	111.5	113.0	110.3	111.1	0.0	14.0	122.0	132.6	0.0	10.9	0.00	0.00	13.34	13.33
26-May	108.9	108.4	108.7	108.4	107.8	108.1	108.1	107.5	108.1	112.1	111.1	113.1	110.4	110.9	0.0	13.1	128.2	138.8	0.0	9.7	0.00	0.00	13.36	13.37
27-May	108.9	108.4	109.9	108.1	107.6	108.8	107.9	107.3	108.2	111.7	111.1	112.7	111.1	111.5	0.0	13.1	117.9	127.6	0.0	10.5	0.00	0.00	13.15	13.14
28-May	109.7	109.2	109.9	108.8	108.5	109.0	109.1	108.3	109.6	112.5	111.5	114.4	111.1	111.1	0.0	12.5	123.7	132.7	0.0	10.5	0.00	0.00	12.54	12.54
29-May	109.0	108.6	109.2	108.4	108.0	108.6	109.0	107.9	108.5	112.2	111.3	113.4	112.3	112.9	0.0	13.2	120.4	131.9	0.0	10.6	0.00	0.00	13.38	13.39
30-May	109.7	109.4	110.0	108.8	108.5	109.5	108.9	108.3	109.4	111.8	111.4	112.6	112.4	112.1	0.4	11.4	112.7	123.5	0.4	9.7	0.48	0.00	11.30	11.31
31-May	109.8	109.3	109.7	109.1	108.7	110.4	108.9	108.4	108.9	112.6	111.6	113.6	111.6	111.6	1.4	11.6	114.8	126.1	1.1	9.7	1.25	0.00	11.32	11.32
1-Jun	109.6	109.5	109.9	113.1	112.7	113.3	110.1	109.1	110.4	116.4	115.2	117.0	111.6	111.6	13.5	24.0	110.8	119.5	12.6	21.1	13.14	12.97	23.77	23.77
2-Jun	109.6	108.9	109.4	112.8	112.2	113.1	109.9	108.6	109.2	116.5	114.8	116.4	110.0	109.0	11.4	24.7	97.3	101.1	12.0	25.1	11.35	11.34	25.00	25.02
3-Jun	108.8	108.0	108.6	112.2	111.2	112.8	108.6	108.4	108.8	115.2	113.7	116.4	107.0	107.8	8.9	20.2	94.8	100.7	9.8	22.0	8.96	8.96	20.41	20.42
4-Jun	107.8	107.3	107.9	112.1	111.2	112.6	108.6	107.6	108.8	113.5	112.7	114.3	110.1	112.0	8.8	21.3	110.4	117.1	8.3	19.5	8.88	8.87	21.22	21.21
5-Jun	108.0	107.5	108.2	112.3	111.3	112.5	108.8	108.2	109.3	114.0	113.8	117.3	112.7	113.8	8.9	22.2	113.4	120.1	8.7	21.0	8.87	8.88	22.59	22.60
6-Jun	109.0	108.5	109.2	113.3	112.2	113.5	109.6	108.9	110.2	114.2	113.8	115.1	112.7	113.8	10.0	20.6	117.0	123.2	8.7	17.0	10.01	10.01	20.77	20.78
7-Jun	109.2	109.0	109.4	113.2	112.2	113.5	109.8	109.3	110.3	114.5	114.0	115.0	112.6	113.0	8.5	19.9	112.4	121.4	7.8	16.9	8.58	8.59	19.80	19.80
8-Jun	109.8	109.4	109.9	113.6	112.8	114.0	110.3	109.6	111.0	115.2	114.8	117.7	112.6	114.7	10.2	22.0	121.6	127.8	9.5	19.6	10.22	10.22	22.25	22.25
9-Jun	110.3	110.0	110.4	114.0	113.3	114.4	110.7	110.0	111.2	115.4	115.1	115.7	112.5	113.6	9.6	22.6	121.7	131.1	8.3	17.7	9.68	9.67	22.51	22.50
10-Jun	110.3	109.9	110.6	113.8	112.6	113.8	110.7	109.5	110.5	115.9	115.4	117.1	112.3	111.6	10.5	24.2	105.4	109.7	10.3	23.4	10.70	10.71	24.36	24.35
11-Jun	109.9	109.0	109.5	113.4	112.1	113.2	109.8	109.0	109.9	115.4	114.3	117.9	110.4	109.4	9.8	23.2	104.8	113.5	10.3	24.6	9.59	9.59	22.83	22.67
12-Jun	108.8	107.9	108.2	112.4	111.6	112.9	109.5	108.1	109.3	115.1	113.8	117.1	108.4	108.2	10.1	21.4	98.6	104.2	10.9	22.6	10.14	10.14	21.50	21.50
13-Jun	107.8	107.4	107.8	112.3	111.3	112.3	108.8	108.2	109.2	113.8	113.2	114.4	109.1	110.6	8.7	20.0	109.6	116.7	8.2	17.6	8.73	8.74	20.00	20.01
14-Jun	108.3	107.8	108.7	112.2	111.2	112.4	108.8	108.0	109.3	113.8	113.2	114.3	110.4	111.1	8.9	20.1	104.1	109.7	8.8	18.8	8.82	8.82	20.01	20.01

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
15-Jun	109.0	108.6	109.1	113.1	111.9	113.7	110.4	98.9	111.0	114.8	114.6	117.5	111.9	112.8	10.3	23.6	128.1	132.1	9.4	22.2	10.40	10.40	23.44	23.44
16-Jun	109.4	109.1	109.7	112.9	111.9	113.3	110.2	109.4	110.6	115.5	115.1	117.1	111.9	112.8	10.5	25.0	107.6	112.6	10.2	24.3	10.60	10.59	25.14	24.93
17-Jun	109.6	109.5	110.4	112.5	111.3	112.8	110.0	109.6	110.3	116.6	115.1	117.7	111.7	110.3	8.9	22.0	87.5	90.3	11.5	27.9	8.88	8.89	22.05	21.74
18-Jun	109.9	109.5	110.4	112.9	111.6	113.3	110.0	109.3	109.9	115.6	114.9	118.2	112.2	113.8	9.5	21.3	86.1	90.3	11.9	26.5	9.43	9.42	20.80	20.80
19-Jun	109.6	108.3	108.7	112.8	110.8	112.0	109.5	108.8	109.7	115.7	114.5	118.8	112.3	111.4	8.8	17.7	75.1	77.9	13.2	27.0	8.75	8.75	17.75	17.74
20-Jun	108.7	108.3	109.5	112.3	111.2	113.0	109.0	108.4	109.9	114.6	114.3	117.0	108.7	109.5	8.2	17.5	84.1	88.9	11.1	22.8	8.13	8.12	17.71	17.71
21-Jun	109.0	108.4	109.5	112.2	110.1	111.3	109.5	108.9	109.8	115.6	115.0	119.3	110.1	111.0	6.7	15.9	73.2	75.2	10.2	26.4	6.67	6.66	15.98	15.97
22-Jun	109.0	108.6	109.7	112.7	111.3	113.1	108.9	108.3	109.6	116.1	114.9	119.0	110.1	109.8	11.7	20.1	89.6	93.5	14.4	25.8	11.93	9.53	20.33	20.33
23-Jun	109.2	108.7	109.9	112.7	111.7	113.1	110.0	109.3	110.7	115.7	114.8	119.0	109.2	110.3	8.6	18.5	90.3	93.4	10.7	24.0	8.72	8.72	18.42	18.42
24-Jun	109.7	109.3	110.2	112.3	111.2	112.0	110.1	109.4	109.9	115.7	114.5	118.8	110.7	111.1	8.7	19.1	84.3	87.1	11.4	25.1	8.64	8.64	19.15	19.16
25-Jun	109.6	108.8	109.3	112.5	111.2	113.1	115.3	109.0	110.1	114.8	113.8	118.1	111.7	112.2	8.6	18.9	103.2	106.0	9.8	21.9	8.68	8.68	18.85	18.86
26-Jun	109.7	109.1	110.0	113.6	112.2	114.1	110.2	109.7	110.8	115.7	115.3	117.6	113.6	114.3	10.0	22.7	114.0	114.8	9.5	22.5	9.98	9.99	22.75	22.75
27-Jun	110.3	110.0	111.0	113.9	113.1	114.4	111.1	110.4	111.7	115.9	115.5	117.2	114.1	114.9	10.2	22.7	109.8	115.1	9.9	21.4	10.15	10.16	22.62	22.62
28-Jun	110.7	110.4	111.7	114.1	113.2	114.7	115.3	110.6	111.7	116.7	116.2	117.9	114.4	115.9	9.8	22.6	109.2	110.7	9.6	22.7	9.72	9.71	22.75	22.75
29-Jun	110.7	109.9	110.3	114.2	113.1	115.0	111.2	110.3	111.3	116.9	115.4	117.8	114.4	113.3	9.9	22.4	111.7	115.4	9.3	21.0	10.22	9.95	22.60	22.59
30-Jun	110.0	109.7	110.2	113.7	112.3	114.9	110.6	109.9	111.3	115.8	115.2	118.3	112.4	113.5	9.2	22.2	113.5	115.8	8.9	22.3	9.30	9.30	22.43	22.43
1-Jul	109.9	109.3	109.8	113.3	112.2	114.6	110.6	109.6	111.1	115.5	114.3	117.2	114.2	115.3	9.1	19.2	115.5	121.2	8.8	18.5	9.13	8.94	19.55	19.55
2-Jul	109.7	109.2	110.3	113.8	112.4	114.2	110.4	109.6	111.4	115.8	115.2	116.3	115.0	116.0	9.3	22.8	112.0	116.8	8.7	20.6	9.40	9.40	22.83	22.83
3-Jul	110.9	110.4	111.5	113.8	112.6	114.1	110.9	110.2	111.6	116.0	114.6	116.4	114.9	113.5	8.4	19.1	105.0	107.4	8.3	19.0	8.38	8.38	19.05	19.05
4-Jul	110.9	110.4	111.4	113.6	112.3	114.5	111.1	110.5	111.8	119.4	114.9	116.3	112.9	113.7	7.3	17.6	106.4	109.4	7.5	17.3	7.40	7.38	17.42	17.42
5-Jul	110.8	109.6	110.2	113.1	111.6	113.3	111.1	109.7	110.4	115.1	114.1	115.7	112.5	112.3	7.2	17.9	108.2	113.9	6.8	16.0	7.14	7.15	17.68	17.68
6-Jul	109.7	109.1	110.0	112.8	111.7	113.6	110.3	109.6	111.2	115.2	114.8	117.9	112.3	113.8	8.6	20.7	95.4	98.7	9.9	24.6	8.53	8.54	20.65	20.66
7-Jul	110.1	109.5	110.9	112.5	111.2	112.7	110.5	109.6	110.3	115.8	114.5	116.6	112.3	113.0	8.4	19.1	87.7	88.8	10.1	23.3	8.64	8.65	19.11	19.10
8-Jul	110.6	109.8	111.1	113.4	111.9	114.5	110.6	109.9	111.2	114.9	114.8	116.9	114.2	115.0	9.4	20.5	101.6	104.6	9.9	23.1	9.33	9.33	20.80	20.81
9-Jul	110.9	110.5	111.2	113.0	111.8	113.7	111.0	110.5	111.3	116.3	115.4	118.0	114.7	115.5	8.4	19.1	95.6	97.2	9.4	21.5	8.37	8.39	19.45	19.32
10-Jul	110.9	110.8	111.2	112.6	111.2	112.9	110.9	109.9	110.8	116.3	115.2	117.8	114.6	113.1	7.9	17.1	75.1	75.5	11.5	25.8	8.01	8.01	17.08	17.08
11-Jul	110.9	109.6	110.4	111.7	110.2	110.8	109.8	108.9	109.6	115.7	114.9	117.5	110.2	109.2	7.8	17.0	67.9	67.6	12.2	28.0	7.87	7.87	17.03	17.02
12-Jul	109.4	108.7	109.1	110.9	110.2	111.3	108.5	107.9	108.5	114.5	113.9	116.7	108.5	107.9	7.0	15.4	76.8	76.9	9.5	21.8	6.96	6.96	15.40	15.39
13-Jul	108.8	108.4	108.8	111.7	110.8	112.7	108.7	108.3	109.3	114.2	113.7	116.7	108.7	109.6	8.4	19.8	99.3	100.8	9.1	21.6	8.35	8.35	19.57	19.56
14-Jul	109.2	108.7	109.4	113.1	111.6	113.8	109.4	108.7	110.3	114.2	113.7	116.8	109.4	110.6	8.9	19.9	102.3	105.5	9.2	20.5	8.85	8.85	19.85	19.85
15-Jul	109.2	109.0	109.5	112.9	112.0	113.6	109.6	108.9	109.9	114.4	113.9	115.3	109.2	108.4	8.0	20.1	107.0	110.6	7.5	18.3	8.02	8.00	19.95	19.94
16-Jul	109.1	108.2	108.8	112.5	111.8	113.1	109.4	108.3	109.2	114.3	113.3	114.5	107.8	107.5	8.7	20.0	106.1	111.4	8.3	18.2	8.63	8.63	19.98	19.98
17-Jul	108.3	107.9	108.7	112.3	111.5	112.9	109.0	108.2	109.6	113.8	113.1	114.2	108.6	109.5	8.7	20.1	109.1	115.0	8.1	17.6	8.74	8.74	20.13	20.13
18-Jul	108.7	108.4	109.1	112.4	111.7	113.0	109.3	108.8	110.0	114.6	113.8	115.9	110.7	111.5	9.7	18.3	103.8	105.6	9.9	19.2	8.43	7.81	18.38	18.38
19-Jul	109.0	108.6	109.3	112.8	111.9	113.5	109.6	108.9	109.7	113.8	113.3	114.3	111.4	112.2	8.5	18.5	106.0	108.8	8.1	17.3	8.53	8.53	18.42	18.41
20-Jul	109.4	109.1	109.9	112.8	111.8	113.1	109.4	109.1	109.7	114.7	114.5	115.4	111.4	110.9	8.8	21.0	100.2	101.8	8.9	21.1	8.70	8.69	21.05	21.05
21-Jul	109.3	108.9	109.7	112.3	111.6	113.0	109.5	108.7	109.5	114.7	114.3	116.8	108.8	108.9	9.5	20.6	86.5	89.2	11.1	24.2	9.39	9.39	20.85	20.86
22-Jul	109.2	107.9	108.6	112.1	110.6	112.5	108.9	108.2	108.8	115.1	114.0	116.7	108.6	108.1	8.3	17.2	84.2	85.7	10.7	23.8	8.34	8.33	17.18	17.18
23-Jul	108.1	107.2	107.8	111.0	110.2	111.7	108.3	107.5	108.4	113.9	112.9	115.5	108.3	109.4	8.4	18.5	91.8	94.2	9.7	21.1	8.37	8.36	18.58	18.58
24-Jul	107.6	107.3	107.9	110.9	110.2	111.8	107.5	107.0	108.2	112.6	112.1	114.2	108.4	107.7	7.9	18.4	101.6	103.8	8.0	18.4	7.98	8.00	18.41	18.40
25-Jul	107.6	107.3	107.6	110.6	110.1	111.2	107.8	107.0	108.0	112.6	112.1	113.7	107.1	107.0	7.8	17.3	104.5	107.4	7.6	16.4	7.80	7.79	17.41	17.41
26-Jul	107.3	106.5	107.0	110.0	109.2	110.2	107.0	106.5	107.2	113.0	111.8	116.1	106.8	106.6	7.4	17.1	83.0	87.7	10.0	22.4	7.40	7.39	16.89	16.88

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
27-Jul	106.3	105.3	105.8	109.8	109.0	110.2	106.6	105.6	106.4	113.3	112.6	115.0	106.1	105.2	8.6	20.5	87.2	90.0	10.3	24.0	8.62	8.62	20.52	20.52
28-Jul	105.7	105.3	105.9	110.2	109.2	110.6	106.1	105.5	106.7	112.9	112.3	114.6	106.1	107.4	8.7	20.7	94.6	97.9	9.9	23.1	8.69	8.68	20.59	20.59
29-Jul	106.4	105.9	106.7	112.2	110.7	113.6	106.8	106.4	107.4	113.0	112.5	114.6	108.3	109.0	13.1	21.1	113.7	115.0	11.3	19.3	12.89	8.67	21.31	21.31
30-Jul	107.4	106.9	107.8	112.2	110.4	111.6	107.7	107.3	108.2	113.2	112.8	114.3	110.0	111.3	8.6	20.9	103.2	106.2	8.5	20.3	8.70	8.70	21.00	20.99
31-Jul	108.5	108.0	109.1	111.7	110.8	112.0	108.6	107.8	109.5	113.8	113.2	114.2	111.6	112.3	8.8	21.1	105.4	107.1	8.6	20.2	8.75	8.76	21.21	21.21
1-Aug	109.6	109.1	110.3	112.2	111.2	112.9	109.2	108.5	110.2	114.2	113.8	115.5	111.7	112.9	9.2	20.3	89.9	93.0	10.7	23.7	9.16	9.17	20.52	20.52
2-Aug	109.6	109.0	109.9	112.2	111.0	112.3	109.7	108.9	110.1	114.2	113.9	114.8	111.4	111.6	8.2	17.9	88.2	90.9	9.7	21.8	8.15	8.16	17.76	17.76
3-Aug	109.4	108.6	109.0	112.0	111.3	112.6	109.2	108.3	109.4	115.3	114.9	116.8	110.6	110.0	9.9	22.7	94.1	94.9	10.8	25.7	9.89	9.89	22.80	22.80
4-Aug	108.5	107.8	108.2	112.0	111.0	112.2	108.4	108.2	108.6	114.9	114.3	115.6	108.9	108.7	10.1	22.4	101.7	102.4	10.3	23.7	10.15	10.15	22.67	22.67
5-Aug	107.7	106.5	107.0	111.6	110.7	112.1	108.4	107.1	108.1	114.6	112.7	115.6	108.3	107.9	9.8	20.8	111.0	115.7	8.9	18.3	9.79	9.80	21.06	21.06
6-Aug	106.3	105.6	105.9	111.3	110.3	111.4	107.2	106.7	107.5	113.5	112.1	114.0	107.9	108.4	8.8	20.7	122.3	126.4	7.2	16.6	8.72	8.71	20.58	20.57
7-Aug	106.9	106.4	107.2	111.9	110.7	112.4	107.7	106.9	108.5	113.9	113.3	116.6	109.3	109.7	9.2	20.7	99.6	101.6	10.3	24.9	9.83	9.83	20.88	20.88
8-Aug	107.5	107.3	107.7	111.8	107.3	110.0	108.1	107.4	108.4	114.4	112.6	116.0	109.4	109.6	0.0	18.4	95.4	98.5	0.0	19.8	0.00	0.00	18.42	18.42
9-Aug	107.4	106.9	107.3	106.7	106.1	106.6	107.3	105.9	106.7	112.6	111.7	115.5	109.2	109.2	0.0	19.6	93.4	99.2	0.0	22.2	0.00	0.00	19.48	19.49
10-Aug	107.1	106.7	107.2	108.7	107.1	111.6	106.5	106.1	106.6	112.8	112.5	116.4	111.2	111.7	4.1	22.4	110.8	113.7	2.7	22.9	4.82	0.00	22.70	22.69
11-Aug	107.6	107.2	108.1	108.7	106.1	106.7	107.0	105.3	107.8	114.4	113.6	117.8	111.3	113.3	0.0	22.8	102.0	105.9	0.0	26.3	0.00	0.00	22.71	22.71
12-Aug	107.9	107.7	108.0	107.4	106.7	108.5	107.6	106.9	108.2	112.8	107.9	111.2	112.5	113.6	0.7	3.0	105.5	107.6	0.6	6.8	0.90	0.00	3.17	0.01
13-Aug	108.0	107.7	108.3	112.0	110.1	114.6	108.5	107.5	109.8	108.4	107.5	109.8	112.5	112.9	11.7	0.0	121.6	125.4	7.8	0.0	11.58	0.00	0.00	0.00
14-Aug	108.2	107.8	108.2	112.0	107.3	108.7	109.6	107.7	110.6	109.6	107.9	110.5	111.5	110.3	0.0	0.0	118.0	121.7	0.0	0.0	0.00	0.00	0.00	0.00
15-Aug	107.4	106.2	107.0	106.6	105.5	106.3	106.5	105.3	106.2	106.6	105.4	106.2	106.8	105.0	0.0	0.0	110.7	115.5	0.0	0.0	0.00	0.00	0.00	0.00
16-Aug	105.9	104.9	105.4	105.2	104.2	104.4	105.7	104.4	105.1	105.7	104.5	105.0	106.7	107.5	0.0	0.0	107.6	112.3	0.0	0.0	0.00	0.00	0.00	0.00
17-Aug	105.5	105.2	105.7	107.2	105.7	110.0	105.3	104.6	105.5	105.2	104.7	105.4	106.8	105.9	3.9	0.0	118.5	121.6	2.8	0.0	3.71	0.00	0.00	0.00
18-Aug	106.3	105.9	106.5	107.7	105.5	106.6	105.8	105.5	106.0	105.7	105.6	106.0	106.8	107.3	0.0	0.0	115.3	118.6	0.0	0.0	0.00	0.00	0.00	0.00
19-Aug	108.2	107.3	111.6	108.7	107.1	111.6	106.6	106.0	106.9	106.6	106.0	106.9	107.3	108.1	4.4	0.0	125.6	128.2	3.2	0.0	4.14	0.00	0.00	0.00
20-Aug	111.1	109.7	112.0	110.5	108.8	110.9	110.0	108.7	110.6	110.0	108.7	110.7	106.9	105.8	0.0	0.0	115.5	119.1	0.0	0.0	0.00	0.00	0.00	0.00
21-Aug	108.6	106.2	108.0	108.0	105.8	107.4	109.5	105.8	107.3	109.7	105.9	107.8	105.2	104.8	0.0	0.0	114.2	119.8	0.0	0.0	0.00	0.00	0.00	0.00
22-Aug	105.1	102.9	104.0	104.7	102.7	103.5	105.2	103.1	104.2	105.3	103.2	104.4	105.9	106.7	0.0	0.0	116.5	120.0	0.0	0.0	0.00	0.00	0.00	0.00
23-Aug	103.1	103.0	103.3	102.8	102.6	103.0	103.2	102.6	103.5	103.1	102.6	103.4	106.6	107.3	0.0	0.0	106.7	112.4	0.0	0.0	0.00	0.00	0.00	0.00
24-Aug	103.1	103.0	103.2	102.7	102.6	102.8	103.3	102.8	103.3	103.3	102.8	103.3	106.6	105.9	0.0	0.0	106.1	108.3	0.0	0.0	0.00	0.00	0.00	0.00
25-Aug	103.1	102.9	103.2	102.7	102.5	102.7	103.1	102.6	103.5	103.1	102.6	103.4	105.3	105.5	0.0	0.0	118.4	123.0	0.0	0.0	0.00	0.00	0.00	0.00
26-Aug	103.0	102.7	103.2	102.6	102.2	102.4	103.2	102.4	103.1	103.2	102.5	103.1	104.7	105.3	0.0	0.0	115.1	120.6	0.0	0.0	0.00	0.00	0.00	0.00
27-Aug	103.5	103.2	103.9	102.9	102.7	103.1	103.4	102.7	103.6	103.3	102.8	103.6	104.7	104.2	0.0	0.0	96.7	102.3	0.0	0.0	0.00	0.00	0.00	0.00
28-Aug	104.2	104.0	104.3	103.7	103.4	103.9	103.7	103.3	104.2	103.5	103.3	104.1	103.9	104.1	0.0	0.0	103.1	106.8	0.0	0.0	0.00	0.00	0.00	0.00
29-Aug	104.7	104.3	104.9	103.8	103.5	104.3	104.2	103.7	104.2	104.2	103.8	104.4	103.9	104.0	0.0	0.0	79.4	82.3	0.0	0.0	0.00	0.00	0.00	0.00
30-Aug	103.8	102.6	103.4	103.3	102.1	103.0	103.4	102.3	103.5	103.5	102.4	103.5	102.4	102.1	0.0	0.0	77.9	83.4	0.0	0.0	0.00	0.00	0.00	0.00
31-Aug	102.4	101.9	102.1	101.6	101.4	101.8	101.8	101.7	101.9	101.9	101.7	101.9	102.3	102.6	0.0	0.0	96.5	100.2	0.0	0.0	0.00	0.00	0.00	0.00

APPENDIX F: ROCKY REACH PROJECT GAP

2015 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

April 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FPE	Fish Passage Efficiency
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
JBS	juvenile bypass system
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RRFF	Rocky Reach Fish Forum
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan
WQS	Water quality standards

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) 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 by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2015 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rocky Reach Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), Rocky Reach Operations Plan, TDG Operational Plan, a Quality Assurance Project Plan (QAPP) for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

Washington State water quality standards provide for a temporary exemption for elevated TDG levels to allow increased downstream migrating juvenile fish passage without causing more harm to fish populations than caused by turbine fish passage. Washington state water quality standards provide different standards for TDG during the non-fish and fish-spill seasons to aid fish passage. In the 401 Certification for the Rocky Reach Project, the non-fish spill season is defined as September 1 through March 31 and the fish-spill season is April 1 through August 31. 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 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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). A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the GAP 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the 401 Certification. These measures include, but are not limited to:

1. Minimizing voluntary spill.
2. During downstream migrating juvenile fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to 212 thousand cubic feet per second kcfs.
6. Implement alternative spillway operations, using of gates 2 through 12, to determine whether TDG levels can be reduced without adverse effects on fish passage. If effective, implement to reduce TDG.

Additionally, Chelan PUD proposes to implement the following measures, as required by the 401 Certification:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to United States Army Corps of Engineers (USACE) Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's flow, TDG, gas bubble trauma (GBT) monitoring, and fish study results, and, in accordance with the previous (2014) GAP, submit to Ecology by December 31.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Rocky Reach Hydroelectric Project, located on the Columbia River downstream of Wells Dam (Figure 1-1). The Project is licensed as Project No. 2145 by the Federal Energy Regulatory Commission (FERC). The 401 Certification for the Project was issued by Ecology on March 17, 2006. The 401 Certification terms and conditions are incorporated in the new FERC license to operate the Project which was issued on February 19, 2009. Section 5.4.3 of the 401 Certification requires Chelan PUD to submit an annual GAP in accordance with Ecology's water quality standards for total dissolved gas TDG beginning on April 1 of the year of implementation.

This GAP is being submitted to Ecology as a condition of the 2006 Special Fish Passage Exemption (WAC 173-201A-200(1)(f)) and Section 5.4.3 of the 401 Certification. Chelan PUD respectfully submits this GAP with the goal of receiving a temporary exemption for TDG commencing with the 2014 fish[1] spill season. This GAP provides details associated with proposed 2015 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

1.1 Project Description

The Rocky Reach Project is owned and operated by Chelan PUD and is located on the Columbia River at river mile 474, about seven miles upstream of the city of Wenatchee. Construction of the dam and powerhouse began in 1956 and the Project was completed and put into production in 1961. The impounding structures are a mass of reinforced concrete consisting of a forebay wall section about 460 feet long, a combined intake and powerhouse section 1,088 feet long, a non-overflow center dam spillway that is 740 feet long consisting of 12 bays, each controlled by a 50 foot wide, 58 foot high radial gate. A 2,000 foot subsurface cutoff wall consisting of a grout curtain and a compacted impervious barrier limits seepage through a terrace forming the east bank.

The forebay wall consists of mass concrete gravity blocks of various heights, with a maximum height of 118 feet. The service bay connects the forebay wall to the powerhouse. The powerhouse contains 11 units, each 86 feet wide and about 200 feet long. The Project's FERC license authorized installed capacity is 865.76 megawatts (MW).

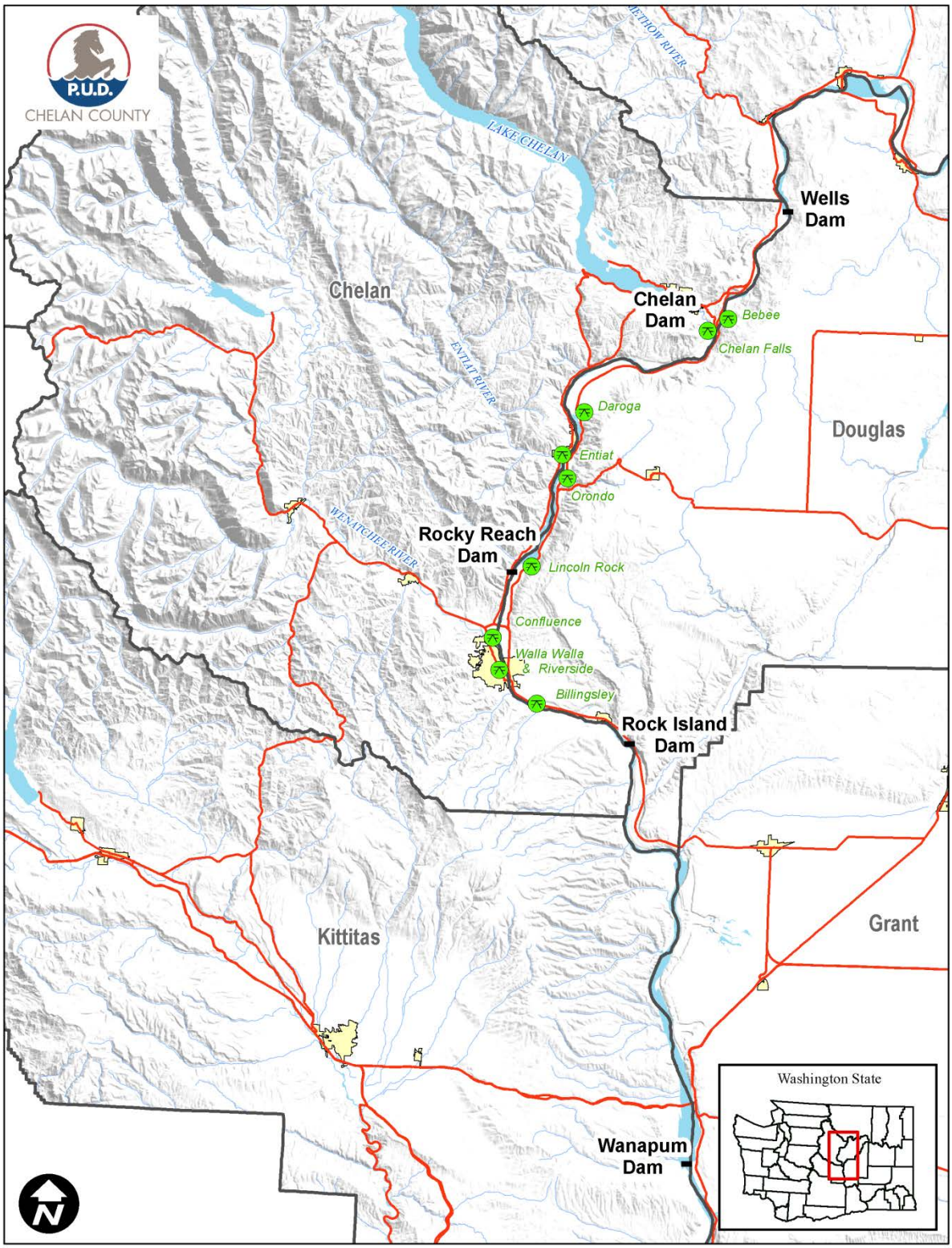

Figure 1-1: Location of Rocky Reach Hydroelectric Project on the Columbia River.

The Project contains an adult fishway to provide upstream fish passage and a juvenile fish bypass system (JBS) which began operation in 2003 to provide downstream fish passage for juvenile salmon and steelhead. The fishway consists of a fish ladder, transportation channel, collection channel and three entrances. The JBS consists of a surface collection system adjacent to the forebay wall, intake screens, and a bypass conduit routed along the downstream side of the powerhouse and spillway, through a fish collection facility, and to an outfall downstream of the Project near the dam's left abutment.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2014 flows at the Rocky Reach Project is shown below in Table 1-1.

Table 1-1: Comparison of 10 year average flows to 2014 flows at the Rocky Reach Project.

Season	10 Year Average Flows (2004-2013)	2014 Flows	Percent of 10 Year Average
Spring (4/1-5/23)	130.43 kcfs	154.8 kcfs	118.7%
Summer (5/24-8/31)	147.4 kcfs	151.4 kcfs	102.7%

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG exemption. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-Spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill (for downstream migrating juveniles) season as April 1 through August 31 of each year. Non-fish spill season is defined as September 1 through March 31, unless otherwise specified in writing to Ecology following consultation with the Rocky Reach Fish Forum and the HCP Coordinating Committee.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rocky Reach Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for the Rocky Reach Project was calculated to be 252 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). Since special criteria have been established in Washington for "voluntary" spills for downstream migrating juvenile fish passage under an approved plan, the TMDL sets TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

Section 5.4.7 of the Rocky Reach Project 401 Certification states: "*This certification, along with the WQMP and the updated GAP, is intended to serve as the Rocky Reach Project's portion of the Detailed Implementation Plan (DIP) for the Mid-Columbia River and Lake Roosevelt TDG TMDL"*.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the Hourly Coordination Agreement, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project through management of a positive or negative "bias" which assigns a project more or less generation depending on whether

the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the HCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 2015 Rocky Reach Operations Plan

Article 402 of the Rocky Reach License requires an annual Operations Plan be submitted to the FERC by February 15 each year for approval (revised submittal date of March 30). This Operations Plan includes the following: (a) descriptions of fisheries (juvenile and adult) and water quality-related operating criteria for the Project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (b) descriptions of fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the Project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (c) an annual schedule for operation and inspection of these facilities. The information contained in the annual Operations Plan is relevant to Chelan PUD's TDG abatement activities and is therefore attached for reference as Appendix C to this GAP.

1.4.2 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rocky Reach HCP serves as the foundation for the fisheries management plan at Rocky Reach Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act (ESA). Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The Rock Reach HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including spill and the use of the JBS. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rocky Reach while operating the JBS exclusively.

1.4.3 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the United States Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the United States Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant PUDs), the USACE, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on ESA listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CCT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.4 Spill Operations

1.4.4.1 Spill Gate Configuration

The standard (fish) spill configuration used at Rocky Reach uses gates 2 through 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 upstream migrating adult fishway entrances.

This spill pattern provides favorable guidance conditions for adult migrant salmon and steelhead. This spill configuration and alternate patterns were tested and it was determined this pattern was as good as, if not better than, the alternate patterns for upmigrating salmonids (Schneider and Wilhelms, 2005). The same pattern is used for juvenile downstream migrating 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.

Note that although the above referenced crown-shaped pattern may be as good as, if not better, than tested alternate patterns for upmigrating salmonids, it may not be ideal for TDG. According to Section 5.4(1)(b)(6) of the 401 Certification, Chelan PUD shall study alternative spillway operations using any of gates 2 through 12. In 2011 and 2012, Chelan PUD studied alternative spillway flow distribution patterns, in order to evaluate the potential to reduce total dissolved gas TDG levels, particularly during high spill levels (above 50 kcfs). Generally, all of the three alternative spill patterns studied resulted in lower TDG levels than the standard spill pattern. Of the three alternative patterns, the flat spill pattern (flow distributed evenly between spillway gates) had a slightly better TDG performance than the other two alternative patterns. Chelan PUD has presented these findings to Ecology, the Rocky Reach Fish Forum (RRFF) and Habitat Conservation Plan Coordinating Committee (HCP CC).

Chelan PUD, through the consultation process with Ecology, the RRFF, and the HCP CC, will develop a schedule to make the necessary changes to perform the new spill configuration. This schedule may include but not be limited to; computer automation of spill gates (2015), and/or changes to system operations and monitoring. Chelan PUD will operate the new spill configuration as a pilot or test spill and further evaluate the results for a designated period of time. Chelan PUD shall develop a monitoring schedule to test operations under the new spill configuration. If upon operating under the new spill configuration data show that optimal results are not occurring as previously evaluated, Chelan PUD shall implement adaptive management in coordination with the RRFF and HCP CC.

1.4.4.2 Spill Scenarios

There are six main scenarios that may result in spill at Rocky Reach Dam. These are described below:

Fish Spill

Spill is an ineffective method of bypassing downstream migrating juvenile fish away from the turbines at Rocky Reach Dam (Steig et. al., 1997) and, consequently, is not considered as the solution for the long-term fish passage program. To minimize or eliminate the need for fish spill, Chelan PUD is focusing its efforts on increasing the fish passage efficiency and survival through the juvenile fish bypass system (JBS).

The JBS continues to be the most efficient non-turbine route for downstream migrating juvenile fish passage at the Rocky Reach Project. The JBS does not require spill for its operation.

Spring Fish Spill Operations

Operating the JBS exclusively, Chelan PUD has been able to meet the HCP survival standards for the three spring migrants (spring/yearling Chinook, steelhead, and sockeye). Chelan PUD will continue operating the JBS exclusively, with no voluntary spill, during the spring of 2015.

Summer Fish Spill Operations

Summer spill at Rocky Reach for subyearling Chinook will be nine percent of day average flow. Commencement of summer spill will be determined using run-timing information at Rocky Reach. Summer spill generally begins in early June and ends in mid-August when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license (707 feet), to prevent overtopping of the Project, and

to maintain optimum operational conditions. When spilling for fish or due to excess inflow or generation, the spillway is operated using gate settings that have been shown to limit TDG production and meet fish passage requirements (Schneider and Wilhelms, 2005). To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rocky Reach. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2014

1.5.1 TDG Compliance 2014

Information regarding spill and TDG are for 2014 are displayed in Tables 1-2 and 1-3 and further described below.

Tailrace 120 percent Standard

TDG data was collected on 153 days during the 2014 fish-spill season in the Rocky Reach tailrace. None of the data was omitted from the data set due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on 11 days. Compliance with this standard was 92.8 percent.

Tailrace 125 percent Standard

Total hours of TDG data collected during the 2014 fish spill season in the Rocky Reach tailrace equaled 3,672. No hours were eliminated from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125 percent for 18 hours. Compliance with this standard was 99.9 percent.

Downstream (Rock Island) Forebay 115 percent Standard

TDG data was collected on 141 days during the 2014 fish spill season in the Rock Island forebay. However, of those 141 days 12 were omitted from the data set used for determination of compliance due to upstream forebay 12C-High TDG exceeding 115 percent. The Rock Island forebay 12C-High TDG exceeded 115 percent on 7 days. Compliance with this standard was 95.0 percent.

Table 1-2: Summary of Spill at the Rocky Reach Project in 2014

Date	Fish Spill Average kcfs	Total Spill Average kcfs	River Flow Average kcfs	% Total Spill	% Fish Spill of Total River	% Fish spill of Total Spill
4/1 - 8/31	8.4	14.6	150.3	9.7	5.6	57.5

Table 1-3: Summary of TDG Compliance at the Rocky Reach Project in 2014

Date	% Compliance with 120% Tailrace Standard	% Compliance with 125% Tailrace Standard	% Compliance with 115% Downstream Forebay TDG Standard
4/1 - 8/31	92.8	99.9	95.0

1.5.2 TDG Activities Implemented 2014

As defined in Section 5.4.1(b) of the 401 Certification, Chelan PUD implemented six actions to minimize voluntary and involuntary spill at Rocky Reach in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rocky Reach Project was the implementation of the operational spill programs and the ability to minimize spill through operation of the JBS. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to 212 kcfs.
- Contracted with Parametrix to have the data gathered during the 2011 and 2012 testing of alternative spillway configurations analyzed and summarized. The report has been reviewed by Ecology, the HCP CC and the RRFF. The results of the report are briefly summarized in Section 1.4.4.1.

1.5.3 TDG Structural Measures Implemented in 2014

No structural gas abatement measures were proposed or implemented at the Rocky Reach Project in 2014.

SECTION 2: PROPOSED 2015 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2014 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Section 5.4.1(b) of the 401 Certification requires Chelan PUD to manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and Anadromous Fish Agreement[2]. During the 2015 fish spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. **Minimize voluntary spill**
   Success of the JBS has enabled Chelan PUD to reduce spill required for fish passage.

2. **Manage voluntary spill in real time**
   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).The TDG Operational Plan is updated annually and routed to the Project operators. It provides the operators a list of actions they are to follow if TDG meets the designated thresholds.

3. **Minimize involuntary spill**
   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. **Participate in Hourly Coordination Agreement**
   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. **Maximize powerhouse discharge as appropriate up to hydraulic capacity**

6. **Implement alternative spillway operation**
   Chelan PUD will develop a proposal in 2015 to present to the HCP Coordinating Committee and Rocky Reach Fish Forum.

Per Section 5.4(5) of the 401 Certification, operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

[2] Additional conditions used to determine compliance with the water quality criteria for TDG can be found in Sections 5.4(1)(d)-(g) of the 401 Certification, as well as Section 4.4 of this Plan.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rocky Reach Project in 2015. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a QAPP.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rocky Reach Project to monitor hourly TDG levels annually from April through August. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The forebay fixed monitoring station (Figure 2-1) is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station (Figure 2-2) is located approximately 0.38 miles downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is east of mid-channel, and is minimally impacted by powerhouse flows when the Project is passing water over the spillway (Schneider and Wilhelms, 2005).

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental to perform calibrations and equipment maintenance during the 2015 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish spill season, and every other month during the non-fish spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. Quality assurance/quality control (QA/QC) measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be 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 will be conducted during the calibrations.

Figure 3-1: Location of forebay fixed monitoring station at Rocky Reach Hydroelectric Project.

3.1.1 Fish Spill Season (April 1 through August 31)

TDG measurements will be recorded throughout the fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.1.2 Non-Fish Spill Season (September 1 through March 31)

TDG measurements will be recorded throughout the non-fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.2 Quality Assurance

Section 5.7.3 of the 401 Certification requires Chelan PUD to maintain a TDG monitoring program that is at least as stringent as the QA/QC calibration and monitoring procedures and protocols developed by the USGS monitoring methodology for the Columbia River.

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as Hydro Lab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's QAPP (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach 401 Water Quality Certification requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. Ecology has recommended Chelan PUD postpone any GBT study and native fish and/or invertebrates until such time at it may be required. Ecology is currently evaluating the need for future GBT studies.

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct (GBT) monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead and subyearling chinook will be examined two days per week during the sampling season (April 1st to August 31st). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). The results of this monitoring effort will be included in the annual report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

Section 5.7.6 of the 401 Certification requires hourly TDG information be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1 above, and any deviation from the TDG Operational Plan or the fish spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft Gas Abatement Annual Monitoring Report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The GAP Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish spill season and non-fish spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (gas bubble trauma) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP[3] used to predict compliance with TDG numeric criteria.

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[3] The WQMP is a response to Ecology's request that the PUD provided the scientific and biological basis for Ecology's Section 401 certification. It is the principal supporting document for the 401. As stated in Chapter 2 of the Comprehensive Plan (Attachment B to the Rocky Reach Settlement Agreement):

> "*Ecology is a participant in the Settlement Group negotiating conditions for relicensing of the Project, and has requested that Public Utility District No. 1 of Chelan County (Chelan PUD) help provide the scientific and biological basis for Ecology's Section 401 Certification. The Settlement Group has developed a Comprehensive Plan that provides the rationale and details behind proposed license articles that the Settlement Group will recommend for inclusion in the New License to be issued by FERC. The Rocky Reach Water Quality Management Plan is in response to Ecology's request and is contained in this chapter of the Comprehensive Plan.*

The WQMP includes Project background; background water quality; management considerations and options investigated; and protection, mitigation, and enhancement measures.

The analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG numeric criteria will include the following steps:

- Input relevant 2008 (post relocation of tailrace fixed monitoring site) and 2009-2013 data,
- Analyze to see if the relationship between quantity of spill and TDG yields a similar or different regression than that predicted for site FOP1 (located just downstream and landward of the current tailrace monitoring site (Figure 2)) in Schneider and Wilhelms (2005),
- If regression is different, look for patterns that may explain the difference,
- Determine if any differences in the regression affect the predictions in Schneider and Wilhelms (2005) to meet TDG standards up to 7Q10 flows.

4.4 Determination of Compliance in Year 5

As per Section 5.4(1)(d) of the 401 Certification, in Year 5 of the effective date of the New License, Chelan PUD shall prepare a report summarizing the results of all TDG studies performed to date, and describing whether compliance with the numeric criteria has been attained.

This report was submitted as a Draft to Ecology and the RRFF on October 31, 2014 and the HCP CC on November 25, 2014. The HCP CC requested an additional 30 day comment period extending the final due date to Ecology on January 30, 2015. Ecology approved the extension and final due date. Comments were received and incorporated into the final report submitted to Ecology on January 30, 2015. Chelan PUD is awaiting Ecology's notification regarding the next actions.

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

As per Section 5.4(3) of the 401 Certification, the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

Additionally, beginning in year 10, and every 10 years thereafter, the revised annual GAP shall include a review of reasonable and feasible gas abatement options to incrementally reduce TDG caused by the Project, in light of new information and technology. If any reasonable and feasible measures are identified, Chelan PUD shall present the data and analysis to the RRFF and develop an implementation plan. The implementation plan shall be included in the GAP for review and approval by Ecology.

SECTION 6: CONCLUSIONS

Pending approval by Ecology, implementation of the measures presented in this 2015 GAP are intended to ensure compliance with the Washington state water quality standards for TDG in the Columbia River at the Rocky Reach Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Anadromous Fish Agreement. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Federal Energy Regulatory Commission (FERC). 2009. Order on Offer of Settlement and Issuing New License, Project No. 2145-060.

Fish Passage Center (FPC). 2009. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.

Schneider, M.L. and S.C. Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. Prepared by COE, Engineer Research and Development Center, for Chelan PUD. July 2005. http://www.chelanpud.org/rr_relicense/study/reports/7773_1.pdf

Steig, T.W., R. Adeniyi, and V. Locke. 1997. Hydroacoustic evaluation of the fish passage through the powerhouse, the spillway, and the surface collector at Rocky Reach Dam in the spring and summer of 1997. Report by Hydroacoustic Technology, Inc. to Chelan Co. PUD, Wenatchee, Wash.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCKY REACH HABITAT CONSERVATION PLAN

The Rocky Reach Habitat Conservation Plan can be found at:
http://www.midcolumbiahcp.org/RR_HCP.pdf

APPENDIX B: 2015 ROCKY REACH TDG OPERATIONAL PLAN

2015 Rocky Reach Operational Plan

for Total Dissolved Gas During Fish Spill Season

April 1 through August 31

(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

APPENDIX C: OPERATIONS PLAN

FERC License Requirement (Article 402)

The 2015 Rocky Reach Operations Plan can be found at the following link:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/44507.pdf

APPENDIX D: 2010 QUALITY ASSURANCE PROJECT PLAN

Rocky Reach Water Quality Monitoring and Reporting

The 2010 Quality Assurance Project Plan can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf

APPENDIX E: 2014 GAS ABATEMENT ANNUAL REPORT

The 2014 Gas Abatement Annual Report can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/43948.pdf

APPENDIX F: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rocky Reach on February 13, 2015 for review and comment. On March 13, 2015, Ecology sent Chelan PUD an email stating that they had reviewed and approved the Gas Abatement Plan. Both emails are included below.

From:	Steinmetz, Marcie
To:	"McKinney, Charlie (ECY)"; "Coffin, Chris (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Sokolowski, Rosana; Bitterman, Deborah
Subject:	Draft 2015 Gas Abatement Plans for Rocky Reach and Rock Island dams
Date:	Friday, February 13, 2015 10:34:00 AM
Attachments:	44505 DRAFT 2015 Rocky Reach GAP 021015.docx 44506 DRAFT 2015 Rock Island GAP 021015.docx

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

To: Chris Coffin, Washington Department of Ecology
Charlie McKinney, Washington Department of Ecology

From: Marcie Steinmetz, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943
DRAFT 2015 Total Dissolved Gas Abatement Plans

Please find attached the 2015 DRAFT Rocky Reach and Rock Island Total Dissolved Gas Abatement Plans for your review. Please submit your comments on or before 5:00 p.m., March 13, 2015 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | Water Resource Specialist
Chelan County Public Utility District No.1 | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

From:	McKinney, Charlie (ECY)
To:	Steinmetz, Marcie
Cc:	Coffin, Chris (ECY)
Subject:	Approvals for GAPS & OPS Plan
Date:	Friday, March 13, 2015 9:55:49 AM
Importance:	High

March 13, 2015

To: Marcie Steinmetz, Chelan PUD No. 1

From: Charles McKinney, WA Dept. of Ecology, Water Quality Program

The WA Department of Ecology (Ecology) has reviewed and approves the **Draft 2015 Total Dissolved Gas Abatement Plans submitted by Chelan PUD for the Rocky Reach and Rock Island Projects.**
Ecology has also reviewed and approves the **Draft 2015 Operations Plan for the Rocky Reach Project.**

Ecology grants Chelan PUD an adjustment to the 110% TDG standard for the purposes of the 2015 Spill Season, as authorized under WAC 173-201A-200(1)(f)(ii), in order to facilitate the passage of ESA listed salmonids at the Project.

Thank you for your cooperation. Please let me know if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX G: ROCK ISLAND PROJECT GAP

2015 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

April 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI HCP	Rock Island Habitat Conservation Plan
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) as required by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2015 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rock Island Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), TDG Operational Plan, the Quality Assurance Project Plan for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

Washington State water quality standards provide for a temporary exemption for elevated TDG levels to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. Washington state water quality standards provide different standards for total dissolved gas (TDG) during the non-fish and fish-spill seasons to aid fish passage. In Ecology's 401 Water Quality Certification (401 Certification) for the Rocky Reach Project, the non-fish spill season is defined as September 1 through March 31 and the fish-spill season is April 1 through August 31. Chelan PUD assumes these dates apply to Rock Island Dam as well. 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 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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).

- A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the Rock Island Total Dissolved Gas Abatement Plan (GAP) 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement the following applicable operational measures:

1. Minimizing voluntary spill.
2. During fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

Additionally, Chelan PUD proposes to implement the following measures:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to U.S. Army Corps of Engineers Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's flow, TDG, gas bubble trauma (GBT) monitoring, and fish (could include juvenile and adult) study results, and, in accordance with the previous (2014) GAP, submit to Ecology by December 31.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Project, located on the Columbia River approximately 12 miles downstream of the city of Wenatchee (Figure 1-1). The Project is licensed as Project No. 943 by the Federal Energy Regulatory Commission (FERC).

This GAP is being submitted to Ecology as a condition of the 2006 Special Fish Passage Exemption (WAC 173-201A-200(1)(f)). Chelan PUD respectfully submits this GAP with the goal of receiving a temporary exemption for TDG commencing with the 2015 fish[1] spill season. This GAP provides details associated with proposed 2015 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

A 401 Certification for the operation of Chelan PUD's Rocky Reach Hydroelectric Project was issued by the Ecology on March 17, 2006. The 2015 Rock Island TDG monitoring and reporting will be conducted in a manner consistent with the TDG and Gas Abatement monitoring and reporting requirements within the Rocky Reach 401 Certification.

1.1 Project Description

Rock Island Project is owned and operated by Chelan PUD. The structure is 3,800 feet in length and is constructed from reinforced concrete. The dam is located at Columbia River mile 453.4, about 12 miles downstream from the city of Wenatchee. The Project contains a reservoir extending 21 miles upriver to the tailrace of Rocky Reach Dam and covers 3,300 acres. The Rock Island Project has no significant water storage capabilities. The normal maximum reservoir elevation of Rock Island Project is 613 feet with a tailrace elevation of 572 feet and a head of 41 feet. The Project discharges into a reservoir ponded by Wanapum Dam located 37.6 miles downstream.

The Project consists of two powerhouses. Powerhouse 1 is located on the east bank of the Project at a 45-degree angle from the bank. The powerhouse consists of 10 vertical shaft turbines with a rated output of 212 mega watts (MW). Powerhouse 2 is located on the west bank and is 470 feet wide, housing eight horizontal shaft turbines with a rated power output of 410 MW. The combined hydraulic capacity of both powerhouses is 220 thousand cubic feet per second (kcfs).

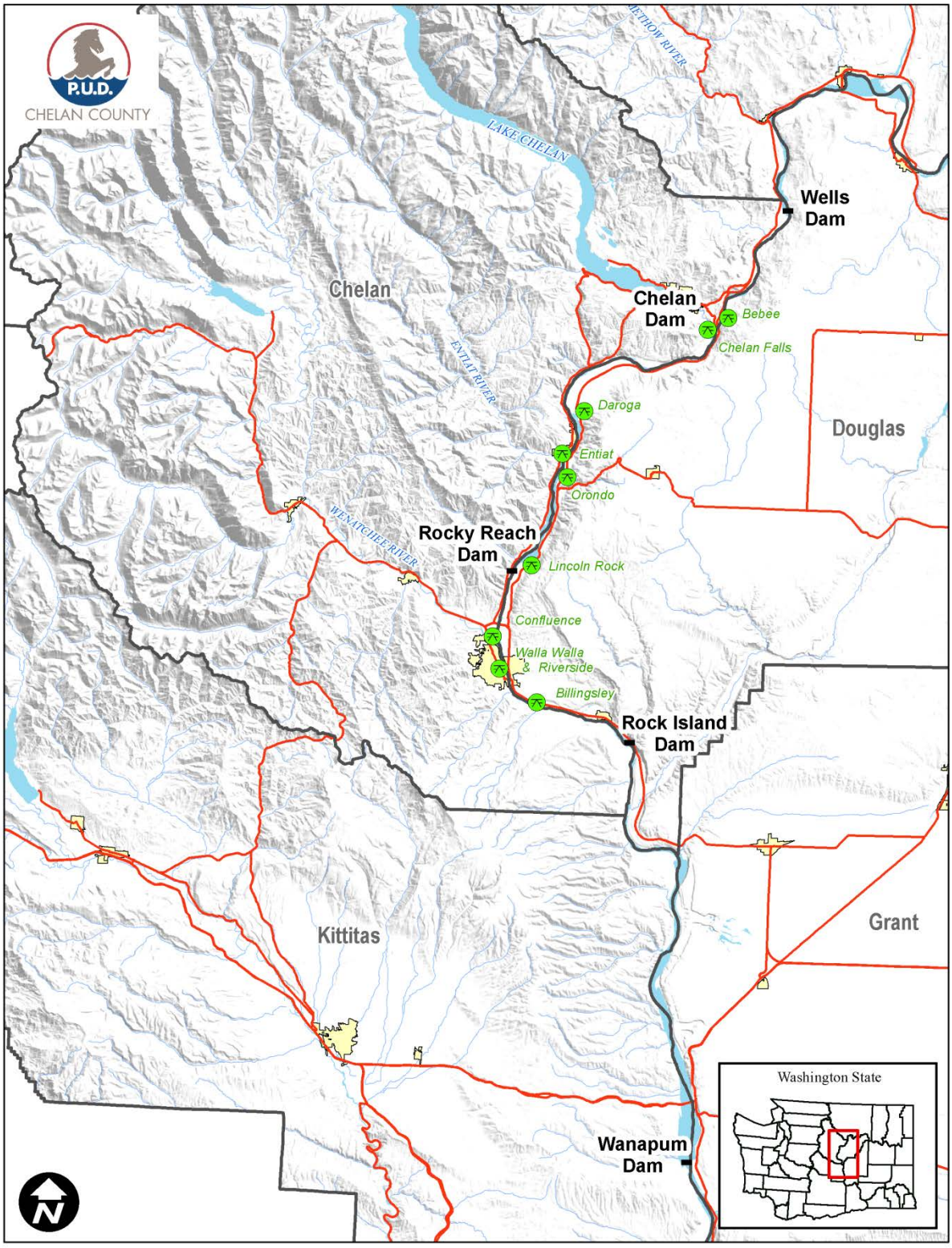

Figure 1-1: Location of Rock Island Hydroelectric Project on the Columbia River.

The Project configuration includes a spillway of 32 bays with a total length of 1,184 feet. Gates are separated by a middle adult fish ladder (located at bay 15) that divides the spillway into east and west sections. The west (Chelan County side) spillway consists of seven deep bays and ten shallow bays, and the east (Douglas County side) spillway consists of six deep bays and eight shallow bays. Each spillway has two or three crest gates, which are stacked one on top of the other. The crest gates are 30 feet wide and either 11 or 22 feet high. The larger crest gates are positioned closest to the water surface, and when fully raised, spill approximately 10 kcfs.

The deep bays have a sill elevation of 559 feet, which is about 13 feet below the average tailwater elevation of 572 feet. The shallow bays have a sill elevation of 581.5 feet, which is about 9.5 feet above the average tailwater elevation.

The focus of juvenile fish bypass at Rock Island Dam has been directed towards optimizing the efficiency of fish passage via spill. To achieve this, nine of the thirty-two spill bays have had their spill gates modified to provide surface spill. Surface spill was accomplished by putting notches in the upper sections of the spill gates. Six of the nine gates have notches that are 8 feet wide by 17 feet deep and can spill up to 2,500 cubic feet per second (cfs). The remaining gates have notches that are smaller and pass less volume (approximately 1,850 cfs). The total amount of water that can be passed through the notched gates is approximately 21,000 cfs. Three of the modified gates have had further modification and now have a "over-under" design which enables surface flow attraction and delivers water in the tailrace towards the surface, thus reducing the uptake of atmospheric gases.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10 year average flows to 2014 flows at the Rock Island Project is shown below in Table 1-1.

Table 1-1: Comparison of 10 year average flows to 2014 flows at the Rock Island Project.

Season	10 Year Average Flows (2004-2013)	2014 Flows	% of 10 Year Average
Spring (4/1-5/23)	145.3	175	120.4
Summer (5/28-8/31)	151	157.8	Stet.

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

The Washington State Administrative Code (WAC) 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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG exemption. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-Spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill season as April 1 through August 31 of each year. Non-fish spill season is defined as September 1 through March 31. Chelan PUD has assumed these dates also apply to Rock Island Dam.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rock Island Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for the Rock Island Project was calculated to be 264 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). Since special criteria have been established in Washington for “voluntary” spills for downstream migrating juvenile fish passage under an approved plan, the TMDL sets TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam’s forebay and tailrace and at the upstream boundaries.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia Projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the Hourly Coordination Agreement, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These preset reservoir levels are maintained at each Project through management of a positive or negative "bias" which assigns a Project more or less generation depending on whether the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the HCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rock Island HCP (RI HCP) serves as the foundation for the fisheries management plan at Rock Island Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the “maximum extent practicable” as required by the Endangered Species Act. Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The RI HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including, but limited to, spill and powerhouse operations. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations.

1.4.2 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant), the Corps, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on Endangered Species Act (ESA) listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CTT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.3 Spill Operations

It is recognized that achieving regulatory TDG levels may not be possible during spill associated with large flood (7Q10) events. However, at Rock Island Dam it may be possible to achieve current regulatory TDG levels during releases for fish bypass and up to the 7Q10 flows (264 kcfs) by selective operation of spillway bays. The Rock Island Project is unique due to the diversity of variations in how flow is released, which may assist in the development of spill scenarios that could result in a reduction of gas in the tailrace.

There are six main scenarios that may result in spill at Rock Island Dam. These are, but are not limited to:

Fish Spill

As part of the Rock Island HCP, 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. 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 percent of the daily average flow to 10 percent of the daily average flow. Summer spill at Rock Island remains at 20 percent of the daily average flow. This summer spill was level was set by the HCP in 2002 and will remain at 20 percent until such time Chelan PUD is able to test survival of subyearling (summer) Chinook. To date, Chelan PUD has not been able to test survival due to tag technology limitations and uncertainties regarding the life history (migration

behavior) of subyearling Chinook. The 20 percent spill level must be maintained until tag technology becomes available that will enable us to accurately measure survival at the current spill level.

Spring Fish Spill Operations
HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations. Chelan PUD will continue spilling 10 percent through the spring migration. Spring fish spill will begin no later than April 17 and will continue until the end of the spring outmigration (95 percent passage point), and subyearling Chinook have arrived at the Project.

Summer Fish Spill Operations
Summer spill at Rock Island for subyearling Chinook will be 20 percent of day average flow over 95 percent of the summer outmigration. Summer spill will commence after the completion of spring spill. Summer spill for subyearling Chinook generally ends no later than August 15 when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity
The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license, to prevent overtopping of the Project, and to maintain optimum operational conditions. With this type of release, flows up to, and in excess of the 7Q10 flood flows (264 kcfs) can be accommodated. To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill
This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill
Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river

reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rock Island. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2014

1.5.1 TDG Compliance 2014

Information regarding spill and TDG are for 2014 are displayed in Tables 1-2 and 1-3 and further described below.

Tailrace 120 percent Standard

TDG data was collected on 146 days during the 2014 fish spill season in the Rock Island tailrace. No days were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on 7 days.
Compliance with this standard was 95.2 percent.

Tailrace 125 percent Standard

Total hours of TDG data collected during the 2014 fish spill season in the Rock Island tailrace equaled 3,654. No hours were omitted from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125 percent for 0 hours.
Compliance with this standard was 100 percent.

Downstream (Wanapum) Forebay 115 percent Standard

TDG data was collected on 153 days during the 2014 fish spill season in the Wanapum forebay. However, of those 153 days 5 were omitted from the data set used for determination of compliance due upstream forebay 12C-High TDG exceeding 115 percent. The Wanapum forebay 12C-High TDG exceeded 115 percent on 24 days. Compliance with this standard was 84.3 percent.

Table 1-2: Summary of Spill at the Rock Island Project in 2014

Date	Fish Spill Average kcfs	Total Spill Average kcfs	River Flow Average kcfs	% Total Spill	% Fish Spill of total River	% Fish spill of Total Spill
4/1 – 8/31	23.5	31.6	156.2	20.2	15.0	74.4

Table 1-3: Summary of TDG Compliance at the Rock Island Project in 2014

Date	% Compliance with 120% Tailrace Standard	% Compliance with 125% Tailrace Standard	% Compliance with 115% Downstream Forebay TDG Standard
4/1 – 8/31	95.2	100	84.3

1.5.2 TDG Activities Implemented in 2014

In 2014 Chelan PUD implemented five actions to minimize voluntary and involuntary spill at Rock Island in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rock Island Project was the implementation of the operational spill programs and the ability to minimize spill through success of survival studies. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

1.5.3 TDG Structural Measures Implemented in 2014

No structural gas abatement measures were proposed or constructed in 2014. However, Chelan PUD continues to utilize the over/under gates that were installed in 2007 to reduce TDG generation at the Project.

SECTION 2: PROPOSED 2015 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2015 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Chelan PUD will manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards sets forth in the HCP and associated Anadromous Fish Agreement. During the 2015 fish spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. Minimize voluntary spill

   Success of the survival studies have allowed Chelan PUD to reduce spring spill required for fish passage.

2. Manage voluntary spill in real time

   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria,

3. Minimize involuntary spill

   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. Participate in Hourly Coordination Agreement

   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. Maximize powerhouse discharge as appropriate up to hydraulic capacity

Operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rock Island Project in 2015. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a quality assurance protection plan.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rock Island Project to monitor hourly TDG levels annually from April through August. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rock Island forebay fixed monitoring station (Figure 3-1) is affixed to the Project, located on the west side of the river, near the right bank fishway and Powerhouse 2, approximately 70 feet from the shore. The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations. The site was chosen based on accessibility and is thought be representative of forebay TDG because water is as well mixed and flow is as constant as at any other location in the forebay. No bridge or other permanent in-water structure is available downriver of Rock Island Project on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the Project on the eastern shoreline (Figure 3-2). This FMS has two means of deploying the dissolved gas probe, a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold that holds the carriage system.

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental (CBE) to perform calibrations and equipment maintenance during the 2015 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish spill season, and every other month during the non-fish spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. QA/QC measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be 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 will be conducted during the calibrations.

Figure 3-1: Location of forebay fixed monitoring station at Rock Island Hydroelectric Project.

Figure 3-2: Location of tailrace fixed monitoring station below Rock Island Hydroelectric Project.

3.1.1 Fish Spill Season (April 1 – August 31)

TDG measurements will be recorded throughout the fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.1.2 Non-Fish Spill Season (September 1 – March 31)

TDG measurements will also be recorded throughout the non-fish spill season at 15-minute intervals. These 15-minute intervals will be averaged into hourly readings for use in determining daily high TDG levels. All hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.2 Quality Assurance

Chelan PUD has developed its Quality Assurance/Quality Control (QA/QC) protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as HydroLab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's Quality Assurance Project Plan (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct GBT monitoring at the Rock Island Bypass Trap. Random samples of 100 spring chinook, steelhead and subyearling chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). he results of this monitoring effort will be included in the Gas Abatement Annual Report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

TDG information will be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. Chelan PUD has added a link to the website to direct the public to the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1, and any deviation from the TDG Operational Plan or the fish spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Gas Abatement Annual Report

Chelan PUD will provide Ecology with a draft TDG annual monitoring report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Monitoring Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish spill season and non-fish spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (GBT) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

Consistent with WAC 173-201A-200(1)(f)(ii), the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

SECTION 6: CONCLUSIONS

Pending approval by Ecology, implementation of the measures presented in this 2015 GAP are intended to ensure compliance with the Washington state water quality standards for TDG in the Columbia River at the Rock Island Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the Rock Island HCP and Anadromous Fish Agreement. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Fish Passage Center (FPC). 2009. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCK ISLAND HABITAT CONSERVATION PLAN

The Rock Island Habitat Conservation Plan can be found at:
http://www.midcolumbiahcp.org/RI_HCP.pdf)

APPENDIX B: 2015 ROCK ISLAND TDG OPERATIONAL PLAN

2015 Rock Island TDG Operational Plan

During Fish Spill Season (April 1 through 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%, reopen notched gates in the reverse order of closure**

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, **please contact Thad Mosey (661-4451, cell 670-5594) and Marcie Steinmetz (661-4186, cell (509) 280-1955) immediately** so they can determine the next steps to take.

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

APPENDIX C: 2010 QUALITY ASSURANCE PROJECT PLAN

Rocky Reach Water Quality Monitoring and Reporting

The 2010 Quality Assurance Project Plan can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf

APPENDIX D: 2014 GAS ABATEMENT ANNUAL REPORT

The 2014 Gas Abatement Annual Report can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/43948.pdf

APPENDIX E: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rock Island on February 13, 2015 for review and comment. On March 13, 2015, Ecology sent Chelan PUD an email stating that they had reviewed and approved the Gas Abatement Plan. Both emails are included below.

From:	Steinmetz, Marcie
To:	"McKinney, Charlie (ECY)"; "Coffin, Chris (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Sokolowski, Rosana; Bitterman, Deborah
Subject:	Draft 2015 Gas Abatement Plans for Rocky Reach and Rock Island dams
Date:	Friday, February 13, 2015 10:34:00 AM
Attachments:	44505 DRAFT 2015 Rocky Reach GAP 021015.docx 44506 DRAFT 2015 Rock Island GAP 021015.docx

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

To: Chris Coffin, Washington Department of Ecology
Charlie McKinney, Washington Department of Ecology

From: Marcie Steinmetz, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943
DRAFT 2015 Total Dissolved Gas Abatement Plans

Please find attached the 2015 DRAFT Rocky Reach and Rock Island Total Dissolved Gas Abatement Plans for your review. Please submit your comments on or before 5:00 p.m., March 13, 2015 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | Water Resource Specialist
Chelan County Public Utility District No.1 | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

From:	McKinney, Charlie (ECY)
To:	Steinmetz, Marcie
Cc:	Coffin, Chris (ECY)
Subject:	Approvals for GAPS & OPS Plan
Date:	Friday, March 13, 2015 9:55:49 AM
Importance:	High

March 13, 2015

To: Marcie Steinmetz, Chelan PUD No. 1

From: Charles McKinney, WA Dept. of Ecology, Water Quality Program

The WA Department of Ecology (Ecology) has reviewed and approves the **Draft 2015 Total Dissolved Gas Abatement Plans submitted by Chelan PUD for the Rocky Reach and Rock Island Projects.**
Ecology has also reviewed and approves the **Draft 2015 Operations Plan for the Rocky Reach Project.**

Ecology grants Chelan PUD an adjustment to the 110% TDG standard for the purposes of the 2015 Spill Season, as authorized under WAC 173-201A-200(1)(f)(ii), in order to facilitate the passage of ESA listed salmonids at the Project.

Thank you for your cooperation. Please let me know if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX H: COMMENTS

From: McKinney, Charlie (ECY)
To: Steinmetz, Marcie
Cc: Peterschmidt, Mark F. (ECY)
Subject: RE: DRAFT 2015 Total Dissolved Gas Annual Report
Date: Wednesday, November 25, 2015 12:16:13 PM

November 25, 2015

To: Marcie Steinmetz, Public Utility District No. 1 of Chelan County

From: Charlie McKinney, WA Department of Ecology

Thank you for the Draft 2015 Total Dissolved Gas Annual Report for the Rocky Reach (FERC Proj. No. 2145) and Rock Island (FERC Proj. No. 943) Hydroelectric Projects. Ecology has reviewed the Report and hereby gives our approval. We have determined that this Report complies with the requirement in the Section 401 Water Quality Certifications for these projects.

Please contact me if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX F: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rocky Reach on February 26, 2016 for review and comment. In an email to Chelan PUD dated March 25, 2016, Ecology stated that they did not have any comments or questions regarding the Rock Island Total Dissolved Gas Abatement Plan.

From: Peterschmidt, Mark F. (ECY)
To: Steinmetz, Marcie
Cc: Bowen, David (ECY); Brown, Chad (ECY)
Subject: RE: DRAFT 2016 Gas Abatement Plans for Rocky Reach and Rock Island
Date: Friday, March 25, 2016 4:46:28 PM

March 25, 2016

To: Marcie Steinmetz, Public Utility District No. 1 of Chelan County

From: Mark Peterschmidt, WA Department of Ecology

Thank you for the Draft 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach (FERC Project No. 2145) and Rock Island (FERC Project No. 943) Hydroelectric Projects. I have reviewed these plans and have no questions of comments to make.
Please contact me if you have any questions.

Mark Peterschmidt
Watershed Unit Supervisor
Water Quality Program, Central Region
509.454.7843 Desk
509.731.7252 Cell

Ecology's Central Regional Office has moved to a new location. The new address is:
1250 W. Alder Street, Union Gap, WA 98903.

From: Steinmetz, Marcie [mailto:Marcie.Steinmetz@chelanpud.org]
Sent: Friday, February 26, 2016 3:47 PM
To: McKinney, Charlie (ECY); Peterschmidt, Mark F. (ECY)
Cc: Smith, Michelle; Sokolowski, Rosana; Bitterman, Deborah; Osborn, Jeff; Steinmetz, Marcie
Subject: DRAFT 2016 Gas Abatement Plans for Rocky Reach and Rock Island

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

To: Charlie McKinney, Washington State Department of Ecology

Mark Peterschmidt, Washington State Department of Ecology

From: Marcie Steinmetz, Water Resource Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: DRAFT 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach and Rock Island projects

Mr. McKinney and Mr. Peterschmidt:

Attached for your review and comment are the DRAFT 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach and Rock Island projects.
Please review and submit any comments you may have on or before 5:00 p.m. March 28, 2016 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | **Water Resource Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

APPENDIX G: ROCK ISLAND PROJECT GAP

From:	Steinmetz, Marcie
To:	Bowen, David (ECY); "Peterschmidt, Mark F. (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Bitterman, Deborah; Sokolowski, Rosana
Subject:	FW: FINAL 2016 Total Dissolved Gas Abatement Plan for Rock Island Hydroelectric Project
Date:	Friday, April 01, 2016 6:43:18 AM
Attachments:	FINAL 2016 Rock Island GAP 04-01-16 FN47500.pdf

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
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To: David Bowen, Washington State Department of Ecology
Mark Peterschmidt, Washington State Department of Ecology

From: Marcie Steinmetz, Water Resource Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: FINAL 2016 Total Dissolved Gas Abatement Plan for the Rock Island Hydroelectric Project

Mr. Bowen and Mr. Peterschmidt:

Attached is the FINAL 2016 Total Dissolved Gas Abatement Plan for the Rock Island Hydroelectric Project.

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

Thank you,

Marcie Steinmetz | **Water Resource Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
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2016 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

April 1, 2016

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI HCP	Rock Island Habitat Conservation Plan
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) as required by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2016 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rock Island Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), TDG Operational Plan, a Quality Assurance Project Plan (QAPP) for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

WAC water quality standard 173-201A-200(1)(f)(ii) provides a temporary criteria adjustment for hydroelectric dams on the Snake and Columbia Rivers, when spilling to aid in fish passage. To receive this criteria adjustment, an Ecology approved gas abatement plan is required. In the 401 Certification for the Rocky Reach Project, the non-fish spill season is defined as September 1 through March 31 and the fish-spill season is April 1 through August 31. Chelan PUD assumes the same timeframes for the Rock Island Project.

The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage and an Ecology approved gas abatement plan is in place:

- TDG must not exceed an average of 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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).
- A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the Rock Island Total Dissolved Gas Abatement Plan (GAP) 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the 401 Certification. These measures include, but are not limited to:

1. Minimizing voluntary spill.
2. During downstream migrating juvenile fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

Additionally, Chelan PUD proposes to implement the following measures:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to U.S. Army Corps of Engineers Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's fish-spill season flow, TDG, gas bubble trauma (GBT) monitoring, and fish (could include juvenile and adult) study results, and, in accordance with the previous (2015) GAP, submit to Ecology by December 31.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Project, located on the Columbia River approximately 12 miles downstream of the city of Wenatchee (Figure 1-1). The Project is licensed as Project No. 943 by the Federal Energy Regulatory Commission (FERC).

This GAP is being submitted to Ecology according to WAC 173-201A-200(1)(f)(ii). Chelan PUD respectfully submits this GAP with the goal of receiving a TDG criteria adjustment for commencing with the 2016 fish spill season. This GAP provides details associated with proposed 2016 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

A 401 Certification for the operation of Chelan PUD's Rocky Reach Hydroelectric Project was issued by the Ecology on March 17, 2006. The 2016 Rock Island TDG monitoring and reporting will be conducted in a manner consistent with the TDG and Gas Abatement monitoring and reporting requirements within the Rocky Reach 401 Certification.

1.1 Project Description

Rock Island Project is owned and operated by Chelan PUD. The structure is 3,800 feet in length and is constructed from reinforced concrete. The dam is located at Columbia River mile 453.4, about 12 miles downstream from the city of Wenatchee. The Project contains a reservoir extending 21 miles upriver to the tailrace of Rocky Reach Dam and covers 3,300 acres. The Rock Island Project has no significant water storage capabilities. The normal maximum reservoir elevation of Rock Island Project is 613 feet with a tailrace elevation of 572 feet and a head of 41 feet. The Project discharges into a reservoir ponded by Wanapum Dam located 37.6 miles downstream.

The Project consists of two powerhouses. Powerhouse 1 is located on the east bank of the Project at a 45-degree angle from the bank. The powerhouse consists of 10 vertical shaft turbines with a rated output of 212 mega watts (MW). Powerhouse 2 is located on the west bank and is 470 feet wide, housing eight horizontal shaft turbines with a rated power output of 410 MW. The combined hydraulic capacity of both powerhouses is 220 thousand cubic feet per second (kcfs).

The Project configuration includes a spillway of 32 bays with a total length of 1,184 feet. Gates are separated by a middle adult fish ladder (located at bay 15) that divides the spillway into east and west sections. The west (Chelan County side) spillway consists of seven deep bays and ten shallow bays, and the east (Douglas County side) spillway consists of six deep bays and eight shallow bays. Each spillway has two or three crest gates, which are stacked one on top of the other. The crest gates are 30 feet wide and either 11 or 22 feet high. The larger crest gates are positioned closest to the water surface, and when fully raised, spill approximately 10 kcfs.

The deep bays have a sill elevation of 559 feet, which is about 13 feet below the average tailwater elevation of 572 feet. The shallow bays have a sill elevation of 581.5 feet, which is about 9.5 feet above the average tailwater elevation.

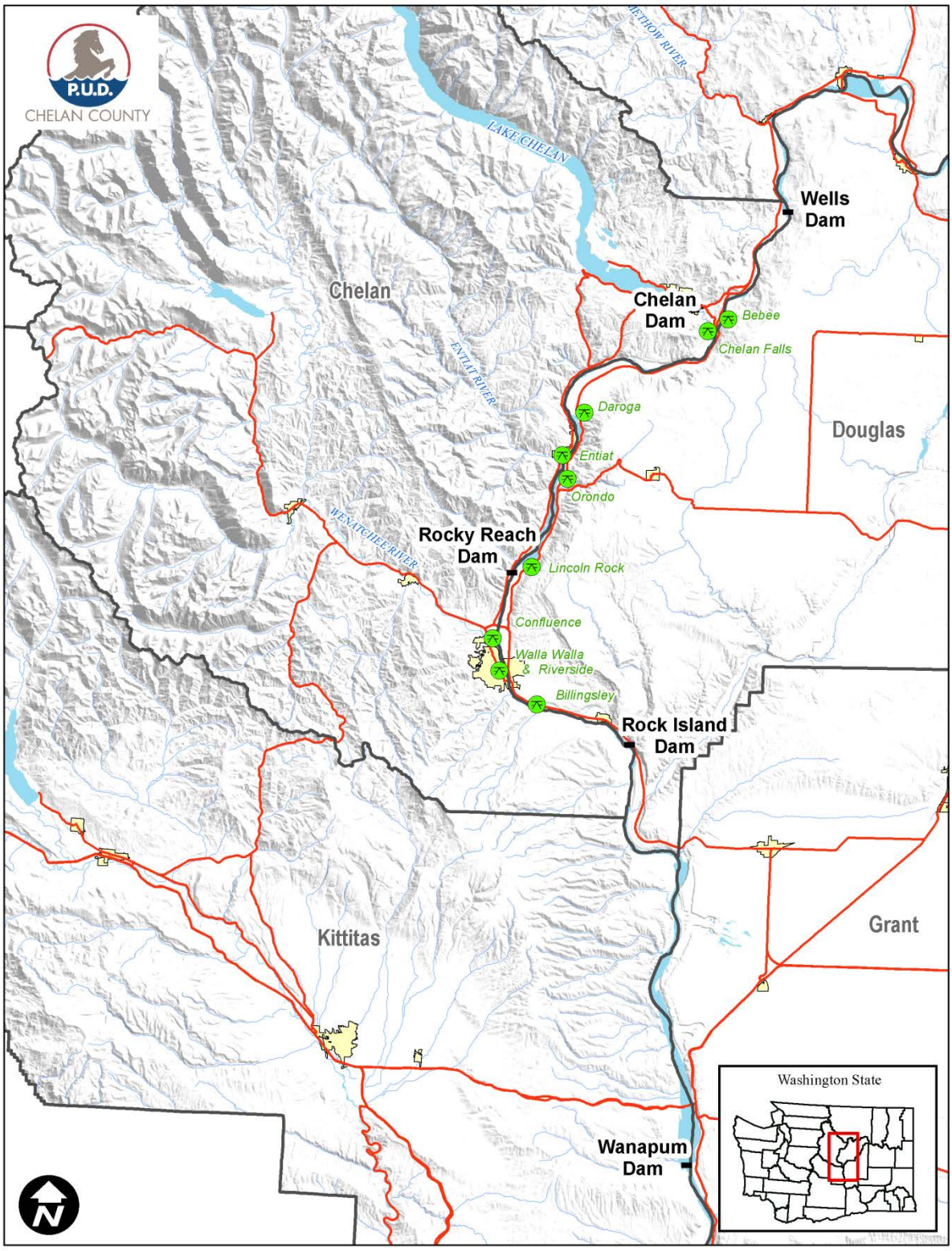

Figure 1-1: Location of Rock Island Hydroelectric Project on the Columbia River.

The focus of juvenile fish bypass at Rock Island Dam has been directed towards optimizing the efficiency of fish passage via spill. To achieve this, nine of the thirty-two spill bays have had their spill gates modified to provide surface spill. Surface spill was accomplished by putting notches in the upper sections of the spill gates. Six of the nine gates have notches that are 8 feet wide by 17 feet deep and can spill up to 2,500 cubic feet per second (cfs). The remaining gates have notches that are smaller and pass less volume (approximately 1,850 cfs). The total amount of water that can be passed through the notched gates is approximately 21,000 cfs. Three of the modified gates have had further modification and now have a "over-under" design which enables surface flow attraction and delivers water in the tailrace towards the surface, thus reducing the uptake of atmospheric gases.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2015 flows at the Rock Island Project is shown below in Figure 1-2.

Mean daily discharge during the 2015 fish-spill season was compared to the 10-year average of mean daily discharge from 2005-2014, as measured at Rock Island Dam. Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 73% of average at Rock Island Dam) over the entire fish-spill season.

Average flow for all months during the spill season was lower than the monthly 10-year average. The maximum hourly flows observed at the Project during the spill season were 147 kcfs, on April 3. Of the 153 days during the spill season (April 1 through August 31), there were no instances where the daily average flows exceeded the 7Q10 264 thousand cubic feet per second (kcfs).

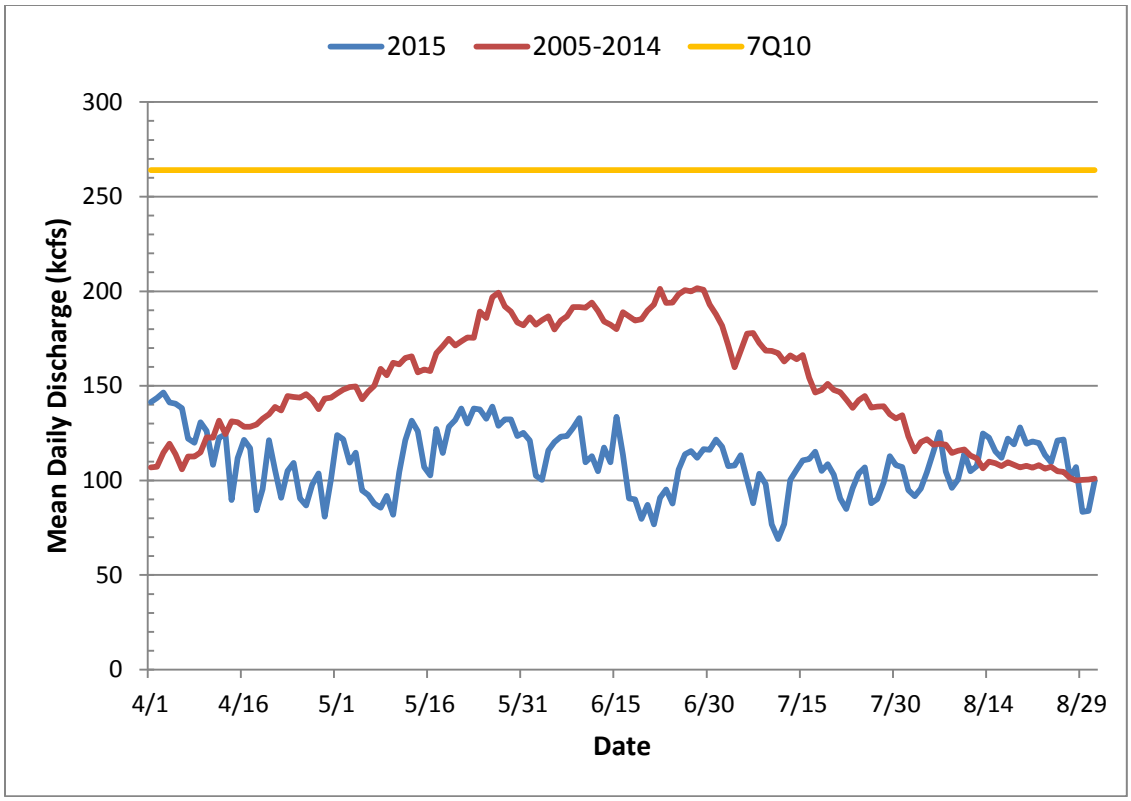

Figure 1-2: Comparison of 2015 vs. previous 10-year average (2005-2014) of mean daily discharge at Rock Island Dam.

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

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 an Ecology-approved gas abatement plan is in place. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, a temporary criteria adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG criteria adjustment. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-Spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill season as April 1 through August 31 of each year. Non-fish spill season is defined as September 1 through March 31. Chelan PUD has assumed these dates also apply to Rock Island Dam.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rock Island Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for the Rock Island Project was calculated to be 264 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). With the option for a temporary TDG criteria adjustment under an approved gas abatement plan, the TMDL set TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the MCHCA, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project through management of a positive or negative "bias" which assigns a project more or less generation depending on whether the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the MCHCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rock Island HCP (RI HCP) serves as the foundation for the fisheries management plan at Rock Island Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act. Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The RI HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including, but limited to, spill and powerhouse operations. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations.

1.4.2 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant), the Corps, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on Endangered Species Act (ESA) listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S.

Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CTT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.3 Spill Operations

It is recognized that achieving regulatory TDG levels may not be possible during spill associated with large flood (7Q10) events. However, at Rock Island Dam it may be possible to achieve current regulatory TDG levels during releases for fish bypass and up to the 7Q10 flows (264 kcfs) by selective operation of spillway bays. The Rock Island Project is unique due to the diversity of variations in how flow is released, which may assist in the development of spill scenarios that could result in a reduction of gas in the tailrace.

There are six main scenarios that may result in spill at Rock Island Dam. These are, but are not limited to:

Fish Spill

As part of the Rock Island HCP, 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. 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 percent of the daily average flow to 10 percent of the daily average flow. Summer spill at Rock Island remains at 20 percent of the daily average flow. This summer spill was level was set by the HCP in 2002 and will remain at 20 percent until such time Chelan PUD is able to test survival of subyearling (summer) Chinook. To date, Chelan PUD has not been able to test survival due to tag technology limitations and uncertainties regarding the life history (migration behavior) of subyearling Chinook. The 20 percent spill level must be maintained until tag technology becomes available that will enable us to accurately measure survival at the current spill level.

Spring Fish Spill Operations

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations. Chelan PUD will continue spilling 10 percent through the spring migration. Spring fish spill will begin no later than April 17 and will continue until the end of the spring outmigration (95 percent passage point), and subyearling Chinook have arrived at the Project.

Summer Fish Spill Operations

Summer spill at Rock Island for subyearling Chinook will be 20 percent of day average flow over 95 percent of the summer outmigration. Summer spill will commence after the completion of spring spill. Summer spill for subyearling Chinook generally ends no later than August 15 when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license, to prevent overtopping of the Project, and to maintain optimum operational conditions. With this type of release, flows up to, and in excess of the 7Q10 flood flows (264 kcfs) can be accommodated. To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rock Island. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2015

1.5.1 TDG Compliance 2015

Over the course of the 2015 fish-spill season, there were no exceedances of the total dissolved gas (TDG) numeric criteria in either the forebay or tailrace of Rock Island Dam, nor at the forebay of Wanapum Dam. Information regarding spill for the 2015 fish-spill season are displayed in Table 1-1

Table 1-1: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2015.

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish-Spill			Other		
			Spill kcfs	% of flow	% of Total Spill	Spill kcfs	% of flow	% of Total Spill
April	113.7	5.2	5.2	4.5	100.0	0.0	0.0	0.0
May	117.3	11.5	11.5	9.8	100.0	0.0	0.0	0.0
June	107.5	21.3	21.3	19.8	100.0	0.0	0.0	0.0
July	100.2	19.3	19.3	19.2	100.0	0.0	0.0	0.0
August	109.5	7.5	7.5	6.9	100.0	0.0	0.0	0.0

1.5.2 TDG Activities Implemented in 2015

In 2015, Chelan PUD implemented five actions to minimize voluntary and involuntary spill at Rock Island in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rock Island Project was the implementation of the operational spill programs and the ability to minimize spill through success of survival studies. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

1.5.3 TDG Structural Measures Implemented in 2014

No structural gas abatement measures were proposed or constructed in 2015. However, Chelan PUD continues to utilize the over/under gates that were installed in 2007 to reduce TDG generation at the Project.

SECTION 2: PROPOSED 2016 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2016 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Chelan PUD will manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards sets forth in the HCP and associated Anadromous Fish Agreement. During the 2016 fish spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. Minimize voluntary spill

   Success of the survival studies have allowed Chelan PUD to reduce spring spill required for fish passage.

2. Manage voluntary spill in real time

   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria,

3. Minimize involuntary spill

   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. Participate in Hourly Coordination Agreement

   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. Maximize powerhouse discharge as appropriate up to hydraulic capacity

Operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rock Island Project in 2016. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a quality assurance protection plan.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rock Island Project to monitor hourly TDG levels annually. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rock Island forebay fixed monitoring station (Figure 3-1) is affixed to the Project, located on the west side of the river, near the right bank fishway and Powerhouse 2, approximately 70 feet from the shore. The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations. The site was chosen based on accessibility and is thought be representative of forebay TDG because water is as well mixed and flow is as constant as at any other location in the forebay. No bridge or other permanent in-water structure is available downriver of Rock Island Project on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the Project on the eastern shoreline (Figure 3-2). This FMS has two means of deploying the dissolved gas probe, a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold that holds the carriage system.

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental (CBE) to perform calibrations and equipment maintenance during the 2016 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish spill season, and every other month during the non-fish spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. QA/QC measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be 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 will be conducted during the calibrations.

TDG levels are recorded at 15-minute intervals and are averaged into hourly readings for use in daily and 12-hour averages, as well as daily high values. The hourly average data is forwarded to the United States Army Corps of Engineers (USACE), Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water

Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data[2].

[2]. The website for the United States Army Corps of Engineers, Columbia River Basin Water Management Division, Rocky Reach Dam, Water Quality Data, and TDG is currently located at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/#RRDW Website locations are subject to change. Please contact USACE at (206) 761-0011 for general questions.

Figure 3-1: Location of forebay fixed monitoring station at Rock Island Hydroelectric Project.

Figure 3-2: Location of tailrace fixed monitoring station below Rock Island Hydroelectric Project.

3.2 Quality Assurance

Chelan PUD has developed its Quality Assurance/Quality Control (QA/QC) protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as HydroLab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's Quality Assurance Project Plan (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct GBT monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead and subyearling Chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). The results of this monitoring effort will be included in the Gas Abatement Annual Report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

TDG information will be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE, Columbia River Basin Water Management Division website where data is posted on an hourly basis. The data can be found on their website by navigating from the USACE home page to the Columbia River Basin Water Management Division web page. From this location, select the Rocky Reach Project from the map and select TDG, Water Quality Data[2].

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1, and any deviation from the TDG Operational Plan or the fish spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft TDG annual report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (GBT) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

Consistent with WAC 173-201A-200(1)(f)(ii), the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

SECTION 6: CONCLUSIONS

Chelan PUD shall implement the measures presented Section 2 of this 2016 GAP. Implementation of these measures are intended to ensure compliance with the WAC for TDG in the Columbia River at the Rock Island Project during the fish-spill season while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Anadromous Fish Agreement. No structural gas abatement measures are planned at the Rock Island Project in 2016. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Fish Passage Center (FPC). 2009. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCK ISLAND HABITAT CONSERVATION PLAN

Anadromous Fish Agreement and Habitat Conservation Plan

Rock Island Hydroelectric Project

FERC License No. 943

Offered for Signing
March 26, 2002

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Anadromous Fish Agreement and Habitat Conservation Plan
Rock Island Hydroelectric Project, FERC No. 943

THIS AGREEMENT for the Rock Island Hydroelectric Project (Project) is entered into between the Public Utility District No. 1 of Chelan County, Washington, (District) a Washington municipal corporation; and the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), the Confederated Tribes of the Umatilla Indian Reservation (Umatilla) (collectively, the Joint Fisheries Parties or the JFP); and American Rivers, Inc., a Washington D.C., nonprofit corporation, (the JFP and American Rivers, are the fisheries parties (FP)). All entities are collectively referred to as the Parties.

INTRODUCTION

A. The site of the Project is habitat for Plan Species. Prior to this Agreement the needs of the Plan Species have been addressed through litigation and agreement. This Agreement is intended to constitute a comprehensive and long-term adaptive management plan for Plan Species and their habitat as affected by the Project.

B. The objective of this Agreement is to achieve No Net Impact (NNI) for each Plan Species affected by the Project on the schedule set out herein and to maintain the same for the duration of the Agreement. NNI consists of two components: (1) 91% Combined Adult and Juvenile Project Survival achieved by project improvement measures implemented within the geographic area of the Project, (2) 9% compensation for Unavoidable Project Mortality provided through hatchery and tributary programs, with 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. The Parties intend these actions to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of Plan Species.

C. The District will receive a Permit for Permit Species upon this Agreement becoming effective. If the District carries out its responsibilities for fish protection and mitigation Measures set out in this Agreement, and provides the necessary monitoring and evaluation all according to the time frames set out for each Measure, the Permit shall continue for the full term of this Agreement subject to Section 2 “Withdrawal From Agreement” and Section 10 “Endangered Species Act”. The Parties shall take the actions set out in this Agreement in support of the District before the Federal Energy Regulatory Commission (FERC) and in other forums.

D. Capitalized terms used in this Agreement are defined in Section 13 “Definitions”.

NOW, THEREFORE, IN CONSIDERATION of the mutual promises and conditions set forth herein, the Parties agree as follows:

SECTION 1 DURATION OF AGREEMENT

1.1 Term. This Agreement shall commence on the date the last Party signs this Agreement as more fully described in Section 1.2 "Staggered Effective Date" and shall continue for a period of fifty- (50) years, unless the Agreement terminates early. In addition, entities listed above that do not sign this Agreement are not a Party to this Agreement.

1.2 Staggered Effective Date.

1.2.1 Upon Signing. The portions of Section 5.4 "Phase 1 Plan to Achieve Survival Standards" related to 2002 operations, Section 4 "Coordinating Committee", and Section 11 "Dispute Resolution" shall become effective immediately upon at least NMFS, USFWS, WDFW and the District signing this Agreement, to the extent that it does not require substantial construction or structural modification of the Dam.

The Parties agree to join with the District's filing with FERC requesting that FERC issue appropriate orders: (1) to amend the Project's existing license to include this Agreement as a condition thereof, and (2) to eliminate from the Project's license the Rock Island Settlement Agreement dated April 24, 1987.

The District shall revise its incidental take permit application for Permit Species based upon this Agreement, and submit a direct take application for the Hatchery Compensation Program. This Agreement and its figures, tables and appendices shall constitute the District's habitat conservation plan in support of the District's incidental take permit application. The Supporting Documents are to be used as supporting documents to the Agreement and as such, do not by themselves, create contractual obligations under this Agreement or through the Permit issued by NMFS.

The Parties shall provide reasonable efforts to expedite any NEPA, SEPA, and other regulatory processes required for this Agreement to become fully effective. The Parties (except the lead agency) may file comments with the lead agency. Such comments will not advocate additional Measures or processes for Plan Species. The Parties shall provide reasonable efforts to expedite the approval process of the District's incidental take permit application.

1.2.2 Upon Completion of Regulatory Reviews. The remainder of this Agreement shall become effective on the later of the follow dates (the latter date is the "Effective Date") that: (1) the FERC issues a final order approving this Agreement and incorporating it into the Project's license, (2) the NMFS issues the District a Permit for the Project based upon this Agreement and (3) the USFWS completes necessary consultations under the ESA.

However, any Party may withdraw from this Agreement within sixty- (60) days of the Effective Date in the event that: (1) the NMFS issues the District a Permit with terms and conditions in addition to or different from those set forth in this Agreement, (2) the FERC fails to include this Agreement, in its entirety, or adds terms or conditions

inconsistent with this Agreement as a license condition of the current Project license or a new long term Project license approved within the term of this Agreement, or (3) a Party as a result of compliance with NEPA or SEPA requires a material change to the terms or conditions of this Agreement. In order to withdraw from this Agreement, a Party shall provide all other Parties with notice of withdrawal and state in the notice the reason for withdrawal. The ability of a Party to withdraw from this Agreement pursuant to this paragraph terminates if not exercised within said period. The notices required by this section shall be in writing and either served in person or provided by U.S. Mail, return receipt requested.

1.3 Early Termination Events. This Agreement shall terminate automatically before the end of its term: (1) in the event the FERC issues the District a non-power license for the Project, (2) in the event the FERC orders removal of the Project, (3) in the event the FERC orders drawdown of the Project, or (4) the District withdraws from this Agreement based on Section 2 "Withdrawal From Agreement".

1.4 Termination or Transfer of License. The District's obligations under this Agreement shall terminate in the event its FERC license is terminated or transferred to another entity. The Parties agree that the terms of this Agreement shall be binding on their respective successors and assigns.

1.5 Continuation of Measures Upon Termination. Except as set forth in Section 7.4.12 "Account Status Upon Termination", Sections 9.1.1 and 9.1.3, Section 10.4 "Permit Suspension, Revocation and Re-Instatement" and Section 10.5 "Early Termination Mitigation", upon expiration of this Agreement, or in the event this Agreement is terminated, voided or determined for any reason to be unenforceable before the end of its term, then: (1) the District shall continue to implement the last agreed to Measures until the FERC orders otherwise, and (2) the Parties are not restrained in any manner from advocating to the FERC measures to replace the Agreement.

SECTION 2 WITHDRAWAL FROM AGREEMENT

2.1 Enough Already.

2.1.1 A Party may withdraw from this Agreement when at least fifteen- (15) years have elapsed from March 1, 1998, subject to the following conditions: (1) No Net Impact (NNI) has not been achieved or has been achieved but has not been maintained, or (2) the Project has achieved and maintained NNI but the Plan Species are not rebuilding and the Project is a significant factor in the failure to rebuild.

2.1.2 If NMFS and the District are in agreement as to specific Measures to remedy the failure to achieve or maintain NNI and the District promptly implements agreed measures that are applicable to the District, NMFS will refrain from suspending or revoking the Permit. In the event that NNI has not been achieved or has been achieved but has not been maintained by March 1, 2013, but the District is otherwise performing all obligations assigned to it in the Permit, and is otherwise in full compliance with all

terms and conditions of this Agreement and the Permit, NMFS and USFWS will not exercise their right to withdraw from this Agreement or revoke the Permit unless such withdrawal is to seek drawdown, dam removal, non-power operations, or actions for achievement of NNI. Should the District, NMFS, and USFWS agree under these circumstances, such actions may be pursued without withdrawal from the Agreement or suspension or revocation of the Permit.

2.2 Non-Compliance. A Party may elect at any time to withdraw from the Agreement based on non-compliance of another Party with the provisions of the Agreement, but only subject to the following procedures: (1) a Party asserts that another Party is not complying with the terms of the Agreement, (2) the Party documents and presents evidence supporting assertion of non-compliance in writing, (3) the issue of non-compliance is taken to dispute resolution, Section 11 "Dispute Resolution", unless waived. Following dispute resolution, a Party choosing to withdraw shall provide all other Parties with notice of withdrawal. The notice shall be in writing and either served in person or provided by U.S. Mail return receipt requested. The right to withdraw shall be waived if not exercised within sixty- (60) days of dispute resolution being completed. Section 2.6 "Withdrawal of Another Party" applies upon a Party's receipt of the notice provided in this section.

2.3 Governmental Action. A Party may elect to withdraw from this Agreement in the event that an entity with regulatory authority takes action that (1) is detrimental to the achievement of the obligations set forth in this Agreement and (2) that materially alters or is contrary to one or more terms set forth in this Agreement.

2.4 Impossibility. A Party may elect to withdraw from the Agreement in the event the Parties agree in writing that the obligations imposed by this Agreement are impossible to achieve.

2.5 Revocation of Permit. A Party may elect to withdraw from the Agreement if the NMFS revokes the Permit.

2.6 Withdrawal of Another Party. Upon receipt of such notice any other Party shall have 120 days from the date of a Party's notice of intent to withdraw, to provide notice to all Parties of its intention to withdraw from this Agreement, or this right to withdraw shall be waived.

2.7 Conditions Precedent to Withdrawal. Two conditions must be satisfied before a Party can withdraw from the Agreement pursuant to Sections 2.3 "Governmental Action", 2.4 "Impossibility", 2.5 "Revocation of Permit" or 2.6 "Withdrawal of Another Party". First, the Party desiring to withdraw from the Agreement shall provide notice to all other Parties of its intent to withdraw. The notice shall be in writing and either served in person or provided by U.S. Mail return receipt requested. The notice shall state the date upon which the Party's withdrawal shall become effective. The date upon which the Party's withdrawal becomes effective shall be no less than sixty- (60) days from the date the notice was provided to all other Parties. Second, prior to the date upon which the

Party's withdrawal becomes effective the withdrawing Party (Parties) must make itself (themselves) available for at least one policy meeting to allow remaining Parties to attempt to persuade the withdrawing Party (Parties) not to withdraw. The policy meeting must take place within the sixty- (60) day period or it is waived.

2.8 Effect of Withdrawal. Except as set forth in Section 1.5 "Continuation of Measures Upon Termination", Sections 9.1.1 and 9.1.3, Section 10.4 "Permit Suspension, Revocation and Re-Instatement" and Section 10.5 "Early Termination Mitigation", in the event a Party withdraws from this Agreement, this Agreement places no constraints on the withdrawing Party, shall not thereafter be binding on the withdrawing Party, and the withdrawing Party may exercise all rights and remedies that the Party would otherwise have.

SECTION 3 SURVIVAL STANDARDS AND ALLOCATION OF RESPONSIBILITY FOR NO NET IMPACT

3.1 No Net Impact ("NNI") shall be achieved on the schedule set out herein and maintained for the duration of the Agreement for each Plan Species affected by the Project. NNI consists of two components: (1) 91% Combined Adult and Juvenile Project Survival achieved by project improvement Measures implemented within the geographic area of the Project, (2) 9% compensation for Unavoidable Project Mortality provided through hatchery and tributary programs, with 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. Measures and survival standards, as provided in Section 5 "Passage Survival Plan", Section 7 "Tributary Conservation Plan" and Section 8 "Hatchery Compensation Plan", shall be evaluated, as provided in Section 4.7 "Progress Reports", and achieved no later than March 2013. The inability to measure a standard due to limitations of technology shall not be construed as a success or a failure to achieve NNI as further explained in Section 5.2.1 91% Combined Adult and Juvenile Survival and Section 5.2.2 "93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival".

3.2 The District shall be responsible for achieving 91% Combined Adult and Juvenile Project Survival, or 93% Juvenile Project Survival or 95% Juvenile Dam Passage Survival as provided in Sections 3 and 5 for each Plan Species affected by the Project. The District shall implement measurement and evaluation programs once approved by the Coordinating Committee. The District shall also be responsible for (1) funding the Tributary Conservation Plan as provided in Section 7; (2) providing the capacity and funding for the 7% Hatchery Compensation Plan as provided in Section 8; and (3) making capacity and funding adjustments to the Hatchery Compensation Plan to reflect and fully compensate for future increases in the run size of each Plan Species as provided in Section 8.3 "Hatchery Production Commitments". If the District is unable to achieve 91% Combined Adult and Juvenile Project Survival or 93% Juvenile Project Survival or 95% Juvenile Dam Passage Survival then the District shall consult with the Parties through the Coordinating Committee to jointly seek a solution. If a solution cannot be

identified to achieve the survival standards identified herein any Party may take action under Section 2.4 “Impossibility” or other provisions of this Agreement.

3.3 The Tributary Committee and Hatchery Committee shall develop plans and programs, which must include evaluation procedures, necessary to implement the Tributary Conservation Plan and the Hatchery Compensation Plan, respectively to compensate for Unavoidable Project Mortality. If Unavoidable Project Mortality is not compensated for through the Hatchery Compensation Plan and the Tributary Conservation Plan, the Hatchery Committee and the Tributary Committee, respectively may examine additional hatchery and tributary improvements to meet the obligation. If the Hatchery Committee and the Tributary Committee are unable to develop plans and programs to fully implement the Hatchery Compensation Plan and Tributary Conservation Plans, respectively, to meet compensation levels necessary to compensate for Unavoidable Project Mortality, then the respective committees may consult with the Coordinating Committee to jointly seek a solution.

3.4 Implementation of Measures to meet NNI shall follow the time frames set out in the Agreement. Where a deadline is not specified, implementation of Measures shall occur as soon as is reasonably possible.

SECTION 4 COORDINATING COMMITTEE

4.1 Establishment of Committee. There shall be a Coordinating Committee composed of one (1) representative of each Party, provided, that the Power Purchasers may participate as a non-voting observer through a single representative, whom they will designate from time to time. Each representative shall have one vote. Each Party shall provide all other Parties with written notice of its designated representative to the Coordinating Committee.

4.2 Meetings. The Coordinating Committee shall meet whenever requested by any two-(2) members following notice.

4.3 Meeting Notice. The Chair of the Coordinating Committee shall provide all committee members with a minimum of ten- (10) day’s advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

4.4 Voting. The Coordinating Committee shall act by unanimous vote of those members present in person or by phone for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Coordinating Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Coordinating Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a

meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Coordinating Committee. A Party may invoke this right only once per delayed item. If the Coordinating Committee cannot reach agreement, then upon request by any Party that issue shall be referred to Dispute Resolution.

4.5 Chair of Coordinating Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Coordinating Committee. The Chair is expected to prepare an annual list of understandings based on the results of studies, prepare progress reports, prepare meeting minutes, facilitate and mediate the meetings and assist the members of the Coordinating Committee in making decisions. At least every three years, the Coordinating Committee shall evaluate the performance of the Chair of the Coordinating Committee.

4.6 Use of Coordinating Committee. The Coordinating Committee will be used as the primary means of consultation and coordination between the District and the FP in connection with the conduct of studies and implementation of the Measures set forth in this Agreement and for dispute resolution. Any entity not executing this Agreement shall not be a Party to this Agreement and shall not be entitled to vote on any committee established by this Agreement. However, any committee established by this Agreement may agree to allow participation of any governmental entities not a Party to this Agreement.

4.7 Authority. The Coordinating Committee shall oversee all aspects of standards, methodologies, and implementation (see Section 4.9 "Methodologies"). The Coordinating Committee shall: (1) establish the protocol(s) and methodologies to determine whether or not the survival standards contained in Section 5 "Passage Survival Plan" are being achieved for each Plan Species; (2) determine whether the Parties are carrying out their responsibilities under this Agreement; (3) determine whether NNI is achieved (see definition "NNI Achieved"); (4) determine the most appropriate standard in Section 5 "Passage Survival Plan" to be measured for each Plan Species; (5) approve all studies prior to implementation; (6) review study results, determine their applicability, and develop an annual list of common understandings based on the studies; (7) provide input on the District's choice of Measures during Phase I; (8) periodically adjust the Measures (after Phase I) to address survival and Unavoidable Project Mortality as provided herein; provided that no more than 9% Unavoidable Project Mortality shall be made up through hatchery and tributary compensation without concurrence of the Coordinating Committee, and hatchery compensation shall not exceed 7% and tributary funding shall not exceed 2% unless agreed to by the Coordinating Committee; (9) resolve disputes brought by the Hatchery and Tributary Committees, and (10) adjust schedules and dates for performance. If the Coordinating Committee cannot reach agreement, then these decisions shall be referred to dispute resolution as set forth in Section 11 "Dispute Resolution".

4.8 Progress Reports. Each year, with the assistance of the Chair of the Coordinating Committee, the Hatchery Committee and the Tributary Committee shall prepare an annual report to the Coordinating Committee describing their progress. Each year, the

Coordinating Committee shall prepare an annual report to the Parties describing the progress toward achieving the survival standards contained in Section 5 "Passage Survival Plan", and common understandings based upon the studies. Annual progress reports shall include information learned from all studies, even those that were not considered to be valid tests. By March 2013, a comprehensive progress report shall be prepared by the District, at the direction of the Coordinating Committee assessing overall status in achieving NNI, and shall include the status of each Plan Species. Comprehensive progress reporting shall continue to occur at successive ten-year intervals.

4.9 Studies and Reports. All studies and reports prepared under this Agreement will be available to all members of the Coordinating Committee as soon as reasonably possible. Draft reports will be circulated through the Coordinating Committee representatives for comment, which shall be due within sixty- (60) days unless the Coordinating Committee decides otherwise, and comments will either be addressed or made an appendix to the final report. All reports will be finalized by March 31 of the year following the year the studies were performed, unless otherwise agreed to by the Coordinating Committee. The reports will be kept on file at the District. All studies will be conducted following techniques and methodologies accepted by the Coordinating Committee. All studies will be based on sound biological and statistical design and analysis. The Coordinating Committee shall have the ability to select an independent, third party for the purpose of providing an independent scientific review of any disputed survival study results and/or report.

4.10 Methodologies/Test Fish. The Coordinating Committee shall approve and the District shall implement the measurement of the survival standards using best available technology and study designs. The Coordinating Committee shall attempt whenever possible to coordinate studies with other studies being performed within the Columbia River basin. The Coordinating Committee shall facilitate the availability of test fish for studies, which may include the rearing of additional fish.

SECTION 5 PASSAGE SURVIVAL PLAN

5.1 Survival Standard Decision Matrix. The decision making process for implementation of the survival standards explained in Sections 5.2 "Implementation of the Survival Standards" and 5.3 "Phased Implementation of Measures to Achieve the Survival Standards" is graphically depicted in Figure 1 "Survival Standard Decision Matrix".

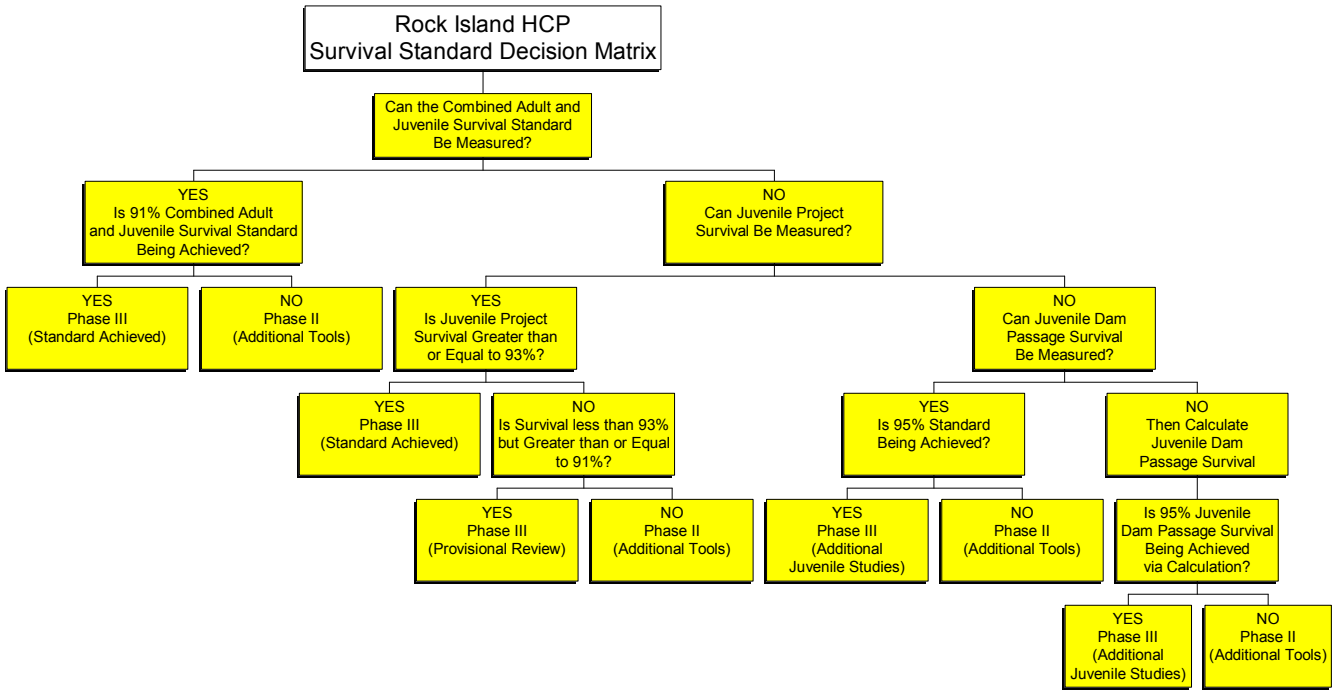


Figure 1, Survival Standard Decision Matrix.

5.2 Implementation of the Survival Standards

5.2.1 91% Combined Adult and Juvenile Survival. The District shall achieve and maintain Combined Adult and Juvenile Project Survival. The Combined Adult and Juvenile Survival standard is 91%. As of 2002, the Parties agree that adult fish survival cannot be conclusively measured for each Plan Species. Based on regional information, the Parties agree that adult survival is estimated to be 98-100%. Until technology is available to differentiate hydro-related mortality from natural adult losses, the District will implement the adult passage plan identified below. Given the present inability to differentiate between the sources of adult mortality, initial compliance with the Combined Adult and Juvenile Survival standard will be based upon the measurement of juvenile survival as provided below, Section "93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival". The District shall implement the measurement of adult survival at some time in the future if methodologies and study plans are agreed to by the Coordinating Committee. Mitigation measures will be adjusted at that time, if necessary, to address the new information.

5.2.2 93% Juvenile Project Survival and 95% Juvenile Dam Passage Survival. Limitations associated with the best available technology have required the development of the following metrics for assessing juvenile fish survival standards at the Project. In order of priority they are (1) measured Juvenile Project Survival; (2) measured Juvenile Dam Passage Survival; and (3) calculated Juvenile Dam Passage Survival. The survival of each Plan Species shall be determined by the Coordinating Committee using one of these metrics, with subsequent evaluations implemented as appropriate, per the following guidelines. If the Combined Adult and Juvenile Project Survival cannot be measured, then Juvenile Project Survival shall be measured as the next best alternative until adult survival measurement is possible.

If Juvenile Project Survival for each Plan Species is measured to be greater than or equal to 93%, then the District will proceed to Phase III (Standard Achieved). The Juvenile Project Survival Standard is 93%. If Juvenile Project Survival is measured at less than 93% but greater than or equal to 91%, then the District will proceed to Phase III (Provisional Review). If Juvenile Project Survival is measured at less than 91%, then the District will proceed to Phase II (Additional Tools).

If Juvenile Project Survival cannot be measured, then Juvenile Dam Passage Survival shall be measured as the next best alternative until project measurement is possible. The Juvenile Dam Passage Survival standard is 95%.

For some Plan Species such as sockeye and sub-yearling chinook where measurement of Juvenile Dam Passage Survival and Juvenile Project Survival is not yet possible, the Juvenile Dam Passage Survival Standard will be calculated based on the best available information (including the proportion of fish utilizing specific passage routes and the use of off-site information), as determined by the Coordinating Committee. This calculation will consider the same elements as measured Juvenile Dam Passage Survival, except that off-site information may be used where site-specific information is lacking.

5.2.3 Methodologies. The survival standards set forth in Section 5 "Passage Survival Plan" shall be measured using the best available technology and study designs approved by the Coordinating Committee. Current methodologies are summarized in Supporting Document D "Briefing Paper Estimating Survival of Anadromous Fish through the Mid-Columbia PUD Hydropower Projects". These methodologies are not exclusive, and may be updated based on new information or techniques.

A valid study is one in which the study design, implementation, and criteria are determined to have been met by the Coordinating Committee, and one in which the study took place during Representative Flow Conditions and normal project operating conditions consistent with the approved study design. The Coordinating Committee will evaluate each study after it is completed to see if previously agreed-to criteria are met. All studies will be evaluated for quality control. If the Committee agrees that critical criteria were violated, then the study will not be included in the overall average over the

three years of testing, and an additional year of testing will take place. In the event that the additional year's test is invalid, the Coordinating Committee will decide how to address the requirement for three years of testing.

Survival studies shall be measured at a ninety-five percent (95%) confidence level, with a standard error of the estimate that shall be not more than plus or minus 2.5% (i.e. 5% error). A study result meeting this precision level will automatically be included in the three-year average, unless the study is determined to be invalid by the Coordinating Committee for other reasons. If, however, a study is considered to have met all other testing protocols, and the Coordinating Committee agrees, it may be included in the calculation of the three-year average so long as the standard error around the point estimate does not exceed plus or minus 3.5%. This decision is not subject to Dispute Resolution.

Point estimates of survival measurements from the three years of studies shall be averaged (arithmetic mean). The point estimate of the average will be used to compare against the pertinent survival standard. If the averaged point estimates equals or exceeds the survival standard, then the standard has been achieved. If the average of the 3 years of survival measurements is no more than 0.5 percent below the survival standard, the Coordinating Committee may decide whether an additional year of study is appropriate. If an additional year of study is undertaken, the study result (if valid) will be included in the calculation of the arithmetic mean.

5.3 Phased Implementation of Measures to Achieve the Survival Standards. The survival standards contained in this Section 5 "Passage Survival Plan" will be achieved in three phases. Under Phase I, the District shall implement the "Phase I Plan to Achieve the Survival Standards" set forth in Section 5.3.1. Studies will be conducted to determine the survival rates beginning in 2004 and lasting for three years, unless additional years of studies are agreed to by the Coordinating Committee. Following the completion of the three-year studies, the Coordinating Committee will determine whether the pertinent survival standard has been achieved. Depending on the results of this determination, the District will either proceed to Phase II (if the applicable survival standard has not been achieved) or Phase III (if the applicable survival standard has been achieved). Phase III also includes steps designed to address gaps in the available information. Juvenile survival studies conducted during Phase I may result in different phase designations for each of the plan species. For example, the District may move to: Phase II (Additional Tools); Phase III (Standard Achieved); Phase III (Provisional Review); or to Phase III (Additional Juvenile Studies) as described in Figure 1, depending on the survival results for individual plan species. If the Coordinating Committee cannot agree on Phase designation, the Coordinating Committee may agree to require an additional year of study to resolve the disagreement, or a Party may institute Section 11 "Dispute Resolution" to determine the Phase designation or address the need for Additional Tools during the period of measurement and evaluation.

5.3.1 Phase I Testing. Beginning in 2002, the District proposes to use acoustic tag technology to measure Juvenile Dam Passage Survival or Juvenile Project Survival and PIT tags to measure Juvenile Project Survival. Current coordination between the District, consultants, NMFS Science Center, and the USGS Biological Research Division is ongoing to design and develop the acoustic tag survival methodology. The results of this effort will then be presented to the Coordinating Committee before study implementation for approval. Between 2002 and 2004, chinook yearlings will be tested. Steelhead tests will begin between 2002 and 2004 as determined by the Coordinating Committee. Sockeye and sub-yearling chinook will be tested if technology exists, or will be calculated as discussed above if not measured by the end of Phase I testing.

5.3.2 Phase II (Additional Tools). If the Coordinating Committee has determined, based on Phase I monitoring and evaluation or Phase III periodic monitoring, that Juvenile Project Survival is less than 91% or Juvenile Dam Passage Survival (measured or calculated) is less than 95%, the District shall move to Phase II for that Plan Species.

(Phase II Additional Tools). If measurement and evaluation concludes that the survival standard(s) being evaluated are not achieved, the Coordinating Committee shall decide on additional Tools for the District to implement in order to achieve the survival standard(s) being evaluated using the following criteria: Likelihood of biological success; Time required to implement; and Cost-effectiveness of solutions, but only where two or more alternatives are comparable in their biological effectiveness. Until the survival standard(s) being evaluated are achieved, the Parties shall continue to implement Phase II (Additional Tools) for the standard and for each Plan Species that is not meeting the pertinent survival standard, except as set forth in Section 2.4 “Impossibility”. The Coordinating Committee will determine the number of valid studies (not to exceed three years) necessary to make a phase determination following the implementation of Additional Tools.

5.3.3 Phase III (Standard Achieved or Provisional Review or Additional Juvenile Studies). The District proceeds to Phase III upon a determination by the Coordinating Committee that the District has (1) verified compliance with the Combined Adult and Juvenile Survival or measured Juvenile Project Survival (Standard Achieved), (2) has evaluated Juvenile Project Survival at less than 93% but greater than or equal to 91% (Provisional Review), or (3) has measured or calculated 95% Juvenile Dam Passage Survival (Additional Juvenile Studies). In short, Phase III indicates that the appropriate standard has either been achieved or is likely to have been achieved and provides additional or periodic monitoring to ensure that survival of the Plan Species remains in compliance with the survival standards in this Section 5 “Passage Survival Plan” for the term of the Agreement.

(Phase III Standard Achieved). The District shall proceed to Phase III (Standard Achieved) following measurement and evaluation that indicate that either the 91% Combined Adult and Juvenile Survival Standard or 93% Juvenile Project Survival is being achieved. In this case, the District shall re-evaluate survival under the applicable

standard every 10 years. Representative species shall be picked by the Coordinating Committee. This re-evaluation will occur over one year and be included in the pertinent average for that particular species. If the survival standard is met, then Phase III (Standard Achieved) status will remain. If the survival standard is not met, then an additional year of testing will occur. If the survival standard remains unmet over three years of re-evaluation, then Phase II designation will take affect for the representative species, and the Coordinating Committee shall re-evaluate the survival of other Plan Species, as appropriate. If the survival standard has been exceeded, the Coordinating Committee shall reduce spill for the next juvenile migration so that the survival standard is achieved, but not exceeded; provided that, if multiple species are migrating at the same time, the Coordinating Committee cannot reduce spill during a time at which a reduction would prevent another species from achieving the survival standard (see Example 1 below).

> Example 1. Steelhead and sockeye migrate during the spring but at different times. Steelhead and sockeye will likely require different levels of spill. It could be possible to reduce spill during the portion of the steelhead migration that does not overlap with sockeye so that the survival standard for steelhead is achieved during this portion of its migration. But, during the period where the sockeye migration overlaps with the steelhead migration, the spill needs of sockeye control the amount of spill provided at the Project. It is accepted by the District that this greater level of spill will result in steelhead exceeding the survival standard during the period of the steelhead migration where steelhead and sockeye are migrating together. The increase in steelhead survival during this period of combined migration will not result in a reduction of spill during the portions of the steelhead migration where steelhead are migrating alone so that the average survival of steelhead throughout their migration achieves the survival standard.

If spill is reduced, the Coordinating Committee shall oversee additional one to three years of testing to confirm achievement of the survival standard under the new operations.

(Phase III Provisional Review.) The District shall proceed to Phase III (Provisional Review) when Juvenile Project Survival studies indicate that Plan Species survival is less than 93% but greater than or equal to 91%. Provisional Review allows the District a one time (plan species specific) five-year period to implement additional measures or conduct additional juvenile or additional adult survival studies to more accurately determine whether the pertinent survival standard is being achieved. If at the end of this period Juvenile Project Survival is still less than 93% but greater than or equal to 91% and the Combined Adult and Juvenile Survival Studies are inconclusive, then the District will move to Phase II (Additional Tools). When the Provisional Review Studies indicate that the Combined Adult and Juvenile Survival estimates are greater than or equal to 91% or when the Juvenile Project Survival Studies indicate that survival is greater than or equal to 93% then the District shall proceed to Phase III (Standard Achieved). If the Provisional Review Studies indicate that the 95% Juvenile Dam Passage Survival Standard has been achieved through direct measurement or calculation, then the District shall proceed to Phase III (Additional Juvenile Studies).

(Phase III Additional Juvenile Studies). The District shall proceed to Phase III (Additional Juvenile Studies) when Juvenile Dam Passage Survival studies or Juvenile Dam Passage calculations indicate that Juvenile Dam Passage Survival is greater than or equal to 95%. Because measurement or calculation of Juvenile Dam Passage Survival does not address juvenile mortality in the pool or the indirect effects of juvenile project passage, the District will evaluate either the 91% Combined Adult and Juvenile Project Survival or the 93% Juvenile Project Survival as determined appropriate by the Coordinating Committee. If at any time during Phase III (Additional Juvenile Studies), the Coordinating Committee approves the use of new survival methodologies, the District will have five years to conduct the appropriate evaluations. The Parties will then proceed based upon the results of these new studies. This re-evaluation will occur over one year. If the survival standard is met, then Phase III (Standard Achieved) status will remain. The Coordinating Committee will determine the number of valid studies (not to exceed three years) necessary to make a phase determination following the implementation of Additional Tools.

5.4 Phase 1 Plan to Achieve Survival Standards. The District shall implement the following activities starting in 2002 and continuing until at least the conclusion of Phase I studies.

5.4.1 Juvenile Measures

a. Spill. The District shall use spill as the juvenile salmonid bypass system at Rock Island Dam under the criteria set out below. The District shall spill twenty percent of the Daily Estimated Flow to encompass 95% of each Plan Species' juvenile migration. The start of spill in the spring shall begin no later than April 17th, but the date may be adjusted by the Coordinating Committee based on in-season migration information. Spring spill shall end no later than June 15th each year, unless otherwise agreed to by the Coordinating Committee based on in-season migration information. Summer spill shall begin no later than July 1 of each year, unless otherwise agreed to by the Coordinating Committee based on in-season migration information. Summer spill will end no later than August 15th of each year unless otherwise agreed to by the Coordinating Committee based on in-season migration information.

Spill outside the specified dates above will occur when it can be demonstrated it is necessary to encompass 95% of the juvenile migration of a Plan Species. The basis for making this determination shall be based on the number of fish captured at the second powerhouse juvenile fish bypass system, compared to the average since 1985. Water will not be spilled for fish past August 31 unless a Party to this agreement provides evidence to the Coordinating Committee that the run timing is such that significant component of a Plan Species migrates through the Forebay, Dam and Tailrace outside the usual migration period (April 1 through August 31). Additional run timing information and species composition monitoring shall be conducted once every 10 years (or on a yearly basis if the second powerhouse bypass trap continues to operate) in order to verify that a significant component (greater than 5%) of the juvenile migration is not present outside the normal bypass operating period (April 1 through August 31) and to verify that the operations established by the Coordinating Committee are adequately protecting 95% of the spring and summer migrations of juvenile Plan Species.

b. Predator Control. The District will conduct control efforts for both northern pikeminnow and piscivorous bird populations for the protection of juvenile Plan Species. Northern pikeminnow will be primarily controlled by utilizing anglers at the dam. Northern pikeminnow tend to congregate in the Tailrace and anglers will exploit this population during the spring and summer months. The pikeminnow removal program may also be expanded to include not only the dam itself, but also the whole reservoir. This may be accomplished by implementing a bounty reward program and using sport anglers to assist in our control efforts. Long lines and trapping may also be utilized to supplement the dam angling and further exploit the pikeminnow population. Piscivorous bird populations, which include, Caspian terns, double-crested cormorants, and various gull species will be hazed. Hazing techniques may include elaborate wire arrays in the tailrace to deter foraging, propane cannons, various pyrotechnics, and lethal control when necessary. This program will continue to run during the juvenile outmigration.

5.4.2 Adult Measures. The District shall emphasize adult project passage Measures in order to give high priority to adult survival in the achievement of 91% Combined Adult and Juvenile Project Survival for each Plan Species. To accomplish this, the District shall implement at least the following Tools:

a. The District shall use best efforts to maintain and operate adult passage systems at the Project according to criteria developed through the Coordinating Committee and as provided in the DFOP.

b. Areas within the adult fish passage systems which are identified by the Coordinating Committee as either continuously out of criteria or where significant delay occurs (as it relates the biological fitness of the adult Plan Species) shall be addressed as soon as feasible.

c. The District shall use best efforts to eliminate identified sources of adult injury and mortality during adult migration through the Dam.

d. By the end of Phase I, the District shall identify adult fallback rates at the Dam. This evaluation will include the magnitude of voluntary and involuntary fallback, will assess how ladder trapping, project operations, the influence of the Turtle Rock Fish Hatchery, and the Wenatchee River have upon observed rates of fallback. This assessment will also determine the biological significance of these fallback events on the overall fitness of adult Plan Species. If the observed rates of adult fallback and steelhead kelt loss are determined to make a significant difference in meeting the relevant survival standard, then the Coordinating Committee shall determine the most cost effective methods to protect adult fallbacks and steelhead kelts at the Dam, and the District shall immediately implement the agreed to Measures. Reduction in fallback rates, mortalities and protection of kelts shall be factored into juvenile bypass and adult passage development and implementation and into Project operation decisions. Before the District is asked to implement additional operation of the bypass system or other measures for

kelts or fallbacks, there will need to be a high level of certainty that these Measures will make a significant difference in meeting the relevant survival standard.

e. The Parties to this Agreement recognize that current technology does not allow for a precise estimate of hydroelectric project induced mortality to adult salmonids. Until adult survival studies can accurately differentiate between natural and hydro-project inducted mortality, the District shall use the best available technology to conduct, on a periodic basis, adult passage verification studies toward the diagnosis of adult loss, injury and delay at Rock Island Dam. Prior to the completion of adult survival studies, compensation for adult mortality shall be assumed completely fulfilled by the District's contribution to the Tributary Fund. Following the completion of adult survival studies, should adult survival rates fall below 98% but the Combined Adult and Juvenile survival rate be maintained above 91%, additional hatchery compensation for that portion of adult losses that exceeds 2%, toward a maximum contribution of 7% hatchery funding and 2% tributary funding, would be utilized to satisfy NNI compensation requirements for each Plan Species.

f. Pursuant to the 2000 Biological Opinion for the Federal Columbia River Power System (the "Bi-Op"), federal action agencies are required to conduct a comprehensive evaluation to assess adult survival at federal dams. The Bi-Op sets forth a series of evaluation methods to be employed. The Coordinating Committee should review the information and techniques utilized in those studies and evaluate their potential for accurately measuring Combined Adult and Juvenile Project Survival. The Coordinating Committee should also evaluate technologies found at the federal dams to increase adult survival for possible implementation at the Project. Based upon those evaluations, the District shall implement as necessary technologies appropriate for the Project.

SECTION 6 RESERVOIR HABITAT AND WATER QUALITY

6.1 When making land use or related permit decisions on Project owned lands that affect reservoir habitat, the District shall consider the cumulative impact effects in order to meet the conservation objectives of the Agreement, requirements of the FERC license, and other applicable laws and regulations. The District further agrees to notify and consider comments from the Parties to the Agreement regarding any land use permit application on Project owned lands.

6.2 The District shall notify all applicants for District permits to use or occupy Project lands or water that such use or occupancy may result in incidental take of species listed as endangered or threatened under the ESA, requiring advance authorization from NMFS or USFWS.

6.3 The Parties recognize that there are potential water quality issues (temperature and dissolved gas) related to cumulative hydropower operations in the Columbia River. The Parties will work together to address water quality issues.

SECTION 7 TRIBUTARY CONSERVATION PLAN

7.1 Tributary Plan. The Tributary Conservation Plan ("Tributary Plan") consists of this Agreement and is supported by Supporting Document A "Tributary Plan, Project Selection, Implementation, and Evaluation", and Supporting Document B "Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers". The Parties recognize that Supporting Documents A and B do not by themselves create contractual obligations.

7.2 Purpose. Under the Tributary Plan, the District shall provide a Plan Species Account to fund projects for the protection and restoration of Plan Species' habitat within the Columbia River watershed (from the Chief Joseph tailrace to the Rock Island tailrace), and the Okanogan, Methow, Entiat and Wenatchee River watersheds, in order to compensate for two percent of Unavoidable Project Mortality; provided that the Parties shall not be required to actually measure whether the Tributary Plan compensates for two percent Unavoidable Project Mortality.

7.3 Tributary Committee

7.3.1 Establishment of Committee. There shall be a Tributary Committee composed of one (1) representative of each Party, provided that an entity eligible to appoint a representative to the Tributary Committee is not required to appoint a representative, and further provided that, representatives from USFWS shall participate in a non-voting, ex-officio capacity unless they otherwise state in writing, and further provided that, the Power Purchasers may participate as a non-voting observer through a single representative, whom they will designate from time to time. The Tributary Committee may select other expert entities, such as land and water trusts/conservancy groups to serve as additional, non-voting members of the Tributary Committee. Each entity eligible to appoint a representative to the Tributary Committee shall provide all other eligible entities with written notice of its designated representative. The Tributary Committee is charged with the task of selecting projects and approving project budgets from the Plan Species Account for purposes of implementing the Tributary Plan.

7.3.2 Meetings. The Tributary Committee shall meet not less than twice per year at times determined by the Tributary Committee. Additionally, the Tributary Committee may meet whenever requested by any two-(2) members following notice.

7.3.3 Meeting Notice. The Chair of the Tributary Committee shall provide all committee members with a minimum of ten- (10) day's advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

7.3.4 Voting. Except as set forth in Section 7.4.2 "Prohibited Use of Account", the Tributary Committee shall act by unanimous vote of those members present for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Tributary Committee meetings. Abstention does not

prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Tributary Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Tributary Committee. A Party may invoke this right only once per delayed item. If the Tributary Committee cannot reach agreement, then upon request of any Party, that issue shall be referred to the Coordinating Committee.

7.3.5 Chair of Tributary Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Tributary Committee. The Chair of the Tributary Committee shall have the same responsibilities and authorities with regard to the Tributary Committee as the Chair of the Coordinating Committee has with regard to the Coordinating Committee. At least every three years, the Tributary Committee shall evaluate the performance of the Chair of the Tributary Committee.

7.4 Plan Species Account.

7.4.1 Establishment of Account. The District shall establish a Plan Species Account in accordance with applicable provisions of Washington State law and this Agreement. Interest earned on the funds in the Plan Species Account shall remain in the Plan Species Account. The Parties to this Agreement may audit the District's records relating to the Account during normal business hours following reasonable notice. The Tributary Committee shall select projects and approve project budgets from the Plan Species Account by joint written request of all members of the Tributary Committee. The Tributary Committee shall act in strict accordance with Section 7.4.2 "Prohibited Use of Account".

7.4.2 Prohibited Uses of Account. No money from the Plan Species Account shall be used to enforce compliance with this Agreement. Members of the Tributary Committee and their expenses shall not be compensated through the Plan Species Account. Administrative costs, staffing and consultants, reports and brochures, landowner assistance and public education costs collectively shall not exceed $80,000 in 1998 dollars in any given year without the unanimous vote of the Tributary Committee.

7.4.3 Reports. At least annually, the District shall provide financial reports of Plan Species Account activity to the Tributary Committee.

7.4.4 Ownership of Assets. Determinations regarding ownership of real and personal property purchased with funds from the Plan Species Account shall be made by the Tributary Committee. Title may be held by the District, by a resource agency or tribe or by a land or water conservancy group, as determined by the Tributary Committee. Unless the Tributary Committee determines that there is a compelling reason for ownership by another entity, the District shall have the right to hold title. All real property purchased shall include permanent deed restrictions to assure protection and conservation of habitat.

7.4.5 Account Status Upon Termination. Upon the Agreement's termination, (1) the District's unspent advance contributions to the Plan Species Account shall be promptly released to the District, (2) if funds remain in the Plan Species Account after the return of the District's advance contributions, then the Tributary Committee shall remain in existence and continue to operate according to the terms of this Agreement until the funds in the Plan Species Account are exhausted, and (3) all real and personal property which the District holds title shall remain its property.

7.5 Plan Species Account Funding

7.5.1 While this Agreement remains in effect, the District shall contribute $485,200, in 1998 dollars, annually to the Plan Species Account. By joint written request, the JFP and American Rivers, Inc.'s representatives to the Tributary Committee may elect for the District to contribute, in advance, any of the annual payments to be made during the first fifteen years of the Agreement, provided that, (1) each annual payment shall be adjusted by the District for inflation based upon a nationally recognized index, (2) the total adjusted amount shall be reduced to present value by the actual discount rate applicable to the District, and reduced by the District's actual cost of financing, and (3) each election shall be for a minimum of three annual payments.

7.5.2 The first installment is due within ninety- (90) days of the Effective Date of the Agreement. The rest of the installments are due by the 31st day of January each year thereafter. The dollar figures shall be adjusted for inflation on the 1st day of January each year based upon the "Consumer Price Index for all Urban Consumers" for the Seattle/Tacoma area, published by the U.S. Department of Labor, Bureau of Labor Statistics. If said index is discontinued or becomes unavailable, a comparable index suitable to the Tributary Committee shall be substituted.

7.6 Tributary Assessment Program. The District shall provide support for a tributary assessment program separate from the Plan Species Account. The tributary assessment program will be utilized to monitor and evaluate the relative performance of projects approved by the Tributary Committee and directly funded by the initial contribution to the Plan Species Account. It is not the intent of the tributary assessment program to measure whether the Plan Species Account has provided a 2% increase in survival for Plan Species. Instead, the program has been established to ensure that the dollars allocated to the Plan species Account are utilized in an effective and efficient manner. The District shall develop, in coordination with and subject to an approval by the Tributary Committee the measurement protocols for the tributary assessment program. The Tributary Committee may choose to either evaluate the relative merits of each project or it may choose to evaluate an aggregation of projects provided that the total cost associated with the tributary assessment program does not exceed $200,000 (not subject to inflation adjustment).

7.7 Project Selection.

7.7.1 Geographic Area and Types of Projects. The Tributary Committee shall select projects and approve budgets for expenditure from the Plan Species Account for the following: (1) Any action, structure, facility, program or measure (referred to herein generally as "projects") intended to further the purpose of the Tributary Plan for Plan Species. Projects shall be chosen based upon the guidelines set forth in Supporting Document A "Tributary Plan Species Account Project Selection, Implementation, and Evaluation" and Supporting Document B "Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers". Projects shall not be implemented outside the area specified in Section 7.2 "Purpose". High priority shall be given to the acquisition of land or interests in land such as conservation easements or water rights or interests in water such as dry year lease options; (2) Studies, implementation, monitoring, evaluation, and legal expenses associated with any project financed from the Plan Species Account; and (3) Prior approved administrative expenses associated with the Plan Species Account.

7.7.2 Coordination With Other Conservation Plans. Whenever feasible, projects selected by the Tributary Committee shall take into consideration and be coordinated with other conservation plans or programs. Whenever feasible, the Tributary Committee shall cost-share with other programs, seek matching funds, and "piggy-back" programs onto other habitat efforts.

7.7.3 Conflict of Interest. After full written disclosure of any potential conflict of interest, which shall appear in the minutes of the Tributary Committee and prior to project approval, the Tributary Committee may approve a project that may benefit a person or entity related to a committee member, or an entity which appointed the committee member.

SECTION 8 HATCHERY COMPENSATION PLAN

8.1 Hatchery Objectives

8.1.1 The District shall provide hatchery compensation for Plan Species (spring chinook salmon, summer chinook salmon, fall chinook salmon, sockeye salmon, coho salmon upstream of Rock Island Dam origin, and summer steelhead). This compensation may include Measures to increase the off-site survival of naturally spawning fish or their progeny.

8.1.2 The District shall implement the specific elements of the hatchery program consistent with overall objectives of rebuilding natural populations and achieving NNI. Species specific hatchery programs objectives developed by the JFP may include contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest.

8.2 Hatchery Committee.

8.2.1 Establishment of the Committee. There shall be a Hatchery Committee composed of one (1) representative of each Party, provided that a Party is not required to appoint a representative and further provided that the Power Purchasers may participate as a non-voting observer through a single representative whom they will designate from time to time. A Party shall provide all other Parties with written notice of its designated representative.

8.2.2 Responsibilities. The Hatchery Committee shall oversee development of recommendations for implementation of the hatchery elements of the Agreement that the District is responsible for funding. This includes overseeing the implementation of improvements, monitoring and evaluation relevant to the District's hatchery programs, as identified in the Hatchery Compensation Plan, the Permit and this Agreement. Hatchery Committee decisions shall be based upon: Likelihood of biological success; Time required to implement; and Cost-effectiveness of solutions. The Hatchery Committee shall also coordinate in-season information sharing and shall discuss unresolved issues.

8.2.3 Meetings. The Hatchery Committee shall meet twice per year or whenever requested by any two-(2) members following notice.

8.2.4 Meeting Notice. The Chair of the Hatchery Committee shall provide all committee members with a minimum of ten- (10) day's advance written notice of all meetings unless a member waives notice in writing or reflects the waiver in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

8.2.5 Voting. The Hatchery Committee shall act by unanimous vote of those members present for the vote and shall develop its own rules of process, provided, that the chair shall ensure that all members are sent notice of all Hatchery Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Hatchery Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties, or as otherwise agreed to by the Hatchery Committee. A Party may invoke this right only once per delayed item. If the Hatchery Committee cannot reach agreement, then upon request of any Party, that issue shall be referred to Coordinating Committee.

8.2.6 Chair of Hatchery Committee. The Parties shall choose and the District shall fund a neutral third party to act as the Chair of the Hatchery Committee. The Chair of the Hatchery Committee shall have the same responsibilities and authorities with regard to the Hatchery Committee as the Chair of the Coordinating Committee has with regard to the Coordinating Committee. At least every three years, the Hatchery Committee shall evaluate the performance of the Chair of the Hatchery Committee.

8.3 Hatchery Operations. The District or its designated agents shall operate the hatchery facilities according to the terms of this Section 8 "Hatchery Compensation Plan", the ESA Section 10 permit(s), and in consultation with the Hatchery Committee.

8.4 Hatchery Production Commitments.

8.4.1 Hatchery Agreements. The District may enter into agreements with other entities for the rearing, release, monitoring and evaluation and research of hatchery obligations. The Hatchery Committee must approve any proposed agreements or trades of production. However, it is the District's responsibility to ensure that their obligations under Section 8 (Hatchery Compensation Plan) are satisfied.

8.4.2 Calculation of Hatchery Levels. The District shall provide the funding and capacity required of the District to meet the 7% hatchery compensation level necessary to achieve NNI for all Plan Species. As set forth below, the initial estimated hatchery production capacities for Plan Species needed to compensate for Unavoidable Project Mortality are based on average adult returns of Plan Species for a baseline period, a 7% compensation requirement, and baseline adult to smolt survival rates for existing mid-Columbia River hatcheries. Juvenile Project Survival estimates, when available, will be used to adjust hatchery based compensation programs. However, should adult survival rates fall below 98% but the Combined Adult and Juvenile survival rates is maintained above 91%, additional hatchery compensation for adult losses, toward a maximum contribution of 7% hatchery compensation, would be utilized to provide compensation for Unavoidable Project Mortality. The rationale for determining the initial capacity requirement is supported by Supporting Document C, "Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Program". The Parties recognize that Supporting Document C is a supporting document and does not by itself, create contractual obligations.

8.4.3 Periodic Adjustment of District Hatchery Levels. Hatchery production levels, except for original inundation mitigation, shall be adjusted in 2013 and every 10 years thereafter as is required to adjust for changes in the average adult returns of Plan Species and for changes in the adult-to-smolt survival rate, and for changes to smolt-to-adult survival rate from the hatchery production facilities, considering methodologies described in the BAMP. The Hatchery Committee will be responsible for determining program adjustments considering the methodology described in BAMP and providing recommended implementation plans to the District. The District will be responsible for funding the implementation plan.

a. Coho. Hatchery compensation for coho will be assessed in 2005 following the development of a continuing coho hatchery program and/or the establishment of a naturally reproducing population of coho (by an entity other than the District and occurring outside this Agreement). The Hatchery Committee shall determine whether a hatchery program and/or, naturally reproducing population of coho exists. Should the Hatchery Committee determine that such a program or population exists, then (1) the Hatchery Committee shall determine the most appropriate means to satisfy the 7% hatchery compensation requirement for coho, and (2) the District shall have the next

juvenile migration to adjust juvenile protection Measures to accommodate coho. Thereafter, the Coordinating Committee shall determine the number of valid studies (not to exceed three years) necessary to make a juvenile phase determination. The programs selected to achieve NNI for coho will utilize an interim value of project survival, based upon a Juvenile Project Survival estimate of 93%, until juvenile project survival studies can be conducted on coho.

b. Okanogan Basin Spring Chinook. Hatchery compensation for Okanogan Basin spring chinook will be assessed in 2007 following the development of a continuing spring chinook hatchery program and/or the establishment of a Threshold Population of naturally reproducing spring chinook in the Okanogan watershed (by an entity other than the District and occurring outside this Agreement). The Hatchery Committee shall determine whether a hatchery program and/or naturally reproducing population of spring chinook is present in the Okanogan Basin. Should the Hatchery Committee determine that such a program or population exists, then the Hatchery Committee shall determine the most appropriate means to satisfy the 7% hatchery compensation requirement for Okanogan Basin spring chinook. Programs to meet the 7% hatchery requirement for Okanogan Basin spring chinook may include but not be limited to: (1) operation and maintenance funding in the amount equivalent to 7% project passage loss or (2) replace project passage losses of hatchery spring chinook with annual releases of equivalent numbers of yearling summer chinook into the Okanogan River Basin or (3) provide funding for acclimation or provide funding for adult collection facilities in the amount equivalent to 7% juvenile passage loss at the Rock Island Project. The programs selected to achieve NNI for Okanogan Basin spring chinook will utilize an interim value of project survival, based upon a Juvenile Project Survival estimate of 93%, until project survival studies can be conducted on Okanogan Basin yearling chinook.

8.4.4 Initial Hatchery Program Levels. The District will continue to fund the operation and maintenance of Rock Island Hatchery Complex necessary to meet production levels. The Parties agree that the initial production commitments to be provided by the District to satisfy 7% Unavoidable Project Mortality and compensation for original inundation are satisfied with production as follows below (See Table 1 for initial production levels, and production levels necessary to achieve 7% Unavoidable Project Mortality). The initial production levels will be maintained until 2013 unless otherwise agreed to by the Hatchery Committee.

a. Spring chinook: 56,000 pounds at about 12 fish per pound (672,000 fish) and, until 2013, 9,600 pounds at about 15 fish per pound (144,000 fish) at the Methow Hatchery (50% of proportion raised for the Rock Island hatchery program). (The intent of the initial production program is to maintain current production levels of fish reared for the District at the Public Utility District No. 1 of Douglas County, Washington ("Douglas PUD") owned Methow Hatchery through a contractual agreement between Douglas PUD and the District).

b. Steelhead: 30,000 pounds at about 6 fish per pound (200,000);

c. Summer/Fall chinook: 144,000 pounds of yearling summer/fall chinook at about 10 fish per pound (1,440,000 fish) and, until 2013, 20,000 pounds at about 10 fish per pound (200,000 fish, a portion of which can be used for studies) at the Carlton Pond (50% of proportion raised for Rock Island hatchery program). (The intent of the initial production program is to maintain current production levels of fish reared for Douglas PUD at the District owned Carlton Pond through a contractual agreement between Douglas PUD and the District).

d. Sockeye: 10,000 pounds at about 20 fish per pound (200,000 fish). This is considered a pilot program that will be continued until such time that the Hatchery Committee agrees to expand the sockeye hatchery production.

8.5 Monitoring and Evaluation.

8.5.1 The Hatchery Committee shall develop a five-year monitoring and evaluation plan for the hatchery program that is updated every five years (see also Section 8.6 "Program Review"). The first monitoring and evaluation plan shall be completed by the Hatchery Committee within one year of the Effective Date of this Agreement. Existing monitoring and evaluation programs shall continue until replaced by the Hatchery Committee.

8.5.2 The Parties agree that over the duration of this Agreement new information and technologies that are developed will be considered and utilized in the monitoring and evaluation of the hatchery program. The District shall fund hatchery program monitoring and evaluation consistent with this Agreement, the general objectives and guidelines listed for each Plan Species in the BAMP and as determined by the Hatchery Committee.

8.5.3 The Hatchery Committee shall plan and the District implement a study (related to the District's production program) to investigate the natural spawning success of hatchery reared steelhead relative to wild steelhead. The Hatchery Committee shall coordinate the study with the Wells and Rocky Reach hatchery committees.

8.6 Program Modification.

8.6.1 Hatchery program modifications shall make efficient use of existing facilities owned by the District or cooperating entities including adult collection, acclimation, and hatchery facilities, provided that the existing facility or the existing facility as modified is compatible with and does not compromise ongoing programs. The District in consultation with the Hatchery Committee shall make reasonable efforts to implement program modifications when needed to achieve overall and specific program objectives. Program modifications may include changes to facilities, release methods, and rearing strategies necessary to achieve NNI as determined by the monitoring and evaluation program.

8.6.2 In December 2001, it is recognized that current monitoring and evaluation programs have identified alternative rearing strategies to be addressed as soon as reasonably possible. These alternative strategies include: the ability to hold steelhead adults on river water prior to spawning; and ability to rear and acclimate steelhead juveniles on Columbia or tributary waters. The District will make every reasonable effort to complete program modifications as soon as reasonably possible following agreement with the Hatchery Committee.

8.6.3 NMFS shall have the opportunity to seek hatchery program modifications (that do not change 7% program levels) but are otherwise necessary to address emergency effects of a hatchery program on listed Permit Species. Such program modifications shall be supported by a minimum of two years of field data from the river or stream in question. Other information documenting a significant and adverse effect on the productivity of listed Permit Species from other rivers can be considered, but only if applicable to the listed Permit Species and stream in question. Any proposal to modify a program will be documented in a memorandum from the Regional Administrator to the Hatchery Committee summarizing the problem, and then followed by up to six months of Hatchery Committee evaluation. The Parties recognize that initially a portion of the production contemplated in this Agreement will be for purposes of supplementation of Plan Species or re-establishing runs in areas from which they have been extirpated. In the event the concerns raised in this Section 8.6.3 involve the use of such a program, NMFS agrees to take the program design and intent into account in reaching any conclusions regarding the need for emergency modifications.

8.7 Program Review. As part of the five year review set forth in Section 8.4 "Monitoring and Evaluation" the Hatchery Committee shall look back comprehensively at the previous five year plan to help prepare the next five year plan. In 2013 as part of the comprehensive review and every ten years thereafter, the hatchery program will undergo a program review incorporating new information from the monitoring and evaluation program. This program review will determine if adult-to-smolt and smolt-to adult survival standard, and hatchery program goals, and objectives as defined in this document and the Section 10 of the ESA permits have been met or sufficient progress is being made towards their achievement. This review shall include a determination of whether hatchery production objectives are being achieved and a review to identify adjustments to the monitoring and evaluation programs. The Hatchery Committee shall be responsible for conducting the hatchery program review, and developing a summary report. The Hatchery Committee shall be responsible for recommending alternative plans to the District in the event that program objectives as defined above are not being met or needed modifications to the monitoring and evaluation have been identified. The Hatchery Committee shall be responsible for developing and the District funding implementation plans.

8.8 Changed Hatchery Policies under ESA.

8.8.1 Except in 2013 and every ten years thereafter, NMFS will refrain from applying hatchery policy decisions that would preclude the 7% hatchery levels (as adjusted) from being achieved. During 2013 and every 10 years thereafter (at the time of the program review), if NMFS proposes hatchery policy decisions that would preclude the 7% hatchery levels (as adjusted) from being achieved, NMFS will (a) propose application of the policies to the Hatchery Committee and seek agreement, (b) propose a revised hatchery program consistent with the principles of NNI and an expeditious transition plan from the existing hatchery program to the revised hatchery program, (c) if agreement is not possible discuss the application of the policies with the Coordinating Committee and then with the Policy Committee, if necessary, and (d) if agreement is still not possible then allow elevation to the Administrator of NMFS. The Parties recognize that initially a portion of the production contemplated in this Agreement will be for purposes of supplementation of Plan Species or re-establishing runs in areas from which they have been extirpated. NMFS agrees to take the program design and intent into account in reaching any conclusions.

8.8.2 Until 2013, facility modifications are based on monitoring and evaluation and may not reflect changes in NMFS hatchery policy. During 2013 and every 10 years thereafter (at the time of the program review), facility modifications can also reflect changes in ESA policy with the understanding that a reasonable period of time will be provided to complete the modifications. The 2013 date for achievement of NNI in Section 3.1 will be adjusted if necessary to reflect the time needed to complete such modifications (as determined by the Hatchery Committee).

8.9 New Hatchery Facilities. Before being required to construct new hatchery facilities, the Hatchery Committee shall make efficient use of existing or modified facilities owned by the District or entities consenting to the use of their facilities, including adult collection, acclimation and hatchery facilities, provided that existing or as modified facility use is compatible with and does not compromise ongoing programs.

SECTION 9 ASSURANCES

9.1 Release, Satisfaction and Covenant Not to Sue.

9.1.1 The Parties, within the limits of their authority, shall from the date of construction of the Project to the Effective Date of this Agreement, release, waive, discharge the District and the District's predecessors, commissioners, agents, representatives, employees, and signatory power purchasers from any and all claims, demands, obligations, promises, liabilities, actions, damages and causes of action of any kind concerning impacts of the Project on Plan Species except for the obligation to provide compensation for original construction impacts of the Project implemented through the hatchery component of this Agreement. This release, waiver, and discharge shall not transfer any of the above listed District liabilities or obligations to any other entity.

9.1.2 Provided that the District is in full compliance with its Permit, this Agreement, and its FERC project license provisions relating to Plan Species, each Party agrees not to institute any action under ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act against the District and its signatory power purchasers related to impacts of the Project on Plan Species from the date this Agreement becomes effective through the date this Agreement terminates.

9.1.3 Termination of this Agreement or withdrawal of a Party shall have no effect upon the release provided for in Section 9.1.1.

9.1.4 This Agreement does not affect, limit or address the imposition of annual charges under the Federal Power Act, or the right of any party in any proceeding or forum to request annual charges.

9.2 Re-Licensing.

9.2.1 With respect to Plan Species, the Parties agree to be supportive of the District's long-term license application(s) to the FERC filed during the term of this Agreement for the time period addressed in this Agreement, provided that the District has adhered to the terms and conditions of this Agreement, the Permit, and the FERC license provisions relating to Plan Species, as well as any future terms, conditions, and obligations agreed upon by the Parties hereto or imposed upon the District by the FERC. To the extent that the District has met such terms and conditions, the Parties agree that the District is a competent license holder with respect to its obligations to Plan Species. If the fifty (50)-year term of this Agreement will expire during a long term license, any Party may advocate for license conditions that take effect after this Agreement expires

9.2.2 This Agreement shall constitute the Parties' terms, conditions and recommendations for Plan Species under Sections 10(a), 10(j) and 18 of the Federal Power Act, and the Fish and Wildlife Coordination Act, provided that, NMFS and USFWS maintain the right to reserve their authorities under Section 18 of the Federal Power Act on the condition that such reserved authority may be exercised only in the event that this Agreement terminates, provided further that, the Parties as part of their terms, conditions and recommendations under Section 10(a) of the Federal Power Act may request that Plan Species protection or mitigation measures contained in a competing license application be included as a condition of the District's new long term license.

9.2.3 Notwithstanding Sections 9.2.2 and 9.7 "Drawdowns/Dam Removal/Non-Power Operations", this Agreement does not limit the participation of any Party in any FERC proceeding to assert: (1) any condition for resources and other aspects of the District's license other than for Plan Species, and (2) to assert conditions for Plan Species to implement this Agreement.

9.3 Limitation of Reopening. During the term of this Agreement the Parties shall not invoke or rely on any re-opener clause set forth in any FERC license applicable to the Project for the purpose of obtaining additional measures or changes in project structures or operations for Plan Species, except as set forth in Sections 9.2.2 and 9.2.3.

9.4 Additional Measures. This Agreement sets out certain actions, responsibilities, and duties with regard to Plan Species to be carried out by the District and by the JFP to satisfy the legal requirements imposed under the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act. This Agreement is not intended to prohibit the Parties from opposing or recommending actions in reference to (1) Project modifications such as pool raises and additional power houses, and (2) activities not related to Project operations that could adversely affect Plan Species. The Parties recognize that various of the JFP have governmental rights, duties, and responsibilities as well as possible rights of action under statutes, regulations, and treaties that are not covered by this Agreement. This Agreement does not limit or affect the ability or right of a Party to take any action under any such law, regulation or treaties. However, the Party shall use their best efforts to exercise their rights and authority under such statutes, regulations and treaties (consistent with their duties and responsibilities under those statutes, regulations, and treaties) in a manner that allows this Agreement to be fulfilled.

9.5 Title 77 RCW. Provided the District is in compliance with the Agreement, the Permit, and the FERC license provisions relating to Plan Species, WDFW shall not request additional protection or mitigation for Plan Species under Title 77 RCW as now exists or as may be amended, unless WDFW is required to take such action by statute.

9.6 Cooperation in Studies/Approval/Permits. The Parties shall cooperate with the District in conducting studies and in obtaining any approvals or permits which may be required for implementation of this Agreement.

9.7 Drawdowns/Dam Removal/Non-Power Operations. With respect to Plan Species under the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, each Party during the term of this Agreement will not advocate for or support additional or different fish protection measures or changes in Project structures or operations other than those set forth in this Agreement. For example, the Parties will not advocate or support partial or complete drawdowns, partial or complete dam removal, and partial or complete non-power operations. However, this Agreement does not preclude: spillway or Tailrace modifications; spill; structural modifications and concrete removal (holes in Dam) to accommodate bypass; structural modifications to accommodate adult passage facility improvements; and future consideration of additional measures that may include reservoir elevation changes if all Parties agree. The Parties agree to work within this Agreement to address any issues that may arise in the future concerning Plan Species.

9.8 Stipulation of Plan Species. Each Party stipulates that the performance of the District's obligations under this Agreement, its Permit, and its FERC license will adequately and equitably conserve, protect, and mitigate Plan Species pursuant to the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act as those Plan Species are affected by the Project through the term of the Agreement.

9.9 Vernita Bar. Nothing in this Agreement is intended to affect the protection of Plan Species in the Hanford Reach or the Vernita Bar Agreement, as it exists now or may be modified in the future.

9.10 Non-Plan Species. Non-Plan Species are not addressed in this Agreement.

SECTION 10 ENDANGERED SPECIES ACT

10.1 Permit Issuance.

10.1.1 NMFS issuance of a Permit to the District assures the District that based upon the best scientific and commercial data available and after careful consideration of all comments received, NMFS has found that with respect to all Permit Species that: (i) any take of a Permit Species by the District under this Agreement will be incidental to the carrying out of otherwise lawful activities; (ii) under this Agreement the District will, to the maximum extent practicable, minimize and mitigate any incidental take of Permit Species; (iii) the District has sufficient financial resources to adequately fund its affirmative obligations under this Agreement; (iv) as long as the actions required by this Agreement to minimize/mitigate incidental take are implemented, any incidental take of a Permit Species will not appreciably reduce the likelihood of the survival and recovery of such species in the wild; and (v) other measures and assurances required by NMFS as being necessary or appropriate are included in this Agreement. The hatchery permits are addressed in Section 10.1.4.

10.1.2 After opportunity for public comment, compliance with NEPA and concurrent with the Effective Date of this Agreement, NMFS will issue a Permit to the District pursuant to Section 10(a)(1)(B) of the ESA to authorize any incidental take of listed Permit Species which may result from the District's otherwise lawful operation of the Project, conducted in accordance with this Agreement and the Permit, and NMFS will issue necessary hatchery Permits (incidental and direct). In addition, the Permit shall authorize any incidental take of listed Permit Species which may result from the District's otherwise lawful operation of the hatchery facilities required by this Agreement, conducted in accordance with this Agreement and the Permit. The Permit and this Agreement shall remain in full force and effect for a period of fifty-(50) years from the Effective Date, or until revocation of the Permit under Section 10.4 "Permit Suspension, Revocation and Re-Instatement", or the District or NMFS' withdraws under Section 2.1 "Enough Already", whichever occurs sooner. Amendments to the Permit or this Agreement shall remain in effect for the then-remaining term of this Agreement or

until revocation under Section 10.4 “Permit Suspension, Revocation and Re-Instatement”, whichever occurs sooner. Withdrawal from this Agreement pursuant to Section 2 “Withdrawal From Agreement” and revocation of the Permit is not limited by the no surprises regulation. The Permit shall incorporate by reference the no surprises rule set forth in 50 CFR 222.307(g) (2001). This Agreement provides for changed circumstances and the mitigation measures to respond to changed circumstances. Any circumstance relating to Permit Species not addressed by this Agreement is an Unforeseen Circumstance.

10.1.3 The Permit shall authorize the District to incidentally take Permit Species that are listed under the ESA, to the extent that such incidental take of such species would otherwise be prohibited under Section 9 of the ESA, and its implementing regulations, or pursuant to a rule promulgated under Section 4(d) of the ESA, and to the extent that the take is incidental to the District’s lawful operation of the Project, subject to the condition that the District must fully comply with all requirements of this Agreement and the Permit. The Permit will be immediately effective upon issuance for Permit Species currently listed under the ESA. The Permit will become effective for currently unlisted Permit Species upon any future listing of such species under the ESA.

10.1.4 In the event that an additional or amended Section 10 permit is required for the implementation of any aspect of the Tributary Conservation Plan or Hatchery Compensation Plan, the NMFS shall expedite the processing of such permits or amendments. The hatchery Permits (direct and incidental) will initially be issued to authorized take through 2013. Beginning in 2013 and every ten (10)-years thereafter, the District or its agent shall submit to NMFS hatchery Permit applications incorporating changes to the Hatchery Program identified in the ten (10)-year program reviews (see Section 8.7 “Program Review”).

10.2 Permit Monitoring. Upon issuance of the Permit, the implementation thereof, including each of the terms of this Agreement shall be monitored and evaluated as provided for in Section 5 “Passage Survival Plan”. Any reports the FERC should require regarding this Agreement shall be provided to the NMFS at the time such reports are provided to the FERC.

10.3 Permit Modification.

10.3.1 The Permit issued to the District, shall be amended in conformance with the provisions 50 CFR 222. 306(a) (2001) through 222. 306(c) (2001), provided, that if said regulations are modified the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

10.3.2 This Agreement provides for on-going, active and adaptive management activities. Adaptive management provides for on going modification of management practices to respond to new information and scientific development. Adaptive management will yield prescriptions that may vary over time. Such changes are provided for in this Agreement and do not require modification of the Agreement or amendment of

the Permit, provided, that such changes will not result in a level of incidental take in excess of that otherwise allowed by this Agreement and the Permit.

10.4 Permit Suspension, Revocation and Re-Instatement. Except as set forth in Section 2.1 "Enough Already", the Permit shall be suspended, revoked and re-instated in conformance with the provisions of 50 CFR 220. 306(d) (2001) and 50 CFR 222. 306(e) (2001), provided, that if said regulations are modified the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

10.5 Early Termination Mitigation. If the Permit is terminated early and de-listing has not occurred, NMFS may require the District to mitigate for any past incidental take of Permit Species that has not been sufficiently mitigated prior to the date of termination. Such mitigation may require the District to continue relevant mitigation measures of the Agreement for some or all of the period, which would have been covered by the Permit. NMFS agrees that the District may invoke the dispute resolution procedures of this Agreement to pursue resolution of any disagreement concerning the necessity or amount of such additional mitigation, NMFS reserves any authority it may have under the ESA or its regulations regarding additional mitigation. So long as the District meets and continues to meet the survival standards, its Tributary Plan funding obligations, and its Hatchery Plan funding and capacity obligations early termination mitigation shall not apply to the District.

10.6 Funding. In its current financial position, the District has sufficient assets to secure funding for its affirmative obligations under the Agreement. To ensure notification of any material change in the financial position of the District during the term of the Permit, the District will provide the NMFS with a copy of its annual report each year of the Permit.

10.7 USFWS. USFWS does not exercise ESA authority over Permit Species.

SECTION 11 DISPUTE RESOLUTION

11.1 Stages of Dispute Resolution.

11.1.1 Stage 1: Coordinating Committee. Any dispute regarding this Agreement shall first be referred to the respective committee dealing with that issue (the Coordinating Committee is the committee of default). That committee shall have twenty- (20) days within which to resolve the dispute. If at the end of twenty- (20) days there is no resolution any Party may request that the dispute proceed to Section 11.1.2 "Stage 2: Policy Committee." However, Tributary Committee and Hatchery Committee disputes must first proceed to the Coordinating Committee, before the Policy Committee is triggered.

11.1.2 Stage 2: Policy Committee. Following the completion of Stage 1, the Chair of the Coordinating Committee or any Party may refer the dispute to the Policy Committee. The Chair of the Coordinating Committee shall chair all meetings of the Policy Committee. The Policy Committee shall have thirty- (30) days, following the referral, to convene and consider the dispute. The Chair of the Coordinating Committee shall provide advance written notice of all meetings. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting.

Each Party shall designate a policy representative who shall be available to participate on the Policy Committee. Any Party that fails to name a Policy Committee representative or to have its Policy Committee representative participate in the Policy Committee shall waive that Party's right to object to the resolution of the dispute by the Policy Committee.

The Policy Committee shall act by unanimous vote of those members present for the vote and shall develop its own rules of process, provided, that the Policy Committee shall ensure that all Parties are sent notice of all Policy Committee meetings. Abstention does not prevent a unanimous vote. If a Party or its designated alternate cannot be present for an agenda item to be voted upon it must notify the Chair of the Coordinating Committee who shall delay a vote on the agenda item for up to five- (5) business days on specified issues to be addressed in a meeting or conference call scheduled with all interested parties. A Party may invoke this right only once per delayed item.

11.1.3 Options following Stage 2. If there is no resolution of a matter following completion of Stage 1 and 2 of this Procedure, then any Party may pursue any other right they might otherwise have. The inability of the Coordinating Committee and the Policy Committee to make a decision shall be considered a dispute. The Parties are encouraged to resolve disputes through alternative dispute resolution.

11.2 Implementation of Settlement Dispute. If the Procedure results in a settlement of the dispute then: (1) the Parties shall implement, consistent with the terms of the settlement, all aspects of the settlement that can lawfully be implemented without FERC approval, or the approval of another federal agency; and (2) where FERC or other federal agency approval is needed before some or all of the settlement can be implemented, all settling Parties shall jointly present the resolution of the dispute to FERC or the appropriate federal agency for approval.

11.3 No Intent to Create Jurisdiction. The Parties agree that this Agreement is not intended to create jurisdiction in any court.

SECTION 12 MISCELLANEOUS

12.1 Conflict Between Agreement and Appendix. In the event of a conflict between this Agreement and an appendix to this Agreement, this Agreement shall control and the Parties shall cause the appendix in conflict to be revised accordingly.

12.2 Amendment of Agreement. This Agreement may be amended or modified only with the written consent of the Parties, provided that, Parties who withdraw from the Agreement do not need to, and have no right to, approve any amendments or modifications, provided further, that this Agreement provides for on-going, active and adaptive management activities. Adaptive management provides for ongoing modification of management practices to respond to new information and scientific developments. Adaptive management will yield prescriptions that may vary over time. Such changes are provided for in this Agreement and do not require modification of the Agreement or amendment of the Permit, provided that such changes will not result in a level of incidental take in excess of that otherwise allowed by this Agreement or modify the provisions set out in Section 3 "Survival Standards and Allocation of Responsibility for No Net Impact", further provided, that unless otherwise agreed to by the Parties NNI applies only to the identified Plan Species on the date this Agreement became effective originally.

12.3 Notices. Except as set forth in Sections 1.2.2 "Upon Completion of Regulatory Reviews," 2.6 "Withdrawal of Another Party" and 2.7 "Conditions Precedent to Withdrawal" all written notices to be given pursuant to this Agreement shall be mailed by first-class mail, postage prepaid to each Party. Parties shall inform all Parties by written notice in the event of a change of address. Notices shall be deemed to be given three- (3) days after the date of mailing.

12.4 Waiver of Default. Any waiver at any time by any Party hereto of any right with respect to any other Party with respect to any matter arising in connection with this Agreement shall not be considered a waiver with respect to any subsequent default or matter.

12.5 Integrated Agreement. All previous communications between the Parties, either verbal or written, with reference to the subject matter of this Agreement are superseded by the terms and provisions of this Agreement, and once executed, this Agreement and its examples, figures, tables and appendices shall constitute the entire agreement between the Parties, provided, that titles to sections and sub-sections thereof are for the assistance of the reader and are not part of the Agreement.

12.6 Benefit and Assignment. This Agreement shall be binding upon and inure to the benefit of the Parties hereto and their successors and assigns provided, no interest, right, or obligation under this Agreement shall be transferred or assigned by any Party hereto to any other Party or to any third party without the written consent of all other Parties, except by a Party: (1) to any person or entity into which or with which the Party making the assignment or transfer is merged or consolidated or to which such Party transfers

substantially all of its assets, (2) to any person or entity that wholly owns, is wholly owned by, or is wholly owned in common with, the Party making the assignment or transfer, provided that, the assignee is bound by the terms of this Agreement and applies for and receives an incidental take permit for listed Plan Species.

12.7 Force Majeure. For purposes of this Agreement, a "*force majeure*" is defined as causes beyond the reasonable control of, and without the fault or negligence of, the District or any entity controlled by the District, including its contractors and subcontractors. Economic hardship shall not constitute *force majeure* under this Agreement.

In the event that the District is wholly or partially prevented from performing obligations under this Agreement because of a *force majeure* event, the District shall be excused from whatever performance is affected by such *force majeure* event to the extent so affected, and such failure to perform shall not be considered a material breach. Nothing in this Section shall be deemed to authorize the District to violate the ESA or render the standards and objectives of this Agreement unobtainable. The suspension of performance shall be no greater in scope and no longer in duration than is required by the *force majeure.*

The District shall notify the other Parties to this Agreement in writing within seven- (7) calendar days after a *force majeure* event. Such notice shall: identify the event causing the delay or anticipated delay; estimate the anticipated length of delay; state the measures taken or to be taken to minimize the delay; and estimate the timetable for implementation of the measures. The District shall have the burden of demonstrating by a preponderance of evidence that delay is warranted by a *force majeure*.

The District shall use a good faith effort to avoid and mitigate the effects of the delay and remedy its inability to perform. A *force majeure* event may require use of the adaptive management provisions of this Agreement in remedying the effects of the *force majeure* event. When there is a delay in performance of a requirement under this Agreement that is attributable to a *force majeure*, the time period for performance of that requirement shall be reasonably extended as determined by the Coordinating Committee. When the District is able to resume performance of its obligation, the District shall give the other Parties written notice to that effect.

12.8 Appropriations. Implementation of this Agreement by the JFP is subject to the availability of appropriated funds. Nothing in this Agreement will be construed by the Parties to require the obligation, appropriation, or expenditure of any money from federal, state or tribal governments. The Parties acknowledge that the JFP will not be required under this Agreement to expend any of its appropriated funds unless and until an authorized official of that agency or government affirmatively acts to commit to such expenditures as evidenced in writing.

12.9 Legal Authority. Each Party to this Agreement hereby represents and acknowledges that it has legal authority to execute this Agreement and is fully bound by the terms hereof. NMFS is authorized to enter into this Agreement pursuant to the ESA, the Federal Power Act, the Fish and Wildlife Coordination Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

12.10 Execution. This Agreement may be executed in counterparts. A copy with all original executed signature pages affixed shall constitute the original Agreement. The date of execution shall be the date of the final Party's signature. Upon execution of this Agreement by the Parties, this Agreement shall be submitted to the Secretary of Interior or her designee for any approval, to the extent required by 25 U.S.C. § 81.

12.11 Indian Tribal or Treaty Reserved Rights. Nothing in this Agreement is intended to nor shall it in any way abridge, limit, diminish, abrogate, adjudicate, or resolve any Indian right reserved or protected in any treaty, executive order, statute or court decree. This Section shall be deemed to modify each and every Section of this Agreement as if it is set out separately in each Section.

12.12 No Precedent/Compromise of Disputed Claims. The conditions described and measures proposed to rectify them set forth in this Agreement are fact specific and uniquely tied to the circumstances currently existing at the Project. The Parties agree that the conditions existing here and the proposed actions to deal with them are not intended to in any way establish a precedent or be interpreted as the position of any party in any proceeding not dealing specifically with the terms of this Agreement. Further, the Parties acknowledge that this Agreement is a compromise of disputed claims for which each Party provided consideration to the other as contemplated under Federal Rule of Evidence 408, and will not be used by any Party in a manner inconsistent with the provisions of Federal Rule of Evidence 408.

12.13 U.S. v. Oregon. Nothing in this Agreement is intended by the signatories who are parties to the continuing jurisdiction case of U.S. v. Oregon, 302 F.Supp. 899 (D. OR 1969), to change the jurisdiction of that court or the parties positions therein.

SECTION 13 DEFINITIONS

Capitalized terms are defined as follows:

13.1 "Agreement" means this document, examples, figures, Table 1, and Appendices A through C. This Agreement is supported by Supporting Documents A through E but does not incorporate these documents.

13.2 "BAMP" means Supporting Document C "Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Program".

13.3 “Combined Adult and Juvenile Project Survival” means that 91% of each Plan Species (juvenile and adult combined) survive Project effects when migrating through the Project’s reservoir, Forebay, Dam and Tailrace including direct, indirect, and delayed mortality wherever it may occur and can be measured (as it relates to the Project) given the available mark-recapture technology.

13.4 “DFOP” means the Detailed Fishway Operating Plan. DFOP is attached hereto as Appendix A “Detailed Fishway Operating Plan” and incorporated herein by this reference.

13.5 “Daily Estimated Flow” means the Bonneville Power Administration’s estimate of the next day’s flow. However, actual flows will be tracked by the District and compared to the estimated flows. Spill will be adjusted based upon the comparison of the actual flows with the estimated flows in order to provide the required amount of spill. Spill will be shaped in steps as agreed to by the Coordinating Committee.

13.6 “Dam” means the concrete structure impounding the Columbia River.

13.7 “ESA” means the Endangered Species Act, 16 U.S.C. ss 1531 through 1543, as amended, and it’s implementing regulations.

13.8 “Essential Fish Habitat Provisions of the Magnuson-Stevens Fishery Conservation and Management Act” means the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1801 et seq., as amended by the Sustainable Fisheries Act and as may be amended, and its implementing regulations.

13.9 “Federal Power Act” means the Federal Power Act, 16 U.S.C. §§ 791a - 828c, as amended, and its implementing regulations.

13.10 “FERC” means the Federal Energy Regulatory Commission or its successor.

13.11 “Fish and Wildlife Coordination Act” means the Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-668c, as amended, and its implementing regulations.

13.12 “Forebay” means the body of water represented in the drawing (which is approximately 500 feet upstream of the Dam), which is attached hereto as Appendix B “Forebay and Tailrace Diagram” and incorporated herein by this reference.

13.13 “Juvenile Dam Passage Survival” means that 95% of each juvenile Plan Species over 95% of each species migration survive Projects effects when migrating through the Project’s Forebay, Dam and Tailrace including direct, indirect and delayed mortality where ever it may occur and can be measured (as it relates to the Project), given the available mark-recapture technology.

13.14 “Juvenile Project Survival” refers to the measurement of survival for juvenile Plan Species over 95% of each species migrating from tributary mouths and through the

Project's reservoir, Forebay, Dam and Tailrace including direct, indirect and delayed mortality, where ever it may occur and can be measured (as it relates to the Project) given the available mark-recapture technology.

13.15 "Juvenile Project Survival Standard" refers to a surrogate measurement of the Combined Adult and Juvenile Survival Standard. If Juvenile Project Survival for each Plan Species is measured to be greater than or equal to 93%, then the District will be assigned to Phase III (Standard Achieved). If Juvenile Project Survival is measured at less than 93% but greater than or equal to 91%, then the District will be assigned to Phase III (Provisional Review). If Juvenile Project Survival is measured at less than 91%, then the District will be assigned to Phase II (Interim Tools).

13.16 "Measures" means any action, structure, facility, or program (on-site or off-site) intended to improve the survival of Plan Species, except those prohibited in Section 9.7 "Drawdowns/Dam Removal/Non-Power Operation". Measures do not include fish transportation unless otherwise agreed by the Coordinating Committee.

13.17 "Pacific Northwest Electric Power Planning and Conservation Act" means the Pacific Northwest Electric Power Planning and Conservation Act, 16 U.S.C. §§ 839 - 839h, 16 U.S.C. §§ 839 - 839h, as amended, and its implementing regulations.

13.18 "Permit" shall mean permit(s) issued to the District by NMFS pursuant to Section 10 of the ESA to authorize take of Permit Species which may result from the District's or its agent's implementation of this Agreement.

13.19 "Permit Species" means all Plan Species except coho salmon (*Oncorhynchus kisutch*). Permit Species do not include coho salmon (*O. kisutch*) since wild coho salmon are extirpated from the Mid-Columbia Region and therefore not protected by the ESA.

13.20 "Plan Species" means spring, summer and fall chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*).

13.21 "Power Purchasers" means Puget Sound Energy, Inc. for the term of its existing long-term power sales contracts with the District.

13.22 "Project" means the Rock Island Hydroelectric Project owned and operated by the Public Utility District No. 1 of Chelan County, Washington pursuant to FERC Project Number 943. The geographic boundaries of the Project (reservoir, Forebay, Dam and Tailrace) are defined in exhibit "K" of the Project's FERC license.

13.23 "RCW" means Revised Code of Washington.

13.24 "Representative Flow Conditions" means that the flow of the Columbia River measured at Grand Coulee Dam during the study is between 205,381 (spring)/164,905 (summer) cubic feet per second and 100,523(spring)/76,318 (summer) cubic feet per second. These flows bound the ten percent to ninety percent range on the flow duration curve attached as Appendix C "Flow Duration Curve". Studies conducted when flow is within this ten percent to ninety percent range (values above) are automatically included in the three-year average as long as the study is otherwise valid. However, when studies are conducted when river flow is between 220,597 (spring)/180,607 (summer) cubic feet per second and 90,152 (spring)/63,291 (summer) cubic feet per second, the Coordinating Committee shall decide whether the study is included in the three year average. This decision is not subject to dispute resolution. These flows bound the five percent to 10 percent range and the ninety to ninety-five percent range on the flow duration curve attached as Appendix C "Flow Duration Curve". The flow duration curve was created by compiling the flows coming out of Grand Coulee Dam. Starting as part of the 2013 comprehensive review, and every ten years thereafter, the Coordinating Committee shall update the flow duration curve and the river flow amounts contained in this definition.

13.25 "Spill" means the passage of water through spill gates.

13.26 "TDG" means total dissolved gas.

13.27 "Tailrace" means the body of water represented in the drawing (which is approximately 1000 feet downstream of the Dam), which is attached hereto as Appendix B "Forebay and Tailrace Diagram" and incorporated herein by this reference.

13.28 "Threshold Population" refers to a naturally reproducing population that contains a five-year average of greater than 500 adults as assessed at Wells Dam and is composed of a population that is reproductively isolated from other populations of the same species".

13.29 "Tools" means any action, structure, facility or program (on-site only) at the Project, except those prohibited in Section 9.7 "Drawdowns/Dam Removal/Non-Power Operation" that are intended to improve the survival of Plan Species migrating through the Project. Tools do not include fish transportation unless otherwise agreed by the Coordinating Committee. This term is a sub-set of Measures.

13.30 "Unavoidable Project Mortality" refers to the assumed 9% mortality caused by the Project to Plan Species that is compensated through the tributary and hatchery programs.

13.31 "Unforeseen Circumstance" is defined by 50 CFR 222.102 (2001), and implemented according to 50 CFR 222.307(g) (2001). If these regulations are modified, the modified regulations will apply only to the extent the modifications were required by subsequent action of Congress or court order, unless the Parties otherwise agree.

IN WITNESS WHEREOF, the Parties hereto execute this Agreement as of the date last signed below.

Dated April 1, 2002

PUBLIC UTILITY DISTRICT NO. 1 OF
CHELAN COUNTY, WASHINGTON

By Charles J. Hosken
(signature)

Charles J. Hosken
(print name)

GENERAL MANAGER
(Title)

Address for Notice:

Public Utility District No. 1 of
Chelan County, Washington
327 N. Wenatchee Avenue
P.O. Box 1231
Wenatchee, WA 98801

Attn: General Manager

Dated 4/5/02

NATIONAL MARINE FISHERIES SERVICE

By _____
(signature)

O. Robert Lohn
(print name)

Regional Administrator
(Title)

Address for Notice:

7600 Sandpoint Way NE
Bin C15700, Bldg 1
Seattle WA 98115-0070

Dated 4/10/2002

UNITED STATES FISH AND WILDLIFE SERVICE

By Rowan W Gould
(signature)

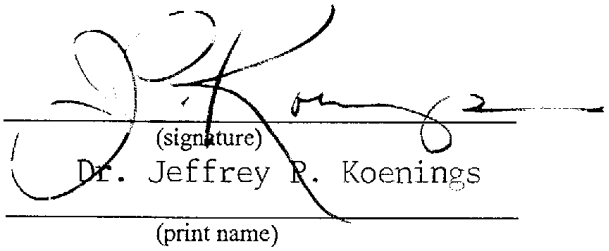
Rowan W. Gould
(print name)

Deputy Regional Director
(Title)

Address for Notice:
Project Leader
US Fish and Wildlife Service
Eastern Washington Ecological Services Office
32 C Street NW
P.O. Box 848
Ephrata, WA 98823

Dated 4/2/2002

WASHINGTON DEPARTMENT OF
FISH AND WILDLIFE

By 
(signature)

Dr. Jeffrey R. Koenings
(print name)

Director
(Title)

Address for Notice:
Washington Department of Fish & Wildlife
600 Capitol Way North
Olympia, WA 98501-1091

Dated April 4, 2002

CONFEDERATED TRIBES OF
THE COLVILLE RESERVATION

By Colleen F. Cawston
(signature)

Colleen F. Cawston
(print name)

Chair, Colville Business Council
(Title)

Address for Notice:
P.O. Box 150
Nespelem, WA 99155

Anadromous Fish Agreement and Habitat Conservation Plan, Rock Island Hydroelectric Project, FERC License No. 943

Originally signed by Public Utility District No. 1 of Chelan County, United States Fish and Wildlife Service, NOAA Fisheries Service, Washington Department of Fish and Wildlife, and Confederated Tribes of the Colville Reservation in April 2002, and approved by the Federal Energy Regulatory Commission on June 21, 2004.

Dated April 25, 2005

CONFEDERATED TRIBES AND BANDS
OF THE YAKAMA NATION

By _____
(signature)

Jerry Meninick
(print name)

Chairman-Yakama Tribal Council
(Title)

Address for Notice:

_____

_____

_____

Dated _____

CONFEDERATED TRIBES OF THE
UMATILLA INDIAN RESERVATION

By _____
(signature)

_____
(print name)

_____
(Title)

Address for Notice:

_____
_____
_____
_____
_____

Dated _____

AMERICAN RIVERS, INC., a Washington D.C., nonprofit corporation

By _____
(signature)

_____
(print name)

_____
(Title)

Address for Notice:

_____
_____
_____
_____
_____

Table 1

HCP Production Commitments for Rock Island Project

Species	Initial Production Levels: Original Inundation[1]	Initial Production Levels: Passage Losses[2]	Initial Production Levels: Total	Calculated 7% Production Levels[3]	Rearing Facility
Spring chinook		672,000	672,000	298,853	EB
		144,000	144,000		Methow
Steelhead		200,000	200,000	51,275	EB
Summer/fall chinook					
Yearlings		1,640,000	1,640,000	541,385	EB
Subyearlings					
Sockeye		200,000	200,000	571,040	EB

EB=Eastbank

[1] Compensates for original inundation by the Project. These amounts are not subject to recalculation, and are provided in addition to the levels necessary to compensate for Unavoidable Project Mortality.
[2] Agreed to production levels to compensate for Unavoidable Project Mortality. These hatchery levels are greater than that required to compensate for 7% Unavoidable Project Mortality. These hatchery levels will be produced from the Effective Date of the Agreement through 2013. These amounts are subject to recalculation every 10 years beginning in 2013.
[3] These are the hatchery levels that are required to compensate for 7% Unavoidable Project Mortality. Original inundation levels must be produced in addition to the hatchery levels in this column.

APPENDIX A
Detailed Fishway Operation Plan (DFOP)

ADULT FISH PASSAGE INFORMATION

The location of adult fish passage facilities is shown on Figure 2 "Rock Island Dam General Site Plan". This information may be out of date and will be reviewed and updated as appropriate by the Coordinating Committee.

ADULT PASSAGE FACILITIES

Adult passage facilities at Rock Island are comprised of three fishways: a right bank fishway, a left bank fishway and a middle fishway. The right bank fishway is located at the south end of the second powerhouse. The middle fishway is located in the approximate center of the spillway. The left bank fishway is located at the north side of the first powerhouse. Each facility includes a counting station, auxiliary water supply, attraction water system with entrances and an exit. Fish passage in each fishway is recorded for 24 hours per day. The recorded fish passage is viewed on the day following recording and the fish passing through each are counted on a daily basis from 15 April through 15 November.

Construction activities and associated modification in operations have potential for impact on adult passage at Rock Island Dam. Construction schedules and activities will be reviewed in advance to limit this potential. Activities which have a high probability of affecting passage will be scheduled during nighttime hours.

ADULT MIGRATION TIMING

For the purpose of operation and maintenance, primary fish passage is considered to occur from March through November. Species primary passage periods at Rock Island are:

Spring Chinook	April 18 - June 23
Summer Chinook	June 24 - September 1
Fall Chinook	September 2 - November
Steelhead	April - March
Coho	August - November
Sockeye	Late June - August 15

OPERATING CRITERIA FOR ADULT PASSAGE

SPILL MANAGEMENT FOR ADULT PASSAGE

1. Spill not provided for juvenile passage will be shaped to avoid delay of upstream migrants according to agencies, tribes, and PUD agreement.

2. Spill shaping requests are based on the tribes and agencies objective of achieving 100% passage efficiency without delay. All spill not provided for juvenile passage shall be shaped in accordance with the criteria developed by the fishery agencies and tribes.

Rock Island Adult Spill Criteria for Spill of 40 Kcfs or Less

Gate Number																	Total Feet Open
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
	3																3
	3		3														6
	3		3			3											9
	3		4			3											10
	3		4			3							6				16
	3		4			3							6		5		21
	3		4			3			3				6		5		24
	3		4			3		3	3				6		5		27
	3		4			3		3	3				5	5	5		31
	3		4			3		3	4				7	5	5		34
	3		4			3		4	4				8	5	5		36
	3		4			3		5	4				8	6	5		38
	3		4			3		5	5				8	7	5		40
	3		4			3		6	6				8	7	5		42
	3		4			3		6	7				9	7	5		44
	3		4			4		7	7				9	7	5		46
	3		4			4		8	8				9	7	5		48
	3		4			4		9	8				9	7	5		49
	3		4			4		10	9				9	7	5		51
	3		4			5		11	9				9	7	5		53
	3		4			6		11	9				9	7	6		55
	3		4			6		11	10				9	8	6		57

Notes:

1. Minimum gate opening for shallow and deep gates are reflected.

2. This criteria should be employed when juvenile criteria is not in effect.

3. Mid-range and higher spill have not been provided revised spill configuration gate settings because of limited operation flexibility.

4. Gates 16, 18, 20, 21, 23, 26-28, and 32 are gantry operated and can only be left fully open or closed.

5. This criteria is only applicable to lower spill level (approximately 40 Kcfs or less).

OPERATING STANDARDS FOR ADULT PASSAGE FACILITIES
Reviewed February 1990

LEFT BANK FISHWAY

Fish Ladder

Water depth over weirs: 1.0 to 1.2 feet.

Entrances

Head: 1.0 to 1.5 feet
Operate two entrances at all times
Weir depth 6.5 foot minimum for each (below tailwater)

Transportation Channel (Between Entrances and Ladder)

A transportation velocity of 1.5 to 4.0 feet per second (prefer 2.0 fps) shall be maintained in all channels and the lower ends of the fish ladders.

Trashracks

Visible buildups of debris shall be cleaned immediately from ladder exit and attraction water intake trashracks.

Visible buildups of debris shall be cleaned immediately from picket leads at the counting window.

Staff Gauges & Water Level Indicators

Shall be readable at all water levels encountered during passage periods.
Staff gauges or water level indicators shall be located upstream and downstream from entrances, at a convenient location for viewing along the ladder.

Staff gauge or water level indicators shall be consistent with water surface readings on the computer.

MIDDLE FISHWAY

Fish Ladder

Water depth over weirs: 1.0 to 1.2 feet

Entrances

Head: 1.0 to 1.5 foot
Main 4 foot wide entrance to be open continually

Weir depth: 8.5 minimum (below tailwater)
The left 2 foot-wide side entrance to be fully opened at all times

Trashracks

Visible buildups of debris shall be cleaned immediately from ladder exit and attraction water intake trashracks.

Visible buildups of debris shall be cleaned immediately from picket leads at the counting window.

Staff Gauges & Water Level Indicators

Shall be readable at all water levels encountered during passage periods.
Staff gauges or water level indicators shall be located upstream and downstream from entrances, at a convenient location for viewing along the ladder.

Staff gauge or water level indicators shall be consistent with water surface readings on the computer.

SECOND POWERHOUSE/RIGHT BANK FISHWAY

Fish Ladder

Water depth over weirs: 1.0 to 1.2 foot

Wing gates at each entrance allow 3.5 foot wide opening when fully open. Minimum opening of wing gates shall be 3.0 foot, which occurs when gate deflections are 16 degrees from the fully open position.

At the left powerhouse entrance, LPE1 shall be continuously open.

The two right powerhouse entrances (RPE1 and RPE2) and the tailrace entrance (TRE) shall be continuously open. High velocity jet at RPE2 shall be operated at and above tailwater elevation 570 (USC+GC). The ball valve (MOV-ROZ) shall be fully open during that time. It is operated from the control panel in the counting station.

Transportation Channel

A transportation velocity of 1.5 to 4.0 feet per second (prefer 2.0 fps) shall be maintained in all channels and the lower ends of the fish ladders.

Trashracks

Visible buildups of debris shall be cleaned immediately from ladder exit trashrack.

Visible buildups of debris shall be cleaned immediately from picketed leads at the counting window.

Traveling Screens at auxiliary Water Intake

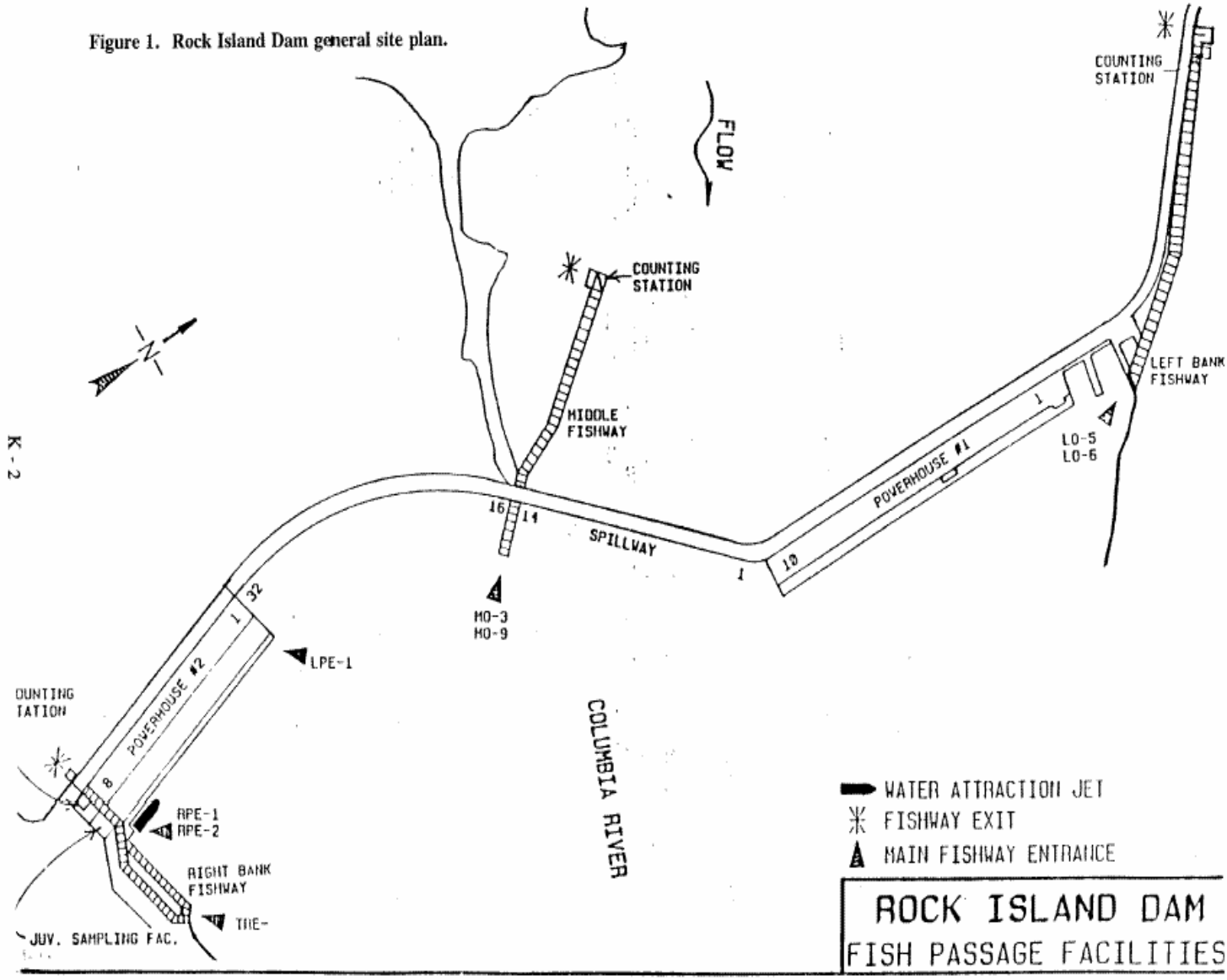
At least one of two traveling screens will be operating while the ladder is operational, and attraction jet at RPE2 is on. Operation of both traveling screens required when attraction water pumps are non-functioning and gravity water must be used. Bypass ports for traveling screens to be checked for debris and to ensure lights operate. Adequate bypass flow to be maintained from bypass pipe in tailrace.

Staff Gauges and Water Level Indicators

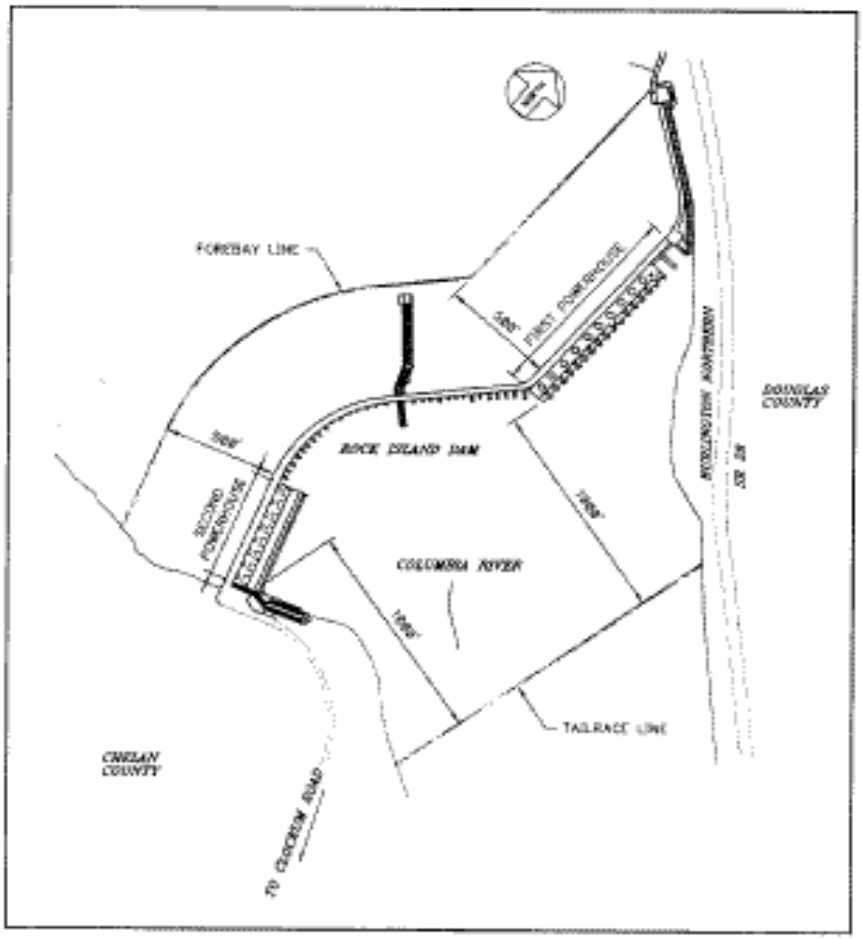
Should be readable at all water levels encountered during passage periods. Staff gauges or water level indicators shall be located upstream and downstream from entrances, and at a convenience location for viewing along the ladder.

Staff gauges or water level indicators shall be consistent with water surface readings on the computer.

Figure 2 “Rock Island Dam General Site Plan”



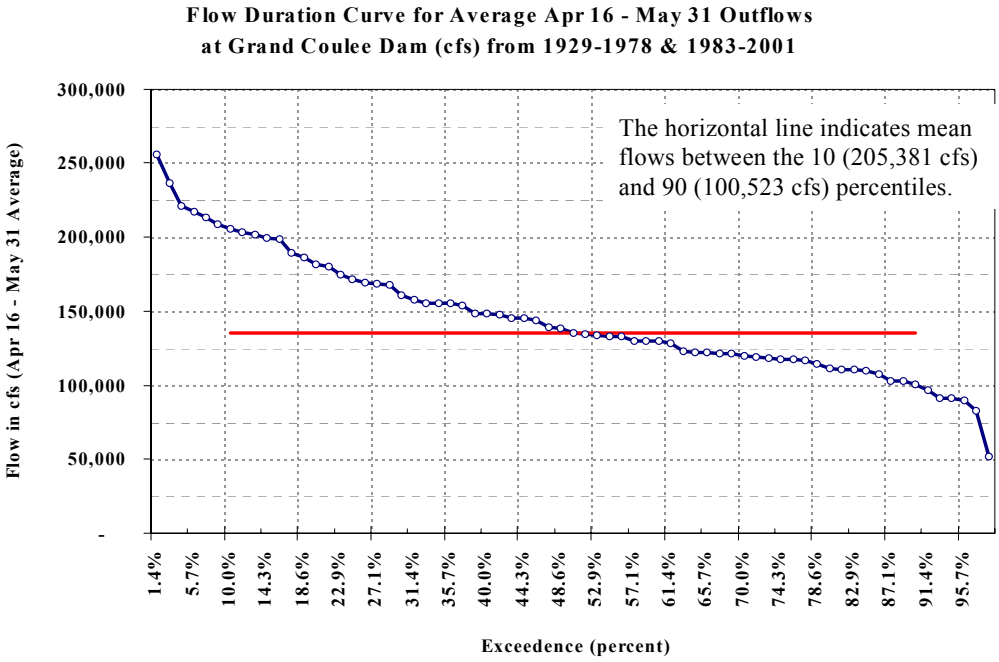
APPENDIX B
Forebay and Tailrace Diagram

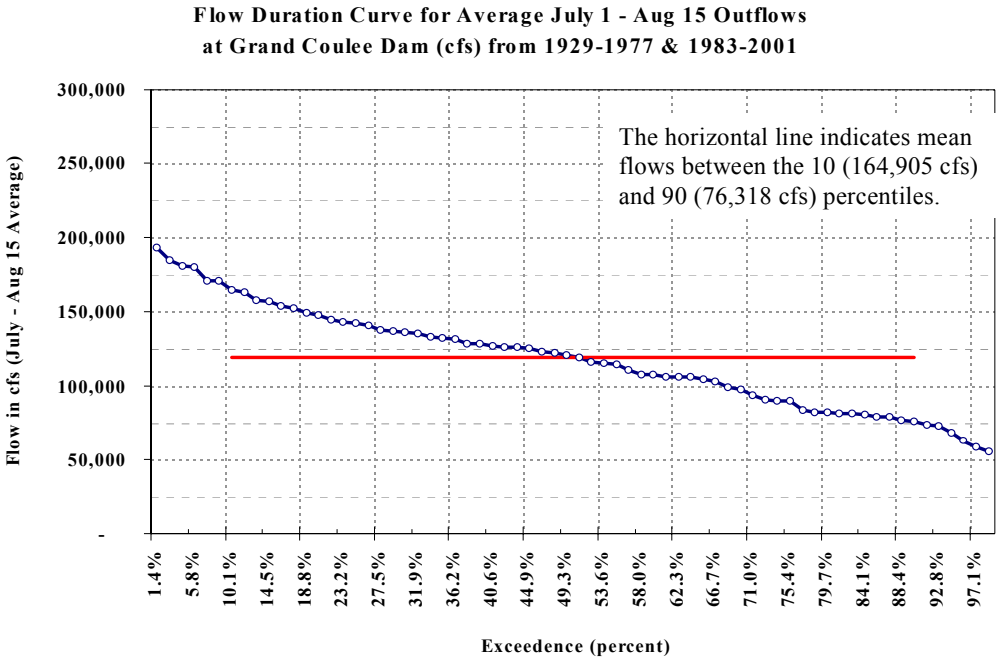


ROCK ISLAND TAILRACE AND FOREBAY

APPENDIX C

Flow Duration Curve





Key Flow Exceedence Values:						
Modeled Outflows at Grand Coulee Dam (1929-1978 record) and Actual Data (1983-2001) from DART.						
Summary Table of BPA modeling (1929-1978)				**Summary Table of BPA modeling (1929-1977)**		
and actual flow data (1983-2001).				**and actual flow data (1983-2001).**		
Spring Flows		Apr16-May31		Summer Flows		Jul1-Aug15
Rank	Percentile	Mean Flows		Rank	Percentile	Mean Flows
1	1.4%	255,259		1	1.4%	192,888
7	**10.0%**	**205,381**		**7**	**10.1%**	**164,905**
18	25.7%	169,289		18	26.1%	140,831
35	50.0%	135,423		35	50.7%	119,087
53	75.7%	117,402		52	75.4%	90,010
63	**90.0%**	**100,523**		**62**	**89.9%**	**76,318**
69	98.6%	51,389		68	98.6%	55,388
NOTE:	1929-1978 data from BPA model results under 00FSH-26, Base Case - 1995 FCRPS biop operations					
	1978 data is not included in the Jul 1 - Aug 15 period because Aug., 1979 is not included in the period of record.					
	1979-1982 water years are not included: they are not part of the modeled record and operations were not representative.					
	1983-2001 water years are observed flows after NWPP Act was implemented (from Columbia River DART website).					

Representative Flow Conditions						
	% Exceedence	Spring Flow (kcfs)	% Exceedence	Summer Flow (kcfs)		
05 Percent	4.30%	220,597	4.30%	180,607		
10 Percent	10.00%	205,381	10.10%	164,905		
90 Percent	90.00%	100,523	89.90%	76,318		
95 Percent	95.70%	90,152	95.70%	63,291		

LIST OF SUPPORTING DOCUMENTS

Supporting Document A	Tributary Plan, Project Selection, Implementation, and Evaluation (1998)
Supporting Document B	Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Rivers (1998)
Supporting Document C	Biological Assessment and Management Plan (BAMP): Mid-Columbia Hatchery Programs (1998)
Supporting Document D	Briefing Paper Estimating Survival of Anadromous Fish through the Mid-Columiba PUD Hydropower Projects (2002)
Supporting Document E	Rock Island Background Biology (1998)

Supporting Documents can be obtained by contacting Public Utility District No. 1 of Chelan County, Washington at 509-663-8121 or the National Marine Fisheries Service web site at <http://www.nwr.noaa.gov/1hydrop/hydroweb/ferchcps.html>

APPENDIX B: 2016 ROCK ISLAND TDG OPERATIONAL PLAN

2016 Rock Island TDG Operational Plan

During Fish Spill Season (April 1 through 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%, reopen notched gates in the reverse order of closure**

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, **please contact Thad Mosey (661-4451, cell 670-5594) and Marcie Steinmetz (661-4186, cell (509) 280-1955) immediately** so they can determine the next steps to take.

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

APPENDIX C: 2010 QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN
Rocky Reach Water Quality Monitoring and Reporting

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

February 19, 2010

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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DISTRIBUTION LIST

Chelan PUD
- Steve Hays
- Dan Garrison
- Michelle Smith
- Keith Truscott

Ecology
- Charlie McKinney
- Jon Merz
- Pat Irle

Rocky Reach Fish Forum

ACRONYMS AND ABBREVIATIONS LIST

cfs	cubic feet per second
Chelan PUD	Public Utility District Number 1 of Chelan County
CRO	Central Region Office of Ecology
CWA	Clean Water Act
DO	dissolved oxygen
DQO	data quality objectives
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
kcfs	thousands of cubic feet per second
mg/L	milligrams per liter
mmHg	millimeters of mercury
MQO	measurement quality objective
N/A	not applicable
NIST	National Institute of Standards and Technology
PI	PI System® from OSIsoft®
Project	Rocky Reach Hydroelectric Project
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	standard method
SOP	standard operating procedure
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WAS	Watershed Assessment Section
WQA	Water Quality Assessment

SECTION 1: BACKGROUND

The Rocky Reach Hydroelectric Project is located on the Columbia River in Chelan County, Washington, approximately seven miles upstream of the city of Wenatchee, Washington (Figure 1-1). The Project utilizes the waters of the Columbia River, whose drainage basin extends over substantial portions of northern Washington, Idaho, Montana and into Canada. The Project reservoir (Lake Entiat) extends 43 miles to Douglas County PUD's Wells Dam. The Project's installed capacity under the license is 865.76 megawatts.

This Federal Energy Regulatory Commission (FERC) licensed Project includes a reservoir with a surface area of approximately 8,235 acres and a concrete-gravity dam approximately 130 feet high and about 2,847 feet long (including the powerhouse) that spans the river. The Project consists of:

- A forebay wall, which is integral with the dam and is formed by 10 blocks of various heights and widths between the powerhouse and west abutment;
- A powerhouse approximately 1,088 feet long, 206 feet wide and 218 feet high that includes 11 generating units and a service bay;
- A spillway that is integral with the dam and consists of twelve 50-foot-wide bays separated by 10-foot-wide piers, with flow through each bay controlled by a 58-foot-high radial gate; with a combined hydraulic capacity of 980 kcfs;
- Two non-overflow east abutment blocks that are integral with the dam, each 125 feet high by 60 feet wide; and
- An east bank seepage cutoff, which is a buried structure that extends roughly 2,000 feet from the east end of the concrete portions of the dam and has a maximum depth of about 200 feet.

The Project includes passage facilities for upstream and downstream migrating fish. The upstream migrant fishway has three main entrances. These are located between spillway bays 8 and 9, at the center of the dam adjacent to powerhouse unit 11, and at the powerhouse service bay between turbine unit 1 and the west shoreline. There are also several submerged orifice entrances at each end of the powerhouse. Fish pass from the entrances into fish collection channels, which converge to guide fish to a pool and weir fish ladder with a counting station at the fishway exit that is near the west shoreline. Attraction water for the powerhouse fishway entrances is provided by three hydraulic turbine-driven pumps with a total capacity of 3,500 cfs and a gravity intake provides attraction water for the spillway entrance. The juvenile fish bypass system includes a surface collection system, turbine intake screens and collection system for turbines 1 and 2, a bypass conduit to the tailrace, and a fish sampling facility.

Figure 1-1: Project Location

The water quality monitoring program described in this Quality Assurance Project Plan (QAPP) is necessary to fulfill the requirements set forth by the Washington State Department of Ecology (Ecology) in the Section 401 water quality certification (401 Certification), Order No. 3155 issued on March 17, 2006, and incorporated into the License by Ordering Paragraph (D) on February 19, 2009. The 401 Certification incorporates, by reference, the Water Quality Management Plan, which is Chapter 2 of the Comprehensive Plan, Attachment B to the Settlement Agreement. This QAPP was prepared in accordance with the Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology, 1993).

To accomplish these measures in accordance with the 401 Certification, the Public Utility District Number 1 of Chelan County (Chelan PUD) will monitor and evaluate total dissolved gas (TDG) in the Project forebay and tailrace (401 Certification, Section 5.4(1)(a)), water temperature in the Project forebay, tailrace, juvenile bypass system, and adult fishway (401 Certification, Section 5.5); and temperature, dissolved oxygen (DO) concentrations, and pH in selected macrophyte beds in the Reservoir (401Certification, Section 5.6). In addition, Chelan PUD will prepare and implement a study of gas bubble trauma (GBT). This QAPP is designed to describe the proposed sampling, monitoring and assessment methods, and subsequent reporting requirements.

In addition to the above mentioned monitoring, Chelan PUD will monitor TDG in the Rock Island forebay. This location is not included in Section 5.4(1)(a) of the 401Certification; however, Chelan PUD is required to report data from this location as per Section 5.4(4) of the 401 Certification.

Chelan PUD plans to coordinate the macrophyte bed monitoring with required resident fish monitoring (as per Chapter 6 of the Comprehensive Plan), which, because additional time is needed to prepare a study plan for the GBT study, will not be conducted until after 2010. These studies will be included in a subsequent annual QAPP update/revision. For these reasons, macrophyte bed monitoring and the GBT study will not be described in this QAPP.

Using the data collected in the first five years of the New License, Chelan PUD will run the CE-QUAL-W2 model to evaluate Project compliance with numeric temperature criteria. An additional QAPP will be drafted to address the modeling effort.

It is necessary to note that some of the monitoring described in this QAPP may not be conducted if unsafe conditions exist. At this time it is not possible to know if unsafe conditions exist, and if so, whether they are temporary or permanent. If permanently unsafe conditions exist, Chelan PUD will consult with Ecology to determine an appropriate alternative.

1.1 REGULATORY FRAMEWORK

1.1.1 Total Dissolved Gas

Washington Administrative Code (WAC) 173-201A-200(1)(f)) establishes, and Ecology administers, Washington state water quality standards for TDG during the non-fish and fish-spill seasons . The current

standard for TDG (in percent saturation) during the non-fish spill season (September 1 through March 31) is 110% for any hourly measurement.

For projects on the Snake and Columbia rivers, the current standard for TDG (in percent saturation) during the fish-spill season (generally assumed to fall between April 1 through August 31) is 120% in the tailrace of the dam spilling water for fish and 115% in the forebay of the next downstream dam, based on the average of the 12 highest consecutive hourly readings in a 24-hour period. A one-hour, 125% maximum standard for TDG also applies throughout the Project during the fish-spill season.

Prior to 2008, the method used to calculate the daily TDG compliance value during the fish-spill season was based on the average of the 12 highest hourly values in a 24-hour period, starting at 0100 hours and ending at 2359 hours. This method was based on Ecology's 1997 Water Quality Standards. In Ecology's 2006 revision to the Water Quality Standards the method for calculating the TDG compliance value was changed to the 12 highest consecutive hourly readings in a 24-hr period.

The revision did not define how to implement the new standard so on April 2, 2008 Ecology sent a letter to all Columbia and Snake river dam operators requesting the use of a rolling average method for calculating the 12 highest consecutive hourly TDG readings in a 24-hour period, beginning at 0100 hours (Ecology 2008). Using a rolling average that begins at 0100 hours results in counting the hours 1400 hours through 2359 hours 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 based on the same group of hours.

This "double-counting" of some of the hourly TDG values could potentially lead to critical management decisions that alter operational or physical characteristics of a particular hydroelectric project. Because there is not yet a formally established method to address this "double counting" issue, in 2009 Chelan PUD followed the methodology below to address such:

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.

Use of the above methodology allowed for the monitoring of consecutive hours while eliminating "double counting". Chelan PUD understands and appreciates the need for consist compliance monitoring and reporting throughout the basin and will modify or replace the methodology described above at such time as Ecology provides an approved method.

1.1.2 Water Temperature

WAC 173-201A-602 designates the section of the Columbia River within the Project as a "salmonid spawning, rearing, and migration" water body (formerly Class A) and therefore water temperature must

remain below 17.5°C, as measured by the 7-day average of the daily maximum temperatures (7-DADMax). When a water body's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.

1.1.3 Dissolved Oxygen and pH

The water quality criteria for DO within the Project require that DO be greater than 8.0 milligrams per liter (mg/L). When DO is lower than the criteria (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(f)).

WAC 173-201A-200(1)(g) provides that pH shall be within the range of 6.5 to 8.5 units with a human-caused variation within the above range of less than 0.5 units.

1.2 HISTORICAL WATER QUALITY INFORMATION

The Columbia River at the Project is designated under current Washington State water quality standards as a "salmonid spawning, rearing, and migration" water body (formerly Class A). Water quality of this designation must meet or exceed the requirements for all or substantially all uses. The characteristic uses for the Project segment of the Columbia River include propagation of fish and wildlife (including salmonid species), water supply (domestic, irrigation, industrial), recreation, navigation and commerce (including power generation).

The Reservoir meets water quality standards numeric criteria for DO, pH, turbidity, and fecal coliform (Chelan PUD, 2004; Table 7 in PDEA). The mid-Columbia River, including the Reservoir is currently listed as impaired for TDG and water temperature with five sites on or near the Reservoir per the 2002/2004 candidate list (Section 303(d) of the Clean Water Act (CWA)). At times, water comes into the Reservoir with temperatures or TDG levels that exceed the numeric criteria. The existence of the Project does have the potential to increase water temperatures during the summer due to the effects of the Reservoir on total water surface area and increased travel time of water moving through the Reservoir. Spill operations at the Project can increase TDG levels in the Columbia River below the Project.

Chelan PUD has conducted water quality surveys within Rocky Reach Hydroelectric Project reservoir targeting specific water quality concerns; some of these studies include annual monitoring over multiple years. In coordination with the US Army Corps of Engineers, Chelan PUD has monitored water temperature at the fishway since 1965 and TDG in the forebay since 1982. More intensive monitoring of temperature and TDG was initiated in 1996. The monitoring data sets consist of daily temperature only (1965 - 1981), hourly temperature and TDG in the forebay (April - August, 1982 - present), and hourly TDG and temperature below the tailrace of the Rocky Reach Hydroelectric Project dam (April – August, 1997 - present). TDG monitoring with improved equipment and calibration procedures during the spring and summer seasons was initiated in 1995 for the forebay and 1997 for the tailrace (McDonald and Priest, 1997; Koehler and McDonald, 1997, 1998).

Douglas PUD has conducted comparable studies at Wells Hydroelectric Project dam, which are the headwaters to the Rocky Reach Hydroelectric Project reservoir. Transparency data are available for both the Rocky Reach Hydroelectric Project dam forebay and the Wells Hydroelectric Project dam forebay (1993 – present) from secchi disk readings from the fishways.

The Rocky Reach Project generally has no adverse effect on the objectives and narrative requirements of the water quality standards. The Project and the Reservoir maintain the water quality, habitat and accessibility necessary to support all the existing beneficial and designated uses included in the standards (WAC 173-201A). These uses include primary contact recreation; aesthetic enjoyment; sports fishing; boating; water supply for domestic, industrial, and agricultural uses; and fish and wildlife habitat, including habitat for spawning, rearing and migration of cold –water salmonid species. The Reservoir has clean, clear water with high water transparency, very low fecal coliform content, and high DO concentrations.

SECTION 2: PROJECT DESCRIPTION

According to the 401 Certification, monitoring, assessment, and reporting are required. Each will be discussed in this QAPP.

The goal of the QAPP is to determine compliance with Washington's numeric water quality criteria (WAC 173-201A). This QAPP was prepared to guide Chelan PUD in this effort. If criteria are not being met, subsequent goals may include identifying any impacts due to ongoing Project operations on the regulated parameters; and determining and implementing any reasonable and feasible solutions to exceedances.

The following are the monitoring requirements of the Rocky Reach 401 Certification. Chelan PUD must:

- Maintain two fixed monitoring stations at Rocky Reach Dam to monitor TDG levels annually from April through August, one in the forebay and one in the tailrace for the term of the New License;
- Monitor hourly water temperatures in the forebay and tailrace annually from April through October for the term of the New License;
- Monitor water temperatures in the juvenile fish bypass system and upstream fishway for one year;
- Monitor DO, temperature, and pH in shallow water habitats, including macrophyte beds, in the Reservoir for one year; and
- Prepare and implement a study of Gas Bubble Trauma.

The reporting of these data includes submitting:

- In year 5 of the effective date of the New License, a report summarizing the results of all TDG studies performed to date, and describing whether compliance with numeric criteria has been attained;
- A Gas Abatement Plan to Ecology for review and approval by April of the year of implementation;
- An annual report to Ecology in an approved format that includes the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, spill levels, and biological effects of GBT;
- Hourly TDG information to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible;
- An annual report to Ecology in an approved format that includes a data assessment of compliance with state water quality criteria, summaries of the data, and a list of any water quality exceedances; and
- Immediate reports to Ecology's Spills Response Program of any spills into state waters, spills onto land where contaminants could potentially drain into state waters, or cause fish kills or any other significant water quality problems.

SECTION 3: ORGANIZATION AND SCHEDULE

This section includes key personnel assigned to the project and an associated organizational chart, and time schedules for field operations, project deliverables, budgeting, and funding information.

3.1 KEY PERSONNEL

This project is to be conducted primarily by Chelan PUD personnel, with assistance as needed, to expedite the process, reduce costs, or improve quality (if needed). All personnel conducting work will have sufficient skills and experience to complete the necessary tasks at a high level of quality. This plan has been designed by Chelan PUD, and is anticipated to be conducted by the personnel outlined in Table 3-1:.

Table 3-1: Key Personnel

Personnel	Responsibility
Waikele Hampton	*Chelan PUD Environmental Permit Coordinator / Project Manager*. Lead responsible for project management, jointly responsible for report generation, data interpretation, field sampling methodology development, and sampling and monitoring.
Steven Hays	*Chelan PUD Fish and Wildlife Senior Advisor*. Jointly responsible for report generation and/or review, data interpretation, and field sampling methodology development. Senior technical review for all reports.
Michelle Smith	*Chelan PUD Licensing and Natural Resource Compliance Manager*. Responsible for QAPP and report review and approval, and funding approval.
Rosana Sokolowski	*Chelan PUD Licensing & Compliance Coordinator*. Responsible for administrative support of QAPP, sampling, data entry, and reporting.
Debby Bitterman	*Chelan PUD Administrative Assistant.* Responsible for administrative support of QAPP.
Charlie McKinney	*Ecology WQ Section Manager, Central Regional Office (CRO).* Oversees Ecology participation regarding 401 certification and Settlement Agreement.
Jon Merz	*Ecology Watershed Unit Supervisor, CRO.* Provides Ecology staff to assist PUD in compliance with 401 Certification and Settlement Agreement. Reviews Ecology work documents.
Patricia Irle	*Ecology Hydropower Projects Manager, CRO.* Lead responsible for tracking compliance with terms of 401 Certification and Settlement Agreement. Includes review of reports and the QAPP and assistance in meeting other requirements as defined in the 401 certification and Settlement Agreement.
To be determined (may be contracted out)	*Field sampler.* Responsible for field activities (including equipment maintenance), documentation and health and safety during field operations. Jointly responsible for report generation as needed.
Kris Pomianek	*Community Outreach Advisor.* Responsible for website creation and maintenance.
Jeff Mettler	*Power Management, P.I. Interface person.* Responsible for providing assistance with data management and recovery.
Ron Franklin	*Health and Safety Officer*. Responsible for overall aspects of health and safety for the QAPP project work.

3.2 SCHEDULE

The schedules below will be closely managed to ensure that no deadlines are missed, or parameter reporting requirements overlooked, unless a Force Majeure event arises, as provided in the Rocky Reach Settlement Agreement.

3.2.1 Monitoring Schedule

The schedule that will be followed has been developed from the requirements stated in the 401 Certification.

Table 3-2: Monitoring Schedule

Parameter	Monitoring Schedule	Comments
TDG	Annually Hourly April-August	Monitors located in the forebay and tailrace of Rocky Reach and in the forebay of Rock Island.
Spill as a surrogate for TDG	Hourly (This will be necessary only during spill events outside of the fish spill season.)	Data collected during the fish spill season will be used to further refine the linear regression developed by Schneider and Wilhelms (2005)
Temperature	Annually, Hourly April - October	Forebay and tailrace
Temperature	Hourly for one year	Juvenile bypass and upstream fishway
Macrophyte beds (temp, DO, pH)	Frequency is TBD; one-year study	This study will be conducted at a later date (likely in 2011)[1]
GBT	TBD	This study will be conducted at a later date (no sooner than 2011)

[1] ***Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for a side-by-side look at macrophyte bed water quality conditions and fish presence/use.***

3.2.2 Reporting Schedule

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

Chelan PUD will report exceedances of the water quality criteria within 48 hours to Ecology's CRO. Note that it may not be possible to provide temperature exceedances that are based on shifts in the temperature from natural because modeling is required to determine this type of exceedance.

3.3 BUDGET AND FUNDING

A preliminary budget has been developed to aid in planning for this work. For the sake of the initial budget, it is assumed that the forebay and tailrace temperature and TDG data will be collected real-time and the remainder of the temperature data will be logged and downloaded monthly or quarterly.
Chelan PUD will fund the monitoring and reporting described herein. These funds will be made available internally earmarked well in advance of the initiation of the monitoring (likely a minimum of two years prior) to ensure sufficient funding is provided.

SECTION 4: DATA QUALITY OBJECTIVES (DQO)

The primary objective for collecting data is to track compliance with water quality standards. The purpose of the QAPP is to identify the methods and standards used to make that determination/decision. Data quality objectives (DQOs) are statistical statements of the level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. They describe what data are needed, and how the data will be used to address the concerns being investigated. The DQOs also establish numeric limits that ensure the data collected are of sufficient quality and quantity for data user applications.

The overall DQO is to ensure that data of known and acceptable quality are provided. Proper execution of each task will yield consistent results that are representative of the media and conditions measured. All data will be calculated and reported in conventional units to allow comparability of the data. There are two types of DQOs, including decision quality objectives and measurement quality objectives (MQOs).

The acquired data will be used to characterize the water quality of the Rocky Reach Reservoir and tailrace. Decision quality objectives to obtain this information are to:

- Generate scientific data of sufficient quality to withstand scientific and legal scrutiny.
- Gather and develop data in accordance with procedures appropriate for its intended use.
- Conduct all methods/procedures specified for this project in compliance with Ecology requirements for environmental investigations.

To ensure that the MQOs of the monitoring effort are within the limits of the work, specific criteria for data parameters have been established as appropriate.

4.1 DECISION QUALITY OBJECTIVES

For this effort, the data collection must be designed in such a manner that the results can be used to determine if the water quality criteria have been met; therefore, quality objectives at the level of the decision are required. These objectives will be met by carefully determining the number of measurements taken to represent a given condition. The Sampling Process Design (Section 5.0) addresses the requirements of the decision quality objectives.

The success of obtaining these objectives can be measured by ensuring that the representativeness, completeness and comparability are controlled. Each is described below.

4.1.1 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. For this investigation, representativeness is a qualitative parameter that is primarily concerned with proper design of the sampling program, and can be best satisfied by ensuring that the monitoring locations are properly located with a sufficient number of data collected.

4.1.2 Comparability

The comparability criterion is a qualitative characteristic that expresses the confidence with which one data set can be compared to another. Principal comparability issues are field sampling techniques, and standardized concentration units and reporting formats. Data comparability is achieved using standard

field sampling techniques and measuring methods; however, comparability is limited by the other MQOs because only when precision and bias (accuracy) are known can data sets be compared with confidence.

4.1.3 Completeness

Completeness is defined as the percentage of valid analytical determinations compared to the total number of determinations. A reasonable completeness goal is 90 percent. Typical field or electronics problems may result in completeness of less than 100 percent. Completeness will be evaluated and documented throughout all monitoring, and corrective actions taken as warranted on a case-by-case basis.

4.2 MEASUREMENT QUALITY OBJECTIVES (MQOS)

The term "data quality" refers to the level of uncertainty associated with a particular data set. Data quality associated with environmental measurement is a function of the sampling plan rationale and procedures used to collect the samples, as well as the monitoring methods and instrumentation used in making the measurements. Uncertainty cannot be eliminated entirely from environmental data. However, quality assurance (QA) programs effective in measuring uncertainty in data are employed to monitor and control deviation from the desired DQOs. Sources of uncertainty that can be traced to the sampling component are poor sampling plan design, incorrect sample handling, faulty sample transportation (if applicable), and inconsistent use of standard operating procedures (SOPs). The most common sources of uncertainty that can be traced to the analytical component of the total measurement system are calibration and contamination (i.e. equipment not "resetting" or fully equilibrating in a new sampling location).

One of the primary goals of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible, and that the methodology employed is actually measuring the parameters in an acceptable manner.

For the field measurements to be conducted under this QAPP (temperature and TDG) MQOs can be specified. Each of the MQOs that pertain to this QAPP is further discussed below. The goals for this effort are outlined in Table 4-1:**.**

Table 4-1: MQOs

Parameter	Smallest Reference Level for Decision Making	Range of Instrument	Precision (Duplicate Samples)	Bias/ Accuracy	Sensitivity/ Resolution
Temperature	0.3°C	-5 to 50°C	20% RPD or ±0.05 units, whichever is least	± 0.1°C	0.01°C
TDG	1% saturation	400 – 1,300 mmHg	N/A	±0.1 % of span	1 mmHg

RPD = relative percent difference
TDG = total dissolved gas
mmHg = millimeters of mercury

4.2.1 Precision

Precision is a measure of the reproducibility of an analysis or set of analyses under a given set of conditions, and generally refers to the distribution of a set of reported values about the mean. The overall precision of a sampling event has both a sampling and an analytical component. The precision provides transparency into presence of random error such as field sampling procedures, handling, and data collection/analysis method. A reduction of precision could be introduced to this work in several ways including using equipment that is not sensitive enough (see Sensitivity below), collecting measurements over a large spatial or temporal regime, using a wide range of types of equipment, etc. A means of determining the precision of a measurement is to conduct duplicate sampling (e.g. making the same measurement in the same location at approximately the same time with the same type of equipment) and looking at the variability in results.

4.2.2 Bias

Bias (otherwise known as accuracy) is the difference between the population mean and the true value of the parameter being measured. Bias in measurements obtained under this QAPP may be introduced by faults in the sampling design (e.g. all of the temperature measurements collected in one location that is not indicative of the mixed flow or strata of interest), inability to measure all forms of the parameter of interest (e.g. inability of a thermometer to reach a temperature regime needed due to physical obstacles), improper or insufficient calibration of instrumentation and/or equipment. Bias will be minimized by following standard protocols for calibration and maintenance, and by following field protocols for stabilization of meter readings.

4.2.3 Sensitivity

Sensitivity denotes the rate at which the analytical response varies with the concentration of the parameter being measured, or the lowest concentration of a parameter that can be detected (often referred to as "resolution" for water quality equipment). For this work, equipment must be selected that provides tight enough tolerances to ensure that the data collected are described to the necessary precision. For example, if water criterion for temperature is concerned with a temperature shift of greater than 0.3 degrees Celsius, then the equipment should be able to measure the water temperature with sensitivity less than 0.3 degrees Celsius, preferably by an order of magnitude. Often, the accuracy is much larger than the resolution. If this is the case, the accuracy is the smallest verifiable value reported by the instrument.

SECTION 5: SAMPLING PROCESS DESIGN

The sampling process design includes the parameters of interest, the measurement location and the frequency of monitoring. The goal of the sampling process design is to ensure that the quality objectives for this effort can be met. The 401 Certification has outlined the requirements for the parameters, frequency, basic location, and schedule of sampling (see Table 5-1).

Table 5-1: Monitoring Parameters, Locations, Frequency, and Criteria

Parameter	Location(s)	Frequency	Metric	Standards
Temperature	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-October	degrees Celsius	17.5[1]
Temperature	Juvenile Fish Bypass, Adult Fishway	Hourly for one year	degrees Celsius	17.5[1]
TDG	Rocky Reach Forebay and Tailrace Rock Island Forebay	Hourly, April-August	% Saturation	120% in tailrace 115% of forebay (as per special fish passage criteria) 110% during outside of fish spill season

[1] When a water body's temperature is warmer than the criteria (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F).
When the background condition of the water is cooler than the criteria, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge); and
(B) Incremental temperature increases resulting from the combined effect of all nonpoint source activities in the water body must not, at any time, exceed 2.8°C (5.04°F).

5.1 MONITORING LOCATION AND DEPTH

The general locations for measurements have been identified in the 401 Certification and are more specifically define below. These locations are included in Table 5-1.

5.1.1 Forebay and Tailrace TDG and Temperature

Annual hourly TDG and temperature data will be measured at Chelan PUD's existing fixed monitoring stations, located in the forebay and tailrace of the Project, as well as in the forebay of the Rock Island Project. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of either the TDG or temperature readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rocky Reach forebay fixed monitoring station is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station is located approximately 0.38 mile downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is

east of mid-channel, and is minimally impacted by powerhouse flows when the project is passing water over the spillway (Schneider and Wilhelms, 2005). See Figure 5-1:.

The Rock Island forebay fixed monitoring station is affixed to the project, located on the west side of the river, near the right bank fishway and Powerhouse 2 (Figure 5-2:). The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations.

Figure 5-1: Locations of the Forebay and Tailrace Fixed Monitoring Stations at Rocky Reach.

Figure 5-2: Location of the Rock Island Forebay Fixed Monitoring Station.

5.1.2 Juvenile Bypass System Temperature

Downloadable data loggers will be deployed in the juvenile bypass system where gatewell water enters the system and at the juvenile sampling facility. Chelan PUD has not yet determined precisely how these instruments will be mounted in the bypass system, but it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

A data logger previously deployed in the entrance to the system will also be used to monitor temperature data in the juvenile fish bypass system.

5.1.3 Upstream Fishway Temperature

Downloadable data loggers will be deployed in two locations of the upstream fishway. Two loggers will be installed at the exit of the fishway, at depths of 703' elevation and near the bottom of the exit to collect data from both shallow and deep portions of the water column. A third logger will be installed near the bottom of the ladder section above where pumped attraction water from the tailrace enters the fishway. Chelan PUD has not yet determined precisely how these instruments will be mounted in the fishway, but again, it is likely they will be bolted to the structure at depths that will remain under water for the duration of the study. Method of mounting the loggers will be provided to Ecology after installation.

SECTION 6: MONITORING PROCEDURES

The following sections present the monitoring procedures that will be used to implement the requirements of the 401 Certification.

6.1 FREQUENCY

Table 5-1 provides the frequency that each water quality parameter will be measured. These frequencies follow the requirements of the 401 Certification, which provide that forebay and tailrace TDG and temperature be monitored on an hourly basis, April to August and April to October, respectively. Hourly temperature monitoring in the juvenile bypass system and upstream fishway will be initiated upon approval of this QAPP and will be conducted for one year, unless Ecology determines, in consultation with the Rocky Reach Fish Forum, that additional monitoring is necessary.

6.2 EQUIPMENT

Forebay and tailrace temperature and TDG data will be collected using instruments that can immediately transmit the data to Chelan PUD headquarters, allowing for real-time data recording. The fishway and juvenile fish bypass temperature data will be collected using a logging device that can be downloaded on a monthly or quarterly basis.

All temperature monitoring equipment will be of sufficient quality to meet the MQOs (Table 4-1:). The monitoring equipment will be Hydrolab's DataSondes or MiniSondes, or Hobo Water Temperature Pro Data Logger, or equivalent. Specifications for all types of equipment described herein are provided in Appendix A. Any of these types of monitoring equipment are referred to as merely equipment in the following discussion.

TDG will be measured using Hydrolab DataSondes or MiniSondes, which use a pressure transducer mounted behind a rigid gas-permeable silicone membrane to measure amount of total dissolved gaseous compounds dissolved in a liquid. The measurement quality objectives, range, precision, accuracy, and resolution of the TDG sensor are provided in Table 4.1. (See Appendix A for Equipment Specifications). TDG will be measured in mmHg and then converted to percent saturation using barometric pressure measurements recorded by a certified barometer located at the project. The conversion equation is as follows:

TDG in percent saturation = (TDG mmHg/barometric pressured mmHg) x 100

To the extent possible, sampling methods will follow protocol established by Hydrolab (or alternative manufacturer), the most current version of the Ecology Field Sampling and Measurements Protocols for the Watershed Assessment Section (Ecology, 1993), and this QAPP.

SECTION 7: QUALITY CONTROL

Field sampling and measurement protocols will follow those described in the Watershed Assessment Section (WAS) protocol manual (Ecology, 1993). Prior to deployment, instruments will be calibrated in a lab and the calibration verified by side-by-side readings. Specific quality control for each parameter measurement is described as follows.

7.1 TEMPERATURE QUALITY CONTROL

For all field-deployed equipment, a pre-and post-calibrated protocol will be conducted in accordance with the manufacturer's recommendations to document instrument bias and performance at representative temperatures. The accuracy of the field thermometers (data loggers and real-time equipment) will be maintained by a two-point comparison between the field equipment and a certified reference thermometer. This comparison will be made prior to and after logger deployment, and at a minimum of annually for real-time equipment. The certified reference thermometer to be used will have a National Institute of Standards and Technology (NIST) Traceable certification. If the mean difference between the NIST-certified thermometer and the field equipment differs by more than the manufacturer's reported specifications during the pre-study calibration, then the thermometer of interest (Sonde or logger) will not be deployed.

Additionally, each month or quarter when the data are downloaded from the loggers Chelan PUD staff will inspect the equipment to ensure it has not been damaged, has sufficient battery power (with the exception of equipment that does not show battery life, which will be replaced prior to expected battery failure), shows no signs of biofouling, and is generally in good condition. It will be cleaned as needed and replaced if damaged. The real-time equipment will be inspected and maintained in accordance with the manufacturer's recommendations.

7.2 TDG QUALITY CONTROL

Calibration and maintenance of the individual sensors of the Hydrolab® multi-probes will continue to follow the manufactures recommendations and regionally accepted methods used by other resource agencies conducting similar monitoring programs, such as the USGS, U.S. Army Corps of Engineers, and other mid-Columbia River Dam operators. The general calibration, maintenance, and deployment methods for the multi-probes also follow regionally accepted methods.

SECTION 8: DATA MANAGEMENT PROCEDURES

Data management will vary depending on whether it is transmitted in real-time or logged and downloaded periodically. The data that are collected in real-time will be automated to be transmitted directly into Chelan PUD's P.I. system as they are collected. This data management system is used on a regular basis across the Chelan PUD to manage power, flows, temperatures and many other parameters. Data that are logged and downloaded monthly or quarterly will be manually added to the P.I. system for consistent ease of availability and safe, archived keeping.

The reported data are anticipated to include the location of collection, the time of collection (by the interval determined if real-time), hourly data (averaged over the hour if more than one reading is collected per hour), and the date of collection.

SECTION 9: ADAPTIVE MANAGEMENT

The 401 Certification incorporates by reference Adaptive Management as defined in the Settlement Agreement. Additionally, conditions within the 401 Certification set forth Adaptive Management processes and measures to achieve full compliance with standards and constitute a water quality attainment plan under WAC 173-201A-510(5). Under Adaptive Management, it may be necessary to revise/modify sampling procedures/locations, as necessary to ensure quality data collection.

SECTION 10: AUDITS AND REPORTS

A process is needed to ensure that the QAPP is implemented correctly, that the quality of the data is acceptable, and that corrective actions are implemented in a timely manner.

10.1 AUDITS

In order to assure that the proper measurement procedures are taking place and to determine if changes in the procedures are needed, two forms of audits will be conducted: field audits and reporting audits, each of which is discussed below.

10.1.1 Field Audits

Once per year the project manager will accompany or oversee Chelan PUD water quality field staff (or contractor) in the field to monitor and audit all field activities including calibrations, maintenance, and multi-probe deployment methods, and safety activities. The auditor will focus on ensuring that all SOPs are followed, calibrations are conducted in compliance with manufacturers' specifications when applicable, and this QAPP is followed. The auditor will provide a brief write up of their observations including any deviations from QAPP and whether it should be changed or the process in the field needs to be addressed. The project manager will be responsible for ensuring that, if needed, any corrective actions meet Ecology and FERC approval, and that each corrective action is implemented. A subsequent audit may be required to ensure that the change has been successfully implemented.

10.1.2 Reporting Audits

It is the responsibility of the Chelan PUD to ensure that all of the reporting requirements of the 401 Certification have been met. The project manager and Licensing and Compliance Coordinator will be responsible for keeping track of the mandated reporting and confirming that it has been met. Specifically, the project manager will access the website monthly or quarterly, as appropriate, to check that the necessary data are present, legible and correct. Additionally, the project manager will review the annual reports to make sure that the data presented are accurate, and verifiable (see Section 12). Any deviations from requirements will be rectified and Ecology will be notified of the deviation and corrective action.

10.2 REPORTS

Reporting will be conducted in a variety of ways, which will depend primarily on the frequency of monitoring.

10.2.1 Periodic Updates

Data collected will be evaluated and flagged to indicate any water quality exceedances and measures taken by the Chelan PUD to address the exceedances. The Chelan PUD will report exceedances of the water quality criteria within 48 hours to the Ecology CRO.

10.2.2 Annual Reports

The 401 Certification provides detailed reporting requirements for water quality monitoring activities conducted by Chelan PUD, including those activities covered under this QAPP. Per Section 5.7(8) of the 401 Certification, data collected under this QAPP will be reported to Ecology on an annual basis by March 1 of each year. The annual report generally will include the results of all sampling and

measurement procedures, conclusions (e.g., compliance with standards), and recommendations for further action (e.g., additional sampling), if necessary.

Additionally, per Section 5.4(4) of the 401 Certification, the TDG data collected during the fish-spill season will be included in a TDG monitoring report (the annual Gas Abatement Report). To monitor compliance with the TDG numeric criteria, Chelan PUD shall report the results of the TDG monitoring, including forebay monitoring data reported by the Rock Island Project, the use of any gas abatement measures, and spill levels. The annual reports will also include the biological effects of GBT (as measured at Rock Island Dam). Presentation of the TDG monitoring results in the annual report should include the following:

- Flow during the preceding year (cfs over time);
- Spill during the preceding year (cfs and duration);
- Reasons for spill;
- TDG levels during spill (hourly);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP; and
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG standards.

This report will be submitted to Ecology by December 31 of each year and will be appended to the March 1 submittal to Ecology discussed above.

Analysis of compliance with the 110% TDG standard (non-fish-spill season) will be addressed in the March 1 submittal.

SECTION 11: DATA REVIEW, VERIFICATION, AND QUALITY ASSESSMENT

Data will be downloaded from the meters or the P.I. system to a spreadsheet and reviewed for outliers and values not conforming to the MQOs. If the objectives have not been met, the project manager will decide how to qualify the data and how the data should be used in the analysis or whether the data should be rejected. As appropriate, the project manager will assign additional data qualifiers where necessary or reject data from further use. Data that is rejected from further use will be recorded in a deleted data database with a description of why the data was rejected, as well as any adjustments needed to correct the reason for the data rejection. These deleted data will then be presented in the annual water quality monitoring report under the QA/QC sections.

Data completeness will be adequate if monitoring is completed with data meeting the MQOs at least 85 percent of the time. A lower rate of data completeness may be acceptable, which will be determined in an overall review of data. All data meeting MQOs will be used.

The results analyses will be evaluated for compliance with acceptance criteria. This evaluation will include collection of temperature data for subsequent modeling, and a statistical evaluation of other data to the numeric criteria. It is anticipated that the average and variance of all data will be assessed to determine the frequency that any numeric water quality criteria have been exceeded, if any. Once the data have been reviewed, verified, and validated, the project manager will determine if the data are of usable quality to make decisions for which the study was designed.

SECTION 12: REFERENCES

APHA, AWWA, and WEF, 1995. Standard Methods for the Examination of Water and Wastewater, Nineteenth Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

Chelan PUD, 2004. Preliminary draft environmental assessment for hydropower license – final, Rocky Reach Hydroelectric Project, FERC Project No. 2145. Chelan PUD, Wenatchee, Washington, June 30, 2004. 271pp.

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Ecology, 2004. Guidelines for Preparing Quality Assurance Project plans for Environmental Studies. Publication No. 04-03-030, Revision of Publication No. 01-03-003. July 2004.

Ecology. 2006. Water quality standards for surface waters of the State of Washington. Chapter 173-201A Washington Administrative Code. Amended November 20, 2006.

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Ecology, 2008. Letter to Columbia and Snake River Dam Operators; RE: Method for averaging 12 consecutive daily average high TDG readings in any one day. Sent by Mr. Chris Maynard on April 2, 2008.

FERC (Federal Energy Regulatory Commission). 2009. Order on Offer of Settlement and Issuing New License for Public Utility District No. 1 of Chelan County, 126 FERC ¶ 61,138.

Parametrix, Inc., and Rensel Associates 2001. Water quality monitoring report – Rocky Reach reservoir, water year 2000. Rocky Reach Hydroelectric Project No. 2145. Prepared by Parametrix, Inc., Kirkland, Washington, in association with Rensel Associates, Aquatic Science Consultants, University of Idaho, for Chelan PUD.

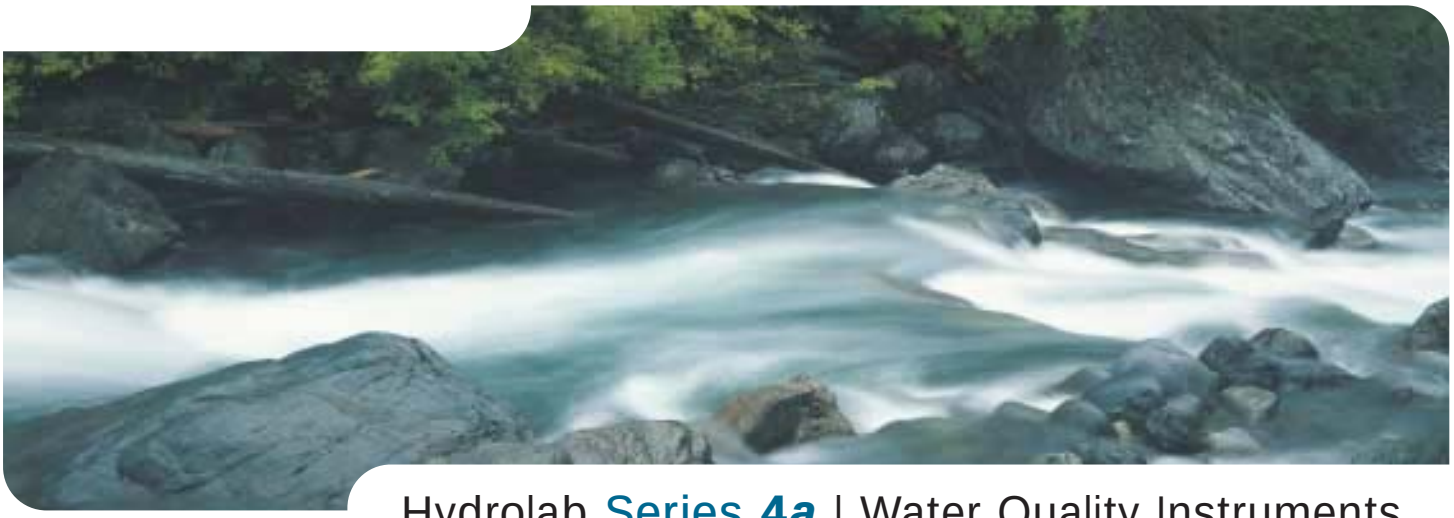
Schneider, Michael L, and S.C Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. Report by U.S. Army Engineer Research and Development Center to Chelan County Public Utility District, Wenatchee, WA.

APPENDIX A: SPECIFICATIONS FOR PROPOSED EQUIPMENT

HYDROLAB®
A HACH COMPANY BRAND

THE WORLD LEADER IN MULTI-PARAMETER WATER QUALITY MONITORING INSTRUMENTATION

> Superior sensor technology > Unsurpassed reliability > Best warranty in the industry



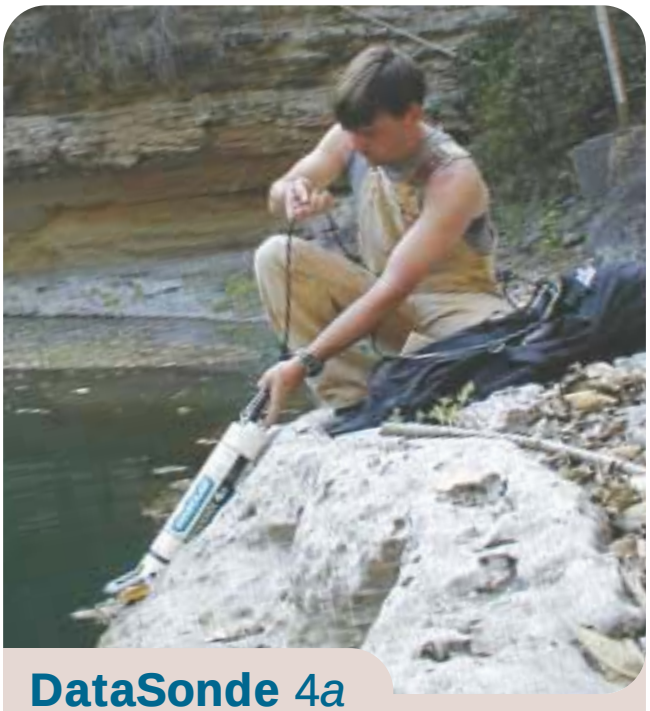
Hydrolab Series ***4a*** | Water Quality Instruments

Helping you preserve the world's water

Hydrolab Series **4a** | Water Quality Instruments

> *For over 40 years Hydrolab has been known for manufacturing reliable water quality instruments.*
> *The Series 4a continues that tradition with several enhancements that provide you with even greater value.*
> *Now, as part of Hach Company, you can expect continuous innovation from Hydrolab, now and into the future!*

*Both the **DataSonde 4a** and the **MiniSonde 4a** are well suited for profiling and spot-checking applications, and are available with battery packs and memory to use for long-term monitoring. Data can be downloaded to the **Surveyor 4a** or a PC.*



DataSonde 4a

> Seven built-in expansion ports
> Designed for in-situ and flow-through applications
> Measures up to 15 parameters
> Excellent long-term deployment capability

MiniSonde 4a

> Four built-in expansion ports
> 1.75" diameter housing – ideal for ground water monitoring, portability, and limited space environments
> Measures up to 10 parameters

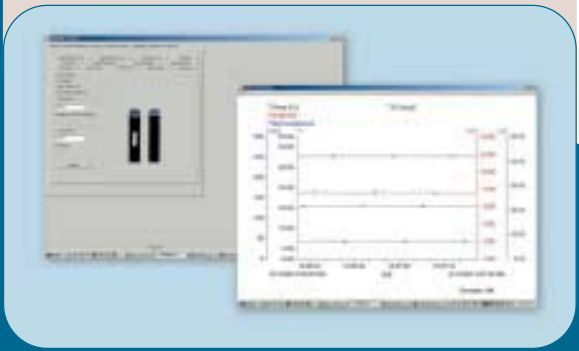
Series **4a** water quality instruments provide the best long-term value: > Easy to use and maintain

Surveyor 4a

- Rugged, waterproof (NEMA 6) case with hand strap
- Displays parameters in real-time or stores data automatically (up to 375,000 measurements)
- Data presented in real-time graphical form or tabular format
- Optional GPS and barometric pressure

Hydras3 LT

- Easy-to-use GUI
- Real-time multiparameter time series graphs *and* vertical profiling
- Simple calibration of any parameter
- Set-up data logging runs in a snap
- One click download for field data collection
- Simultaneous, multiple probe download capability
- Available for free download at www.hydrolab.com



*Superior **Sensor** Technology*

At the heart of the Series 4a instruments is Hydrolab's superior sensor technology. Advanced design and sensor technology make these instruments the most reliable in the field. The Series 4a features watertight sensors based on superior technology to produce instruments that are longer lasting, more reliable, less expensive, and easier to maintain. This means lower operating costs in the long run, and better value for you.

*The **DataSonde 4a** and **MiniSonde 4a** system, proven during years of field testing, provides the following advantages:*

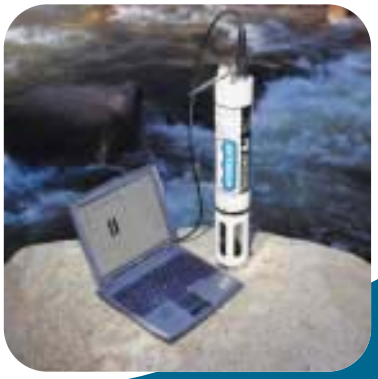
- *Sensor connection is protected from the environment*
- *Fewer components for smoother, glitch-free operation*
- *Sensors cannot become loose or trap water or debris*

> Superior sensor technology > Unsurpassed reliability > Guaranteed after-sale support

Hydrolab Series **4*a***

Engineered for dependable performance and durability in the field, Series 4*a* water quality instruments by Hydrolab can measure up to 15 parameters at once. These rugged instruments offer the highest long-term value, providing you years of reliable water quality data.

The three components of Hydrolab's Series 4*a* product line are the DataSonde 4*a*, MiniSonde 4*a* and Surveyor 4*a*. These instruments come with a two-year warranty – the best you'll find in the industry.



- > Configured to fit your specific need
- > Profiling or long-term deployment
- > Surface or ground water
- > Remote or attended monitoring

Hydrolab Series 4*a*: DataSonde 4*a* | MiniSonde 4*a* | Surveyor 4*a*

- Temperature
- Conductivity
- Dissolved Oxygen
- Rebuildable pH
- ORP
- 4-Beam Turbidity
- Self-Cleaning Turbidity
- Level & Depth
- Chlorophyll a
- Blue-Green Algae
- Rhodamine WT
- Li-Cor® Ambient Light
- Ammonium/Ammonia
- Nitrate
- Chloride
- GPS
- Barometric Pressure
- Transmissivity
- Total Dissolved Gas

HYDROLAB®
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HACH®
Be Right™

OTT

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TYPICAL PERFORMANCE SPECIFICATIONS

	RANGE	ACCURACY	RESOLUTION	AVAILABLE INSTRUMENT *
Temperature	-5 to 50° C	±0.10° C	0.01° C	D, M
Specific Conductance	0 to 100 mS/cm	±1% of reading; ±0.001 mS/cm	4 digits	D, M
pH	0 to 14 units	±0.2 units	0.01 units	D, M
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L at ≤ 20 mg/L ±0.6 mg/L at > 20 mg/L	0.01 mg/L	D, M
ORP	-999 to 999 mV	±20 mV	1 mV	D, M
Depth Vented Level 0-25 m 0-100 m 0-200 m	0 to 10 m 0 to 25 m 0 to 100 m 0 to 200 m	±0.003 m ±0.05 m ±0.05 m ±0.1 m	0.001 m 0.01 m 0.01 m 0.1 m	D, M D, M D, M D, M
Salinity	0 to 70 ppt	±0.2 ppt	0.01 ppt	D, M
4-Beam Turbidity	0 to 1000 NTU	±5% of reading; ±1 NTU	0.1 NTU (<100 NTU) 1 NTU (≥100 NTU)	D
Self-Cleaning Turbidity	0 to 3000 NTU	±1%, up to 100 NTU ±3%, 100-400 NTU ±5%, 400-3000 NTU	0.1, up to 400 NTU 1.0, 400-3000 NTU	D, M
Ammonium/Ammonia	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Nitrate	0 to 100 mg/L-N	Greater of ±5% of reading or ±2 mg/L-N (typical)	0.01 mg/L-N	D, M
Chloride	0.5 to 18,000 mg/L	Greater of ±5% of reading or ±2 mg/L (typical)	4 digits	D, M
Total Dissolved Gas	400 to 1300 mmHg	±0.1% of span	1.0 mmHg	D, M
Ambient Light	0 to 10,000 µmol $s^{-1}m^{-2}$	±5% of reading or ±1 µmol $s^{-1}m^{-2}$	1 µmol $s^{-1}m^{-2}$	D
Chlorophyll *a*	0 to 500 µg/L 0 to 50 µg/L 0 to 5 µg/L	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 µg/L	D, M
Rhodamine WT	0 to 1000 ppb 0 to 100 ppb 0 to 10 ppb	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 ppb	D, M
Blue-Green Algae	100 to 2,000,000 cells/mL 100 to 200,000 100 to 20,000	±3% for signal level equivalents of 1ppb Rhodamine WT dye	0.01 cells/mL	D, M
Barometric Pressure	500 to 850 mmHg	±10 mmHg	0.1 mmHg	S
Global Positioning System	-90 to 90° Latitude -18 to 180° Longitude	25 m CEP (50%) without SA and DGPS 2 m CEP (50%) with DGPS	0.1”	S

* D = DataSonde 4*a* M = MiniSonde 4*a* S = Surveyor 4*a*

INSTRUMENT SPECIFICATIONS

Computer Interface	RS-232, SDI-12
Memory	DataSonde 4*a* – 120,000 measurements MiniSonde 4*a* – 120,000 measurements Surveyor 4*a* – 375,000 measurements
Battery Supply	DataSonde 4*a* – 8 C batteries MiniSonde 4*a* – 8 AA batteries Surveyor 4*a* – rechargeable nickel metal hydride
Typical Battery Life (1-hour intervals)	DataSonde 4*a* – 313 days MiniSonde 4*a* – 114 days Surveyor 4*a* – 12-16 hours
Operating Temperature	-5 to 50° C
Maximum Depth	DataSonde 4*a* & MiniSonde 4*a* – 225 m
Size	DataSonde 4*a*: Outer diameter – 3.5”/8.9 cm; Length – 23”/58.4 cm; Weight – 7.4 lbs/3.35 kg MiniSonde 4*a*: Outer diameter – 1.75”/4.4 cm; Length – 21”/53.3 cm; Weight – 2.2 lbs/1.0 kg with extended battery pack: 29.5”/74.9 cm, Weight – 2.9 lbs/1.3 kg Surveyor 4*a*: 11x4x5”/27.9x10.2x3.8 cm, Weight – 2 lbs/0.9 kg

Hydrolab

5600 Lindbergh Drive
Loveland, CO 80539
(800) 949-3766
(970) 669-3050
fax (970) 461-3921
hydrolab.com

HYDROLAB®
A HACH COMPANY BRAND

BENEFITS & SPECIFICATIONS

- Uses a pH glass sensor
- Both feature a single refillable, flowing junction reference electrode OR optional low ionic strength electrode
- Standard reference electrode is more reliable, lasts longer, is easily maintained, and refills in seconds
- Reference electrode is maintained and refilled independently of pH and/or ORP
- Two-year warranty

pH SENSOR

Range	0 to 14 pH units
Accuracy	±0.2 units
Resolution	0.01 units

ORP SENSOR

Range	-999 to 999 mV
Accuracy	±20 mV
Resolution	1 mV

Hydrolab

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HYDROLAB®
A HACH COMPANY BRAND

BENEFITS & SPECIFICATIONS

DISSOLVED OXYGEN SENSOR

- Uses field-proven Clark Cell technology
- Provides a continuous steady-state reading
- Low maintenance – no need to recondition the sensor
- Two-year warranty

Range	0 to 50 mg/L
Accuracy	±0.2 mg/L for 20 mg/L or less ±0.6 mg/L for over 20 mg/L
Resolution	0.01 mg/L

SPECIFIC CONDUCTANCE SENSOR

- Hydrolab uses the four graphite electrode cell methodology:
  - Increases sample exchange
  - Open cell design provides more reliable data
  - Reduces measurement error due to fouling and air bubbles (bubbles rise above the electrodes out of the way and debris and sediment fall below)
  - Easily maintained without damaging electrodes
  - Resists corrosion
- Also measures salinity, resistivity, and TDS
- Two-year warranty

Range	0 to 100 mS/cm
Accuracy	±1% of reading, ±0.001 mS/cm
Resolution	4 digits

SAMPLE CIRCULATOR

Only Hydrolab offers a sample circulator for more reliable readings. The DataSonde 4*a* and MiniSonde 4*a* integrated sample circulator facilitates fast, accurate, steady-state dissolved oxygen measurements. Other sensors receive similar benefits.

- Creates a flow of water past the sensors
- Provides “sufficient sample flow across membrane surface” in accordance with Standard Methods Article 4500-OG
- Reduces response time – important to detect moving contaminant plumes or movement within water column
- Reduces sensor fouling – sweeps away inert debris and biological growth
- Allows deployment in any environment, even in poorly mixed areas

Hydrolab

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Loveland, CO 80539
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fax (970) 461-3921
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HYDROLAB®
A HACH COMPANY BRAND

HOBO® Water Temp Pro

AWARD-WINNING TECHNOLOGY AE50 HOBO® WEATHER STATION HOBO® WATER TEMP PRO

Size/Weight: 11.4 x 3.0 cm (4.5" X 1.19") with 6.4 mm (0.25") hole in mounting bail
42 grams (1.5 oz)

$110

The durable HOBO Water Temp Pro has 12-bit resolution and a precision sensor for ±0.2°C accuracy over a wide temperature range. A temperature-compensated real time clock provides better than ± 1 minute per month time accuracy. Designed with a durable streamlined case for extended deployment in fresh or salt water up to 50°C, the Water Temp Pro is equipped with an infrared (IR) interface for data offload in the field, even when the logger is wet.

Key Specifications

Measurement Range: 0° to 50°C (32°F to 122°F) in water (nonfreezing); –20°C to 70°C (-4°F to 158°F) in air

Waterproof: To 120 m (400 ft)

Accuracy: ±0.2°C at 0 to 50°C (± 0.36°F at 32° to 122°F)

Resolution: 0.02°C at 25°C (0.04°F at 77°F)

Time accuracy: Better than ±1 minute per month

Capacity: 21,580 12-bit measurements

CE Compliant with all relevant directives in the European Union (EU)

Bp BoxCar®Pro-compatible

Features

Accurate:
12-bit resolution and precision sensor for ±0.2°C accuracy at 0° to 50°C (±0.36°F accuracy at 32°F to 122°F)
Includes a NIST-traceable accuracy certificate at room temperature
Real-time clock for better than ±1 minute per month time accuracy

Easy to Use:
High-speed infrared (IR) interface offloads full logger <30 seconds
Programmable start time/date
User-selectable sampling interval: 1 second to 9 hours
Uses popular BoxCar® Pro 4.3+ for system launch and data retrieval

Reliable:
Factory-replaceable battery lasts 6 years (typical); temperature extremes will reduce battery life
Battery level indication at launch
Offload data, check logger and battery status while logging using BoxCar Pro
Non-volatile EEPROM memory retains measurements even if battery fails
Blinking LED confirms operation with option to suppress signal during logging
UV-stable plastic for long-term immersion in fresh or salt water*
Rugged, streamlined case design withstands years of use in stream conditions
Rated for use up to 50°C in water, 70°C in air
The dark gray case blends in, minimizing chances of tampering
Optional protective boot for high water flow, flooding, or conditions with debris *(see pg. 38)*

Detailed Specifications

Response Time: 5 minutes in water, 12 minutes in air moving 2 m/sec, typical to 90%
Memory modes: Stop when full or Wrap-around when full
Data offload: Readout full logger in < 30 seconds while logging or when stopped
Buoyancy: +13 grams (0.5 oz) (fresh water at 25°C); +17 grams (0.6 oz) with optional boot
Battery : One 3.6 V Lithium, factory replaceable ONLY
Battery Life: 6 years typical, temperature extremes reduce battery life
Drop proof to 1.5 m (5')
Note: NIST-traceable certification at additional temperature points is also available through Onset at additional cost.

The HOBO Water Temp Pro received an AE50 award for product innovation from the American Society of Agricultural Engineer's Resource *magazine.*

** Not for prolonged exposure to chlorinated water.*

IR Basestation for HOBO® Water Temp Pro

Operating Range: 0° to 40°C (32° to 104°F) 0 to 95% RH
Size/Weight: 3.2 x 6.4 x 1.5 cm (1.3 x 2.5 x 0.6 in.); 54 g (2.0 oz)

$60

The Infrared (IR) Basestation is required for communications between the HOBO Water Temp Pro and the PC. Simply place the logger 4 to 5 inches away from an IR Basestation (connected to a PC) within the 30° angle of view to read out the Water Temp Pro. The IR Basestation requires a 9-pin serial port in the PC. For use with USB port, see USB-to-Serial Adapter (pg 43). The Water Temp Pro is not compatible with IR ports on PCs or laptops.

Note: The IR Basestation is not waterproof.

HOBO Water Temp Pro Ordering

Description	Part No.	Qty. 1-9	10-99	100+
HOBO Water Temp Pro	H20-001	$110	$102	$94
IR Basestation	BST-IR	$60	$56	$51
Protective boot—black	BOOT-BLK	$15	$14	$13
Protective boot—white	BOOT-WHT	$15	$14	$13
Factory replacement battery service		$35		
Replacement caps				
Cap for Water Temp Pro (without Boot)	85-CAPLUG-H20	$2		
Cap for Boot-BLK	85-CAPLUG-H20-B	$2		
Cap for Boot-WHT	85-CAPLUG-H20-W	$2		
Software				
BoxCar Pro 4.3 Starter Kit (Windows®)	BCP4.3-ON	$95	$88	$81

Note: A BoxCar Pro Starter Kit and IR Base Station are required to operate the HOBO Water Temp Pro. Each starter kit includes software, computer interface cable and software manual. See page 42 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

underwater

StowAway® TidbiT®

$119

Small size: approx.
3.0 x 4.1 x 1.7 cm thick
(1.2 x 1.6 x 0.65"); 23 gm (0.8 oz)

The StowAway TidbiT is Onset's smallest data logger and is widely used for monitoring temperatures in streams, lakes, oceans, and soils. Small size, rugged case and alarm indication also make this a popular choice for monitoring conditions in shipping applications.

Key Specifications

Ideal for underwater applications up to 30° C

StowAway TidbiT: Model TBI32-05+37

Range†: -4° to 37°C (24° to 99°F)
Accuracy: ±0.2° at 20°C (±0.4° at 70°F)
Resolution: 0.16° at 20°C (0.29° at 70°F)

StowAway TidbiT: Model TBI32-20+50

Range†: -20° to 50°C (-4° to 122°F)
Accuracy: ±0.4°at 20°C (±0.8° at 70°F)
Resolution: 0.3°C at 20°C (0.6° at 70°F)

Capacity: 32,520 measurements

† *Specified range is narrower than nominal range due to precision calibration process. Using TidbiT Temp loggers in wet environments (>90% RH) over 86°F (30°C) for extended periods of more than 8 weeks cumulative may lead to premature failure. For applications over 30°C, use the HOBO Water Temp Pro (pg 35).*
Note: For Onset's lowest cost underwater temperature monitoring solutions, see HOBO Pendant Temp (pg 17). For depths greater than 300m see HOBO Stainless Temp (pg 18).

Features and Specifications

Waterproof to 300 m (1000 feet)
IR communications and Optic Shuttle for readout when wet—even underwater!
Programmable start time/date or triggered start on location with Optic Coupler or magnet
Small Size and Alarm Indication
5-year, non-replaceable battery (typical use*)
NIST-traceable temperature accuracy certificate available
Multiple sampling with minimum, maximum or averaging
Mounting tab
Time accuracy: ±1 minute per week at 20°C (68°F)
Memory modes: Stop when full, Wrap-around when full
Response time in water: 5 minutes (typical to 90%)
Response time in air moving 1m/second: 20 minutes

** 16 three-month deployments in water (35° to 80°F) with 4 minute or longer intervals (no multiple sampling)*

Optic Shuttle™

$199

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x 1.0" thick)
without coupler; 28.35 g (1 oz)

The pocket-sized Optic Shuttle provides a convenient way to readout and relaunch TidbiT data loggers and bring the data back to your host PC.

Features and Specifications

Waterproof to 15 psi (30 feet)
128K capacity enough for 4 full 32K loggers
Data offload time from logger: 6 minutes typical from 32K logger
Data readout time to PC: 3 minutes typical for complete offload
TidbiT Coupler and Optic Coupler included
Uploads the same data to a PC as if the data were read out directly from the logger
6 year factory-replaceable battery (typical)

Optic Base Station™

$80

Size/Weight: 132 x 20 x 25 mm
(5.25 long x 0.8 tall x .95" thick)
without coupler; 56.7 g (2 oz)

The Optic Base Station is used to communicate between the host computer and either a StowAway TidbiT data logger or an Optic Shuttle. An Optic Coupler and TidbiT Coupler for connecting the base station to loggers are also included.

StowAway TidbiT Ordering

Description	Part No.	Qty. 1-9	10-99	100+
32K StowAway TidbiT				
(-4° to 37°C)	TBI32-05+37	$119	$110	$101
(-20° to 50°C)	TBI32-20+50	$119	$110	$101
Optic Base Station for TidbiT	DSA	$80	$74	$68
Optic Shuttle for TidbiT	DTA128B	$199	$183	$169
Software				
BoxCar Pro 4.3 Starter Kit (Windows)	BCP4.3-ON	$95	$88	$81
BoxCar 3.7 Starter Kit (Windows)	BC3.7-ON	$20	$19	$17

Note: A BoxCar Pro 4.3 or BoxCar 3.7 starter kit and an Optic Base Station are required to operate the TidbiT loggers. Each starter kit includes software, computer interface cable and software manual. The Optic Base Station includes an Optic Base Station, Optic Coupler and TidbiT Coupler. See pages 42-43 for software information. Use with USB port requires USB-Serial Adapter (pg 43) and BoxCar Pro 4.3+.

B BoxCar®-compatible

Bp BoxCar®Pro-compatible

CE Compliant with all relevant directives in the European Union (EU)

APPENDIX B: CONSULTATION RECORD

B.1 Comments Letters Received

Email From Patricia Irle
Received January 1, 2010

Hi, Kelee -

I've attached a copy of the draft QAPP with some comments. However, I think it would be helpful if you could address the comments below, and submit it for another review. At that time, I'll send Section 4 to our in-house expert… (I think he needs some of the following information to do a thorough job…)

General comments:

1) TDG. How will determine whether TDG standards are being met during non-fish-spill season?
2) Temperature. QAPP notes (page 3) that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.
3) Temperature in the bypass. How do you expect to apply the standard here?
4) Please include all sampling locations.

Thanks!
Pat
(509) 454-7864

B.2 Response to Comments

Date	Section	Agency Comment	Chelan PUD Response
1/5/10	General	How will Chelan PUD determine whether TDG standards are being met during non-fish-spill season?	As per Section 5.4 (1)(a) of the 401 Certification which states: "Outside of the fish spill season, Chelan PUD may use spill as a surrogate for TDG levels," Chelan PUD will use spill as a surrogate for TDG levels outside the fish spill season. This use of spill as a surrogate for TDG levels is made possible by a linear regression developed by Schneider and Wilhelms (2005). Chelan PUD will continue to refine said regression using data collected during the April – August fish spill season.
		Temperature in the bypass. How do you expect to apply the standard here?	Monitoring will confirm whether temperatures in the bypass system increase from the entrance (forebay) to exit (sampling facility). Any observed temperature increases will be evaluated to determine impact on Columbia River temperatures.
		Please include all sampling locations.	Forebay and tailrace TDG and temperature locations have been identified in Section 5.1.1. Juvenile bypass temperature collection locations are stated in Section 5.1.2. Fishway temperature locations are stated in Section 5.1.3.
	Section 1 3rd paragraph	Says three, then lists four groups….	Language has been revised in response to comment.
	Section 1	QAPP notes that data collected will be used to run the CE-QUAL-W2 model. The QAPP seems to imply that temperature data from the forebay will be adequate to run the model. Please explain.	This may be a misinterpretation of what is written. As per Section 5.5(1)(b) of the 401 Certification, "Chelan PUD will collect or compile meteorological and water temperature data, including hourly water temperature data from the Wells Dam tailrace, for at least the first 5 years of New License; such data shall be of sufficient quality to meet technical peer review group standards for running the model." As stated previously in the Section and in the 401, Chelan PUD will collect temperature data in the forebay, fishways, juvenile bypass, and tailrace, as well as use data collected at Wells Dam.
	Table 3-2	"This study will be conducted at a later date (no sooner than 2011)." Why not?	Chelan PUD plans to coordinate this study with the resident fish study (see Chapter 6 of the Settlement Agreement), which is tentatively scheduled to commence in 2011. This will allow for concurrent analyses of macrophyte bed water quality conditions and fish presence/use. Note added to the table to clarify this.
	Table 5-1	Regarding standards column: This does not make sense in terms of the two locations identified.	Chelan PUD does not fully understand your comment, as these *are* the numeric criteria, but the table has been revised to clarify.
	5.1.1 1st Paragraph	Note that there is a slight temperature gradient. Please discuss how this may affect the results.	The monitoring device is located deep enough in the water column to not be effected by near surface temperature gradients. Language has been added to the section in response to comment.
	5.1.1 2nd Paragraph	Can you cite the study?	Citation added.
	5.1.1 3rd Paragraph	Explain how this will affect the accuracy of the TDG results…	The monitoring device is located below the depth at which bubbles form on the membrane; therefore, no effect in accuracy is expected. Language has been added to the section in response to comment.

Date	Section	Agency Comment	Chelan PUD Response
	5.1.2 1st Paragraph	This should be part of this report.	Language revised in response to comment.
	5.1.2 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	5.1.3 1st Paragraph	When do you expect to provide this?	Method of mounting the loggers will be provided after installation. Language added in response to comment.
	Section 9	I don't know that we need this. If the project changes, it will require changes to the overall objectives. Why include here?	Chelan PUD does not intend to change any projects. This adaptive management section is intended to addresses the potential need to revise/modify procedures/locations to ensure quality data collection. The language in this section has been revised in an attempt to clarify the intent of the section.
	Section 9 3rd Paragraph	This, then, isn't adaptive management…. And shouldn't be in this section.	Paragraph deleted.
	General	Suggested grammatical, formatting, etc revisions.	Chelan PUD appreciates your time and effort in making these suggestions. The suggested changes have been accepted as appropriate.
2/4/10	Section 1	Our primary concern is with regard to collecting data for a future computer temperature model run. It is stated (page 3) that an additional QAPP will be drafted to address this modeling effort. Because the model is to be run based in the first five years of data, it is critical that a QAPP be prepared immediately, to address collection of this data. Please include a data for completing that QAPP.	This is a valid point. Water temperature data to be used in the model is addressed in this QAPP; however, we agree it is necessary to draft a second QAPP that addresses the climatic data that will be used in the model. In order to proceed with the additional QAPP, Chelan PUD feels it is necessary to work collaboratively with Ecology to decide what climatic data sources should be used in this effort. Once that is determined, we can proceed with the drafting of the climatic data QAPP. Because we do not have an anticipated completion date for the second QAPP, we have not added/revised language in this QAPP to address this comment.
		The draft document describes two annual reports that will be sent to Ecology as part of this QAPP; one due in April, one in December (see pages 9 and 25 of the report). It is not clear which document will include the results and analysis for the 110% standards. Please clarify.	Clarifying language added in response to comment. Please note that the December submittal will address TDG only. This report will be appended to the March 1 submittal that is to address all parameters addressed in this QAPP.
	Table 3-2	It is indicated that spill as a surrogate for TDG will collected hourly. A minor suggestion: for consistency, could you move the comment "This will be necessary only during spill events outside of the fish season" into the second column?	Table revised in response to comment.
	Table 3-2	TDG: You should be monitoring or compiling information at each of three sites: forebay and tailrace of Rocky Reach, and forebay of Rock Island. Please clarify.	Table revised in response to comment.
	Table 5-1	TDG: Please include Rock Island forebay in the table under "Locations". And, 110% under "standards".	Table revised in response to comment.

APPENDIX D: 2015 GAS ABATEMENT ANNUAL REPORT

2015
TOTAL DISSOLVED GAS ANNUAL REPORT

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145
and
ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

December 4, 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABBREIATIONS

7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
CCT	Confederated Tribes of the Colville Reservation
Chelan PUD	Public Utility District No. 1 of Chelan County
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
Grant PUD	Public Utility District No. 2 of Grant County
GBT	gas bubble trauma
HCP	Anadromous Fish Agreement and Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
JBS	juvenile bypass system
kcfs	thousand cubic feet per second
msl	mean sea level
NMFS	National Marine Fisheries Service
project	Hydroelectric Project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RM	river mile
RRFF	Rocky Reach Fish Forum
SCADA	supervisory control and data acquisition
standards	Washington State water quality standards
TDG	total dissolved gas
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQC	water quality certification
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual report to summarize the results of the 2015 total dissolved gas (TDG) monitoring, associated spill, biological monitoring and gas abatement methods during the fish-spill period (April 1 through August 31) within the Rocky Reach and Rock Island Hydroelectric Projects.

Over the course of the 2015 fish-spill season, there were no exceedances of the total dissolved gas (TDG) numeric criteria in either the forebays or tailrace of Rocky Reach and Rock Island dams, nor at the forebay of Wanapum Dam.

Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 71.6% of average at Rocky Reach, and 73% of average at Rock Island dams) over the entire fish-spill season.

In 2015, spill events at Rocky Reach Dam were involuntary April 1 through May 31 and both voluntary and involuntary June 1 through August 7 (summer fish-spill period). Between June 1 and the end of summer fish-spill on August 7, 98% of the total volume spilled was voluntary, while 2% was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 14 with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates on August 12.

To achieve the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of 9% of daily average river flow at the Rocky Reach Dam for a duration covering 95% of the subyearling outmigration during the summer of 2015. The summer spill program for subyearling passage began on June 1 and ended on August 11. Percent daily river flow spilled during the summer period was 9%.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Project. Spring fish-spill of 10% of total river flow began on April 16 and was continued through May 31. During the spring fish-spill period, 10% of total river flow was spilled. Of that 10%, 100% of it was voluntary spill for fish. Rock Island fish-spill increased to 20% upon onset of the summer outmigration of subyearling Chinook salmon. Summer spill began on June 1 and continued through August 11. During the summer fish-spill period, 20% of total river flow was spilled. Of that 20% of total river flow, 100% of it was voluntary spill for fish

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of gas bubble trauma (GBT) between April 17 and July 16, 2015. During 2015 monitoring, 2,650 smolts were examined for GBT. Of these, 10, or 0.38%, showed signs of GBT.

In 2015, Chelan PUD implemented gas abatement measures as outlined in the Washington State Department of Ecology (Ecology) 401 Water Quality Certification (WQC) (Ecology, 2006). Chelan PUD will continue to closely monitor TDG levels during the fish-spill season, while implementing the abatement measures outlined in Ecology's approved Gas Abatement Plans (GAP), the WQC (Ecology, 2006), and the Rocky Reach Hydroelectric Project Quality Assurance Project Plan (QAPP) (Chelan PUD, 2010b).

SECTION 2: *INTRODUCTION*

2.1 Report Organization

Specific requirements of this annual report are listed below as defined in Appendix A of the Federal Energy Regulatory Commission (FERC) License Order (FERC, 2009), Section 5.4(4) of the WQC (Ecology, 2006).

5.4(4). Total Dissolved Gas Annual Report

a) Flow over the preceding year (cubic feet per second over time)
b) Spill over the preceding year (cubic feet per second and duration)
c) Reasons for spill (e.g., for fish, turbine down time)
d) TDG levels during spill (hourly)
e) Summary of TDG exceedances and what was done to correct the excedances
f) Results of the fish passage efficiency (FPE) studies and survival per the Habitat Conservation Plan (HCP)
g) Analysis of monitoring data for confirmation or refinement of the regression equations in the Water Quality Management Plan (WQMP) (Table 2-7Analysis of the TDG monitoring in comparison to the regression equations use to predict compliance with the TDG numeric criteria
h) All monitoring and studies performed for TDG control and abatement

Chelan PUD has prepared this annual report to address the requirements of the WQC. The following Sections of the report specifically address the listed requirements for the fish-spill period as follows:

Section 1 – Project Description	• Project description • fixed monitoring stations • regulatory framework • HCP results
Section 2 – Operations	• Flow • Spill • Fish-spill programs
Section 3 – Results	• Monitoring results o TDG o biological (gas bubble trauma or GBT) o regression analysis o discussion of exceedances
Section 4 – Abatement measures and Corrective Actions	• Abatement measures • Corrective actions
Section 5 - Conclusions	• Summary

2.2 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. The Rocky Reach and Rock Island projects are located in mid-Washington State on the mainstem of the Columbia River and are owned and operated by Chelan PUD. This area is 59 river miles (RM), from the forebay of Rocky Reach Dam (RM 474) downstream to the forebay of Wanapum Dam (RM 415) owned and operated by the Public Utility District No. 1 of Grant County (Figure 1-1). There are 21 RM between Rocky Reach and Rock Island dams and 38 RM between Rock Island and Wanapum dams.

*2.2.1 **Rocky Reach Project Description***

The powerhouse at Rocky Reach Dam contains a total of 11 vertical axis-generating units and is situated on the west half of the river parallel to the flow. The spillway houses 12 individually opening 170-ton tainter gates arranged on the east half of the river, perpendicular to the river flow (Figure 1-2). The normal maximum reservoir water surface elevation is 707 feet with an average tailrace water surface elevation of 618 feet, providing a gross head of 89 feet. The depth of the stilling basin immediately downstream of the project is approximately 40 feet at average tail water elevation.

In 2003, Chelan PUD began operation of the juvenile bypass system (JBS), which continues to be the primary juvenile non-turbine passage route at Rocky Reach Dam. Testing completed during the first year of operation enabled Chelan PUD to determine the juvenile guidance efficiency of the JBS and estimate the level of spill necessary to meet the HCP survival standards. Voluntary spill is used at Rocky Reach Dam to supplement the effectiveness of the JBS, when needed, to maintain survival goals of the HCP (See Section 2.3 for details). Due to the effectiveness of the JBS, Chelan PUD has reduced or eliminated 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 JBS. During the subyearling Chinook migration (generally mid-June to mid/late August), a spill level of 9% of daily flow (reduced from 15%) has been provided.

The 2015 fish-spill program at Rocky Reach Dam was managed to maximize fish passage, maintain HCP requirements, minimize voluntary spill, and still stay within the terms of Ecology's TDG fish-spill water quality criteria. Voluntary spill levels were managed in real time as detailed in the TDG Operational Plan (Appendix A) for Rocky Reach Dam.

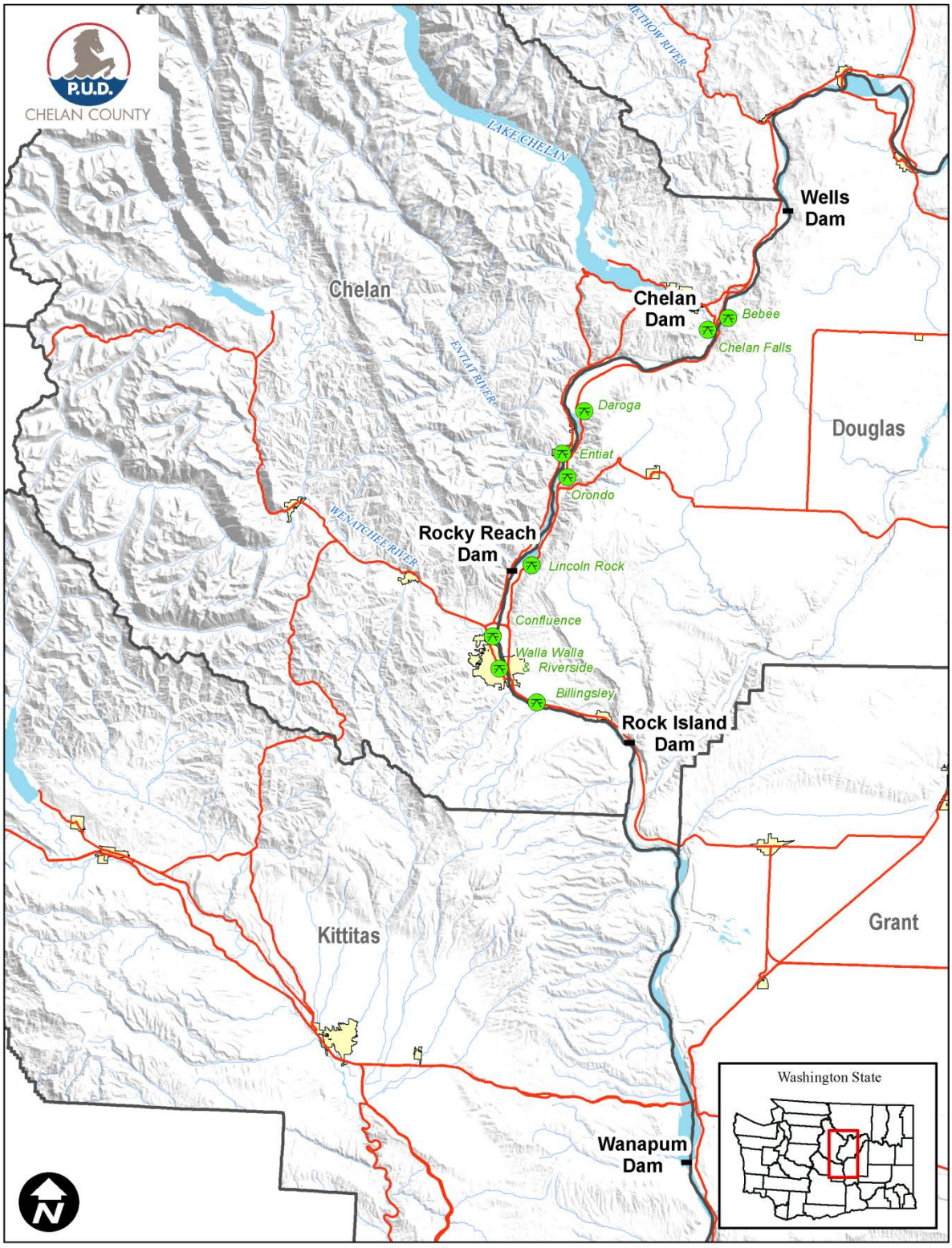

Figure 2-1: Project Location

2.2.2 ***Rock Island Project Description***

The 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. The spillway is 1,184 feet 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 or cfs) surface spill for fish bypass. The normal maximum reservoir elevation of Rock Island project is 613 feet with a tailrace elevation of 572 feet, with a total head of 41 feet. Tailrace bathymetry below Rock Island is complex, and ranges in elevation from approximately 580 feet below bays 21-23 to approximately 520 feet below Bay 1. Chelan PUD has installed the following three TDG abatement structures at Rock Island:

1. Notched gates

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

2. Spill deflector in Bay 16

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

3. Three over/under gates

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

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

2.3 Fixed Monitoring Stations

In accordance with Section 5.4.1(a) of the 401 WQC (Ecology, 2006), Chelan PUD currently operates and maintains four fixed-site water quality monitoring stations (FMS) that record barometric pressure (millimeters of mercury (mm/Hg)), TDG % saturation, and temperature (degrees Celsius). Barometric pressure, TDG percentage saturation, and temperature are recorded

at 15-minute intervals, throughout the year in accordance with Chelan PUD's Ecology and the FERC approved QAPP (Chelan PUD, 2010b).

TDG data enables plant operators to adjust spill volumes to maintain gas levels to reduce the likelihood of exceeding the TDG criteria. These 15-minute intervals are averaged into hourly readings for use in compiling daily and 12-hour averages. All hourly data are forwarded to Chelan PUD headquarters building and then onto the United States Army Corps of Engineers (USACE) Reservoir Control Center and posted at their site on the World Wide Web: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/.

Each Chelan PUD FMS is equipped with a Hydrolab® Minisonde® 5, enclosed in a submerged conduit (Figures 1-2 through 1-4). These Hydrolab® Minisonde® 5's or probes are connected to an automated system that allows Chelan PUD to monitor barometric pressure, TDG, and water temperature on an hourly basis. Probes are maintained and calibrated as outlined in the QAPP.

Forebay FMS were located at fixed sites on the upstream face of Rocky Reach and Rock Island dams (Figures 1-2 and 1-3, respectively). The probes were lowered down a conduit, secured to the upstream face of each project, and submerged to a depth of approximately 15 feet.

Tailrace monitoring stations are located downstream of both projects. The Rocky Reach Dam monitoring station is located approximately one third of a mile downstream of the spillway on the JBS outfall (Figure 1-2), as required by the 401 WQC (Ecology, 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 Total Maximum Daily Load (TMDL).

No bridge or other permanent in-water structure is available downriver of Rock Island Dam on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the project on the eastern shoreline (Figure 1-4). This FMS has two means of deploying the probe; scaffolding that holds a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold. The fixed pipe was installed August 25, 2014 due to the extreme fluctuations of the Rock Island Dam tailrace as a result of the Wanapum Reservoir drawdown emergency.

Figure 2-2: Rocky Reach Dam, forebay, tailrace and fixed monitoring stations.

Figure 2-3: Rock Island Dam, forebay fixed monitoring station.

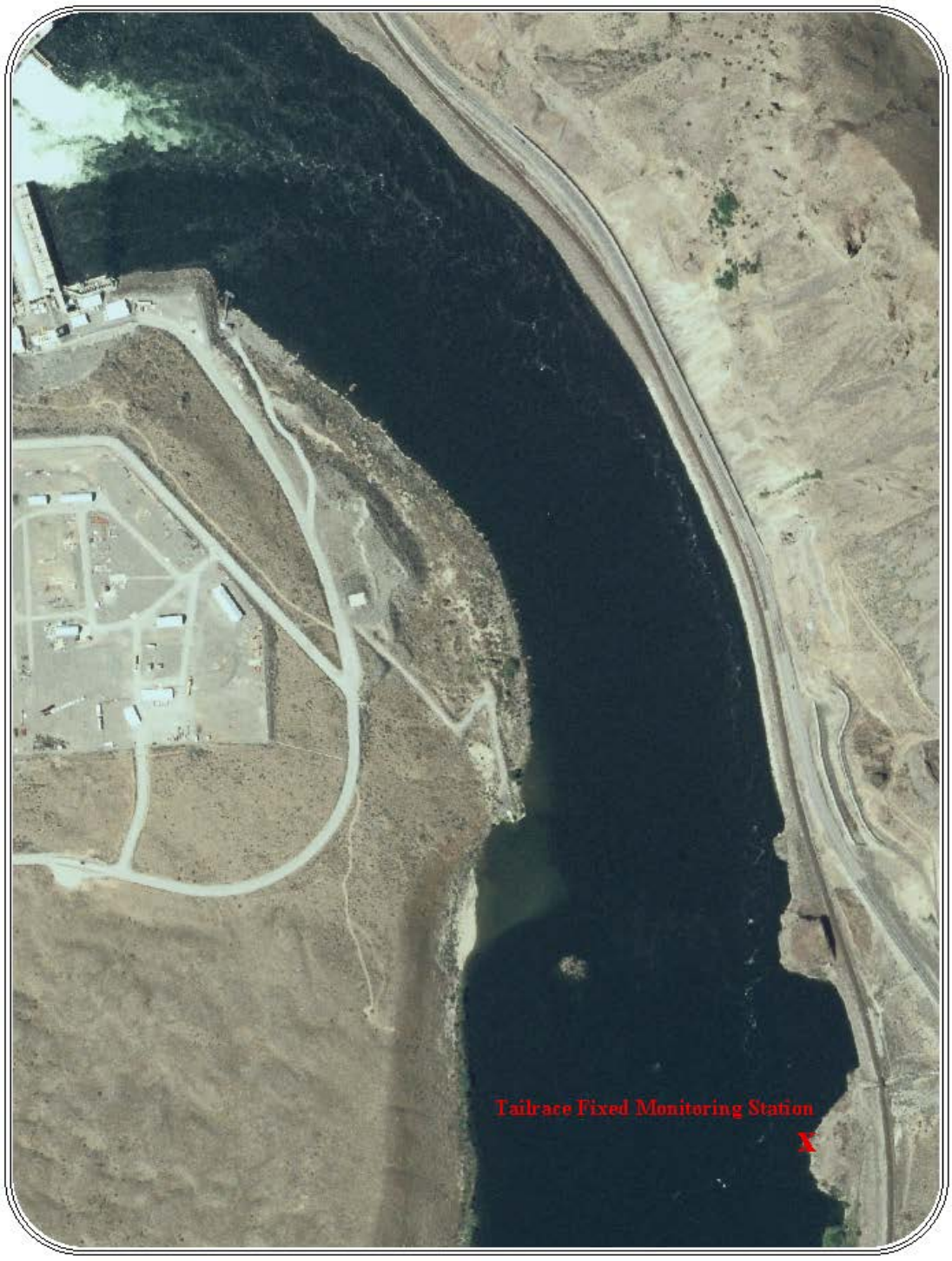

Figure 2-4: Rock Island Dam, tailrace fixed monitoring station.

2.4 Regulatory Framework

The Washington State water quality numeric criteria for TDG (Washington Administrative Code (WAC) 173-201A-200(1)(f)) address standards for the surface waters of Washington State. Under the water quality standards (standards), TDG shall not exceed 110% 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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110%) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers, there are three separate standards with regard to the TDG exemption: 1) in the tailrace of a dam, TDG shall not exceed 125% as measured in any one hour period and 2) TDG shall not exceed 120% in the tailrace of a dam and shall not exceed 115% in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period).

It is important to note that the TDG water quality standards identified above are intended to help protect aquatic life designated uses within the project. This includes Ecology's allowance of higher TDG levels during the fish-spill season, which allow dams to spill water to help achieve juvenile salmonid passage performance standards.

Specific passage performance or survival standards for the project are outlined in the HCP for the Rocky Reach Project. Specifically, the HCP provides that Chelan PUD achieve and maintain combined adult and juvenile project survival. The combined adult juvenile survival standard is 91%. The 91% standard is composed of 98% adult project passage survival and 93% juvenile project survival.

Chelan PUD is currently in Phase III - Standards Achieved. This means that the 91% adult-juvenile combined survival standard is achieved for the spring migrating HCP species; sockeye and spring Chinook salmon, and steelhead. Summer/fall subyearling Chinook salmon are in Phase III - Additional Juvenile Studies, due to limitations on acoustic tag technology for subyearlings and the unpredictable migration behavior of these Upper Columbia River subyearling Chinook salmon. Coho salmon, the last HCP species, is in Phase III - Standards Achieved - Interim.

Achieving the survival standards as described above and in addition to meeting TDG numeric criteria as outlined in WAC 173-201A-200(1)(f), are an integral part of meeting the water quality standards as described in the project's 401 WQC (Ecology, 2006).

*2.4.1 **7Q10 Flows***

Section 5.4.1(b) of the 401 WQC (Ecology, 2006) and WAC 173-201A-200(f)(i) state that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for Rocky Reach Dam was calculated to be 252 thousand cubic feet per second (kcfs), and 264 kcfs at Rock Island Dam.

2.4.2 ***Daily Total Dissolved Gas Compliance Value Calculation Method***

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

On May 21, 2008, Ecology requested, via memo, that all Columbia and Snake River dam operators use a rolling average method for calculating the twelve highest consecutive hourly TDG readings in a twenty-four hour period, beginning at 0100 hours, based on Ecology's 2006 revised water quality standards (Ecology, 2008). Using a rolling average method that begins at 0100 hours results in counting the hours 1400 through 2359 twice: in the average calculations on the day they occur and on the next reporting day. As a result, a TDG water quality standard exceedance may be indicated on two separate days based on the same group of hours. For the 2015 fish-spill period, there were no TDG exceedances and therefore, no double counting occurred.

SECTION 3: *OPERATIONS*

3.1 Description of 2015 Fish-Spill Season Flow Characteristics

Mean daily discharge during the 2015 fish-spill season was compared to the 10-year average of mean daily discharge from 2005-2014, as measured at Rocky Reach (Figure 2-1) and Rock Island dams (Figure 2-2). Mean daily flow discharges during the 2015 fish-spill season were lower than the 2005-2014 average (about 71.6% of average at Rocky Reach, and 73% of average at Rock Island dams) over the entire fish-spill season.

Average flow for all months during the spill season was lower than the monthly 10-year average at both projects. The maximum hourly flows observed at Rocky Reach and Rock Island dams during the spill season were 138 kcfs and 147 kcfs, respectively, on April 3. Of the 153 days during the spill season (April 1 through August 31), there were no instances where the daily average flows exceeded the 7Q10 value at Rocky Reach or Rock Island dams.

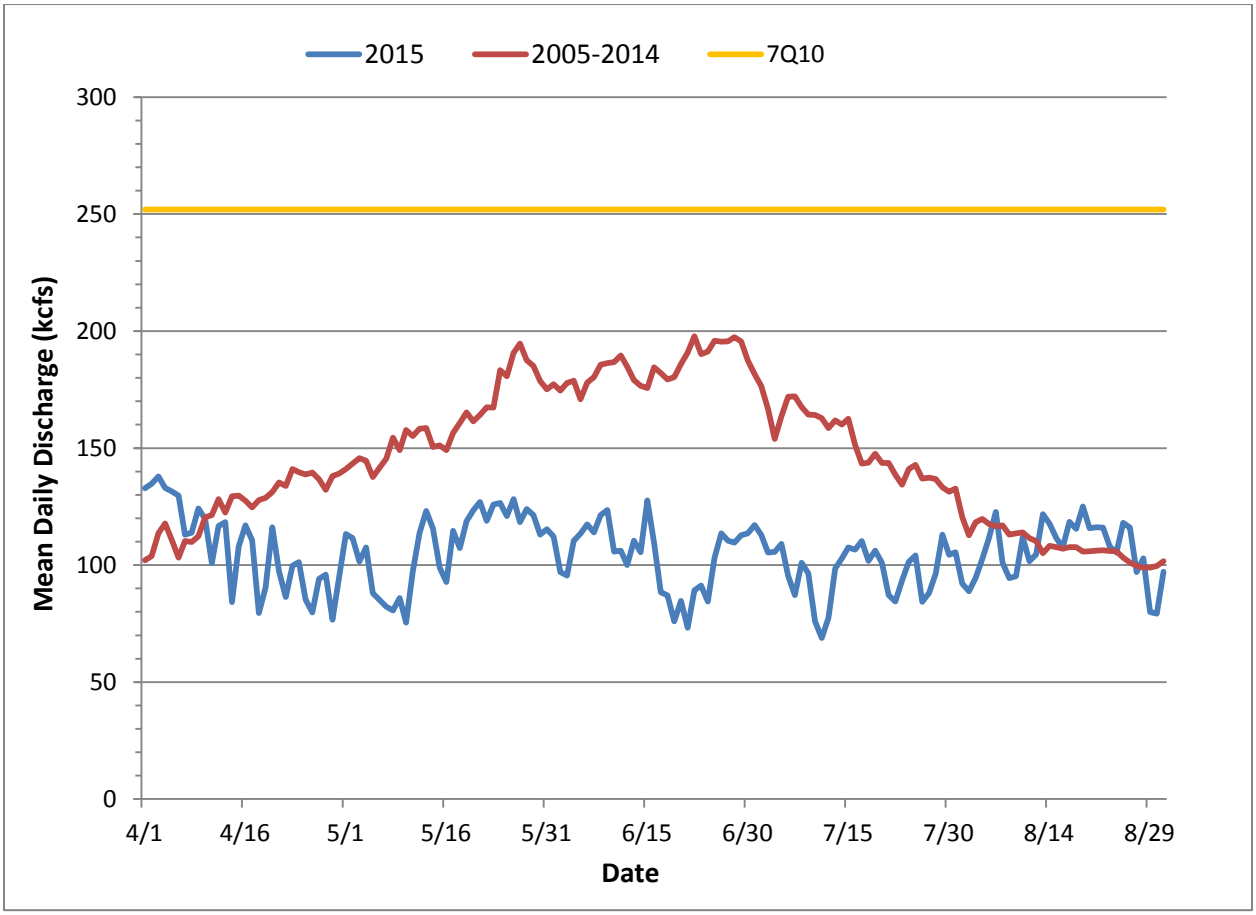

Figure 3-1: Comparison of 2015 vs. previous 10-year average (2005-2015) of mean daily discharge at Rocky Reach Dam.

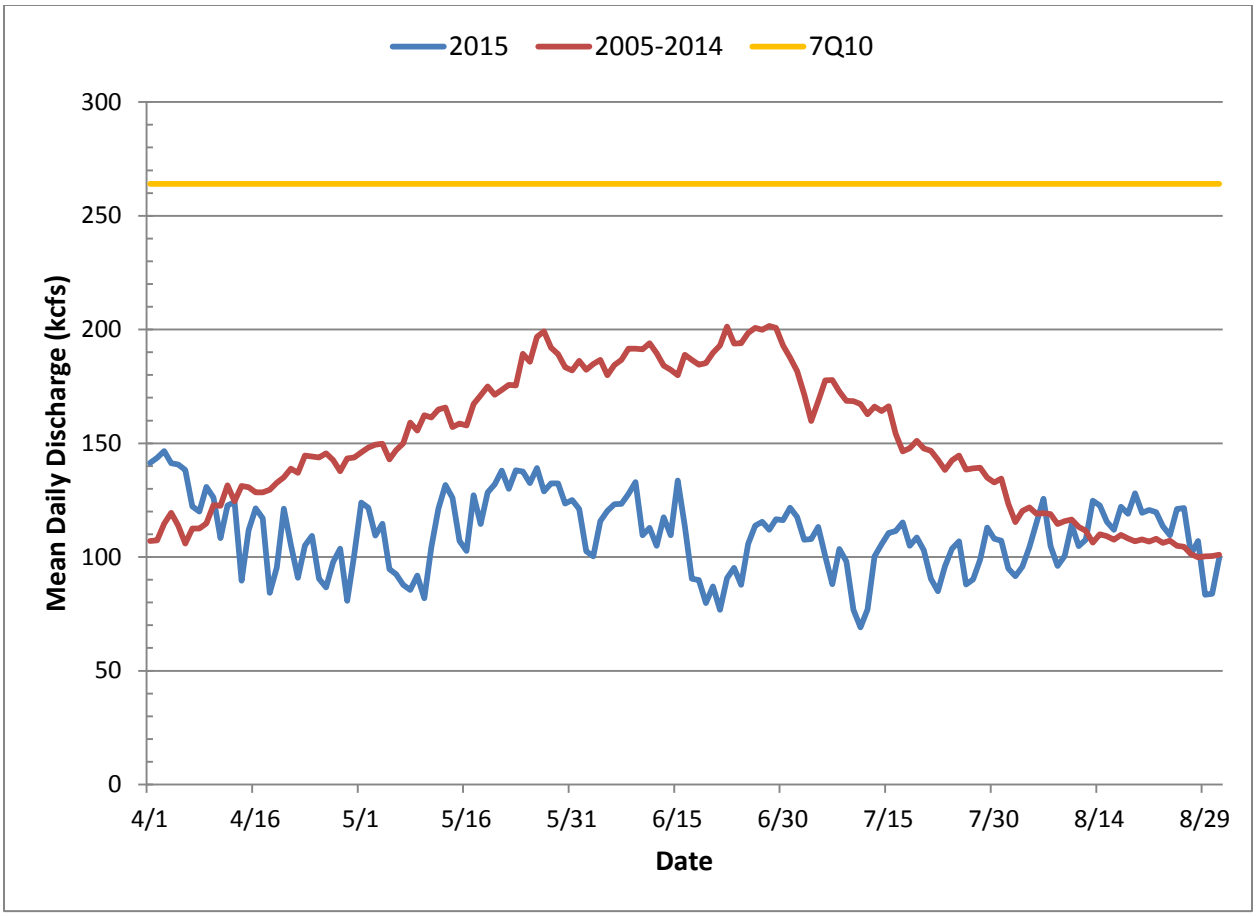

Figure 3-2: Comparison of 2015 vs. previous 10-year average (2005-2014) of mean daily discharge at Rock Island Dam.

3.2 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 Rock Island Dam are also instructed to inform the operators at Rocky Reach Dam when the Rock Island Dam forebay TDG level exceeds 115%. Since implementation of this plan, the number of TDG exceedances in the tailrace of each project has been reduced.

*3.2.1 **Rocky Reach Dam***

The standard spill configuration used at Rocky Reach Dam uses gates 2 through 8 with a minimum discharge per spill bay of about four 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 through 12 are used only in high flow conditions when gates 2 through 8 cannot pass enough water. The standard spill pattern is deviated from only when needed during high flow and spill events.

3.2.2 ***Rock Island Dam***

Spill at Rock Island Dam is provided to cover 95% of the juvenile outmigration for steelhead, and sockeye, yearling and subyearling Chinook salmon.

Optimizing spill efficiency and reducing TDG levels has been a key task for Chelan PUD at Rock Island Dam. To accomplish this task, nine of the 32 spill gates have been modified with notches (notched spill gate) in the upper section of the spill gate, in order to provide efficient spill that also provides high juvenile salmonid passage survival. In addition to notched spill gates, three spill gates have been modified to pass spill over one gate and under another, termed over/under spill gates, effectively passing juvenile fish and reducing TDG levels in the tailrace associated with spill.

3.2.2.1 Existing Spill Plan

The existing juvenile fish-spill plan at Rock Island Dam is implemented for normal forebay and tail water elevations. The usual operating range for the Rock Island Dam forebay is 612 ft to 613 feet mean sea level (msl) and tail water is 570 feet. Spill for juvenile fish passage is provided between the first of April and up to the end of August each year.

Notched spill gates are numbers 1, 16, 18, 24, 26, and 29. These gates can be opened or closed sequentially by the operators using electric hoists. Over/under spill gates are numbers 30, 31, and 32. Once these gates are installed prior to the start of spring fish-spill season, they remain open until the close of the season. A mechanic crew installs the gates (in their operating configuration) with a crane, so the operators themselves cannot sequentially open or close the over/under gates as they do with the notched gates. As a result, Rock Island Dam can spill no less than 7.2 kcfs (total discharge for the three gates) from the date of installation (late March/early April) to the date of removal (late August/early September). Sequencing of the notched and over/under spill gates vary from year to year depending upon inflows, headwater control, and any scheduled maintenance of the gates.

3.3 Fish-Spill Programs

Specific survival standards for the project are outlined in the HCP for the Rocky Reach and Rock Island projects. Chelan PUD is required to meet and maintain survival standards for fish migrating through the projects. Reservoir and dam passage survival are the key components of project survival. Chelan PUD uses a different combination of tools to facilitate fish passage at the Rocky Reach and Rock Island dams because of each dam's unique features. At Rocky Reach Dam, passage is facilitated by the JBS, which is the primary method to increase juvenile dam passage survival. The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.

At Rock Island Dam, spill is still the preferred method of moving fish past the dam, with most of the spill being passed through the modified notched spill gates. Results of survival studies

conducted at Rock Island Dam 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 Dam remains at 20% of the daily average flow.

The fish-spill programs implemented by Chelan PUD at each project are dictated by the timing and duration of each species of outmigration. In the spring, generally mid-April through early- June, yearling Chinook salmon, steelhead and sockeye migrate past the projects, while subyearling Chinook salmon migrate during the summer, generally mid-June to mid/late-August. Appendix B contains the specific 2015 Fish-Spill Season Memoranda announcing the spring and summer fish-spill periods.

During the spring of 2015, Chelan PUD operated the JBS exclusively with no voluntary spill for yearling Chinook salmon, steelhead, and sockeye passage. Spring fish-spill began at Rock Island Dam on April 16, 2015 at 0001 hours and ended May 31, 2015 at 2400 hours (see Appendix D).

Summer fish-spill began on June 1, 2015 at 0001 hours immediately following the end of the spring fish-spill season and continued through 2400 hours on August 7, 2015 at Rocky Reach and August 11, 2015 at Rock Island dams (see Appendix B). Tables 2-1 and 2-2 provide a summary of the 2015 fish-spill for Rocky Reach and Rock Island dams respectively.

Table 3-1: Summary of fish-spill operations at Rocky Reach Dam.

Rocky Reach Dam			
Date	**Juvenile Fish Passage Program**	**Quantity**	**Notes**
1–Apr	JBS Operation Began		Operated exclusively with no fish-spill during the spring (April 1 – May 31)[1]
1–June	Summer Spill Initiated	9% of daily average river flow	Spill for sub-yearling (summer) Chinook salmon
7–Aug	End of summer spill		
31–Aug	JBS Operation Ended		
Notes: [1] The efficiency of the JBS has allowed for elimination of the need to spill for fish during the spring migration season, thereby reducing TDG levels.			

Table 3-2: Summary of fish-spill operations at Rock Island Dam.

Rock Island Dam		
Date	**Juvenile Fish Passage Program**	**Quantity**
1-Apr	Fish Bypass Operation Began	
16-Apr	Spring Spill Initiated	10% daily average river flow
31-May	End of Spring Spill	
1-June	Start of Summer Spill	20% of daily average river flow
11-Aug	End of Summer Spill	
31-Aug	Fish Bypass Operation Ended	

3.4 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 may 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

Tables 2-3 and 2-4 show the monthly averages for river flow, total spill, fish-spill, and other spill for the Rocky Reach and Rock Island dams.

Table 3-3: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rocky Reach Dam, April 1 through August 31, 2015.

Month	**Average Flow kcfs**	**Average Spill kcfs**	**Spill Purpose**					
			Fish-Spill			**Other**		
			Spill kcfs	**% of flow**	**% of Total Spill**	**Spill kcfs**	**% of flow**	**% of Total Spill**
April	107.4	0.5	0.0	0.0	0.0	0.5	0.4	100.0
May	108.9	0.3	0.0	0.0	0.0	0.3	0.2	100.0
June	103.6	9.6	9.5	9.2	99.0	0.1	0.1	1.0
July	98.4	8.5	8.4	8.5	98.4	0.1	0.1	1.6
August	106.2	2.9	2.1	2.0	72.3	0.8	0.8	27.7

Table 3-4: Average monthly total flow, spill, and percent of total flow spilled for different purposes at Rock Island Dam, April 1 through August 31, 2015.

Month	Average Flow kcfs	Average Spill kcfs	Spill Purpose					
			Fish-Spill			Other		
			Spill kcfs	% of flow	% of Total Spill	Spill kcfs	% of flow	% of Total Spill
April	113.7	5.2	5.2	4.5	100.0	0.0	0.0	0.0
May	117.3	11.5	11.5	9.8	100.0	0.0	0.0	0.0
June	107.5	21.3	21.3	19.8	100.0	0.0	0.0	0.0
July	100.2	19.3	19.3	19.2	100.0	0.0	0.0	0.0
August	109.5	7.5	7.5	6.9	100.0	0.0	0.0	0.0

3.4.1 ***Voluntary and Involuntary Spill***

In 2015, spill events at Rocky Reach Dam were involuntary (forced) April 1 through May 31 and both voluntary and involuntary June 1 through August 7 (summer fish-spill period). Between June 1 and the end of summer fish-spill on August 7, 98% of the total volume spilled was voluntary, while 2% was involuntary (forced) spill due to repairs on units with mechanical issues discovered in 2013.

At Rock Island Dam, there was no spill until April 14, with the placement of the over/under gates in preparation for the start of the spring fish-spill season. All spill during the spring and summer spill periods (April 16 through May 31 and June 1 through August 11, respectively) was voluntary spill for fish. From August 12 through August 31, there was no spill that occurred with the exception minimal spill due to the removal of the over/under gates on August 12.

To achieve HCP passage requirements for subyearling (summer) Chinook salmon, Chelan PUD maintained a target spill level of 9% of daily average river flow at the Rocky Reach Dam for a duration covering 95% of the subyearling outmigration during the summer of 2015. The summer spill program for subyearling passage began on June 1 and ended on August 11. Percent daily river flow spilled during the summer period was 9%.

Spill through modified gates remains the primary fish passage measure used to meet HCP survival standards at the Rock Island Hydroelectric Project. Spring fish-spill of 10% began on April 16 and was continued through May 31. During the spring fish-spill period, 10% of total river flow was spilled. Of that 10%, 100% of it was voluntary spill for fish. Rock Island Dam fish-spill increased to 20% upon onset of the summer outmigration of subyearling Chinook. Summer spill began on June 1 and continued through August 11. During the summer fish-spill period, 20% of total river flow was spilled. Of that 20%, 100% of it was voluntary spill for fish

SECTION 4: *RESULTS*

The following sections describe the 2015 fish-spill season flow characteristics compared to the previous ten-year average, the 2015 fish-spill season programs, the 2015 biological TDG monitoring results, and the TDG data for the fish-spill season.

4.1 Biological Evaluations

The following sections provide a summary of fisheries management and results from GBT monitoring. Note that no survival studies were conducted in 2015.

No survival studies on spring migrants (yearling Chinook and sockeye salmon and steelhead) were conducted in 2015 as HCP survival standards have been achieved for all three species at both projects. Additionally, due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for summer/fall subyearling Chinook have been conducted since 2004.

4.1.1 Gas Bubble Trauma Monitoring

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach Project WQC (Ecology, 2006) requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. On April 21, 2014, Chelan PUD received a letter from Ecology postponing the GBT monitoring until such a time as is determined to be appropriate by Ecology. Ecology is currently evaluating the need for future GBT studies below Rocky Reach Dam. Currently, Chelan PUD conducts a Smolt Monitoring Program at Rock Island Dam.

As part of the Fish Passage Center's (FPC) Smolt Monitoring Program at Rock Island Dam, yearling and subyearling Chinook salmon and steelhead were examined for evidence of GBT between April 17 and July 16, 2015. 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, the sample was changed from yearling to subyearling Chinook salmon when the subyearling Chinook salmon collection exceeded the yearling Chinook salmon collection. A random sample of up to 100 subyearling was examined two days per week. Examinations followed FPC standardized procedure as outlined by FPC (2009). During 2015 monitoring, 2,650 smolts were examined for GBT. Of these, 10, or 0.38%, showed signs of GBT. Table 3-1 provides the summary results of 2015 GBT monitoring.

Table 4-1: Number salmon and steelhead smolts examined for external signs of GBT of at Rock Island Dam in 2015.

Species	Number of fish examined	Fish with GBT		Location with GBT			
				Fins		Eyes	
		N	%	N	%	N	%
Chinook yearling	846	4	0.47%	4	0.47%	0	0.00%
Steelhead	642	2	0.31%	2	0.31%	0	0.00%
Chinook Sub-yearling	1,162	4	0.34%	4	0.34%	0	0.00%
Total	*2,650*	*10*	*0.38%*	*10*	*0.38%*	*0*	*0.00%*

4.2 Data Evaluation and Analyses

Data collection, quality assurance/quality controls (QA/QC), and analyses of TDG values were conducted in accordance with the QAPP for the FMS (Chelan PUD, 2010b). For this report, hourly TDG data recorded during 2015 were analyzed for apparent exceedances of current water quality standards. TDG values are rounded to the nearest number for example; 115.2 is rounded to 115, 115.5 is rounded to 116.

All of the TDG probes used during 2015 were calibrated and maintained in accordance with the methods and schedules described in the QAPP (Chelan PUD, 2010b). TDG probes that did not pass calibration tests were sent back to the manufacture for repair and/or replaced prior to deployment. Calibration reports are included in Appendix C of this report. Suspect or clearly erroneous TDG values were omitted from the analysis, but are included, as well as explanation for omission, in Appendix D of this report.

The data QA/QC issues during 2015 were related to the following issues; program upgrades, communication errors, and/or down time during calibration. Overall, data loss for Chelan PUD operated FMS during the 2015 fish-spill season was 38 hourly readings or 0.26% of the total available data collection hours. Table 3-2 displays the number of TDG values that were omitted from the dataset due to QA/QC issues during the 2015 fish-spill season.

Table 4-2: Overview of total dissolved gas data set during 2015 fish-spill season April 1 through August 31.

Location	Available data hours	Number of omitted/lost hourly readings[1]	Percent data loss (%)
RRFB	3,672	2	0.05
RRTR	3,672	3	0.08
RIFB	3,672	13	0.35
RITR	3,672	20	0.54
Total	*14,688*	*38*	*0.26*

Note: RRFB = Rocky Reach Dam Forebay, RRTR = Rocky Reach Dam Tailrace, RIFB = Rock Island Dam Forebay, RITR = Rock Island Dam Tailrace.
[1]See Appendix D for dates, times, and circumstances relating to omitted/lost data

4.3 Total Dissolved Gas Monitoring During the Fish-Spill Season

The following sections discuss the results of TDG monitoring from the 2015 fish-spill season within the project and at the Wanapum Dam forbay compliance point location. Specific sections of this document include TDG averages with associated figures for each FMS compliance point location, a breakdown of all TDG exceedances and possible explanations for those exceedances, and the connection between elevated TDG levels and involuntary spill during the 2015 fish-spill season. Summary values for all hourly average TDG measurements taken from each FMS during the 2015 fish-spill season are presented in Table 3-4 below.

Table 4-3: Summary of hourly averages total dissolved gas measurements from each FMS during the 2015 fish-spill season.

Location	Data Interval	Mean	Standard Deviation	Minimum	Maximum
RRFB	04/01 – 08/31	108.1	1.9	102.4	111.1
RRTR	04/01 – 08/31	109.8	3.3	101.6	120.2
RIFB	04/01 – 08/31	108.0	2.2	101.8	115.3
RITR	04/01 – 08/31	111.7	3.4	101.9	119.4
WANF	04/01 – 08/31	109.5	2.8	102.3	115.0
Notes: Values represent % saturation RRFB = Rocky Reach Dam forebay, RRTR = Rocky Reach Dam tailrace, RIFB = Rock Island Dam forebay, RRTR = Rocky Reach Dam tailrace, WANF = Wanapum Dam forebay					

4.3.1 Total Dissolved Gas Averages

Total dissolved gas averages during the fish-spill season in Figures 3-1 through 3-9 display the average of the 12-highest consecutive hourly readings, spill vs. TDG, and a regression analysis of predicted TDG levels vs. actual TDG at Rocky Reach Dam tailrace. Figure 4-8 shows that actual 2015 TDG fish-spill data was lower than predicted regression equations in the WQMP, Table 2-7 (Chelan PUD, 2006). The average of the 12-highest consecutive hourly TDG readings from each day during the spring and summer fish-spill seasons from each FMS is presented in Appendix E of this report.

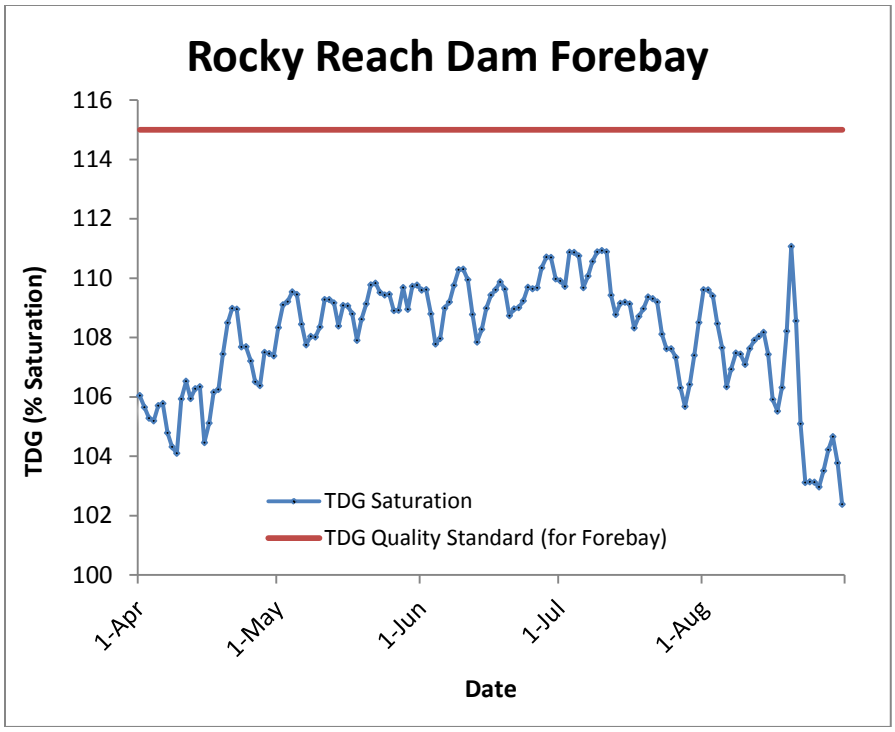

Figure 4-1: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam forebay FMS.

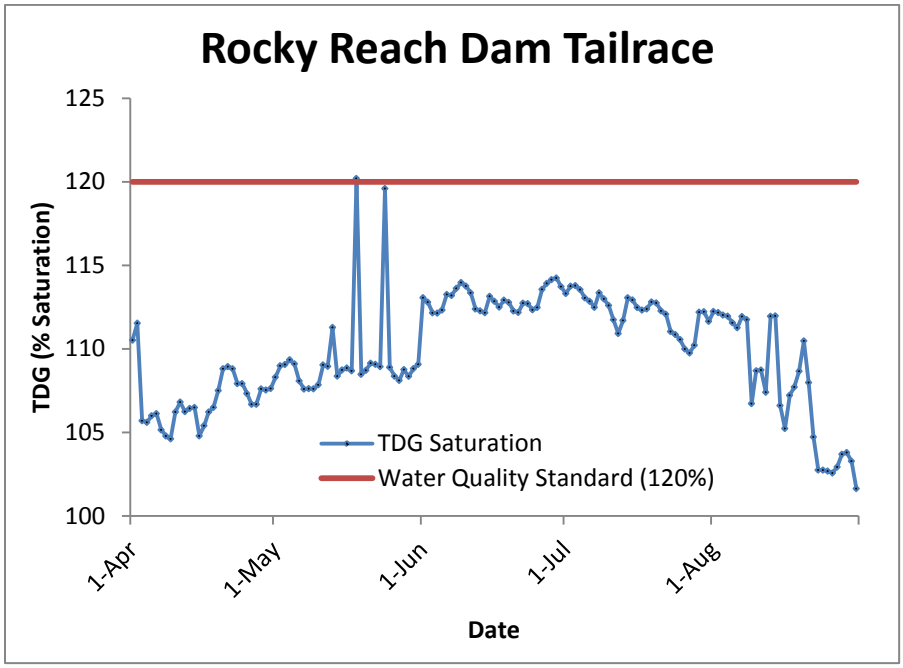

Figure 4-2: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam tailrace FMS.

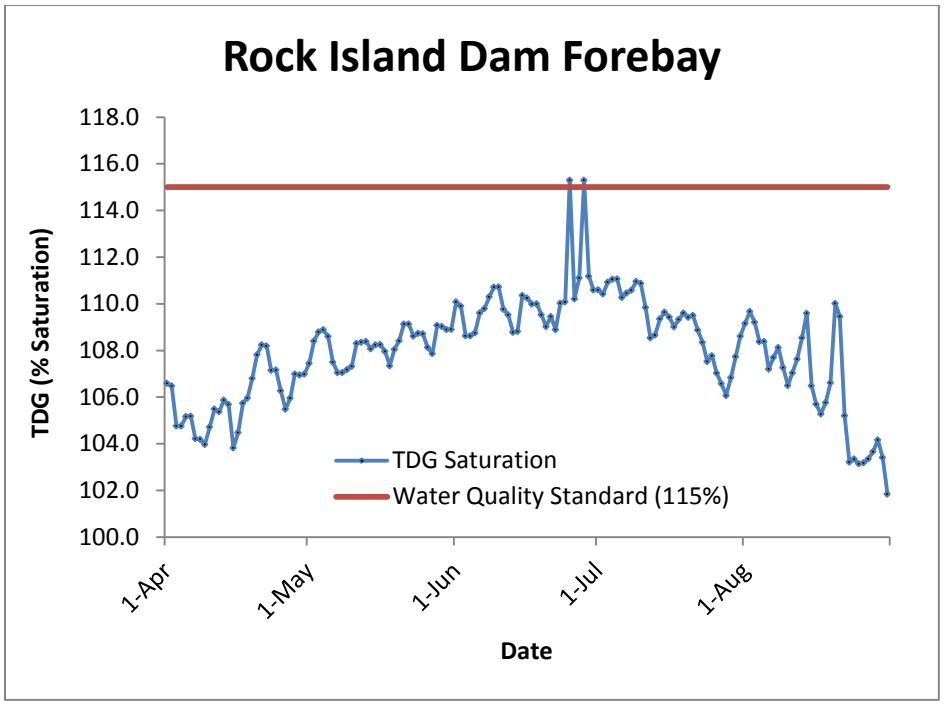

Figure 4-3: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rock Island Dam forebay FMS.

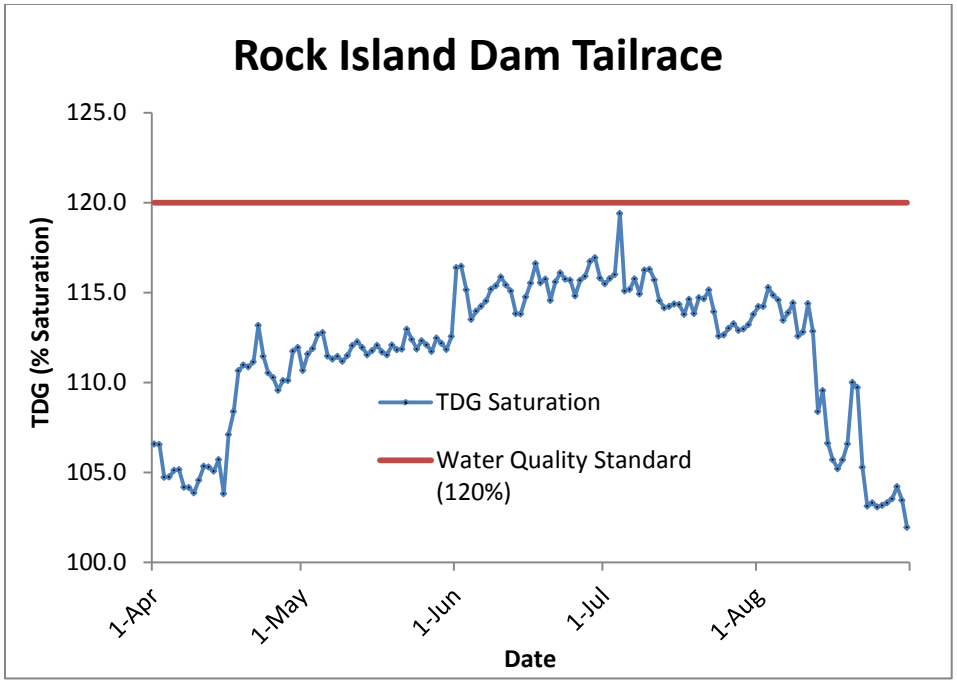

Figure 4-4: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rock Island Dam tailrace FMS.

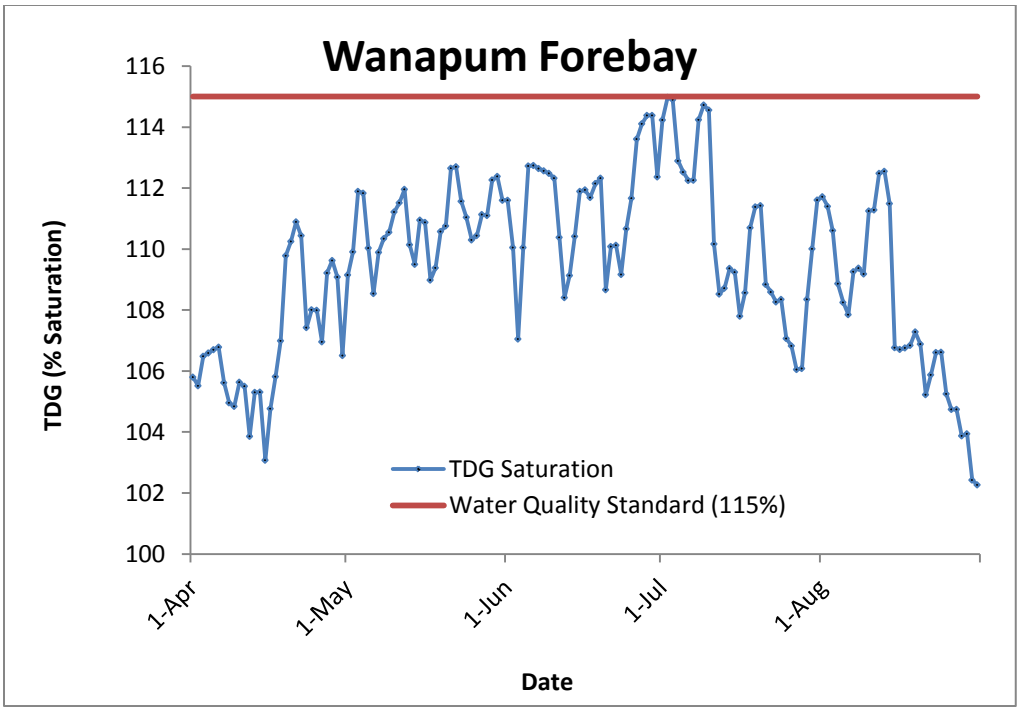

Figure 4-5: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Wanapum Dam forebay FMS.

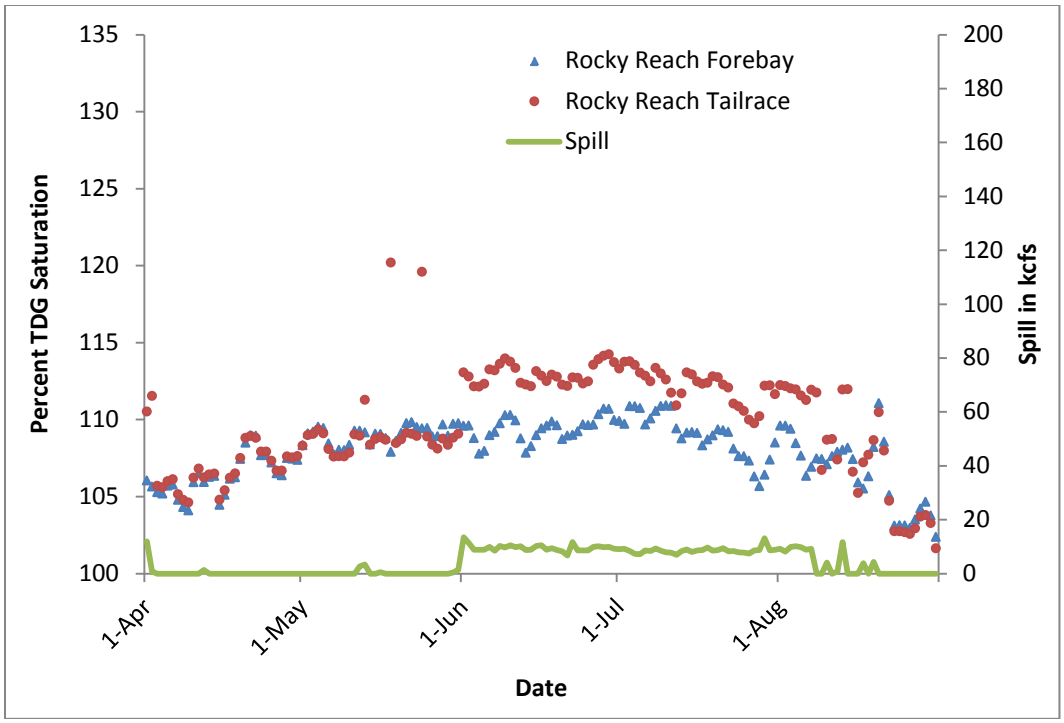

Figure 4-6: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach Dam forebay and tailrace FMS.

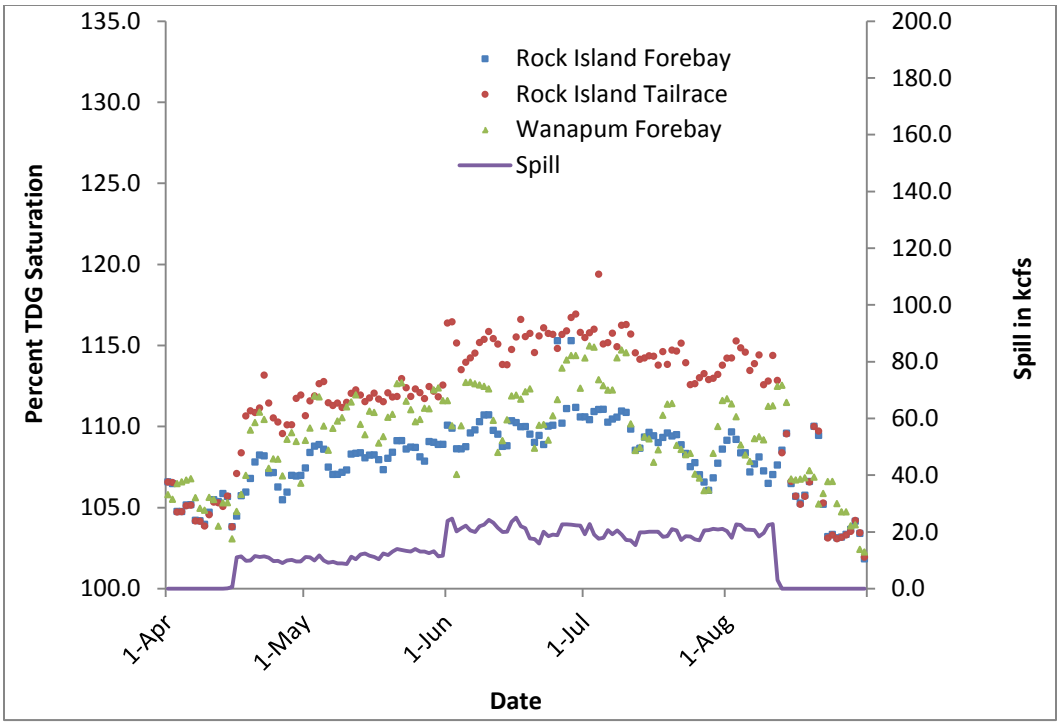

Figure 4-7: Spill and total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Island Dam forebay and tailrace and the Wanapum Dam forebay FMS.

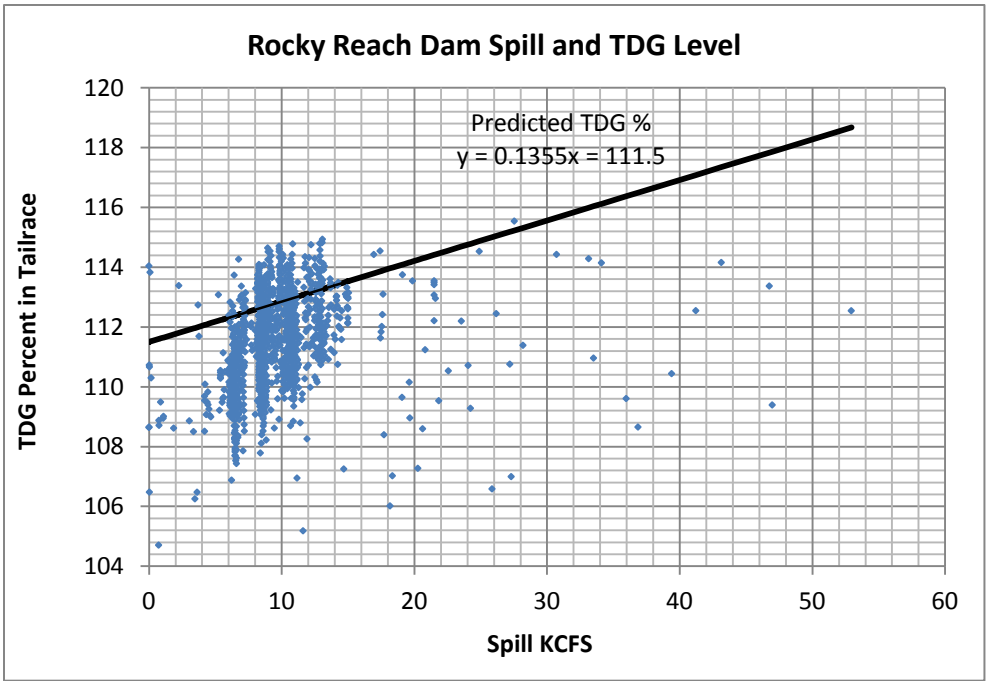

Figure 4-8: 2015 Rocky Reach Dam tailrace TDG % vs. predicted TDG %.

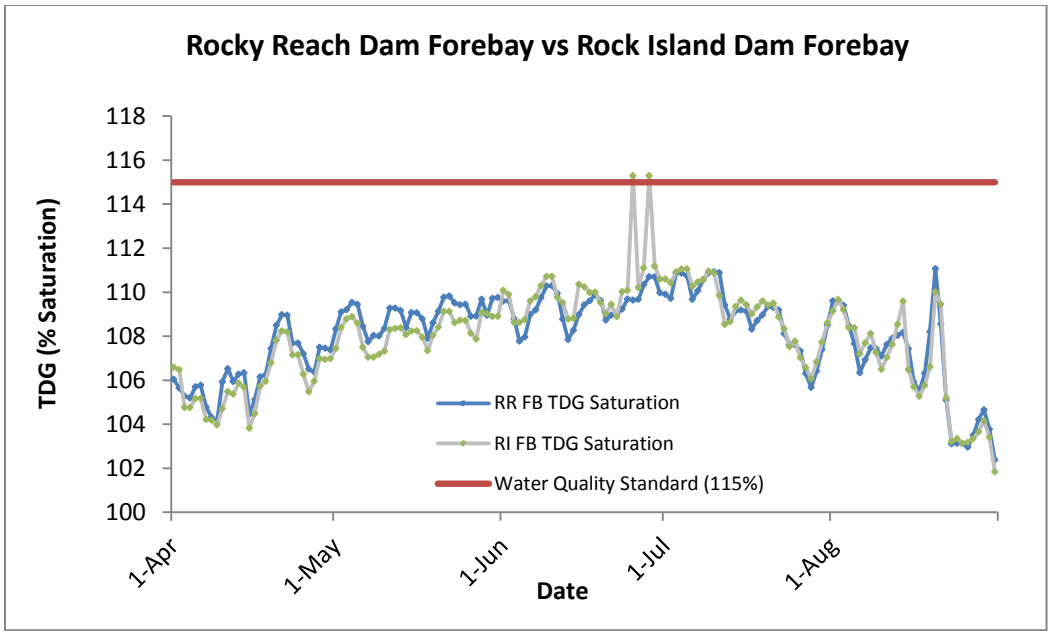

Figure 4-9: Total dissolved gas measurements (average of the 12-highest consecutive hourly TDG readings in a 24-hour period) from the 2015 fish-spill season recorded at the Rocky Reach and Rock Island dam forebays FMS.

4.3.2 ***Total Dissolved Gas Exceedances***

During the 2015 fish-spill season, TDG levels never exceeded the current water quality standards as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD). All TDG data is presented in Appendix E of this report.

4.3.3 ***Discussion of Exceedances***

There were no exceedances of the numeric criteria for the Rocky Reach, Rock Island, and the forbay of Wanapum dams.

SECTION 5: *TOTAL DISSOLVED GAS ABATEMENT MEASURES AND CORRECTIVE ACTIONS IMPLEMENTED IN 2015*

5.1 Operational

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

5.1.1 Rocky Reach Project

Results of survival studies have allowed Chelan PUD to greatly reduce spill and eliminate for fish at Rocky Reach Dam. The JBS 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 2015 are shown in Table 4-1 below. The JBS continues to be the most efficient non-turbine route for fish passage and does not require spill for its operation.

Table 5-1: Rocky Reach Dam fish-spill Comparison 2003-2015.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
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% [2]
2005	Summer	10-Jun	15-Aug	67	9%
Total				**85.5**	
2006	Spring	2-May	1-Jun	19.0	0% / 24% [2]
2006	Summer	2-Jun	11-Aug	71	9%
Total				**90**	
2007	Spring	No Spill	No Spill	0	0%
2007	Summer	2-Jun	21-Aug	81	9%
Total				**81**	
2008	Spring	No Spill	No-Spill	0	0%
2008	Summer	8-Jun	31-Aug	81	9%
Total				**81**	
2009	Spring	No Spill	No Spill	0	0%
2009	Summer	10-Jun	31-Aug	78	9%
Total				**78**	
2010	Spring	No Spill	No Spill	0	0%
2010	Summer	9-Jun	20-Aug	73	9%
Total				**73**	
2011	Spring	No Spill	No Spill	0	0%

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2011	Summer	4-Jun	12-Aug	70	9%
Total				**70**	
2012	Spring	No Spill	No Spill	0	0%
2012	Summer	26-May	9-Aug	76	9%
Total				**76**	
2013	Spring	No Spill	No Spill	0	0%
2013	Summer	5-June	21-August	78	9%
Total				**78**	
2014	Spring	No Spill	No Spill	0	0%
2014	Summer	24-May	24 - August	93	9%
Total				**93**	
2015	Spring	No Spill	No Spill	0	0%
2015	Summer	1-June	11-August	73	9%
Total				**73**	**9%**

Notes: [1] Percentage of daily average river flow at Rocky Reach Dam. Two values in this column represents two different spill levels during the season (first value is the spill level for yearling Chinook and steelhead, second value is the spill level for sockeye.)
[2]24 days of on/off spill test for sockeye

The goal of the Rocky Reach Project GAP (Appendix E), approved by Ecology in April of 2015 is to implement measures to achieve compliance with the standards for TDG in the Columbia River at the project while continuing to meet the fish passage and survival standards set forth in the 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 A).
3. Minimized spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoided spill, to the extent practicable, by continuing to participate in the Hourly Coordination Agreement, to the extent it reduces TDG.
5. Maximized powerhouse discharge as appropriate up to 212 kcfs.
6. Continued the analysis of the three alternate spillway configurations that were tested in 2011 and 2012 (Chelan PUD, 2013b) to determine if any would be efficient at minimizing TDG. Chelan PUD is currently in the process of writing the program for gate operation in order to implement the flattened spill gate configuration during the non-fish-spill period.

5.1.2 ***Rock Island Project***

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 2015 are shown in Table 4-2 below.

Table 5-2: Rock Island Dam fish-spill comparison, 2003-2015.

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2003	Spring	17-Apr	31-May	45	20%
2003	Summer	1-Jun	16-Aug	77	20%
Total				**122**	
2004	Spring	17-Apr	8-Jun	53	20%
2004	Summer	9-Jun	4-Aug	57	20%
Total				**110**	
2005	Spring	17-Apr	9-Jun	54	20%
2005	Summer	10-Jun	9-Aug	61	20%
Total				**115**	
2006	Spring	17-Apr	13-Jun	58	20%
2006	Summer	14-Jun	11-Aug	59	20%
Total				**117**	
2007	Spring	17-Apr	1-Jun	46	10%
2007	Summer	2-Jun	21-Aug	81	20%
Total				**127**	
2008	Spring	17-Apr	7-Jun	52	10%
2008	Summer	8-Jun	16-Aug	70	20%
Total				**122**	
2009	Spring	17-Apr	9-Jun	54	10%
2009	Summer	10-Jun	17-Aug	69	20%
Total				**123**	
2010	Spring	17-Apr	8-Jun	53	10%
2010	Summer	9-Jun	20-Aug	73	20%
Total				**126**	
2011	Spring	17-Apr	3-Jun	48	10%
2011	Summer	4-Jun	24-Aug	82	20%
Total				**130**	
2012	Spring	17-Apr	27-May	41	10%
2012	Summer	28-May	18-Aug	83	20%
Total				**124**	
2013	Spring	17-Apr	4-June	49	10%
2013	Summer	5-June	18-Aug	75	20%
Total				**124**	
2014	Spring	17-Apr	23 – May	37	10%
2014	Summer	24 - May	24 - Aug	93	20%
Total				**130**	

Year	Season	Spill Start Date	Spill Stop Date	Days of Spill	Spill Level[1]
2015	Spring	16-Apr	23 – May	46	10%
2015	Summer	1-Jun	11 - Aug	72	20%
Total				**128**	
Notes: Percentage of daily average river flow at Rock Island Dam					

The goal of the Rock Island Project GAP (Appendix G) approved by Ecology in April of 2015, 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 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 A).
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.

As well as the Hourly Coordination Agreement, Chelan PUD participates in various water quality forums. The USACE hosts a year-end TDG Monitoring and QA/QC meeting, at which presentations are made from the various agencies conducting TDG and other water quality monitoring within the Columbia River Basin. Topics include data completeness, quality, calibration results, new or improved monitoring methods, etc. Agencies presenting at this meeting included the United States Geological Services, USACE, other mid-Columbia River PUDs, and private consultants. Chelan PUD has participated in these yearend meetings.

Chelan PUD has also regularly attended the Transboundary Gas Group meetings since early in its history. Although the frequency of the Transboundary Gas Group meetings has lessened, Chelan PUD will attend the next scheduled meeting.

5.2 Structural

No structural modifications were made or utilized at Rocky Reach or Rock Island dams in 2015.

5.3 Corrective Actions

Actions taken to maintain/regain compliance with the TDG standards in 2015 included:

- Implementation of the TDG Operational Plan.

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

- Attempted to maximize turbine flows by setting minimum generation requirements, which included establishing a common methodology for setting minimum generation requirements specific to Rocky Reach and Rock Island dams for the management of TDG. Each dam's minimum generation requirements were then allocated to power purchasers that receive a percentage of the projects' output.

- Participation in regional spill/project operation meeting in the spring. This meeting brought together representatives from Natural Resources, Marketing, and Operations from Chelan, Douglas, and Grant PUDs, as well as representatives from Bonneville Power Administration (BPA) and the Corps. Discussions included topics such as:
    - Each project's operational limitations, competing regulations, fish studies, and/or other natural resources requirements (e.g. Hanford Reach fall Chinook salmon flow protection requirements).
    - The possibility of shifting generation away from those projects that produce relatively low levels of TDG to those that have the propensity to produce higher TDG levels (e.g. reevaluation of the regional Spill Priority List).
    - Each project's planned maintenance schedules and how it may limit ability to spill water through spillways and/or pass water through turbine units.

- Implementation of the Spill Priority List which included, for example, having the Mid-Columbia project (i.e. Grant, Chelan, and Douglas PUDs) operators working to coordinate spill to reduce the overall TDG on the entire Columbia River system. The Columbia River Basin projects Spill Priority List provided guidance to federal river operators when there was insufficient generation request available to pass the needed amount of water through the Federal Columbia River Power System. A mechanism through hourly coordination was used to shift load from the non-federal projects to the federal projects (by mutual agreement) to reduce the amount of spill (and associated TDG levels) that would otherwise occur at the federal projects using the Spill Priority List. Although this measure may not have resulted in direct decreases in TDG at Chelan PUD's projects (and in some cases it may have increased TDG within Chelan PUD's project if spill was shifted to either Rocky Reach or Rock Island dams in order to reduce spill at another project within the system), it was meant to help mitigate high TDG levels throughout the entire Columbia River system.

- Preemptive spill can be used to coordinate spill sought to manage both the spill rate and the forebay elevation for better TDG management. The spill rate could be stabilized if a project's storage was used to absorb flow fluctuations from upstream projects. Generally, a target operation of one foot from the allowed maximum at each project could be used. When flows spike high, the storage could be used to lower the need for spill; when flows

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

SECTION 6: *CONCLUSIONS*

During the 2015 fish-spill season, TDG levels never exceeded the current numeric water quality standards as measured at each of Chelan PUD's FMS as well as the Wanapum Dam forebay compliance point (owned/operated by Grant PUD).

Chelan PUD will continue to closely monitor TDG levels during the fish-spill season in accordance with Ecology approved GAPs, the Rocky Reach Project 401 WQC (Ecology, 2006), and the Rocky Reach Project QAPP (Chelan PUD, 2010b).

SECTION 7: *LIST OF LITERATURE*

Chelan PUD. 2006. Rocky Reach Comprehensive Settlement Agreement, Attachment B, Rocky Reach Comprehensive Plan, Chapter 2, Water Quality Management Plan. Chelan PUD, Wenatchee, WA.

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

Washington State Department of Ecology (Ecology). 2006. Water Quality Certification for the Rocky Reach Project. Order No. 3155 dated March 17, 2006.

Washington State Department of Ecology (Ecology). 2008. Memo to Columbia and Snake River Dam Operators; RE: Method for averaging 12 consecutive daily average high TDG readings in any one day. Sent by Mr. Chris Maynard on April 2, 2008.

Washington State Department of Ecology (Ecology). 2008a. Memo to Columbia and Snake River Dam Operators; RE: Clarification of WAC 201A-200(1)(f)(ii), Measuring Total Dissolved Gas (TDG) During Fish-spill on the Columbia and Snake Rivers. Sent by Susan Braley on May 21, 2008.

APPENDIX A: 2015 TDG OPERATION PLANS

2015 Rocky Reach Operational Plan
for Total Dissolved Gas During Fish Spill Season
April 1 – August 31
(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

2015 Rock Island Operational Plan
for Total Dissolved Gas During Fish Spill Season
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, please contact Thad Mosey (661-4451) and Marcie Steinmetz (661-4186) immediately so they can determine the next steps to take.

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

APPENDIX B: FISH-SPILL MEMOS

From:	Pwr Mgt - Chelan Environmental
To:	Baker, Megan (Avista); Bill C. Key (NextEraEnergy); Caramanolis, Ath (Morgan Stanley); Esch, Steve (Avistacorp); Fee, Mike (Morgan Stanley); Follini, Robert (Avista); Frank, Jennifer (Avista); Johnson, Bill (Avista); Kikkert, Sabrina (Morgan Stanley); Killam, Ryan (Morgan Stanley); Locke, Kathy (Avista); Loder, David (NextEraEnergy); Lucas, John (Morgan Stanley); Mattern,Kim (Avista); Mymko, Ryan (Morgan Stanley); Neff, Christin S. (NexteraEnergy); Ohm, Jennifer (Avista); Patrick Maher (Avista); Silkworth, Steve (Avista); Spannagel, Dave (Avista); Ward, Suzette (Avista); West Power Trading; West Realtime (Constellation RT); Wilkinson, John (Morgan Stanley); Wilson, Craig (Avista); Wright, Jasper (Morgan Stanley); Constellation Wholesale Trading & Portfolio Operations; Brennan Mueller; Bryant, Tom; Buehn, Scott; "Cash.desk@powerex.com"; Fields, Willard; Gray, Jim; Netik, Irena (PSE); Jaspers, Janet; Taylor, Joe (Mid-C); "Joel Molander"; "Josh Jacobs"; Keller, Lance; Ken Finicle; Owen, Hugh; "Paul Wetherbee"; pwxrealtime; "Load Office PSE"; Pwr Mgt - Chelan Preschedule; RI Chief Operators; RI Senior Operators; "Salvador Avalos"; System Operations; Garrison, Dan; Cronrath, Chris W.; Myers, Devin P.; West, Todd; Hemstrom, Steven; Nystrom, Chris; Whitehall, Brad; Steinmetz, Marcie; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.
Subject:	Start of 2015 Spring Fish Spill at the Rock Island Project - Thursday, 16 April
Date:	Tuesday, April 14, 2015 4:18:12 PM
Importance:	High

Good Afternoon, Everyone.

The purpose of this email is to notify all of you that Rock Island Dam will begin spring fish spill on **Thursday, 16 April 2015, at 00:00 hours**. The daily spill percentage will be **10% of the day average river flow forecasted for the Project**.

Consistent with the past 12 years, spill will be "shaped" in hourly blocks within each 24-hour day to provide slightly more spill volume during periods when juvenile salmon are passing the dam, and less volume during hours with lower fish passage. The average spill rate of all blocks will equal 10% of day average river flow.

Spring spill normally continues through the end of May at 10%. Summer fish spill will be 20% of the day average flow and usually begins the first week of June.

Please call or send an email, if you have any questions regarding Rock Island's fish spill program for 2015.

Thank you.

Thad

Thad Mosey

Chelan County PUD

(509) 670-5594

ROCK ISLAND
FISH SPILL MEMORANDUM

To: Rock Island Operators and System Operators

From: Thad Mosey (Ext. 4451) cell: 670-5594

Date: May 31, 2015

Subject: Summer fish spill for June 1 - 2, 2015

Rock Island will spill an average of **20% of the daily average river flow** during summer 2015. Below are spill rates shaped by hourly blocks, and they sum to 20% of the total estimated daily average flow rate at Rock Island.

Rock Island Spill for smolt passage: **Monday and Tuesday, June 1 - 2, 2015**

Spill Type		Start Date	Start Time	Stop Date	Stop Time	Spill (Kcfs)	
Fish		6/1/15	0001	6/1/15	0100	28.3	
Fish		6/1/15	0100	6/1/15	0200	23.4	
Fish	**Mon**	6/1/15	0200	6/1/15	1000	17.5	
Fish		6/1/15	1000	6/1/15	1100	23.4	
Fish		6/1/15	1100	6/1/15	2400	28.3	day ave ***24.3***
Fish		6/2/15	0001	6/2/15	0100	29.2	
Fish		6/2/15	0100	6/2/15	0200	24.1	
Fish	**Tues**	6/2/15	0200	6/2/15	1000	17.5	
Fish		6/2/15	1000	6/2/15	1100	24.1	
Fish		6/2/15	1100	6/2/15	2400	29.2	day ave ***24.9***

2015 – RI Operators

Please use gates in the following sequence for fish spill and any additional forced spill: **32, 31, 30, 1, 26, 18, 24, 29, and 16.** If total spill volume exceeds capacity of the three over/under gates and six notched gates listed, please use the full gates located in bays **17, 19, 20, 22, 25, 7, and 8** in the sequence shown. If it is necessary to spill more water for headwater control than the gates listed above can handle, take whatever action is necessary to maintain plant safety.

If inflow is insufficient to maintain both headwater and spill, reduce generation as necessary, then call Thad Mosey (4451) or Lance Keller (4299) to get information on current spill balance and options. If you have questions, please call Thad at Ext. 4451, cell 670-5594, or home 782-2428. Thank you.

ROCKY REACH
FISH SPILL MEMORANDUM

To: Rocky Reach Operators, Energy Resources, and System Operators

From: Thad Mosey (Ext. 4451); Cell: 670-5594

Date: May 31, 2015

Subj: **Rocky Reach Summer Spill for June 1 and 2, 2015**

Summer spill at Rocky Reach for subyearling Chinook smolts is 9% of the daily average river flow. This spill level will be in place through the first part of August. Spill is shaped to aid passage of Chinook smolts.

Spill Type		Start Date	Start Time	Stop Date	Stop Time	Spill (kcfs)	
Fish		6/1/15	0000	6/1/15	0100	**10.6**	
Fish		6/1/15	0100	6/1/15	0700	**7.1**	
Fish	**Mon**	6/1/15	0700	6/1/15	0900	**10.6**	
Fish		6/1/15	0900	6/1/15	1500	**14.2**	
Fish		6/1/15	1500	6/1/15	2400	**10.6**	**day ave 10.6**
Fish		6/2/15	0000	6/2/15	0100	**11.1**	
Fish		6/2/15	0100	6/2/15	0700	**7.4**	
Fish	**Tues**	6/2/15	0700	6/2/15	0900	**11.1**	
Fish		6/2/15	0900	6/2/15	1500	**14.8**	
Fish		6/2/15	1500	6/2/15	2400	**11.1**	**day ave 11.1**

Please put fish spill, immediate replacement spill, or spill for headwater control at Rocky Reach Dam through spill gates in the “normal” pattern in the automated gate control program **using gates 7 – 2. If additional spill is necessary to maintain headwater control, use whatever additional gates are necessary to maintain Plant safety.**

If you have questions or comments, please call Thad Mosey at 509-661-4451, by cell phone 670-5594 or at home any time day or night, at 509-782-2428. Please call Thad (ext. 4451) or Lance Keller (ext. 4299) if you need assistance with any of the fish spill operations above. Thank you.

From:	Pwr Mgt - Chelan Environmental
To:	Hemstrom, Steven; All RR Operators; Buehn, Scott; Todd V; Jaspers, Janet; Taylor, Joe (Mid-C); Keller, Lance; Owen, Hugh; "Powerex"; pwxrealtime; Pwr Mgt - Chelan Preschedule; RR/Ch/Steh Management; System Operations; Slice Customers - Fish Spill; "Bob Huber"; Brennan Mueller; True, Bruce (PGN); jeff j; "Greg Lange"; Netik, Irena (PSE); "Joel Molander"; "Josh jacobs"; Ken Finicle; "Paul Wetherbee"; "Salvador Avalos"; "Simon Arlen"; "Steve Pope"; West, Todd; Lucas, Terry; "lrogers@gcpud.org"; "mehinge@gcpud.org"; "rrecten@gcpud.org"; Steinmetz, Marcie; Nystrom, Chris; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.
Cc:	Truscott, Keith; Smith, Jeff; Hays, Steve; Osborn, Jeff; Craig, Kimberlee
Subject:	Confirmation - Rocky Reach Dam will end fish spill at midnight tonight, 7 August
Date:	Friday, August 07, 2015 3:56:42 PM
Importance:	High

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at the Rocky Reach Project tonight, 7 August, at 2400 hours (midnight).

Please disregard the previously sent spill memo for 8 August.

Thank you.

Thad

From:	Pwr Mgt - Chelan Environmental
To:	Baker, Megan (Avista); Bill C. Key (NextEraEnergy); Caramanolis, Ath (Morgan Stanley); Esch, Steve (Avistacorp); Fee, Mike (Morgan Stanley); Follini, Robert (Avista); Frank, Jennifer (Avista); Johnson, Bill (Avista); Kikkert, Sabrina (Morgan Stanley); Killam, Ryan (Morgan Stanley); Locke, Kathy (Avista); Loder, David (NextEraEnergy); Lucas, John (Morgan Stanley); Mattern,Kim (Avista); Mymko, Ryan (Morgan Stanley); Neff, Christin S. (NexteraEnergy); Ohm, Jennifer (Avista); Patrick Maher (Avista); Silkworth, Steve (Avista); Spannagel, Dave (Avista); Ward, Suzette (Avista); West Power Trading; West Realtime (Constellation RT); Wilkinson, John (Morgan Stanley); Wilson, Craig (Avista); Wright, Jasper (Morgan Stanley); Constellation Wholesale Trading & Portfolio Operations; Brennan Mueller; Bryant, Tom; Buehn, Scott; "Cash.desk@powerex.com"; Fields, Willard; Gray, Jim; Netik, Irena (PSE); Jaspers, Janet; Taylor, Joe (Mid-C); "Joel Molander"; "Josh Jacobs"; Keller, Lance; Ken Finicle; Owen, Hugh; "Paul Wetherbee"; pwxrealtime; "Load Office PSE"; Pwr Mgt - Chelan Preschedule; RI Chief Operators; RI Senior Operators; "Salvador Avalos"; System Operations; Garrison, Dan; Cronrath, Chris W.; Myers, Devin P.; West, Todd; Hemstrom, Steven; Whitehall, Brad; Steinmetz, Marcie; Underwood, Alene; "centralsupport@GCPUD.org"; Carrington, Gregg E.; "PS_ATF@gcpud.org"; Truscott, Keith
Cc:	Truscott, Keith; Smith, Jeff; Hays, Steve; Osborn, Jeff; Craig, Kimberlee
Subject:	Confirmation - Rock Island Dam will end fish spill at midnight tonight, 11 August
Date:	Tuesday, August 11, 2015 3:44:59 PM
Importance:	High

Hello Everyone.

This email is intended to provide confirmation that Chelan PUD ***will end summer fish spill*** for the season at the Rock Island Project tonight, 11 August, at 2400 hours (midnight).

Thank you.

Thad

APPENDIX C: CALIBRATION REPORTS

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 10:10
Departure Time: 11:00

Site:
RRDW

	FMS ID	65718		65718	
	Time	10:25		10:50	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		758.2	754		754
Temp ºC			4.0		4.0
TDGsat			97.2		99.7
TDG mmHg			733		752

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 20-Jan-15
BP Station: 758.2 mmHg
Time: 10:30

	Std	Initial	Final
Temperature ºC	3.89	4.0	N / C
TDG 100%	758.2	758	N / C
TDG 113%	858.2	858	N / C
TDG 126%	958.2	957	N / C
TDG 139%	1058.2	1057	N / C
Depth m	N/A		

Comments: 962/1133

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 11:05
Departure Time: 11:40

Site:
RRH

FMS ID	65720		65720	
Time	11:10		11:35	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	756.5	754	756.2	754
Temp ºC		4.0		4.0
TDGsat		95.6		97.5
TDG mmHg		721		735

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 20-Jan-15
BP Station: 756.5 mmHg
Time: 11:15

	Std	Initial	Final
Temperature ºC	4.20	4.3	N / C
TDG 100%	756.5	756	N / C
TDG 113%	856.5	856	N / C
TDG 126%	956.5	956	N / C
TDG 139%	1056.5	1056	N / C
Depth m	N/A		

Comments: 977/1164

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 13:25
Departure Time: 14:00

Site:
RIS

FMS ID	65719		65719	
Time	13:30		13:55	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	758.7	759	758.4	758
Temp ºC		4.1		4.1
TDGsat		96.4		98.2
TDG mmHg		732		744

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 20-Jan-15
BP Station: 758.3 mmHg
Time: 13:35

	Std	Initial	Final
Temperature ºC	4.09	4.2	N / C
TDG 100%	758.3	757	N / C
TDG 113%	858.3	857	N / C
TDG 126%	958.3	957	N / C
TDG 139%	1058.3	1057	N / C
Depth m	N/A		

Comments: 970/1140

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 20-Jan-15
Arrival Time: 14:20
Departure Time: 15:10

Site:
RIGW

FMS ID	65721		65721	
Time	14:25		15:00	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	758.5	758	758.1	758
Temp ºC		4.1		4.1
TDGsat		96.4		99.5
TDG mmHg		731		754

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 20-Jan-15
BP Station: 758.8 mmHg
Time: 14:35

	Std	Initial	Final
Temperature ºC	4.93	5.1	N / C
TDG 100%	758.8	759	N / C
TDG 113%	858.8	859	N / C
TDG 126%	958.8	959	N / C
TDG 139%	1058.8	1060	N / C
Depth m	N/A		

Comments: 957/1105

Report created February 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 9:05
Departure Time: 9:55

Site:
RRDW

FMS ID	65718		65718	
Time	9:20		9:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	750.6	748	751.0	749
Temp ºC		5.7		5.2
TDGsat		104.9		106.3
TDG mmHg		785		796

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 16-Mar-15
Time: 9:25
BP Station: 750.7 mmHg

	Std	**Initial**	**Final**
Temperature ºC	5.99	6.1	N / C
TDG 100%	750.7	752	751
TDG 113%	850.7	853	851
TDG 126%	950.7	954	951
TDG 139%	1050.7	1055	1051
Depth m	N/A		

Comments: 960/1155; new TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 10:05
Departure Time: 10:40

Site:
RRH

	FMS ID	65720		65720	
	Time	10:10		10:30	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		749.3	749	749.0	749
Temp ºC			5.7		5.7
TDGsat			104.4		103.6
TDG mmHg			782		776

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 16-Mar-15
BP Station: 749 mmHg
Time: 10:15

	Std	Initial	Final
Temperature ºC	14.24	14.3	N / C
TDG 100%	749.0	751	749
TDG 113%	849	852	849
TDG 126%	949	953	949
TDG 139%	1049	1054	1049
Depth m	N/A		

Comments: 951/1165; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 11:20
Departure Time: 12:15

Site:
RIGW

FMS ID	65721		65721	
Time	11:30		12:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	752.7	754	752.4	754
Temp ºC		5.7		5.8
TDGsat		103.6		105.6
TDG mmHg		781		796

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 16-Mar-15
BP Station: 752.6 mmHg
Time: 11:35

	Std	**Initial**	**Final**
Temperature ºC	14.20	14.3	N / C
TDG 100%	752.6	756	753
TDG 113%	852.6	857	853
TDG 126%	952.6	958	953
TDG 139%	1052.6	1059	1053
Depth m	N/A		

Comments: 948/1141; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 16-Mar-15
Arrival Time: 13:05
Departure Time: 13:45

Site:
RIS

FMS ID	65719		65719	
Time	13:15		14:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	750.9	753	750.2	753
Temp ºC		5.8		5.8
TDGsat		103.7		105.6
TDG mmHg		781		795

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 16-Mar-15
Time: 13:20
BP Station: 750.8 mmHg

	Std	Initial	Final
Temperature ºC	6.38	6.5	N / C
TDG 100%	750.8	752	751
TDG 113%	850.8	853	851
TDG 126%	950.8	954	951
TDG 139%	1050.8	1055	1051
Depth m	N/A		

Comments: 942/1175; New TDG membrane

Report created April 06, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 9:30
Departure Time: 10:20

Site:
RRDW

FMS ID	65718		65718	
Time	9:50		10:15	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.8	741	742.8	741
Temp ºC		7.4		7.4
TDGsat		105.7		106.9
TDG mmHg		783		792

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 13-Apr-15
BP Station: 742.8 mmHg
Time: 9:55

	Std	**Initial**	**Final**
Temperature ºC	7.20	7.3	N / C
TDG 100%	742.8	743	N / C
TDG 113%	842.8	843	N / C
TDG 126%	942.8	943	N / C
TDG 139%	1042.8	1043	N / C
Depth m	N/A		

Comments: 946/1163, New TDG membrane

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 10:25
Departure Time: 11:00

Site:
RRH

FMS ID	65720		65720	
Time	10:30		10:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.9	741	740.7	740
Temp ºC		7.3		7.3
TDGsat		105.3		104.3
TDG mmHg		780		772

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 13-Apr-15
Time: 10:40
BP Station: 740.9 mmHg

	Std	**Initial**	**Final**
Temperature ºC	7.40	7.5	N / C
TDG 100%	740.9	741	N / C
TDG 113%	840.9	840	N / C
TDG 126%	940.9	940	N / C
TDG 139%	1040.9	1040	N / C
Depth m	N/A		

Comments: 952/1169, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 11:30
Departure Time: 12:10

Site:
RIS

FMS ID	65719		65719	
Time	11:40		12:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.7	745	742.5	745
Temp ºC		7.3		7.3
TDGsat		104.6		106.3
TDG mmHg		779		792

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 13-Apr-15
BP Station: 742.5 mmHg
Time: 11:45

	Std	**Initial**	**Final**
Temperature ºC	7.29	7.4	N / C
TDG 100%	742.5	742	N / C
TDG 113%	842.5	843	N / C
TDG 126%	942.5	943	N / C
TDG 139%	1042.5	1042	N / C
Depth m	N/A		

Comments: 934/1149, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 13-Apr-15
Arrival Time: 12:30
Departure Time: 13:25

Site:
RIGW

FMS ID	65721		65721	
Time	12:35		13:20	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	742.5	744	741.9	744
Temp ºC		7.3		7.4
TDGsat		104.7		106.2
TDG mmHg		779		790

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 13-Apr-15
BP Station: 742.4 mmHg
Time: 12:45

	Std	Initial	Final
Temperature ºC	7.80	7.9	N / C
TDG 100%	742.4	743	N / C
TDG 113%	842.4	843	N / C
TDG 126%	942.4	943	N / C
TDG 139%	1042.4	1042	N / C
Depth m	N/A		

Comments: 940/1167, New TDG membrane.

Report created May 10, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 9:25
Departure Time: 10:25

Site:
RRDW

FMS ID	65718		65718	
Time	9:35		10:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.7	738		738
Temp ºC		10.9		10.9
TDGsat		109.5		107.5
TDG mmHg		808		793

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 12-May-15
BP Station: 740.2 mmHg
Time: 9:55

	Std	**Initial**	**Final**
Temperature ºC	11.05	11.2	N / C
TDG 100%	740.2	740	N / C
TDG 113%	840.2	841	N / C
TDG 126%	940.2	941	N / C
TDG 139%	1040.2	1041	N / C
Depth m	N/A		

Comments: 940

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 10:30
Departure Time: 11:05

Site:
RRH

FMS ID	65720		65720	
Time	10:35		11:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	738.4	738	738.3	738
Temp ºC		10.8		10.8
TDGsat		108.5		110.0
TDG mmHg		801		812

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 12-May-15
BP Station: 738.3 mmHg
Time: 10:40

	Std	Initial	Final
Temperature ºC	11.05	11.2	N / C
TDG 100%	738.3	739	N / C
TDG 113%	838.3	839	N / C
TDG 126%	938.3	939	N / C
TDG 139%	1038.3	1039	N / C
Depth m	N/A		

Comments: 934

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 11:35
Departure Time: 12:15

Site:
RIS

FMS ID	65719		65719	
Time	11:30		12:10	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.1	743		743
Temp ºC		11.0		11.0
TDGsat		107.1		108.6
TDG mmHg		796		807

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 12-May-15
BP Station: 740.6 mmHg
Time: 11:50

	Std	**Initial**	**Final**
Temperature ºC	11.30	11.5	N / C
TDG 100%	740.6	740	N / C
TDG 113%	840.6	840	N / C
TDG 126%	940.6	941	N / C
TDG 139%	1040.6	1041	N / C
Depth m	N/A		

Comments: 936

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 12-May-15
Arrival Time: 12:35
Departure Time: 13:20

Site:
RIGW

FMS ID	65721		65721	
Time	12:40		13:15	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	741.0	743	741.0	743
Temp ºC		11.0		10.9
TDGsat		107.8		109.8
TDG mmHg		801		816

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 12-May-15
BP Station: 741.3 mmHg
Time: 12:45

	Std	Initial	Final
Temperature ºC	10.94	11.1	N / C
TDG 100%	741.3	742	N / C
TDG 113%	841.3	842	N / C
TDG 126%	941.3	942	N / C
TDG 139%	1041.3	1042	N / C
Depth m	N/A		

Comments: 932

Report created June 02, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 8:00
Departure Time: 8:35

Site:
RRDW

	FMS ID	65718		65718	
	Time	8:15		8:30	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		738.2	736	738.0	736
Temp ºC			15.6		15.6
TDGsat			111.8		112.4
TDG mmHg			823		827

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 10-Jun-15
BP Station: 738.2 mmHg
Time: 8:15

	Std	Initial	Final
Temperature ºC	16.09	16.2	N / C
TDG 100%	738.2	739	N / C
TDG 113%	838.2	839	N / C
TDG 126%	938.2	939	N / C
TDG 139%	1038.2	1039	N / C
Depth m	N/A		

Comments: 930

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 8:40
Departure Time: 9:15

Site:
RRH

	FMS ID	65720		65720	
	Time	8:50		9:10	
		2ºstd	FMS	2ºstd	FMS
Depth m					
BP mmHg		736.1	736	736.1	736
Temp ºC			15.6		15.6
TDGsat			109.8		108.7
TDG mmHg			808		800

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 10-Jun-15
Time: 8:55
BP Station: 736.3 mmHg

	Std	Initial	Final
Temperature ºC	16.45	16.6	N / C
TDG 100%	736.3	737	N / C
TDG 113%	836.3	837	N / C
TDG 126%	936.3	937	N / C
TDG 139%	1036.3	1037	N / C
Depth m	N/A		

Comments: 929

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 10:00
Departure Time: 10:45

Site:
RIGW

FMS ID	65721		65721	
Time	10:10		10:35	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	739.2	741	739.0	741
Temp ºC		15.7		15.7
TDGsat		113.8		112.7
TDG mmHg		843		835

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 10-Jun-15
BP Station: 739.3 mmHg
Time: 10:15

	Std	**Initial**	**Final**
Temperature ºC	16.76	16.9	N / C
TDG 100%	739.3	741	739
TDG 113%	839.3	841	839
TDG 126%	939.3	941	939
TDG 139%	1039.3	1040	1039
Depth m	N/A		

Comments: 935

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 10-Jun-15
Arrival Time: 11:05
Departure Time: 11:35

Site:
RIS

FMS ID	65719		65719	
Time	11:15		11:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	737.9	740	737.9	740
Temp ºC		15.8		15.8
TDGsat		109.5		110.3
TDG mmHg		810		816

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 10-Jun-15
BP Station: 737.9 mmHg
Time: 11:20

	Std	Initial	Final
Temperature ºC	16.30	16.4	N / C
TDG 100%	737.9	738	N / C
TDG 113%	837.9	838	N / C
TDG 126%	937.9	938	N / C
TDG 139%	1037.9	1038	N / C
Depth m	N/A		

Comments: 922

Report created July 03, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 9:00
Departure Time: 9:50

Site:
RRDW

FMS ID	65718		65718	
Time	9:25		9:45	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.2	738		738
Temp ºC		18.3		18.3
TDGsat		110.8		112.1
TDG mmHg		818		827

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 08-Jul-15
BP Station: 740.2 mmHg
Time: 9:30

	Std	Initial	Final
Temperature ºC	18.70	18.8	N / C
TDG 100%	740.2	741	N / C
TDG 113%	840.2	841	N / C
TDG 126%	940.2	941	N / C
TDG 139%	1040.2	1042	N / C
Depth m	N/A		

Comments: 942

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 9:55
Departure Time: 10:25

Site:
RRH

FMS ID	65720		65720	
Time	10:00		10:20	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	738.5	738	737.4	737
Temp ºC		18.3		18.3
TDGsat		108.9		109.9
TDG mmHg		804		810

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 08-Jul-15
BP Station: 738.3 mmHg
Time: 10:05

	Std	**Initial**	**Final**
Temperature ºC	18.79	18.9	N / C
TDG 100%	738.3	738	N / C
TDG 113%	838.3	838	N / C
TDG 126%	938.3	939	N / C
TDG 139%	1038.3	1039	N / C
Depth m	N/A		

Comments: 952

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 11:00
Departure Time: 11:45

Site:
RIS

FMS ID	65719		65719	
Time	11:05		11:25	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.1	742	740.0	742
Temp ºC		18.7		18.7
TDGsat		109.3		111.1
TDG mmHg		811		824

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 08-Jul-15
BP Station: 740 mmHg
Time: 11:10

	Std	**Initial**	**Final**
Temperature ºC	18.90	19.0	N / C
TDG 100%	740.0	739	N / C
TDG 113%	840	840	N / C
TDG 126%	940	940	N / C
TDG 139%	1040	1040	N / C
Depth m	N/A		

Comments: 932

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 08-Jul-15
Arrival Time: 12:00
Departure Time: 12:40

Site:
RIGW

FMS ID	65721		65721	
Time	12:15		12:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	740.2	742	739.4	741
Temp ºC		18.7		18.7
TDGsat		115.1		114.2
TDG mmHg		854		846

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 08-Jul-15
BP Station: 740.1 mmHg
Time: 12:20

	Std	Initial	Final
Temperature ºC	19.65	19.8	N / C
TDG 100%	740.1	739	N / C
TDG 113%	840.1	840	N / C
TDG 126%	940.1	940	N / C
TDG 139%	1040.1	1041	N / C
Depth m	N/A		

Comments: 929

Report created August 09, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 7:55
Departure Time: 9:00

Site:
RRDW

FMS ID	65718		65718	
Time	8:25		8:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.4	741	742.3	740
Temp ºC		20.0		20.0
TDGsat		105.9		107.0
TDG mmHg		785		792

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 11-Aug-15
BP Station: 742.4 mmHg
Time: 8:30

	Std	**Initial**	**Final**
Temperature ºC	19.91	20.0	N / C
TDG 100%	742.4	743	742
TDG 113%	842.4	844	842
TDG 126%	942.4	945	942
TDG 139%	1042.4	1045	1042
Depth m	N/A		

Comments: 948

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 9:10
Departure Time: 9:45

Site:
RRH

FMS ID	65720		65720	
Time	9:20		9:40	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	740.5	740	740.5	740
Temp ºC		20.0		20.0
TDGsat		106.8		107.2
TDG mmHg		790		793

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 11-Aug-15
BP Station: 740.5 mmHg
Time: 9:25

	Std	Initial	Final
Temperature ºC	20.67	20.8	N / C
TDG 100%	740.5	741	741
TDG 113%	840.5	842	841
TDG 126%	940.5	942	941
TDG 139%	1040.5	1043	1041
Depth m	N/A		

Comments: 941

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 10:20
Departure Time: 10:55

Site:
RIS

FMS ID	65719		65719	
Time	10:30		10:50	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	742.8	745	742.8	745
Temp ºC		20.1		20.1
TDGsat		107.1		107.7
TDG mmHg		798		802

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 11-Aug-15
BP Station: 742.8 mmHg
Time: 10:35

	Std	**Initial**	**Final**
Temperature ºC	20.28	20.4	N / C
TDG 100%	742.8	742	743
TDG 113%	842.8	843	843
TDG 126%	942.8	944	943
TDG 139%	1042.8	1044	1043
Depth m	N/A		

Comments: 936

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 11-Aug-15
Arrival Time: 11:20
Departure Time: 12:05

Site:
RIGW

FMS ID	65721		65721	
Time	11:30		12:00	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.3	745	743.1	745
Temp ºC		20.1		20.1
TDGsat		111.8		113.2
TDG mmHg		833		843

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 11-Aug-15
BP Station: 743.3 mmHg
Time: 11:35

	Std	**Initial**	**Final**
Temperature ºC	20.74	20.9	N / C
TDG 100%	743.3	743	N / C
TDG 113%	843.3	843	N / C
TDG 126%	943.3	944	N / C
TDG 139%	1043.3	1044	N / C
Depth m	N/A		

Comments: 937

Report created August 23, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 9:40
Departure Time: 10:40

Site:
RRDW

FMS ID	65718		65718	
Time	10:05		10:35	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	743.8	742	743.6	742
Temp ºC		18.6		18.6
TDGsat		100.4		102.3
TDG mmHg		745		759

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 09-Sep-15
BP Station: 743.6 mmHg
Time: 10:10

	Std	Initial	Final
Temperature ºC	18.69	18.8	N / C
TDG 100%	743.6	742	744
TDG 113%	843.6	842	844
TDG 126%	943.6	943	944
TDG 139%	1043.6	1043	1044
Depth m	N/A		

Comments: 949

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 10:55
Departure Time: 11:35

Site:
RRH

FMS ID	65720		65720	
Time	11:00		11:30	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	741.5	742	741.1	741
Temp ºC		18.7		18.6
TDGsat		101.5		103.2
TDG mmHg		753		765

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 09-Sep-15
BP Station: 741.3 mmHg
Time: 11:05

	Std	**Initial**	**Final**
Temperature ºC	18.75	18.8	N / C
TDG 100%	741.3	740	N / C
TDG 113%	841.3	840	N / C
TDG 126%	941.3	940	N / C
TDG 139%	1041.3	1041	N / C
Depth m	N/A		

Comments: 947

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 12:20
Departure Time: 13:15

Site:
RIS

FMS ID	65719		65719	
Time	12:30		13:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	743.3	746	743.0	746
Temp ºC		18.7		18.8
TDGsat		101.1		102.8
TDG mmHg		754		767

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 09-Sep-15
Time: 12:35
BP Station: 743.1 mmHg

	Std	Initial	Final
Temperature ºC	19.38	19.5	N / C
TDG 100%	743.1	746	742
TDG 113%	843.1	845	842
TDG 126%	943.1	945	943
TDG 139%	1043.1	1045	1043
Depth m	N/A		

Comments: 951

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 09-Sep-15
Arrival Time: 13:30
Departure Time: 15:00

Site:
RIGW

FMS ID	65721		65721	
Time	13:40		14:15	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	744.0	746	743.6	746
Temp ºC		18.7		18.7
TDGsat		101.2		102.8
TDG mmHg		755		767

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 09-Sep-15
BP Station: 743.8 mmHg
Time: 13:45

	Std	Initial	Final
Temperature ºC	19.87	20.0	N / C
TDG 100%	743.8	745	744
TDG 113%	843.8	846	843
TDG 126%	943.8	946	943
TDG 139%	1043.8	1047	1044
Depth m	N/A		

Comments: 935

Report created September 26, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 9:15
Departure Time: 10:00

Site:
RRDW

FMS ID	65718		65718	
Time	9:35		9:55	
	2ºstd	FMS	2ºstd	FMS
Depth m				
BP mmHg	748.7	747	748.5	747
Temp ºC		15.9		15.9
TDGsat		99.6		101.9
TDG mmHg		744		761

Comments:

Calibration Type: Field
Probe ID: 65718
Date: 21-Oct-15
BP Station: 748.7 mmHg
Time: 9:40

	Std	Initial	Final
Temperature ºC	15.69	15.8	N / C
TDG 100%	748.7	750	N / C
TDG 113%	848.7	850	N / C
TDG 126%	948.7	950	N / C
TDG 139%	1048.7	1050	N / C
Depth m	N/A		

Comments: 956

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 10:10
Departure Time: 10:45

Site:
RRH

FMS ID	65720		65720	
Time	10:20		10:40	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	746.3	747	745.6	746
Temp ºC		15.9		15.9
TDGsat		98.9		98.8
TDG mmHg		739		737

Comments:

Calibration Type: Field
Probe ID: 65720
Date: 21-Oct-15
BP Station: 746.3 mmHg
Time: 10:25

	Std	**Initial**	**Final**
Temperature ºC	15.81	15.9	N / C
TDG 100%	746.3	747	746
TDG 113%	846.3	848	846
TDG 126%	946.3	948	946
TDG 139%	1046.3	1048	1046
Depth m	N/A		

Comments: 950

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 11:15
Departure Time: 12:00

Site:
RIS

FMS ID	65719		65719	
Time	11:25		11:55	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.3	752	748.2	751
Temp ºC		15.9		15.9
TDGsat		97.9		99.9
TDG mmHg		736		750

Comments:

Calibration Type: Field
Probe ID: 65719
Date: 21-Oct-15
BP Station: 748.3 mmHg
Time: 11:30

	Std	**Initial**	**Final**
Temperature ºC	15.52	15.7	N / C
TDG 100%	748.3	746	748
TDG 113%	848.3	847	848
TDG 126%	948.3	948	948
TDG 139%	1048.3	1048	1048
Depth m	N/A		

Comments: 944

Report created October 28, 2015

Columbia Basin Environmental

Site Visit / Calibration Report

Client: Public Utility District No. 1 of Chelan County

Date: 21-Oct-15
Arrival Time: 12:20
Departure Time: 13:20

Site:
RIGW

FMS ID	65721		65721	
Time	12:30		13:05	
	2ºstd	**FMS**	**2ºstd**	**FMS**
Depth m				
BP mmHg	748.9	751	748.6	750
Temp ºC		15.9		15.9
TDGsat		98.9		100.8
TDG mmHg		743		756

Comments:

Calibration Type: Field
Probe ID: 65721
Date: 21-Oct-15
BP Station: 748.8 mmHg
Time: 12:35

	Std	Initial	Final
Temperature ºC	16.01	16.1	N / C
TDG 100%	748.8	747	749
TDG 113%	848.8	847	849
TDG 126%	948.8	948	949
TDG 139%	1048.8	1048	1049
Depth m	N/A		

Comments: 948

Report created October 28, 2015

APPENDIX D: 2015 DATA LOSSES

Hours of Data losses at Rocky Reach and Rock Island Dams during the fish-spill season

Date	Rocky Reach			Rock Island		
	Forebay	Tailrace	Reason	Forebay	Tailrace	Reason
4/13/2015		1	Calibration	1	1	Calibration
5/12/2015	1	1	Calibration	1	1	Calibration
5/28/2015					1	Server Patch
5/29/2015					1	Server Patch
6/10/2015	1	1	Calibration	3	5	Calibration and fuse blown on radio
6/15/2015				3	3	SCADA server down
8/3/2015					1	SCADA server down
8/11/2015				1	1	Calibration
8/12/2015					2	Data cable replacement
8/17/2015				4	4	Solar panel service
Total	**2**	**3**		**13**	**20**	

Notes:
Calibration = probe is taken off line while calibration occurs
Communication error = probe not communicating/downloading data
Server patch = Upgrades to the server
Site maintenance = while Chelan PUD was upgrading the carriage that holds the probe, it was disconnected
System Control and Data Acquisition (SCADA) server down = Chelan PUD's data server was down

APPENDIX E: 2015 DATA

Hourly Total Dissolved gas readings during the 2015 fish-spill season

Notes:
FONT = Exceedances of the water quality TDG numeric critera are in bold red. Note, all exceedances in the Rocky Reach Forebay are for the upstream Wells Dam Project. TDG is rounded to the nearest number: 115.2 is rounded to 115, therefore not in exceedance)
121.2 (119.6) = Instances of "double counting", value in parentheses represents the TDG value used to eliminate "double counting"
110.8 = Not counted toward exceedances because RR FB > 115 (for RI FB) or RI FB > 115 (for Wanapum FB).

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
1-Apr	106.0	105.7	106.3	110.5	109.7	115.6	106.6	105.6	108.4	106.6	105.6	108.2	105.8	105.9	12.0	0.0	132.4	142.0	8.9	0.0	11.82	0.00	0.00	0.00
2-Apr	105.7	104.9	105.7	111.5	106.4	111.6	106.5	105.3	106.5	106.6	105.3	106.5	105.5	105.6	0.7	0.0	134.5	143.0	0.5	0.0	1.33	0.00	0.00	0.00
3-Apr	105.3	104.8	105.3	105.7	105.1	105.5	104.8	104.6	105.0	104.7	104.6	104.9	106.5	106.8	0.0	0.0	136.3	146.8	0.0	0.0	0.00	0.00	0.00	0.00
4-Apr	105.2	104.9	105.4	105.6	105.2	105.9	104.8	104.4	104.9	104.8	104.4	104.9	106.6	107.2	0.0	0.0	132.5	140.7	0.0	0.0	0.00	0.00	0.00	0.00
5-Apr	105.7	105.4	105.9	106.0	105.8	106.3	105.2	104.9	105.3	105.1	104.9	105.2	106.7	107.0	0.0	0.0	131.2	141.3	0.0	0.0	0.00	0.00	0.00	0.00
6-Apr	105.8	105.0	105.8	106.1	105.4	106.2	105.2	104.4	105.1	105.2	104.5	105.1	106.8	106.9	0.0	0.0	129.1	137.9	0.0	0.0	0.00	0.00	0.00	0.00
7-Apr	104.8	104.4	104.7	105.2	104.8	105.0	104.2	104.0	104.4	104.2	104.0	104.3	105.6	105.5	0.0	0.0	111.9	121.2	0.0	0.0	0.00	0.00	0.00	0.00
8-Apr	104.3	103.9	104.2	104.8	104.4	104.7	104.2	103.6	104.0	104.2	103.6	103.9	105.0	105.3	0.0	0.0	112.9	121.0	0.0	0.0	0.00	0.00	0.00	0.00
9-Apr	104.1	103.8	104.2	104.6	104.4	104.9	104.0	103.4	104.2	103.9	103.4	104.1	104.8	105.4	0.0	0.0	123.4	131.3	0.0	0.0	0.00	0.00	0.00	0.00
10-Apr	105.9	105.1	106.5	106.2	105.5	107.1	104.7	104.2	105.1	104.6	104.1	104.9	105.6	106.1	0.0	0.0	119.2	126.8	0.0	0.0	0.00	0.00	0.00	0.00
11-Apr	106.5	106.2	106.8	106.8	106.5	107.0	105.5	105.3	105.7	105.3	105.2	105.6	105.5	105.1	0.0	0.0	100.4	107.4	0.0	0.0	0.00	0.00	0.00	0.00
12-Apr	105.9	105.0	105.5	106.2	105.7	108.4	105.4	104.7	105.6	105.3	104.7	105.5	103.9	103.8	1.3	0.0	115.5	124.1	1.1	0.0	1.05	0.00	0.00	0.00
13-Apr	106.3	105.6	106.6	106.4	106.0	106.8	105.9	105.1	106.9	105.1	102.2	106.0	105.3	105.9	0.0	0.0	117.4	122.7	0.0	0.0	0.00	0.00	0.00	0.00
14-Apr	106.3	105.0	106.2	106.5	105.3	106.3	105.7	104.0	105.2	105.7	104.2	105.5	105.3	104.8	0.0	0.1	84.0	89.3	0.0	0.2	0.00	0.00	0.06	0.00
15-Apr	104.5	103.8	104.1	104.8	104.3	104.6	103.8	103.5	104.2	103.8	103.5	104.0	103.1	103.6	0.0	0.5	109.6	113.8	0.0	0.4	0.00	0.00	0.04	0.04
16-Apr	105.1	104.4	105.5	105.4	104.8	105.9	104.5	103.8	104.8	107.1	106.6	108.0	104.8	105.4	0.0	11.1	116.5	120.4	0.0	9.6	0.00	0.00	10.98	11.00
17-Apr	106.2	105.7	106.4	106.2	105.9	106.5	105.7	105.1	106.1	108.4	107.7	109.6	105.8	107.1	0.0	11.4	107.9	115.5	0.0	10.6	0.00	0.00	11.50	11.50
18-Apr	106.2	106.0	106.4	106.5	106.3	106.8	106.0	105.3	106.4	110.7	109.6	112.9	107.0	108.6	0.0	9.8	78.3	85.2	0.0	13.1	0.00	0.00	9.81	9.80
19-Apr	107.4	106.8	107.8	107.5	106.9	107.9	106.8	106.4	107.1	111.0	110.1	113.6	109.8	111.5	0.0	9.9	90.5	96.2	0.0	12.0	0.00	0.00	9.81	9.81
20-Apr	108.5	107.9	108.8	108.8	108.2	109.4	107.8	107.3	108.1	110.9	110.0	111.8	110.3	110.6	0.0	11.6	116.2	122.3	0.0	10.4	0.00	0.00	11.57	11.56
21-Apr	109.0	108.8	109.2	108.9	108.7	109.2	108.2	107.8	108.8	111.1	110.7	114.5	110.9	111.9	0.0	11.2	95.8	102.7	0.0	14.9	0.00	0.00	11.31	11.30
22-Apr	109.0	107.7	108.5	108.8	107.7	108.1	108.2	106.4	107.3	113.2	110.9	115.0	110.4	108.3	0.0	11.4	86.5	92.3	0.0	16.5	0.00	0.00	11.37	11.36
23-Apr	107.7	107.5	107.9	107.9	107.7	108.2	107.1	106.8	107.3	111.5	110.2	114.1	107.4	108.2	0.0	10.9	100.2	105.7	0.0	11.9	0.00	0.00	10.99	10.99
24-Apr	107.7	107.2	107.5	107.9	107.4	107.7	107.2	106.2	106.9	110.5	109.2	112.0	108.0	108.3	0.0	9.8	99.6	107.9	0.0	10.1	0.00	0.00	9.83	9.82
25-Apr	107.2	106.7	107.1	107.3	106.9	107.2	106.3	105.6	106.1	110.3	109.3	111.6	108.0	107.7	0.0	9.9	86.3	92.2	0.0	11.5	0.00	0.00	9.82	9.81
26-Apr	106.5	105.7	106.1	106.7	105.9	106.3	105.5	104.9	105.2	109.6	107.9	110.1	107.0	107.1	0.0	9.1	79.1	85.9	0.0	10.8	0.00	0.00	9.02	9.01
27-Apr	106.4	106.0	106.6	106.7	106.3	107.0	106.0	105.5	106.2	110.1	109.1	112.1	109.2	111.0	0.0	9.9	95.1	99.1	0.0	11.3	0.00	0.00	9.83	9.83
28-Apr	107.5	107.1	107.7	107.6	107.3	107.8	107.0	106.5	107.3	110.1	109.7	111.9	109.6	111.0	0.0	10.1	93.8	102.0	0.0	11.1	0.00	0.00	10.14	10.14
29-Apr	107.5	106.9	107.3	107.5	106.7	107.0	107.0	105.8	106.2	111.7	109.8	113.4	109.1	106.8	0.0	9.6	76.2	80.8	0.0	13.1	0.00	0.00	9.51	9.51
30-Apr	107.4	107.0	107.6	107.6	107.1	107.8	107.0	106.3	107.7	111.9	110.2	115.5	106.5	107.6	0.0	9.6	95.8	103.3	0.0	14.6	0.00	0.00	9.48	9.49
1-May	108.3	107.8	108.6	108.3	107.8	108.5	107.4	107.2	107.7	110.7	109.9	111.4	109.1	109.9	0.0	11.1	112.0	122.4	0.0	9.9	0.01	0.00	11.73	11.06
2-May	109.1	108.8	109.3	109.0	108.6	109.3	108.4	107.6	108.8	111.6	110.5	112.8	109.9	110.7	0.0	11.1	111.2	120.4	0.0	10.3	0.00	0.00	10.47	10.46
3-May	109.2	109.0	109.4	109.1	108.7	109.6	108.8	108.2	109.1	111.9	111.0	113.1	111.9	113.3	0.0	9.9	101.3	109.2	0.0	9.5	0.00	0.00	9.84	9.83

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
4-May	109.5	109.2	109.8	109.4	109.0	109.5	108.9	108.4	109.2	112.6	111.7	113.8	111.8	111.9	0.0	11.8	106.5	114.4	0.0	11.4	0.00	0.00	11.75	11.75
5-May	109.5	108.7	109.0	109.1	108.3	108.7	108.6	107.4	107.7	112.8	110.8	113.5	110.0	108.8	0.0	10.0	86.7	93.9	0.0	11.8	0.00	0.00	10.05	10.04
6-May	108.4	107.7	108.2	108.1	107.4	107.9	107.5	106.9	107.3	111.5	109.7	114.5	108.5	108.8	0.0	9.2	83.6	90.7	0.0	14.4	0.00	0.00	9.06	9.04
7-May	107.8	107.2	108.1	107.6	106.9	107.5	107.0	106.8	107.2	111.3	110.4	113.8	109.9	111.6	0.0	9.5	81.3	87.6	0.0	12.7	0.00	0.00	9.51	9.50
8-May	108.0	107.6	108.4	107.6	107.2	107.8	107.1	106.7	107.2	111.5	109.9	114.5	110.3	110.3	0.0	8.9	80.4	85.5	0.0	14.7	0.00	0.00	9.02	9.00
9-May	108.0	107.4	108.0	107.6	107.1	107.6	107.2	106.8	107.4	111.2	109.6	112.6	110.5	111.1	0.0	8.9	85.7	91.9	0.0	11.3	0.00	0.00	9.02	9.01
10-May	108.4	107.9	109.2	107.9	107.4	108.1	107.3	107.1	107.7	111.5	110.1	113.2	111.2	112.3	0.0	8.7	75.1	80.4	0.0	12.0	0.00	0.00	8.68	8.68
11-May	109.3	108.9	109.7	109.0	108.6	109.5	108.3	107.9	108.6	112.1	111.4	114.2	111.5	112.8	0.0	11.3	96.7	104.1	0.0	15.0	0.00	0.00	11.27	11.27
12-May	109.3	108.8	109.2	109.0	108.8	110.7	108.4	107.6	108.2	112.3	110.6	114.3	112.0	111.5	2.6	10.4	114.1	122.6	2.7	10.9	1.63	0.00	10.33	10.32
13-May	109.2	108.8	109.3	111.3	109.8	114.8	108.4	107.9	110.5	111.9	111.3	114.1	110.1	110.3	3.4	12.1	121.6	130.8	3.4	11.3	4.63	0.00	12.09	12.09
14-May	108.4	108.2	108.5	108.4	108.1	108.5	108.1	107.4	108.3	111.5	111.1	112.9	109.5	110.2	0.0	12.4	115.4	126.4	0.0	10.9	0.00	0.00	12.53	12.52
15-May	109.1	108.8	109.5	108.7	108.5	109.1	108.2	107.8	108.6	111.8	111.5	113.2	111.0	112.0	0.0	11.6	97.3	109.0	0.0	11.1	0.07	0.00	11.77	11.78
16-May	109.1	108.8	109.3	108.9	108.6	109.5	108.3	107.6	108.2	112.1	111.1	113.6	110.9	109.7	0.6	11.2	93.7	102.5	0.4	12.6	0.28	0.00	11.05	11.04
17-May	108.8	107.6	108.0	108.7	107.7	108.2	108.0	106.7	107.6	111.7	109.5	112.1	109.0	109.5	0.0	10.4	111.4	125.1	0.0	9.2	0.00	0.00	10.43	10.43
18-May	107.9	107.6	108.0	120.2	107.2	107.9	107.3	106.9	107.7	111.5	110.9	114.4	109.4	110.2	0.0	12.4	106.0	116.0	0.0	11.9	0.00	0.00	12.38	12.39
19-May	108.6	108.2	108.8	108.5	107.9	108.7	108.0	107.3	108.6	112.1	110.8	116.2	110.6	110.8	0.0	11.9	117.0	125.9	0.0	13.6	0.00	0.00	11.72	11.73
20-May	109.1	108.7	109.5	108.7	108.3	109.0	108.4	107.8	108.8	111.8	111.1	113.1	110.8	111.3	0.0	13.1	122.7	131.6	0.0	11.6	0.00	0.00	13.23	13.23
21-May	109.8	109.5	110.0	109.1	108.9	109.4	109.1	108.5	109.7	111.9	111.6	112.6	112.7	114.5	0.0	14.0	127.0	138.6	0.0	10.9	0.00	0.00	13.30	13.30
22-May	109.8	109.5	109.8	109.1	108.8	109.4	109.1	108.4	109.1	113.0	111.9	114.4	112.7	113.0	0.0	13.6	118.7	129.7	0.0	10.9	0.00	0.00	13.62	13.61
23-May	109.5	109.0	109.4	108.9	108.6	109.1	108.6	108.0	108.8	112.4	111.4	112.8	111.6	113.3	0.0	13.3	125.7	137.9	0.0	10.0	0.00	0.00	13.26	13.26
24-May	109.4	109.2	109.8	119.6	108.7	109.2	108.7	108.1	109.2	111.9	111.6	112.5	111.0	110.8	0.0	13.1	125.2	137.5	0.0	9.7	0.00	0.00	13.16	13.16
25-May	109.5	108.9	109.3	108.9	108.3	108.7	108.7	107.9	108.5	112.3	111.5	113.0	110.3	111.1	0.0	14.0	122.0	132.6	0.0	10.9	0.00	0.00	13.34	13.33
26-May	108.9	108.4	108.7	108.4	107.8	108.1	108.1	107.5	108.1	112.1	111.1	113.1	110.4	110.9	0.0	13.1	128.2	138.8	0.0	9.7	0.00	0.00	13.36	13.37
27-May	108.9	108.4	109.9	108.1	107.6	108.8	107.9	107.3	108.2	111.7	111.1	112.7	111.1	111.5	0.0	13.1	117.9	127.6	0.0	10.5	0.00	0.00	13.15	13.14
28-May	109.7	109.2	109.9	108.8	108.5	109.0	109.1	108.3	109.6	112.5	111.5	114.4	111.1	111.1	0.0	12.5	123.7	132.7	0.0	10.5	0.00	0.00	12.54	12.54
29-May	109.0	108.6	109.2	108.4	108.0	108.6	109.0	107.9	108.5	112.2	111.3	113.4	112.3	112.9	0.0	13.2	120.4	131.9	0.0	10.6	0.00	0.00	13.38	13.39
30-May	109.7	109.4	110.0	108.8	108.5	109.5	108.9	108.3	109.4	111.8	111.4	112.6	112.4	112.1	0.4	11.4	112.7	123.5	0.4	9.7	0.48	0.00	11.30	11.31
31-May	109.8	109.3	109.7	109.1	108.7	110.4	108.9	108.4	108.9	112.6	111.6	113.6	111.6	111.6	1.4	11.6	114.8	126.1	1.1	9.7	1.25	0.00	11.32	11.32
1-Jun	109.6	109.5	109.9	113.1	112.7	113.3	110.1	109.1	110.4	116.4	115.2	117.0	111.6	111.6	13.5	24.0	110.8	119.5	12.6	21.1	13.14	12.97	23.77	23.77
2-Jun	109.6	108.9	109.4	112.8	112.2	113.1	109.9	108.6	109.2	116.5	114.8	116.4	110.0	109.0	11.4	24.7	97.3	101.1	12.0	25.1	11.35	11.34	25.00	25.02
3-Jun	108.8	108.0	108.6	112.2	111.2	112.8	108.6	108.4	108.8	115.2	113.7	116.4	107.0	107.8	8.9	20.2	94.8	100.7	9.8	22.0	8.96	8.96	20.41	20.42
4-Jun	107.8	107.3	107.9	112.1	111.2	112.6	108.6	107.6	108.8	113.5	112.7	114.3	110.1	112.0	8.8	21.3	110.4	117.1	8.3	19.5	8.88	8.87	21.22	21.21
5-Jun	108.0	107.5	108.2	112.3	111.3	112.5	108.8	108.2	109.3	114.0	113.8	117.3	112.7	113.8	8.9	22.2	113.4	120.1	8.7	21.0	8.87	8.88	22.59	22.60
6-Jun	109.0	108.5	109.2	113.3	112.2	113.5	109.6	108.9	110.2	114.2	113.8	115.1	112.7	113.8	10.0	20.6	117.0	123.2	8.7	17.0	10.01	10.01	20.77	20.78
7-Jun	109.2	109.0	109.4	113.2	112.2	113.5	109.8	109.3	110.3	114.5	114.0	115.0	112.6	113.0	8.5	19.9	112.4	121.4	7.8	16.9	8.58	8.59	19.80	19.80
8-Jun	109.8	109.4	109.9	113.6	112.8	114.0	110.3	109.6	111.0	115.2	114.8	117.7	112.6	114.7	10.2	22.0	121.6	127.8	9.5	19.6	10.22	10.22	22.25	22.25
9-Jun	110.3	110.0	110.4	114.0	113.3	114.4	110.7	110.0	111.2	115.4	115.1	115.7	112.5	113.6	9.6	22.6	121.7	131.1	8.3	17.7	9.68	9.67	22.51	22.50
10-Jun	110.3	109.9	110.6	113.8	112.6	113.8	110.7	109.5	110.5	115.9	115.4	117.1	112.3	111.6	10.5	24.2	105.4	109.7	10.3	23.4	10.70	10.71	24.36	24.35
11-Jun	109.9	109.0	109.5	113.4	112.1	113.2	109.8	109.0	109.9	115.4	114.3	117.9	110.4	109.4	9.8	23.2	104.8	113.5	10.3	24.6	9.59	9.59	22.83	22.67
12-Jun	108.8	107.9	108.2	112.4	111.6	112.9	109.5	108.1	109.3	115.1	113.8	117.1	108.4	108.2	10.1	21.4	98.6	104.2	10.9	22.6	10.14	10.14	21.50	21.50
13-Jun	107.8	107.4	107.8	112.3	111.3	112.3	108.8	108.2	109.2	113.8	113.2	114.4	109.1	110.6	8.7	20.0	109.6	116.7	8.2	17.6	8.73	8.74	20.00	20.01
14-Jun	108.3	107.8	108.7	112.2	111.2	112.4	108.8	108.0	109.3	113.8	113.2	114.3	110.4	111.1	8.9	20.1	104.1	109.7	8.8	18.8	8.82	8.82	20.01	20.01

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
15-Jun	109.0	108.6	109.1	113.1	111.9	113.7	110.4	98.9	111.0	114.8	114.6	117.5	111.9	112.8	10.3	23.6	128.1	132.1	9.4	22.2	10.40	10.40	23.44	23.44
16-Jun	109.4	109.1	109.7	112.9	111.9	113.3	110.2	109.4	110.6	115.5	115.1	117.1	111.9	112.8	10.5	25.0	107.6	112.6	10.2	24.3	10.60	10.59	25.14	24.93
17-Jun	109.6	109.5	110.4	112.5	111.3	112.8	110.0	109.6	110.3	116.6	115.1	117.7	111.7	110.3	8.9	22.0	87.5	90.3	11.5	27.9	8.88	8.89	22.05	21.74
18-Jun	109.9	109.5	110.4	112.9	111.6	113.3	110.0	109.3	109.9	115.6	114.9	118.2	112.2	113.8	9.5	21.3	86.1	90.3	11.9	26.5	9.43	9.42	20.80	20.80
19-Jun	109.6	108.3	108.7	112.8	110.8	112.0	109.5	108.8	109.7	115.7	114.5	118.8	112.3	111.4	8.8	17.7	75.1	77.9	13.2	27.0	8.75	8.75	17.75	17.74
20-Jun	108.7	108.3	109.5	112.3	111.2	113.0	109.0	108.4	109.9	114.6	114.3	117.0	108.7	109.5	8.2	17.5	84.1	88.9	11.1	22.8	8.13	8.12	17.71	17.71
21-Jun	109.0	108.4	109.5	112.2	110.1	111.3	109.5	108.9	109.8	115.6	115.0	119.3	110.1	111.0	6.7	15.9	73.2	75.2	10.2	26.4	6.67	6.66	15.98	15.97
22-Jun	109.0	108.6	109.7	112.7	111.3	113.1	108.9	108.3	109.6	116.1	114.9	119.0	110.1	109.8	11.7	20.1	89.6	93.5	14.4	25.8	11.93	9.53	20.33	20.33
23-Jun	109.2	108.7	109.9	112.7	111.7	113.1	110.0	109.3	110.7	115.7	114.8	119.0	109.2	110.3	8.6	18.5	90.3	93.4	10.7	24.0	8.72	8.72	18.42	18.42
24-Jun	109.7	109.3	110.2	112.3	111.2	112.0	110.1	109.4	109.9	115.7	114.5	118.8	110.7	111.1	8.7	19.1	84.3	87.1	11.4	25.1	8.64	8.64	19.15	19.16
25-Jun	109.6	108.8	109.3	112.5	111.2	113.1	115.3	109.0	110.1	114.8	113.8	118.1	111.7	112.2	8.6	18.9	103.2	106.0	9.8	21.9	8.68	8.68	18.85	18.86
26-Jun	109.7	109.1	110.0	113.6	112.2	114.1	110.2	109.7	110.8	115.7	115.3	117.6	113.6	114.3	10.0	22.7	114.0	114.8	9.5	22.5	9.98	9.99	22.75	22.75
27-Jun	110.3	110.0	111.0	113.9	113.1	114.4	111.1	110.4	111.7	115.9	115.5	117.2	114.1	114.9	10.2	22.7	109.8	115.1	9.9	21.4	10.15	10.16	22.62	22.62
28-Jun	110.7	110.4	111.7	114.1	113.2	114.7	115.3	110.6	111.7	116.7	116.2	117.9	114.4	115.9	9.8	22.6	109.2	110.7	9.6	22.7	9.72	9.71	22.75	22.75
29-Jun	110.7	109.9	110.3	114.2	113.1	115.0	111.2	110.3	111.3	116.9	115.4	117.8	114.4	113.3	9.9	22.4	111.7	115.4	9.3	21.0	10.22	9.95	22.60	22.59
30-Jun	110.0	109.7	110.2	113.7	112.3	114.9	110.6	109.9	111.3	115.8	115.2	118.3	112.4	113.5	9.2	22.2	113.5	115.8	8.9	22.3	9.30	9.30	22.43	22.43
1-Jul	109.9	109.3	109.8	113.3	112.2	114.6	110.6	109.6	111.1	115.5	114.3	117.2	114.2	115.3	9.1	19.2	115.5	121.2	8.8	18.5	9.13	8.94	19.55	19.55
2-Jul	109.7	109.2	110.3	113.8	112.4	114.2	110.4	109.6	111.4	115.8	115.2	116.3	115.0	116.0	9.3	22.8	112.0	116.8	8.7	20.6	9.40	9.40	22.83	22.83
3-Jul	110.9	110.4	111.5	113.8	112.6	114.1	110.9	110.2	111.6	116.0	114.6	116.4	114.9	113.5	8.4	19.1	105.0	107.4	8.3	19.0	8.38	8.38	19.05	19.05
4-Jul	110.9	110.4	111.4	113.6	112.3	114.5	111.1	110.5	111.8	119.4	114.9	116.3	112.9	113.7	7.3	17.6	106.4	109.4	7.5	17.3	7.40	7.38	17.42	17.42
5-Jul	110.8	109.6	110.2	113.1	111.6	113.3	111.1	109.7	110.4	115.1	114.1	115.7	112.5	112.3	7.2	17.9	108.2	113.9	6.8	16.0	7.14	7.15	17.68	17.68
6-Jul	109.7	109.1	110.0	112.8	111.7	113.6	110.3	109.6	111.2	115.2	114.8	117.9	112.3	113.8	8.6	20.7	95.4	98.7	9.9	24.6	8.53	8.54	20.65	20.66
7-Jul	110.1	109.5	110.9	112.5	111.2	112.7	110.5	109.6	110.3	115.8	114.5	116.6	112.3	113.0	8.4	19.1	87.7	88.8	10.1	23.3	8.64	8.65	19.11	19.10
8-Jul	110.6	109.8	111.1	113.4	111.9	114.5	110.6	109.9	111.2	114.9	114.8	116.9	114.2	115.0	9.4	20.5	101.6	104.6	9.9	23.1	9.33	9.33	20.80	20.81
9-Jul	110.9	110.5	111.2	113.0	111.8	113.7	111.0	110.5	111.3	116.3	115.4	118.0	114.7	115.5	8.4	19.1	95.6	97.2	9.4	21.5	8.37	8.39	19.45	19.32
10-Jul	110.9	110.8	111.2	112.6	111.2	112.9	110.9	109.9	110.8	116.3	115.2	117.8	114.6	113.1	7.9	17.1	75.1	75.5	11.5	25.8	8.01	8.01	17.08	17.08
11-Jul	110.9	109.6	110.4	111.7	110.2	110.8	109.8	108.9	109.6	115.7	114.9	117.5	110.2	109.2	7.8	17.0	67.9	67.6	12.2	28.0	7.87	7.87	17.03	17.02
12-Jul	109.4	108.7	109.1	110.9	110.2	111.3	108.5	107.9	108.5	114.5	113.9	116.7	108.5	107.9	7.0	15.4	76.8	76.9	9.5	21.8	6.96	6.96	15.40	15.39
13-Jul	108.8	108.4	108.8	111.7	110.8	112.7	108.7	108.3	109.3	114.2	113.7	116.7	108.7	109.6	8.4	19.8	99.3	100.8	9.1	21.6	8.35	8.35	19.57	19.56
14-Jul	109.2	108.7	109.4	113.1	111.6	113.8	109.4	108.7	110.3	114.2	113.7	116.8	109.4	110.6	8.9	19.9	102.3	105.5	9.2	20.5	8.85	8.85	19.85	19.85
15-Jul	109.2	109.0	109.5	112.9	112.0	113.6	109.6	108.9	109.9	114.4	113.9	115.3	109.2	108.4	8.0	20.1	107.0	110.6	7.5	18.3	8.02	8.00	19.95	19.94
16-Jul	109.1	108.2	108.8	112.5	111.8	113.1	109.4	108.3	109.2	114.3	113.3	114.5	107.8	107.5	8.7	20.0	106.1	111.4	8.3	18.2	8.63	8.63	19.98	19.98
17-Jul	108.3	107.9	108.7	112.3	111.5	112.9	109.0	108.2	109.6	113.8	113.1	114.2	108.6	109.5	8.7	20.1	109.1	115.0	8.1	17.6	8.74	8.74	20.13	20.13
18-Jul	108.7	108.4	109.1	112.4	111.7	113.0	109.3	108.8	110.0	114.6	113.8	115.9	110.7	111.5	9.7	18.3	103.8	105.6	9.9	19.2	8.43	7.81	18.38	18.38
19-Jul	109.0	108.6	109.3	112.8	111.9	113.5	109.6	108.9	109.7	113.8	113.3	114.3	111.4	112.2	8.5	18.5	106.0	108.8	8.1	17.3	8.53	8.53	18.42	18.41
20-Jul	109.4	109.1	109.9	112.8	111.8	113.1	109.4	109.1	109.7	114.7	114.5	115.4	111.4	110.9	8.8	21.0	100.2	101.8	8.9	21.1	8.70	8.69	21.05	21.05
21-Jul	109.3	108.9	109.7	112.3	111.6	113.0	109.5	108.7	109.5	114.7	114.3	116.8	108.8	108.9	9.5	20.6	86.5	89.2	11.1	24.2	9.39	9.39	20.85	20.86
22-Jul	109.2	107.9	108.6	112.1	110.6	112.5	108.9	108.2	108.8	115.1	114.0	116.7	108.6	108.1	8.3	17.2	84.2	85.7	10.7	23.8	8.34	8.33	17.18	17.18
23-Jul	108.1	107.2	107.8	111.0	110.2	111.7	108.3	107.5	108.4	113.9	112.9	115.5	108.3	109.4	8.4	18.5	91.8	94.2	9.7	21.1	8.37	8.36	18.58	18.58
24-Jul	107.6	107.3	107.9	110.9	110.2	111.8	107.5	107.0	108.2	112.6	112.1	114.2	108.4	107.7	7.9	18.4	101.6	103.8	8.0	18.4	7.98	8.00	18.41	18.40
25-Jul	107.6	107.3	107.6	110.6	110.1	111.2	107.8	107.0	108.0	112.6	112.1	113.7	107.1	107.0	7.8	17.3	104.5	107.4	7.6	16.4	7.80	7.79	17.41	17.41
26-Jul	107.3	106.5	107.0	110.0	109.2	110.2	107.0	106.5	107.2	113.0	111.8	116.1	106.8	106.6	7.4	17.1	83.0	87.7	10.0	22.4	7.40	7.39	16.89	16.88

2015	Rocky Reach Forebay			Rocky Reach Tailrace			Rock Island Forebay			Rock Island Tailrace			Wanapum Forbay		Average Daily Spill		Total Flow		% Flow Spilled		Rocky Reach		Rock Island	
	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	24-hr Avg	High	12-hr Avg	High	RR	RI	RR	RI	RR	RI	Other	Fish	Other	Fish
27-Jul	106.3	105.3	105.8	109.8	109.0	110.2	106.6	105.6	106.4	113.3	112.6	115.0	106.1	105.2	8.6	20.5	87.2	90.0	10.3	24.0	8.62	8.62	20.52	20.52
28-Jul	105.7	105.3	105.9	110.2	109.2	110.6	106.1	105.5	106.7	112.9	112.3	114.6	106.1	107.4	8.7	20.7	94.6	97.9	9.9	23.1	8.69	8.68	20.59	20.59
29-Jul	106.4	105.9	106.7	112.2	110.7	113.6	106.8	106.4	107.4	113.0	112.5	114.6	108.3	109.0	13.1	21.1	113.7	115.0	11.3	19.3	12.89	8.67	21.31	21.31
30-Jul	107.4	106.9	107.8	112.2	110.4	111.6	107.7	107.3	108.2	113.2	112.8	114.3	110.0	111.3	8.6	20.9	103.2	106.2	8.5	20.3	8.70	8.70	21.00	20.99
31-Jul	108.5	108.0	109.1	111.7	110.8	112.0	108.6	107.8	109.5	113.8	113.2	114.2	111.6	112.3	8.8	21.1	105.4	107.1	8.6	20.2	8.75	8.76	21.21	21.21
1-Aug	109.6	109.1	110.3	112.2	111.2	112.9	109.2	108.5	110.2	114.2	113.8	115.5	111.7	112.9	9.2	20.3	89.9	93.0	10.7	23.7	9.16	9.17	20.52	20.52
2-Aug	109.6	109.0	109.9	112.2	111.0	112.3	109.7	108.9	110.1	114.2	113.9	114.8	111.4	111.6	8.2	17.9	88.2	90.9	9.7	21.8	8.15	8.16	17.76	17.76
3-Aug	109.4	108.6	109.0	112.0	111.3	112.6	109.2	108.3	109.4	115.3	114.9	116.8	110.6	110.0	9.9	22.7	94.1	94.9	10.8	25.7	9.89	9.89	22.80	22.80
4-Aug	108.5	107.8	108.2	112.0	111.0	112.2	108.4	108.2	108.6	114.9	114.3	115.6	108.9	108.7	10.1	22.4	101.7	102.4	10.3	23.7	10.15	10.15	22.67	22.67
5-Aug	107.7	106.5	107.0	111.6	110.7	112.1	108.4	107.1	108.1	114.6	112.7	115.6	108.3	107.9	9.8	20.8	111.0	115.7	8.9	18.3	9.79	9.80	21.06	21.06
6-Aug	106.3	105.6	105.9	111.3	110.3	111.4	107.2	106.7	107.5	113.5	112.1	114.0	107.9	108.4	8.8	20.7	122.3	126.4	7.2	16.6	8.72	8.71	20.58	20.57
7-Aug	106.9	106.4	107.2	111.9	110.7	112.4	107.7	106.9	108.5	113.9	113.3	116.6	109.3	109.7	9.2	20.7	99.6	101.6	10.3	24.9	9.83	9.83	20.88	20.88
8-Aug	107.5	107.3	107.7	111.8	107.3	110.0	108.1	107.4	108.4	114.4	112.6	116.0	109.4	109.6	0.0	18.4	95.4	98.5	0.0	19.8	0.00	0.00	18.42	18.42
9-Aug	107.4	106.9	107.3	106.7	106.1	106.6	107.3	105.9	106.7	112.6	111.7	115.5	109.2	109.2	0.0	19.6	93.4	99.2	0.0	22.2	0.00	0.00	19.48	19.49
10-Aug	107.1	106.7	107.2	108.7	107.1	111.6	106.5	106.1	106.6	112.8	112.5	116.4	111.2	111.7	4.1	22.4	110.8	113.7	2.7	22.9	4.82	0.00	22.70	22.69
11-Aug	107.6	107.2	108.1	108.7	106.1	106.7	107.0	105.3	107.8	114.4	113.6	117.8	111.3	113.3	0.0	22.8	102.0	105.9	0.0	26.3	0.00	0.00	22.71	22.71
12-Aug	107.9	107.7	108.0	107.4	106.7	108.5	107.6	106.9	108.2	112.8	107.9	111.2	112.5	113.6	0.7	3.0	105.5	107.6	0.6	6.8	0.90	0.00	3.17	0.01
13-Aug	108.0	107.7	108.3	112.0	110.1	114.6	108.5	107.5	109.8	108.4	107.5	109.8	112.5	112.9	11.7	0.0	121.6	125.4	7.8	0.0	11.58	0.00	0.00	0.00
14-Aug	108.2	107.8	108.2	112.0	107.3	108.7	109.6	107.7	110.6	109.6	107.9	110.5	111.5	110.3	0.0	0.0	118.0	121.7	0.0	0.0	0.00	0.00	0.00	0.00
15-Aug	107.4	106.2	107.0	106.6	105.5	106.3	106.5	105.3	106.2	106.6	105.4	106.2	106.8	105.0	0.0	0.0	110.7	115.5	0.0	0.0	0.00	0.00	0.00	0.00
16-Aug	105.9	104.9	105.4	105.2	104.2	104.4	105.7	104.4	105.1	105.7	104.5	105.0	106.7	107.5	0.0	0.0	107.6	112.3	0.0	0.0	0.00	0.00	0.00	0.00
17-Aug	105.5	105.2	105.7	107.2	105.7	110.0	105.3	104.6	105.5	105.2	104.7	105.4	106.8	105.9	3.9	0.0	118.5	121.6	2.8	0.0	3.71	0.00	0.00	0.00
18-Aug	106.3	105.9	106.5	107.7	105.5	106.6	105.8	105.5	106.0	105.7	105.6	106.0	106.8	107.3	0.0	0.0	115.3	118.6	0.0	0.0	0.00	0.00	0.00	0.00
19-Aug	108.2	107.3	111.6	108.7	107.1	111.6	106.6	106.0	106.9	106.6	106.0	106.9	107.3	108.1	4.4	0.0	125.6	128.2	3.2	0.0	4.14	0.00	0.00	0.00
20-Aug	111.1	109.7	112.0	110.5	108.8	110.9	110.0	108.7	110.6	110.0	108.7	110.7	106.9	105.8	0.0	0.0	115.5	119.1	0.0	0.0	0.00	0.00	0.00	0.00
21-Aug	108.6	106.2	108.0	108.0	105.8	107.4	109.5	105.8	107.3	109.7	105.9	107.8	105.2	104.8	0.0	0.0	114.2	119.8	0.0	0.0	0.00	0.00	0.00	0.00
22-Aug	105.1	102.9	104.0	104.7	102.7	103.5	105.2	103.1	104.2	105.3	103.2	104.4	105.9	106.7	0.0	0.0	116.5	120.0	0.0	0.0	0.00	0.00	0.00	0.00
23-Aug	103.1	103.0	103.3	102.8	102.6	103.0	103.2	102.6	103.5	103.1	102.6	103.4	106.6	107.3	0.0	0.0	106.7	112.4	0.0	0.0	0.00	0.00	0.00	0.00
24-Aug	103.1	103.0	103.2	102.7	102.6	102.8	103.3	102.8	103.3	103.3	102.8	103.3	106.6	105.9	0.0	0.0	106.1	108.3	0.0	0.0	0.00	0.00	0.00	0.00
25-Aug	103.1	102.9	103.2	102.7	102.5	102.7	103.1	102.6	103.5	103.1	102.6	103.4	105.3	105.5	0.0	0.0	118.4	123.0	0.0	0.0	0.00	0.00	0.00	0.00
26-Aug	103.0	102.7	103.2	102.6	102.2	102.4	103.2	102.4	103.1	103.2	102.5	103.1	104.7	105.3	0.0	0.0	115.1	120.6	0.0	0.0	0.00	0.00	0.00	0.00
27-Aug	103.5	103.2	103.9	102.9	102.7	103.1	103.4	102.7	103.6	103.3	102.8	103.6	104.7	104.2	0.0	0.0	96.7	102.3	0.0	0.0	0.00	0.00	0.00	0.00
28-Aug	104.2	104.0	104.3	103.7	103.4	103.9	103.7	103.3	104.2	103.5	103.3	104.1	103.9	104.1	0.0	0.0	103.1	106.8	0.0	0.0	0.00	0.00	0.00	0.00
29-Aug	104.7	104.3	104.9	103.8	103.5	104.3	104.2	103.7	104.2	104.2	103.8	104.4	103.9	104.0	0.0	0.0	79.4	82.3	0.0	0.0	0.00	0.00	0.00	0.00
30-Aug	103.8	102.6	103.4	103.3	102.1	103.0	103.4	102.3	103.5	103.5	102.4	103.5	102.4	102.1	0.0	0.0	77.9	83.4	0.0	0.0	0.00	0.00	0.00	0.00
31-Aug	102.4	101.9	102.1	101.6	101.4	101.8	101.8	101.7	101.9	101.9	101.7	101.9	102.3	102.6	0.0	0.0	96.5	100.2	0.0	0.0	0.00	0.00	0.00	0.00

APPENDIX F: ROCKY REACH PORJECT GAP

2015 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

April 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Douglas PUD	Public Utility District No. 1 of Douglas County
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FPE	Fish Passage Efficiency
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
JBS	juvenile bypass system
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RRFF	Rocky Reach Fish Forum
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan
WQS	Water quality standards

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) 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 by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid downstream migrating juvenile fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2015 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rocky Reach Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), Rocky Reach Operations Plan, TDG Operational Plan, a Quality Assurance Project Plan (QAPP) for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

Washington State water quality standards provide for a temporary exemption for elevated TDG levels to allow increased downstream migrating juvenile fish passage without causing more harm to fish populations than caused by turbine fish passage. Washington state water quality standards provide different standards for TDG during the non-fish and fish-spill seasons to aid fish passage. In the 401 Certification for the Rocky Reach Project, the non-fish spill season is defined as September 1 through March 31 and the fish-spill season is April 1 through August 31. 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 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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). A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the GAP 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement applicable operational measures specified in Section 5.4.1(b) of the 401 Certification. These measures include, but are not limited to:

1. Minimizing voluntary spill.
2. During downstream migrating juvenile fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to 212 thousand cubic feet per second kcfs.
6. Implement alternative spillway operations, using of gates 2 through 12, to determine whether TDG levels can be reduced without adverse effects on fish passage. If effective, implement to reduce TDG.

Additionally, Chelan PUD proposes to implement the following measures, as required by the 401 Certification:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to United States Army Corps of Engineers (USACE) Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's flow, TDG, gas bubble trauma (GBT) monitoring, and fish study results, and, in accordance with the previous (2014) GAP, submit to Ecology by December 31.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Rocky Reach Hydroelectric Project, located on the Columbia River downstream of Wells Dam (Figure 1-1). The Project is licensed as Project No. 2145 by the Federal Energy Regulatory Commission (FERC). The 401 Certification for the Project was issued by Ecology on March 17, 2006. The 401 Certification terms and conditions are incorporated in the new FERC license to operate the Project which was issued on February 19, 2009. Section 5.4.3 of the 401 Certification requires Chelan PUD to submit an annual GAP in accordance with Ecology's water quality standards for total dissolved gas TDG beginning on April 1 of the year of implementation.

This GAP is being submitted to Ecology as a condition of the 2006 Special Fish Passage Exemption (WAC 173-201A-200(1)(f)) and Section 5.4.3 of the 401 Certification. Chelan PUD respectfully submits this GAP with the goal of receiving a temporary exemption for TDG commencing with the 2014 fish[1] spill season. This GAP provides details associated with proposed 2015 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

1.1 Project Description

The Rocky Reach Project is owned and operated by Chelan PUD and is located on the Columbia River at river mile 474, about seven miles upstream of the city of Wenatchee. Construction of the dam and powerhouse began in 1956 and the Project was completed and put into production in 1961. The impounding structures are a mass of reinforced concrete consisting of a forebay wall section about 460 feet long, a combined intake and powerhouse section 1,088 feet long, a non-overflow center dam spillway that is 740 feet long consisting of 12 bays, each controlled by a 50 foot wide, 58 foot high radial gate. A 2,000 foot subsurface cutoff wall consisting of a grout curtain and a compacted impervious barrier limits seepage through a terrace forming the east bank.

The forebay wall consists of mass concrete gravity blocks of various heights, with a maximum height of 118 feet. The service bay connects the forebay wall to the powerhouse. The powerhouse contains 11 units, each 86 feet wide and about 200 feet long. The Project's FERC license authorized installed capacity is 865.76 megawatts (MW).

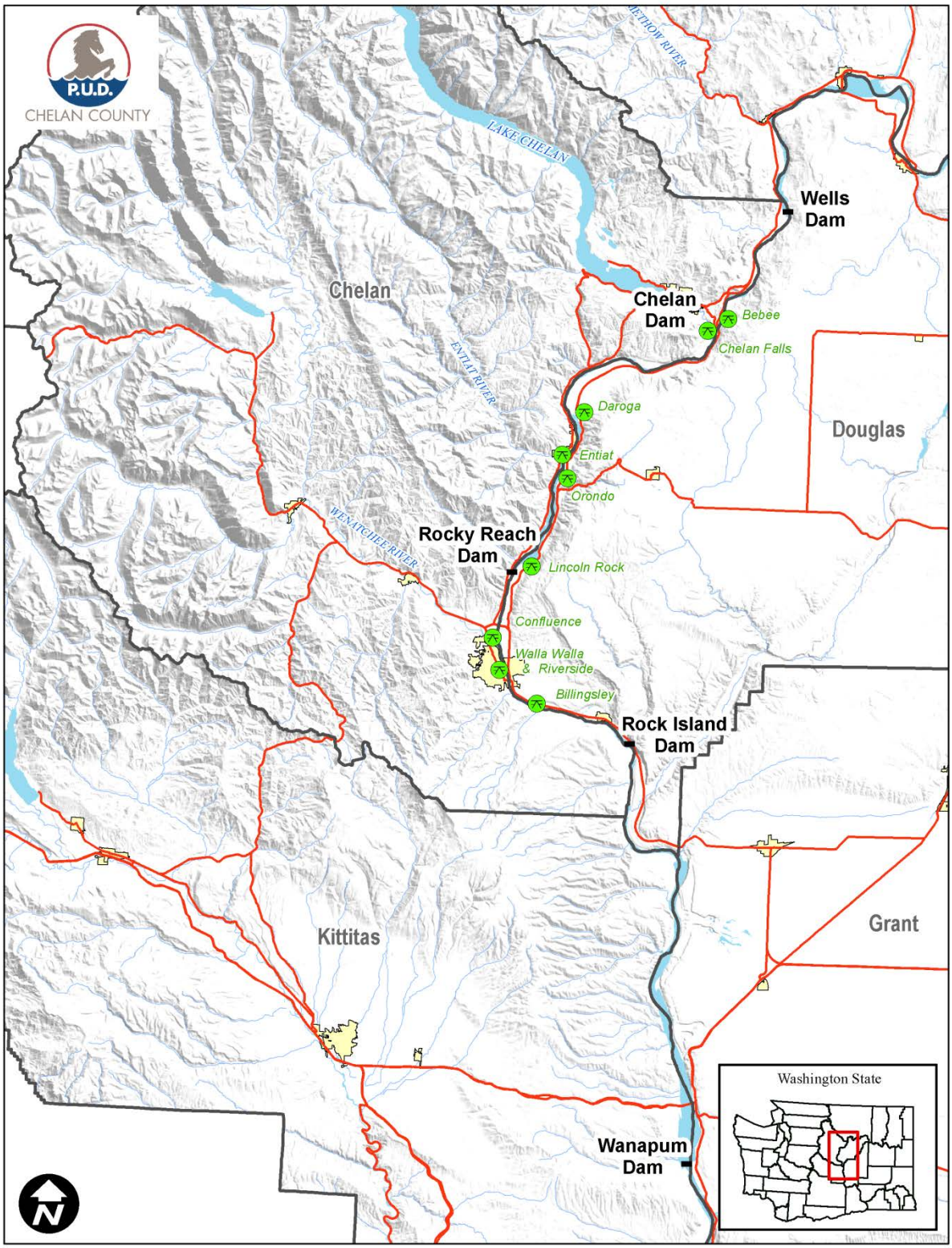

Figure 1-1: Location of Rocky Reach Hydroelectric Project on the Columbia River.

The Project contains an adult fishway to provide upstream fish passage and a juvenile fish bypass system (JBS) which began operation in 2003 to provide downstream fish passage for juvenile salmon and steelhead. The fishway consists of a fish ladder, transportation channel, collection channel and three entrances. The JBS consists of a surface collection system adjacent to the forebay wall, intake screens, and a bypass conduit routed along the downstream side of the powerhouse and spillway, through a fish collection facility, and to an outfall downstream of the Project near the dam's left abutment.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10-year average flows to 2014 flows at the Rocky Reach Project is shown below in Table 1-1.

Table 1-1: Comparison of 10 year average flows to 2014 flows at the Rocky Reach Project.

Season	10 Year Average Flows (2004-2013)	2014 Flows	Percent of 10 Year Average
Spring (4/1-5/23)	130.43 kcfs	154.8 kcfs	118.7%
Summer (5/24-8/31)	147.4 kcfs	151.4 kcfs	102.7%

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG exemption. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-Spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill (for downstream migrating juveniles) season as April 1 through August 31 of each year. Non-fish spill season is defined as September 1 through March 31, unless otherwise specified in writing to Ecology following consultation with the Rocky Reach Fish Forum and the HCP Coordinating Committee.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rocky Reach Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for the Rocky Reach Project was calculated to be 252 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). Since special criteria have been established in Washington for "voluntary" spills for downstream migrating juvenile fish passage under an approved plan, the TMDL sets TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam's forebay and tailrace and at the upstream boundaries.

Section 5.4.7 of the Rocky Reach Project 401 Certification states: "*This certification, along with the WQMP and the updated GAP, is intended to serve as the Rocky Reach Project's portion of the Detailed Implementation Plan (DIP) for the Mid-Columbia River and Lake Roosevelt TDG TMDL"*.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the Hourly Coordination Agreement, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project through management of a positive or negative "bias" which assigns a project more or less generation depending on whether

the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the HCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 2015 Rocky Reach Operations Plan

Article 402 of the Rocky Reach License requires an annual Operations Plan be submitted to the FERC by February 15 each year for approval (revised submittal date of March 30). This Operations Plan includes the following: (a) descriptions of fisheries (juvenile and adult) and water quality-related operating criteria for the Project turbines, the downstream fish passage facility, fishways, spillways, and sluiceways; (b) descriptions of fisheries- and water-quality-related protocols for startup, in-season operation, shutdown, and inspection of the Project turbines, the downstream passage facility, fishways (including fish salvage), spillways, and sluiceways; and (c) an annual schedule for operation and inspection of these facilities. The information contained in the annual Operations Plan is relevant to Chelan PUD's TDG abatement activities and is therefore attached for reference as Appendix C to this GAP.

1.4.2 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rocky Reach HCP serves as the foundation for the fisheries management plan at Rocky Reach Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the "maximum extent practicable" as required by the Endangered Species Act (ESA). Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The Rock Reach HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including spill and the use of the JBS. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rocky Reach while operating the JBS exclusively.

1.4.3 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the United States Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the United States Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant PUDs), the USACE, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on ESA listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CCT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.4 Spill Operations

1.4.4.1 Spill Gate Configuration

The standard (fish) spill configuration used at Rocky Reach uses gates 2 through 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 upstream migrating adult fishway entrances.

This spill pattern provides favorable guidance conditions for adult migrant salmon and steelhead. This spill configuration and alternate patterns were tested and it was determined this pattern was as good as, if not better than, the alternate patterns for upmigrating salmonids (Schneider and Wilhelms, 2005). The same pattern is used for juvenile downstream migrating 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.

Note that although the above referenced crown-shaped pattern may be as good as, if not better, than tested alternate patterns for upmigrating salmonids, it may not be ideal for TDG. According to Section 5.4(1)(b)(6) of the 401 Certification, Chelan PUD shall study alternative spillway operations using any of gates 2 through 12. In 2011 and 2012, Chelan PUD studied alternative spillway flow distribution patterns, in order to evaluate the potential to reduce total dissolved gas TDG levels, particularly during high spill levels (above 50 kcfs). Generally, all of the three alternative spill patterns studied resulted in lower TDG levels than the standard spill pattern. Of the three alternative patterns, the flat spill pattern (flow distributed evenly between spillway gates) had a slightly better TDG performance than the other two alternative patterns. Chelan PUD has presented these findings to Ecology, the Rocky Reach Fish Forum (RRFF) and Habitat Conservation Plan Coordinating Committee (HCP CC).

Chelan PUD, through the consultation process with Ecology, the RRFF, and the HCP CC, will develop a schedule to make the necessary changes to perform the new spill configuration. This schedule may include but not be limited to; computer automation of spill gates (2015), and/or changes to system operations and monitoring. Chelan PUD will operate the new spill configuration as a pilot or test spill and further evaluate the results for a designated period of time. Chelan PUD shall develop a monitoring schedule to test operations under the new spill configuration. If upon operating under the new spill configuration data show that optimal results are not occurring as previously evaluated, Chelan PUD shall implement adaptive management in coordination with the RRFF and HCP CC.

1.4.4.2 Spill Scenarios

There are six main scenarios that may result in spill at Rocky Reach Dam. These are described below:

Fish Spill

Spill is an ineffective method of bypassing downstream migrating juvenile fish away from the turbines at Rocky Reach Dam (Steig et. al., 1997) and, consequently, is not considered as the solution for the long-term fish passage program. To minimize or eliminate the need for fish spill, Chelan PUD is focusing its efforts on increasing the fish passage efficiency and survival through the juvenile fish bypass system (JBS).

The JBS continues to be the most efficient non-turbine route for downstream migrating juvenile fish passage at the Rocky Reach Project. The JBS does not require spill for its operation.

Spring Fish Spill Operations

Operating the JBS exclusively, Chelan PUD has been able to meet the HCP survival standards for the three spring migrants (spring/yearling Chinook, steelhead, and sockeye). Chelan PUD will continue operating the JBS exclusively, with no voluntary spill, during the spring of 2015.

Summer Fish Spill Operations

Summer spill at Rocky Reach for subyearling Chinook will be nine percent of day average flow. Commencement of summer spill will be determined using run-timing information at Rocky Reach. Summer spill generally begins in early June and ends in mid-August when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity

The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license (707 feet), to prevent overtopping of the Project, and

to maintain optimum operational conditions. When spilling for fish or due to excess inflow or generation, the spillway is operated using gate settings that have been shown to limit TDG production and meet fish passage requirements (Schneider and Wilhelms, 2005). To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill

This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill

Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rocky Reach. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2014

1.5.1 TDG Compliance 2014

Information regarding spill and TDG are for 2014 are displayed in Tables 1-2 and 1-3 and further described below.

Tailrace 120 percent Standard

TDG data was collected on 153 days during the 2014 fish-spill season in the Rocky Reach tailrace. None of the data was omitted from the data set due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on 11 days. Compliance with this standard was 92.8 percent.

Tailrace 125 percent Standard

Total hours of TDG data collected during the 2014 fish spill season in the Rocky Reach tailrace equaled 3,672. No hours were eliminated from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125 percent for 18 hours. Compliance with this standard was 99.9 percent.

Downstream (Rock Island) Forebay 115 percent Standard

TDG data was collected on 141 days during the 2014 fish spill season in the Rock Island forebay. However, of those 141 days 12 were omitted from the data set used for determination of compliance due to upstream forebay 12C-High TDG exceeding 115 percent. The Rock Island forebay 12C-High TDG exceeded 115 percent on 7 days. Compliance with this standard was 95.0 percent.

Table 1-2: Summary of Spill at the Rocky Reach Project in 2014

Date	Fish Spill Average kcfs	Total Spill Average kcfs	River Flow Average kcfs	% Total Spill	% Fish Spill of Total River	% Fish spill of Total Spill
4/1 - 8/31	8.4	14.6	150.3	9.7	5.6	57.5

Table 1-3: Summary of TDG Compliance at the Rocky Reach Project in 2014

Date	% Compliance with 120% Tailrace Standard	% Compliance with 125% Tailrace Standard	% Compliance with 115% Downstream Forebay TDG Standard
4/1 - 8/31	92.8	99.9	95.0

1.5.2 TDG Activities Implemented 2014

As defined in Section 5.4.1(b) of the 401 Certification, Chelan PUD implemented six actions to minimize voluntary and involuntary spill at Rocky Reach in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rocky Reach Project was the implementation of the operational spill programs and the ability to minimize spill through operation of the JBS. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to 212 kcfs.
- Contracted with Parametrix to have the data gathered during the 2011 and 2012 testing of alternative spillway configurations analyzed and summarized. The report has been reviewed by Ecology, the HCP CC and the RRFF. The results of the report are briefly summarized in Section 1.4.4.1.

1.5.3 TDG Structural Measures Implemented in 2014

No structural gas abatement measures were proposed or implemented at the Rocky Reach Project in 2014.

SECTION 2: PROPOSED 2015 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2014 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Section 5.4.1(b) of the 401 Certification requires Chelan PUD to manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards set forth in the HCP and Anadromous Fish Agreement[2]. During the 2015 fish spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. **Minimize voluntary spill**
   Success of the JBS has enabled Chelan PUD to reduce spill required for fish passage.

2. **Manage voluntary spill in real time**
   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).The TDG Operational Plan is updated annually and routed to the Project operators. It provides the operators a list of actions they are to follow if TDG meets the designated thresholds.

3. **Minimize involuntary spill**
   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. **Participate in Hourly Coordination Agreement**
   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. **Maximize powerhouse discharge as appropriate up to hydraulic capacity**

6. **Implement alternative spillway operation**
   Chelan PUD will develop a proposal in 2015 to present to the HCP Coordinating Committee and Rocky Reach Fish Forum.

Per Section 5.4(5) of the 401 Certification, operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

[2] Additional conditions used to determine compliance with the water quality criteria for TDG can be found in Sections 5.4(1)(d)-(g) of the 401 Certification, as well as Section 4.4 of this Plan.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rocky Reach Project in 2015. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a QAPP.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rocky Reach Project to monitor hourly TDG levels annually from April through August. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The forebay fixed monitoring station (Figure 2-1) is located on the upstream side of the dam, affixed to the corner between the powerhouse and spillway, approximately mid-channel. The tailrace fixed monitoring station (Figure 2-2) is located approximately 0.38 miles downstream of the dam. The standpipe is affixed to the downstream side of a pier nose supporting the juvenile bypass system outfall pipe. This location is east of mid-channel, and is minimally impacted by powerhouse flows when the Project is passing water over the spillway (Schneider and Wilhelms, 2005).

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental to perform calibrations and equipment maintenance during the 2015 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish spill season, and every other month during the non-fish spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. Quality assurance/quality control (QA/QC) measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be 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 will be conducted during the calibrations.

Figure 3-1: Location of forebay fixed monitoring station at Rocky Reach Hydroelectric Project.

3.1.1 Fish Spill Season (April 1 through August 31)

TDG measurements will be recorded throughout the fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.1.2 Non-Fish Spill Season (September 1 through March 31)

TDG measurements will be recorded throughout the non-fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.2 Quality Assurance

Section 5.7.3 of the 401 Certification requires Chelan PUD to maintain a TDG monitoring program that is at least as stringent as the QA/QC calibration and monitoring procedures and protocols developed by the USGS monitoring methodology for the Columbia River.

Chelan PUD has developed its QA/QC protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as Hydro Lab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's QAPP (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

GBT monitoring is not conducted on an annual basis at Rocky Reach Dam. However, Section 5.4(1)(c) of the Rocky Reach 401 Water Quality Certification requires Chelan PUD to develop and implement a plan to study GBT below Rocky Reach Dam. Ecology has recommended Chelan PUD postpone any GBT study and native fish and/or invertebrates until such time at it may be required. Ecology is currently evaluating the need for future GBT studies.

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct (GBT) monitoring at the Rock Island Bypass Trap. Random samples of 100 spring Chinook, steelhead and subyearling chinook will be examined two days per week during the sampling season (April 1st to August 31st). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). The results of this monitoring effort will be included in the annual report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

Section 5.7.6 of the 401 Certification requires hourly TDG information be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. To meet this requirement, Chelan PUD maintains a link on its website that directs the public to the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1 above, and any deviation from the TDG Operational Plan or the fish spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Annual Report

Chelan PUD will provide Ecology with a draft Gas Abatement Annual Monitoring Report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The GAP Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish spill season and non-fish spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (gas bubble trauma) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation
- Analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP[3] used to predict compliance with TDG numeric criteria.

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[3] The WQMP is a response to Ecology's request that the PUD provided the scientific and biological basis for Ecology's Section 401 certification. It is the principal supporting document for the 401. As stated in Chapter 2 of the Comprehensive Plan (Attachment B to the Rocky Reach Settlement Agreement):

> "*Ecology is a participant in the Settlement Group negotiating conditions for relicensing of the Project, and has requested that Public Utility District No. 1 of Chelan County (Chelan PUD) help provide the scientific and biological basis for Ecology's Section 401 Certification. The Settlement Group has developed a Comprehensive Plan that provides the rationale and details behind proposed license articles that the Settlement Group will recommend for inclusion in the New License to be issued by FERC. The Rocky Reach Water Quality Management Plan is in response to Ecology's request and is contained in this chapter of the Comprehensive Plan.*

The WQMP includes Project background; background water quality; management considerations and options investigated; and protection, mitigation, and enhancement measures.

The analysis of monitoring data for confirmation or refinement of the regression equations in the WQMP used to predict compliance with TDG numeric criteria will include the following steps:

- Input relevant 2008 (post relocation of tailrace fixed monitoring site) and 2009-2013 data,
- Analyze to see if the relationship between quantity of spill and TDG yields a similar or different regression than that predicted for site FOP1 (located just downstream and landward of the current tailrace monitoring site (Figure 2)) in Schneider and Wilhelms (2005),
- If regression is different, look for patterns that may explain the difference,
- Determine if any differences in the regression affect the predictions in Schneider and Wilhelms (2005) to meet TDG standards up to 7Q10 flows.

4.4 Determination of Compliance in Year 5

As per Section 5.4(1)(d) of the 401 Certification, in Year 5 of the effective date of the New License, Chelan PUD shall prepare a report summarizing the results of all TDG studies performed to date, and describing whether compliance with the numeric criteria has been attained.

This report was submitted as a Draft to Ecology and the RRFF on October 31, 2014 and the HCP CC on November 25, 2014. The HCP CC requested an additional 30 day comment period extending the final due date to Ecology on January 30, 2015. Ecology approved the extension and final due date. Comments were received and incorporated into the final report submitted to Ecology on January 30, 2015. Chelan PUD is awaiting Ecology's notification regarding the next actions.

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

As per Section 5.4(3) of the 401 Certification, the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

Additionally, beginning in year 10, and every 10 years thereafter, the revised annual GAP shall include a review of reasonable and feasible gas abatement options to incrementally reduce TDG caused by the Project, in light of new information and technology. If any reasonable and feasible measures are identified, Chelan PUD shall present the data and analysis to the RRFF and develop an implementation plan. The implementation plan shall be included in the GAP for review and approval by Ecology.

SECTION 6: CONCLUSIONS

Pending approval by Ecology, implementation of the measures presented in this 2015 GAP are intended to ensure compliance with the Washington state water quality standards for TDG in the Columbia River at the Rocky Reach Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the Rocky Reach HCP and Anadromous Fish Agreement. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Federal Energy Regulatory Commission (FERC). 2009. Order on Offer of Settlement and Issuing New License, Project No. 2145-060.

Fish Passage Center (FPC). 2009. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.

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Schneider, M.L. and S.C. Wilhelms. 2005. Rocky Reach Dam: Operational and Structural Total Dissolved Gas Management. Prepared by COE, Engineer Research and Development Center, for Chelan PUD. July 2005. http://www.chelanpud.org/rr_relicense/study/reports/7773_1.pdf

Steig, T.W., R. Adeniyi, and V. Locke. 1997. Hydroacoustic evaluation of the fish passage through the powerhouse, the spillway, and the surface collector at Rocky Reach Dam in the spring and summer of 1997. Report by Hydroacoustic Technology, Inc. to Chelan Co. PUD, Wenatchee, Wash.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCKY REACH HABITAT CONSERVATION PLAN

The Rocky Reach Habitat Conservation Plan can be found at:
http://www.midcolumbiahcp.org/RR_HCP.pdf

APPENDIX B: 2015 ROCKY REACH TDG OPERATIONAL PLAN

2015 Rocky Reach Operational Plan

for Total Dissolved Gas During Fish Spill Season

April 1 through August 31

(All spill between these dates is subject to the actions contained in this plan.)
(Applies only when not spilling for headwater control)

Protocol

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

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

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

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

APPENDIX C: OPERATIONS PLAN

FERC License Requirement (Article 402)

The 2015 Rocky Reach Operations Plan can be found at the following link:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/44507.pdf

APPENDIX D: 2010 QUALITY ASSURANCE PROJECT PLAN

Rocky Reach Water Quality Monitoring and Reporting

The 2010 Quality Assurance Project Plan can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf

APPENDIX E: 2014 GAS ABATEMENT ANNUAL REPORT

The 2014 Gas Abatement Annual Report can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/43948.pdf

APPENDIX F: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rocky Reach on February 13, 2015 for review and comment. On March 13, 2015, Ecology sent Chelan PUD an email stating that they had reviewed and approved the Gas Abatement Plan. Both emails are included below.

From:	Steinmetz, Marcie
To:	"McKinney, Charlie (ECY)"; "Coffin, Chris (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Sokolowski, Rosana; Bitterman, Deborah
Subject:	Draft 2015 Gas Abatement Plans for Rocky Reach and Rock Island dams
Date:	Friday, February 13, 2015 10:34:00 AM
Attachments:	44505 DRAFT 2015 Rocky Reach GAP 021015.docx 44506 DRAFT 2015 Rock Island GAP 021015.docx

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

To: Chris Coffin, Washington Department of Ecology
Charlie McKinney, Washington Department of Ecology

From: Marcie Steinmetz, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943
DRAFT 2015 Total Dissolved Gas Abatement Plans

Please find attached the 2015 DRAFT Rocky Reach and Rock Island Total Dissolved Gas Abatement Plans for your review. Please submit your comments on or before 5:00 p.m., March 13, 2015 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | Water Resource Specialist
Chelan County Public Utility District No.1 | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

From:	McKinney, Charlie (ECY)
To:	Steinmetz, Marcie
Cc:	Coffin, Chris (ECY)
Subject:	Approvals for GAPS & OPS Plan
Date:	Friday, March 13, 2015 9:55:49 AM
Importance:	High

March 13, 2015

To: Marcie Steinmetz, Chelan PUD No. 1

From: Charles McKinney, WA Dept. of Ecology, Water Quality Program

The WA Department of Ecology (Ecology) has reviewed and approves the **Draft 2015 Total Dissolved Gas Abatement Plans submitted by Chelan PUD for the Rocky Reach and Rock Island Projects.**
Ecology has also reviewed and approves the **Draft 2015 Operations Plan for the Rocky Reach Project.**

Ecology grants Chelan PUD an adjustment to the 110% TDG standard for the purposes of the 2015 Spill Season, as authorized under WAC 173-201A-200(1)(f)(ii), in order to facilitate the passage of ESA listed salmonids at the Project.

Thank you for your cooperation. Please let me know if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX G: ROCK ISLAND PROJECT GAP

2015 TOTAL DISSOLVED GAS ABATEMENT PLAN

FINAL

ROCK ISLAND HYDROELECTRIC PROJECT
FERC Project No. 943

April 2015

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

TERMS AND ABREVIATIONS

401 Certification	Washington State Department of Ecology 401 Water Quality Certification
7Q10	highest seven consecutive day average flow with a 10-year recurrence frequency
cfs	cubic feet per second
Chelan PUD	Public Utility District No. 1 of Chelan County
CCT	Confederated Tribes of the Colville Indian Reservation
BPA	Bonneville Power Administration
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FCRSP	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FPC	Fish Passage Center
FMS	fixed monitoring station
GAP	Gas Abatement Plan
GBT	gas bubble trauma
Grant PUD	Public Utility District No. 2 of Grant County
HCP	Habitat Conservation Plan
HCP CC	Habitat Conservation Plan Coordinating Committee
kcfs	thousand cubic feet per second
NMFS	National Marine Fisheries Service
MCHCA	Mid Columbia Hourly Coordination Agreement
Project	hydroelectric project
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI HCP	Rock Island Habitat Conservation Plan
TDG	total dissolved gas
TMDL	total maximum daily load
UCR	Upper Columbia River
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQMP	Water Quality Management Plan

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EXECUTIVE SUMMARY

This Total Dissolved Gas Abatement Plan (GAP) is being submitted to the Washington State Department of Ecology (Ecology) as required by Washington Administrative Code (WAC) 173-201A-200. This section of the WAC allows Ecology to temporarily adjust total dissolved gas (TDG) criteria to aid fish[1] passage past hydroelectric dams when consistent with an Ecology-approved gas abatement plan. Chelan County Public Utility District No.1 (Chelan PUD) has prepared this annual GAP to provide an overview of operational implementation actions Chelan PUD will take at the Project during 2015 to meet TDG requirements, while ensuring the fish passage requirements are met as set forth in the Rock Island Habitat Conservation Plan (HCP) and Anadromous Fish Agreement. This GAP includes plans for physical and biological monitoring and is accompanied by the fisheries management plan (HCP), TDG Operational Plan, the Quality Assurance Project Plan for Rocky Reach Water Quality Monitoring and Reporting, and the Gas Abatement Annual Report.

Washington State water quality standards provide for a temporary exemption for elevated TDG levels to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. Washington state water quality standards provide different standards for total dissolved gas (TDG) during the non-fish and fish-spill seasons to aid fish passage. In Ecology's 401 Water Quality Certification (401 Certification) for the Rocky Reach Project, the non-fish spill season is defined as September 1 through March 31 and the fish-spill season is April 1 through August 31. Chelan PUD assumes these dates apply to Rock Island Dam as well. 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 115 percent as measured in the forebay of the next downstream dams and must not exceed an average of 120 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).

- A maximum TDG one hour average of 125 percent must not be exceeded during spill for fish passage.

The goal of the Rock Island Total Dissolved Gas Abatement Plan (GAP) 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 Anadromous Fish Agreement. These plans are provided as Appendix A.

[1] Unless otherwise noted "fish" refers to downstream migrating juveniles.

To meet the above stated goal, Chelan PUD plans to implement the following applicable operational measures:

1. Minimizing voluntary spill.
2. During fish passage, managing voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria, using the TDG Operational Plan (Appendix B).
3. Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
4. Avoiding spill by continuing to participate in the Hourly Coordination Agreement or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.
5. Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

Additionally, Chelan PUD proposes to implement the following measures:

1. Consult with Ecology if there are any non-routine operational changes that may affect TDG.
2. Monitor for TDG at Chelan PUD's fixed-site monitoring stations. TDG data will be collected on an hourly basis throughout the year and will be reported to U.S. Army Corps of Engineers Reservoir Control Center's website.
3. Prepare an annual report summarizing Chelan PUD's flow, TDG, gas bubble trauma (GBT) monitoring, and fish (could include juvenile and adult) study results, and, in accordance with the previous (2014) GAP, submit to Ecology by December 31.

SECTION 1: INTRODUCTION

Chelan PUD owns and operates the Project, located on the Columbia River approximately 12 miles downstream of the city of Wenatchee (Figure 1-1). The Project is licensed as Project No. 943 by the Federal Energy Regulatory Commission (FERC).

This GAP is being submitted to Ecology as a condition of the 2006 Special Fish Passage Exemption (WAC 173-201A-200(1)(f)). Chelan PUD respectfully submits this GAP with the goal of receiving a temporary exemption for TDG commencing with the 2015 fish[1] spill season. This GAP provides details associated with proposed 2015 operations and activities to achieve TDG standards, a review of any proposed structural TDG abatement measures and technologies, and physical and biological monitoring plans.

A 401 Certification for the operation of Chelan PUD's Rocky Reach Hydroelectric Project was issued by the Ecology on March 17, 2006. The 2015 Rock Island TDG monitoring and reporting will be conducted in a manner consistent with the TDG and Gas Abatement monitoring and reporting requirements within the Rocky Reach 401 Certification.

1.1 Project Description

Rock Island Project is owned and operated by Chelan PUD. The structure is 3,800 feet in length and is constructed from reinforced concrete. The dam is located at Columbia River mile 453.4, about 12 miles downstream from the city of Wenatchee. The Project contains a reservoir extending 21 miles upriver to the tailrace of Rocky Reach Dam and covers 3,300 acres. The Rock Island Project has no significant water storage capabilities. The normal maximum reservoir elevation of Rock Island Project is 613 feet with a tailrace elevation of 572 feet and a head of 41 feet. The Project discharges into a reservoir ponded by Wanapum Dam located 37.6 miles downstream.

The Project consists of two powerhouses. Powerhouse 1 is located on the east bank of the Project at a 45-degree angle from the bank. The powerhouse consists of 10 vertical shaft turbines with a rated output of 212 mega watts (MW). Powerhouse 2 is located on the west bank and is 470 feet wide, housing eight horizontal shaft turbines with a rated power output of 410 MW. The combined hydraulic capacity of both powerhouses is 220 thousand cubic feet per second (kcfs).

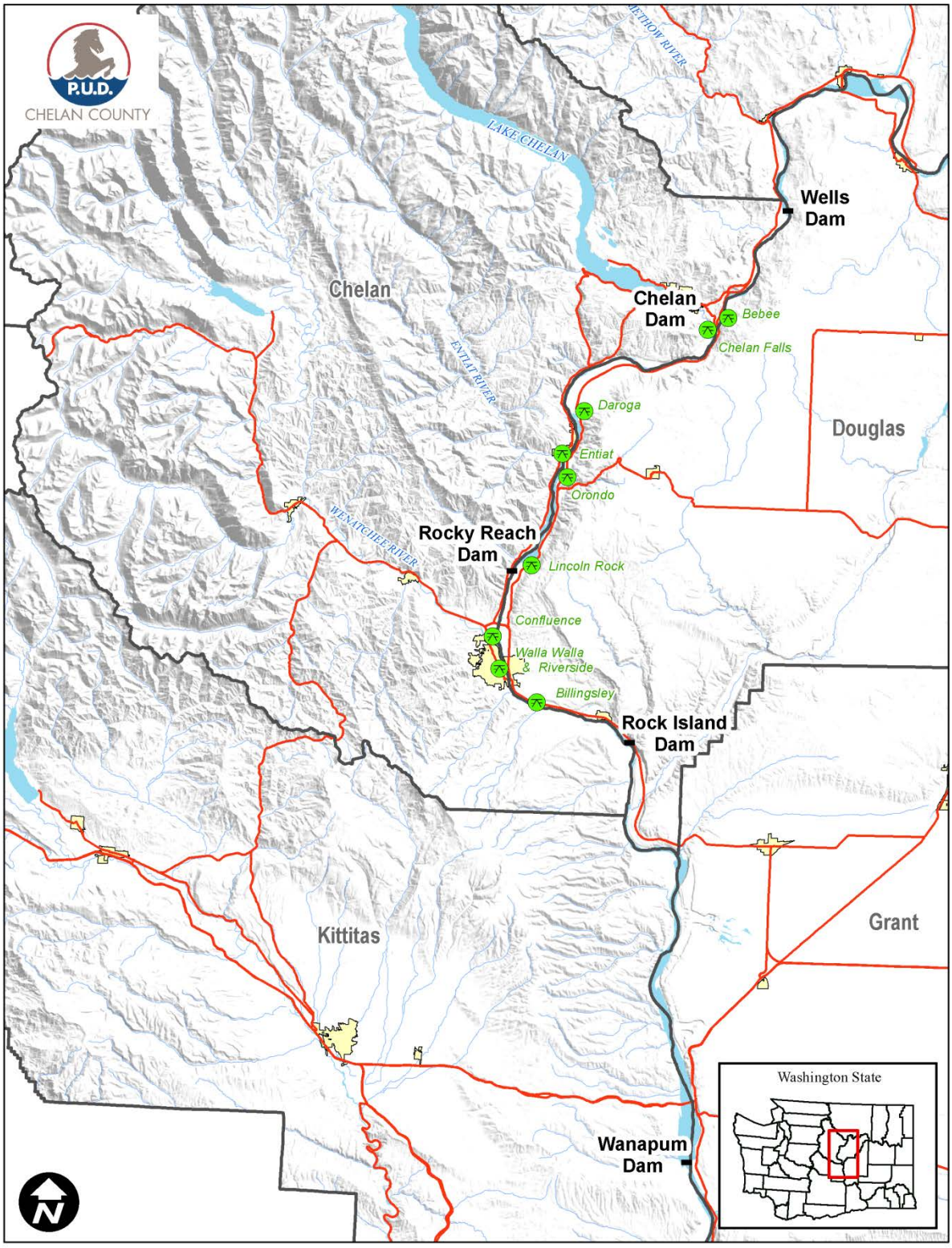

Figure 1-1: Location of Rock Island Hydroelectric Project on the Columbia River.

The Project configuration includes a spillway of 32 bays with a total length of 1,184 feet. Gates are separated by a middle adult fish ladder (located at bay 15) that divides the spillway into east and west sections. The west (Chelan County side) spillway consists of seven deep bays and ten shallow bays, and the east (Douglas County side) spillway consists of six deep bays and eight shallow bays. Each spillway has two or three crest gates, which are stacked one on top of the other. The crest gates are 30 feet wide and either 11 or 22 feet high. The larger crest gates are positioned closest to the water surface, and when fully raised, spill approximately 10 kcfs.

The deep bays have a sill elevation of 559 feet, which is about 13 feet below the average tailwater elevation of 572 feet. The shallow bays have a sill elevation of 581.5 feet, which is about 9.5 feet above the average tailwater elevation.

The focus of juvenile fish bypass at Rock Island Dam has been directed towards optimizing the efficiency of fish passage via spill. To achieve this, nine of the thirty-two spill bays have had their spill gates modified to provide surface spill. Surface spill was accomplished by putting notches in the upper sections of the spill gates. Six of the nine gates have notches that are 8 feet wide by 17 feet deep and can spill up to 2,500 cubic feet per second (cfs). The remaining gates have notches that are smaller and pass less volume (approximately 1,850 cfs). The total amount of water that can be passed through the notched gates is approximately 21,000 cfs. Three of the modified gates have had further modification and now have a "over-under" design which enables surface flow attraction and delivers water in the tailrace towards the surface, thus reducing the uptake of atmospheric gases.

1.2 River Flows

The climate of the Columbia Basin in eastern Oregon, Washington and British Columbia is best described as desert. The major portion of the precipitation experienced within the basin falls in the form of snow during the period of November through March of each year. Runoff usually occurs from mid-April through July, with the historical peak occurring during the month of June. Storage dams in the United States and Canada capture spring and summer high flows to hold for release in the winter months. A comparison of the 10 year average flows to 2014 flows at the Rock Island Project is shown below in Table 1-1.

Table 1-1: Comparison of 10 year average flows to 2014 flows at the Rock Island Project.

Season	10 Year Average Flows (2004-2013)	2014 Flows	% of 10 Year Average
Spring (4/1-5/23)	145.3	175	120.4
Summer (5/28-8/31)	151	157.8	Stet.

1.3 Regulatory Framework

1.3.1 Total Dissolved Gas Standards

The Washington State Administrative Code (WAC) 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. Ecology may approve, on a per application basis, a temporary exemption to the TDG standard (110 percent) to allow spill for juvenile fish passage on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). On the Columbia and Snake rivers there are three separate standards with regard to the TDG exemption. First, in the tailrace of a dam, TDG shall not exceed 125 percent as measured in any one-hour period. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive (12C-High) hourly readings in any one day (24-hour period). The increased levels of spill resulting in elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS, 2000).

1.3.2 Fish-Spill Season

Section 5.4.2 of the Rocky Reach 401 Certification defines the fish-spill season as April 1 through August 31 of each year. Non-fish spill season is defined as September 1 through March 31. Chelan PUD has assumed these dates also apply to Rock Island Dam.

1.3.3 Incoming Total Dissolved Gas Levels

During the fish passage season, TDG concentrations in the Rock Island Project forebay are primarily determined by the upstream water management activities of upstream dams.

1.3.4 Flood Flows - 7Q10

WAC 173-201A-200(f)(i) states that the water quality criteria for TDG shall not apply when the stream flow exceeds the seven-day, ten-year frequency flood stage (7Q10). The 7Q10 flood flow for the Rock Island Project was calculated to be 264 kcfs (Pickett, et al., 2004).

1.3.5 Total Dissolved Gas Total Maximum Daily Load

In 2004, Ecology established a TDG Total Maximum Daily Load (TMDL) for the mid-Columbia River which set TDG allocations for each dam (Pickett, et al., 2004). Since special criteria have been established in Washington for “voluntary” spills for downstream migrating juvenile fish passage under an approved plan, the TMDL sets TDG loading capacities and allocations for the Mid-Columbia River and Lake Roosevelt, both in terms of percent saturation for fish passage and excess pressure above ambient for non-fish passage. Allocations are specified for each dam and for upstream boundaries. Fish passage allocations must be met at fixed monitoring stations. Non-fish passage allocations must be met in all locations, except for an area below each dam (other than Grand Coulee) from the spillway downstream to the end of the aerated zone. Attainment of allocations will be assessed at monitoring sites in each dam’s forebay and tailrace and at the upstream boundaries.

1.4 Project Operations

The Project is an integral part of the seven-dam Mid-Columbia River Hydroelectric System (Grand Coulee to Priest Rapids). Each of the seven dams is operated in accordance with the terms of the Mid-Columbia Hourly Coordination Agreement (MCHCA), which seeks to coordinate operations for all of the mid-Columbia Projects for the best use of flows for generation and to meet fishery (juvenile and adult) and other environmental resource needs.

Under the Hourly Coordination Agreement, power operations are coordinated to meet daily load requirements through the assignment of "coordinated generation" through Central Control hosted at the Public Utility District No. 2 of Grant County (Grant PUD). Automatic control logic is used to maintain pre-set reservoir levels in order to meet load requirements and minimize involuntary spill. These preset reservoir levels are maintained at each Project through management of a positive or negative "bias" which assigns a Project more or less generation depending on whether the reservoir elevation should be increased or decreased in order to maximize system benefits and minimize involuntary spill.

In addition to the HCA discussed above, the Project operates within the constraints of its FERC regulatory and license requirements, as well as the plans and agreements discussed below.

1.4.1 Habitat Conservation Plan

In 2004, the FERC amended the existing license to include the Anadromous Fish Agreement and HCP for the Rock Island Project. The HCP is a programmatic approach developed by Chelan PUD and the fishery agencies and tribes for reducing and eliminating the effects of the Rock Island Project on salmon and steelhead.

The Rock Island HCP (RI HCP) serves as the foundation for the fisheries management plan at Rock Island Dam. It fundamentally describes a 100 percent No Net Impact (NNI) concept with necessary outcomes required for mainstem passage, habitat improvement and protection, and hatchery programming. All measures proposed in the HCP are intended to minimize and mitigate impacts to the Plan species, to the “maximum extent practicable” as required by the Endangered Species Act. Plan species include: Upper Columbia River (UCR) steelhead, UCR yearling spring Chinook, UCR subyearling summer/fall Chinook, Okanogan River sockeye, and coho salmon. The RI HCP provides for optional tools Chelan PUD may implement to aid in juvenile fish passage past the Project, including, but limited to, spill and powerhouse operations. Chelan PUD implements these tools to aid in juvenile fish passage as necessary to ensure success toward NNI.

HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations.

1.4.2 Other International and Regional Agreements

The Columbia River is managed, and the Project is operated, for fish (juvenile and adult) habitat and flow by the following international and regional agreements:

- *Columbia River Treaty*: An agreement between Canada and the United States in which Canada has agreed to provide storage for improving flow in the Columbia River to maximize power and flood control.

- *Pacific Northwest Coordination Agreement*: An agreement among the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and 15 public and private generating utilities to maximize usable hydroelectric energy. Chelan PUD is a member of this agreement.

- *Mid-Columbia Hourly Coordination Agreement*: An agreement whereby the mid-Columbia PUDs (Chelan, Douglas, and Grant), the Corps, the USBR, and BPA coordinate operations in order to maximize the output of hydroelectric power. Effects have included reducing forebay elevation fluctuations and spill.

- *The Federal Columbia River Power System (FCRPS) Biological Opinion:* by NMFS, applies to actions by the Corps, the USBR, and BPA for impacts on Endangered Species Act (ESA) listed salmon and steelhead on the Columbia River system. A Technical Management Team sets flow releases and other operations of the FCRPS that determines the daily and weekly flows that will pass through the Project.

- *Hanford Reach Fall Chinook Protection Program Agreement:* The three mid-Columbia PUDs, NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Confederated Tribes of the Colville Indian Reservation (CTT), and BPA have agreed to river flow management actions to support Grant PUD's effort the manage flow in the Hanford Reach to protect fall Chinook salmon redds and pre-emergent fry during the spawning to emergence periods (typically October to May).

1.4.3 Spill Operations

It is recognized that achieving regulatory TDG levels may not be possible during spill associated with large flood (7Q10) events. However, at Rock Island Dam it may be possible to achieve current regulatory TDG levels during releases for fish bypass and up to the 7Q10 flows (264 kcfs) by selective operation of spillway bays. The Rock Island Project is unique due to the diversity of variations in how flow is released, which may assist in the development of spill scenarios that could result in a reduction of gas in the tailrace.

There are six main scenarios that may result in spill at Rock Island Dam. These are, but are not limited to:

Fish Spill

As part of the Rock Island HCP, 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. 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 percent of the daily average flow to 10 percent of the daily average flow. Summer spill at Rock Island remains at 20 percent of the daily average flow. This summer spill was level was set by the HCP in 2002 and will remain at 20 percent until such time Chelan PUD is able to test survival of subyearling (summer) Chinook. To date, Chelan PUD has not been able to test survival due to tag technology limitations and uncertainties regarding the life history (migration

behavior) of subyearling Chinook. The 20 percent spill level must be maintained until tag technology becomes available that will enable us to accurately measure survival at the current spill level.

Spring Fish Spill Operations
HCP Phase III (Standards Achieved) has been met for all spring migrants (spring/yearling Chinook, steelhead, and sockeye) at Rock Island under 10 percent spill operations. Chelan PUD will continue spilling 10 percent through the spring migration. Spring fish spill will begin no later than April 17 and will continue until the end of the spring outmigration (95 percent passage point), and subyearling Chinook have arrived at the Project.

Summer Fish Spill Operations
Summer spill at Rock Island for subyearling Chinook will be 20 percent of day average flow over 95 percent of the summer outmigration. Summer spill will commence after the completion of spring spill. Summer spill for subyearling Chinook generally ends no later than August 15 when 95 percent of the migration of subyearling Chinook has passed the Project.

Due to tag technology limitations and uncertainties regarding their life history (outmigration behavior) no survival studies for subyearling Chinook have been conducted since 2004, nor are any planned at this time.

Additional information about the HCP standards, including annual progress reports are included in Appendix A of this GAP.

Flow in Excess of Hydraulic Capacity
The minimal storage and limited hydraulic capacity of the Project occasionally force Chelan PUD to spill water past the Project. This spill is required to maintain headwater elevations within the limits set by the Project's FERC license, to prevent overtopping of the Project, and to maintain optimum operational conditions. With this type of release, flows up to, and in excess of the 7Q10 flood flows (264 kcfs) can be accommodated. To reduce negative impacts of flow in excess of hydraulic capacity Chelan PUD completed and implemented a TDG Operational Plan. This plan is attached as Appendix B. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Plant Load Rejection Spill
This type of spill occurs when the plant is forced off line by an electrical fault, which trips breakers, or any activity forcing the units off line. This is an emergency situation and generally requires emergency spill. When the units cannot pass flow, the flow must be passed by other means, such as spill, to avoid overtopping the dam. During emergency spill, Chelan PUD will implement the TDG Operational Plan. This plan is attached as Appendix B.

Immediate Replacement Spill
Immediate replacement spill is used to manage TDG levels throughout the Columbia River basin. The Technical Management Team (including NMFS, USACE, and BPA) manages this spill. Immediate replacement spill occurs when TDG levels are significantly higher in one river

reach than they are in another reach. To balance the TDG levels throughout the basin, spill is reduced and generation increased in the reach with high TDG levels and the energy is transferred to reaches with lower TDG levels where spill is increased. The result is higher generation in the reaches with high TDG levels, increased spill in reaches with lower TDG levels, and equal distribution of TDG levels throughout the basin.

To control TDG levels that may result from immediate replacement spill, Chelan PUD will implement the TDG Operational Plan (Appendix B).

Maintenance Spill

Maintenance spill is utilized for any maintenance activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include forebay debris flushing, checking gate operation, gate maintenance, and all other maintenance that would require spill. The Federal Energy Regulatory Commission requires that all spillway gates be operated once per year. This operation requires a minimal amount of spill for a short duration annually and is generally accomplished in conjunction with fish passage spill operations.

To control TDG levels that may result from maintenance spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Error in Communication Spill

Error in communication with the USACE Reservoir Control Center, including computer malfunctions or human error in transmitting proper data, can contribute to spill. Hourly coordination between hydroelectric projects on the river minimizes this type of spill, but it does occur occasionally.

To control TDG levels that may result from error in communication spill, Chelan PUD will implement the TDG Operational Plan (Appendix B). Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

Reduced Generation Spill

Reduced electric demand on the system can, at times, result in the need to spill water at run-of-the river projects such as Rock Island. Hourly coordination between hydroelectric projects on the river can minimize this type of spill, but it does occur.

To control TDG levels that may result from reduced generation spill, Chelan PUD will implement the TDG Operational Plan (Appendix B), when possible. Chelan PUD anticipates implementation of the TDG Operational Plan to be an operational function, requiring no structural modification to the Project.

1.5 Spill and Total Dissolved Gas Compliance - Previous Year 2014

1.5.1 TDG Compliance 2014

Information regarding spill and TDG are for 2014 are displayed in Tables 1-2 and 1-3 and further described below.

Tailrace 120 percent Standard

TDG data was collected on 146 days during the 2014 fish spill season in the Rock Island tailrace. No days were omitted from the data set used for determination of compliance due to flows exceeding the 7Q10 flows. The tailrace 12C-High TDG exceeded 120 percent on 7 days.
Compliance with this standard was 95.2 percent.

Tailrace 125 percent Standard

Total hours of TDG data collected during the 2014 fish spill season in the Rock Island tailrace equaled 3,654. No hours were omitted from the data set due to flows in exceedance of the 7Q10 flow. Hourly tailrace TDG levels exceeded 125 percent for 0 hours.
Compliance with this standard was 100 percent.

Downstream (Wanapum) Forebay 115 percent Standard

TDG data was collected on 153 days during the 2014 fish spill season in the Wanapum forebay. However, of those 153 days 5 were omitted from the data set used for determination of compliance due upstream forebay 12C-High TDG exceeding 115 percent. The Wanapum forebay 12C-High TDG exceeded 115 percent on 24 days. Compliance with this standard was 84.3 percent.

Table 1-2: Summary of Spill at the Rock Island Project in 2014

Date	Fish Spill Average kcfs	Total Spill Average kcfs	River Flow Average kcfs	% Total Spill	% Fish Spill of total River	% Fish spill of Total Spill
4/1 – 8/31	23.5	31.6	156.2	20.2	15.0	74.4

Table 1-3: Summary of TDG Compliance at the Rock Island Project in 2014

Date	% Compliance with 120% Tailrace Standard	% Compliance with 125% Tailrace Standard	% Compliance with 115% Downstream Forebay TDG Standard
4/1 – 8/31	95.2	100	84.3

1.5.2 TDG Activities Implemented in 2014

In 2014 Chelan PUD implemented five actions to minimize voluntary and involuntary spill at Rock Island in order to meet TDG water quality standards. The primary operational action to reduce spill at the Rock Island Project was the implementation of the operational spill programs and the ability to minimize spill through success of survival studies. These efforts included:

- Minimizing voluntary spill.
- During fish passage, managing voluntary spill levels in real time to meet TDG numeric criteria.
- Minimizing spill, to the extent practicable, by scheduling maintenance based on predicted flows.
- Avoiding spill by continuing to participate in the Hourly Coordination Agreement.
- Maximizing powerhouse discharge as appropriate up to hydraulic capacity.

1.5.3 TDG Structural Measures Implemented in 2014

No structural gas abatement measures were proposed or constructed in 2014. However, Chelan PUD continues to utilize the over/under gates that were installed in 2007 to reduce TDG generation at the Project.

SECTION 2: PROPOSED 2015 ACTION PLAN TO ACHIEVE TDG STANDARDS

The following sections describe TDG abatement measures proposed for implementation during 2015 to achieve compliance with TDG water quality standards.

2.1 Operational TDG Abatement Measures

Chelan PUD will manage spill toward meeting water quality criteria for TDG during all flows below 7Q10 levels, but only to the extent consistent with meeting the passage and survival standards sets forth in the HCP and associated Anadromous Fish Agreement. During the 2015 fish spill season, Chelan PUD proposes to use a combination of the following measures as needed to meet water quality criteria for TDG:

1. Minimize voluntary spill

   Success of the survival studies have allowed Chelan PUD to reduce spring spill required for fish passage.

2. Manage voluntary spill in real time

   During fish passage, manage voluntary spill levels in real time in an effort to continue meeting TDG numeric criteria,

3. Minimize involuntary spill

   Minimize involuntary spill, to the extent practicable, by scheduling maintenance based on predicted flows.

4. Participate in Hourly Coordination Agreement

   Chelan PUD endeavors to avoid involuntary spill by continuing to participate in the Hourly Coordination Agreement, or any successor agreement to which Chelan PUD is a party, to the extent it reduces TDG.

5. Maximize powerhouse discharge as appropriate up to hydraulic capacity

Operational and structural changes that may affect TDG must be subject to review and approval by Ecology during the design and development phase to assure that such changes incorporate consideration of TDG abatement, when appropriate.

2.2 Proposed Structural TDG Abatement Measures and Technologies

No structural gas abatement measures are planned at the Rock Island Project in 2015. Chelan PUD will continue to monitor and investigate the feasibility of implementing new technologies as they become available.

SECTION 3: PHYSICAL AND BIOLOGICAL MONITORING AND QUALITY ASSURANCE

The following sections describe Chelan PUD's TDG compliance monitoring program. The program includes a fixed-site monitoring program and a quality assurance protection plan.

3.1 Fixed-Site Monitoring Stations for TDG

Chelan PUD currently maintains two fixed monitoring stations (FMS) at the Rock Island Project to monitor hourly TDG levels annually from April through August. The fixed monitoring stations are installed to a depth of approximately 15 feet. This depth varies as the forebay and tailrace river elevations fluctuate with river flows. This depth variation is not expected to affect the accuracy of the TDG readings because the instruments are located below the depth where gas bubbles form on the membrane and are deep enough in the water column to not be affected by near surface temperature gradients.

The Rock Island forebay fixed monitoring station (Figure 3-1) is affixed to the Project, located on the west side of the river, near the right bank fishway and Powerhouse 2, approximately 70 feet from the shore. The standpipe is installed to a depth of approximately 15 feet, though this depth varies as the forebay river elevation fluctuates with river flows and project operations. The site was chosen based on accessibility and is thought be representative of forebay TDG because water is as well mixed and flow is as constant as at any other location in the forebay. No bridge or other permanent in-water structure is available downriver of Rock Island Project on which to attach a monitoring station. For this reason, Chelan PUD developed a monitoring station about 1.5 miles downriver from the Project on the eastern shoreline (Figure 3-2). This FMS has two means of deploying the dissolved gas probe, a carriage system with a cable attached to an ecology block in the river, and a fixed pipe attached to the scaffold that holds the carriage system.

Chelan PUD has entered into a Professional Services Agreement with Columbia Basin Environmental (CBE) to perform calibrations and equipment maintenance during the 2015 monitoring season. Calibration and equipment maintenance will be conducted monthly during the fish spill season, and every other month during the non-fish spill season. It is anticipated at this time that Chelan PUD will continue to contract with CBE into the future. QA/QC measures will be accomplished through training in instrument maintenance, operation, and factory prescribed calibration methods. A detailed log will be 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 will be conducted during the calibrations.

Figure 3-1: Location of forebay fixed monitoring station at Rock Island Hydroelectric Project.

Figure 3-2: Location of tailrace fixed monitoring station below Rock Island Hydroelectric Project.

3.1.1 Fish Spill Season (April 1 – August 31)

TDG measurements will be recorded throughout the fish spill season at 15-minute intervals, enabling plant operators to adjust spill volumes to maintain gas levels to prevent exceedances of the TDG criteria. These 15-minute intervals will be averaged into hourly readings for use in compiling daily and 12-hour averages. Beginning on April 1 all hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.1.2 Non-Fish Spill Season (September 1 – March 31)

TDG measurements will also be recorded throughout the non-fish spill season at 15-minute intervals. These 15-minute intervals will be averaged into hourly readings for use in determining daily high TDG levels. All hourly data will be forwarded to Chelan PUD headquarters building and then onto the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

3.2 Quality Assurance

Chelan PUD has developed its Quality Assurance/Quality Control (QA/QC) protocols following established protocols by other resource agencies conducting similar monitoring programs, such as the USGS, USACE, and other mid-Columbia River Dam operators, as well as HydroLab Corporation's recommendations. These QA/QC protocols are included in Chelan PUD's Quality Assurance Project Plan (Appendix D) per Section 5.7(2) of the Rocky Reach 401 Certification.

3.3 Biological (Gas Bubble Trauma) Monitoring Plan

Chelan PUD, in conjunction with the Fish Passage Center (FPC), will continue to conduct GBT monitoring at the Rock Island Bypass Trap. Random samples of 100 spring chinook, steelhead and subyearling chinook will be examined two days per week during the sampling season (April 1 to August 31). Examinations for GBT symptoms will follow a standardized FPC protocol (FPC, 2009). he results of this monitoring effort will be included in the Gas Abatement Annual Report (see Section 4.3 below).

SECTION 4: TDG COMPLIANCE REPORTING METHODS

4.1 Water Quality Web-Site

TDG information will be made available to the public via Chelan PUD's website, as close to the time of occurrence as technologically feasible. Chelan PUD has added a link to the website to direct the public to the USACE Reservoir Control Center at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/, where the data is posted on a nearly hourly basis.

4.2 Notifications

Chelan PUD shall notify Ecology, Central Regional Office, Water Quality Program within 48 hours (either before or after) of any TDG spill; this includes the start of spill for fish, as defined in Section 1.2.1, and any deviation from the TDG Operational Plan or the fish spill plan that adversely affects TDG levels. This notification may be either electronic or by letter.

4.3 Gas Abatement Annual Report

Chelan PUD will provide Ecology with a draft TDG annual monitoring report by October 31 of each year for initial review and comment. Chelan PUD will submit the final report by December 31 of that same year. The TDG Annual Monitoring Report will include:

- Flow over the preceding year (cfs over time);
- Spill over the preceding year (cfs and duration);
- Reasons for spill (e.g. for fish, turbine down time);
- TDG levels during spill (hourly)(to include fish spill season and non-fish spill season);
- Summary of exceedances and what was done to correct the exceedances;
- Results of the fish passage efficiency (FPE) studies and survival per the HCP;
- Result of biological monitoring (GBT) at Rock Island Bypass Trap (conducted in conjunction with the Fish Passage Center);
- Results of QA/QC implementation

SECTION 5: UPDATES TO THE GAS ABATEMENT PLAN

Consistent with WAC 173-201A-200(1)(f)(ii), the GAP will be revised annually, to reflect any new or improved information and technologies, and submitted to Ecology for review and approval, by April 1 of the year of implementation.

SECTION 6: CONCLUSIONS

Pending approval by Ecology, implementation of the measures presented in this 2015 GAP are intended to ensure compliance with the Washington state water quality standards for TDG in the Columbia River at the Rock Island Project during the fish spill season while continuing to meet the fish passage and survival standards set forth in the Rock Island HCP and Anadromous Fish Agreement. This GAP will be updated annually to reflect any changes in implementation schedules, new or improved technologies, or TDG abatement measures.

SECTION 7: LITERATURE CITED

Fish Passage Center (FPC). 2009. GBT monitoring program protocol for juvenile salmonids. FPC, Portland, OR.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Pickett, P.J., H. Rueda, and M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Prepared jointly by the U.S. Environmental Protection Agency and the Washington State Department of Ecology in cooperation with the Spokane Tribe of Indians. Ecology Publication Number 04-03-002. June 2004.

Washington State Department of Ecology (Ecology). 2006. Section 401 Water Quality Certification for the Rocky Reach Hydroelectric Project. Order# 3155 dated March 17, 2006.

APPENDIX A: ROCK ISLAND HABITAT CONSERVATION PLAN

The Rock Island Habitat Conservation Plan can be found at:
http://www.midcolumbiahcp.org/RI_HCP.pdf)

APPENDIX B: 2015 ROCK ISLAND TDG OPERATIONAL PLAN

2015 Rock Island TDG Operational Plan

During Fish Spill Season (April 1 through 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%, reopen notched gates in the reverse order of closure**

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

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

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

4. If it becomes necessary to implement any further actions to attain TDG compliance, **please contact Thad Mosey (661-4451, cell 670-5594) and Marcie Steinmetz (661-4186, cell (509) 280-1955) immediately** so they can determine the next steps to take.

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

APPENDIX C: 2010 QUALITY ASSURANCE PROJECT PLAN

Rocky Reach Water Quality Monitoring and Reporting

The 2010 Quality Assurance Project Plan can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/33937.pdf

APPENDIX D: 2014 GAS ABATEMENT ANNUAL REPORT

The 2014 Gas Abatement Annual Report can be found at:
http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/43948.pdf

APPENDIX E: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rock Island on February 13, 2015 for review and comment. On March 13, 2015, Ecology sent Chelan PUD an email stating that they had reviewed and approved the Gas Abatement Plan. Both emails are included below.

From:	Steinmetz, Marcie
To:	"McKinney, Charlie (ECY)"; "Coffin, Chris (ECY)"
Cc:	Smith, Michelle; Osborn, Jeff; Sokolowski, Rosana; Bitterman, Deborah
Subject:	Draft 2015 Gas Abatement Plans for Rocky Reach and Rock Island dams
Date:	Friday, February 13, 2015 10:34:00 AM
Attachments:	44505 DRAFT 2015 Rocky Reach GAP 021015.docx 44506 DRAFT 2015 Rock Island GAP 021015.docx

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PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
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To: Chris Coffin, Washington Department of Ecology
Charlie McKinney, Washington Department of Ecology

From: Marcie Steinmetz, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: Rocky Reach Hydroelectric Project No. 2145 and Rock Island Hydroelectric Project No. 943
DRAFT 2015 Total Dissolved Gas Abatement Plans

Please find attached the 2015 DRAFT Rocky Reach and Rock Island Total Dissolved Gas Abatement Plans for your review. Please submit your comments on or before 5:00 p.m., March 13, 2015 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | Water Resource Specialist
Chelan County Public Utility District No.1 | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

From:	McKinney, Charlie (ECY)
To:	Steinmetz, Marcie
Cc:	Coffin, Chris (ECY)
Subject:	Approvals for GAPS & OPS Plan
Date:	Friday, March 13, 2015 9:55:49 AM
Importance:	High

March 13, 2015

To: Marcie Steinmetz, Chelan PUD No. 1

From: Charles McKinney, WA Dept. of Ecology, Water Quality Program

The WA Department of Ecology (Ecology) has reviewed and approves the **Draft 2015 Total Dissolved Gas Abatement Plans submitted by Chelan PUD for the Rocky Reach and Rock Island Projects.**
Ecology has also reviewed and approves the **Draft 2015 Operations Plan for the Rocky Reach Project.**

Ecology grants Chelan PUD an adjustment to the 110% TDG standard for the purposes of the 2015 Spill Season, as authorized under WAC 173-201A-200(1)(f)(ii), in order to facilitate the passage of ESA listed salmonids at the Project.

Thank you for your cooperation. Please let me know if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX H: COMMENTS

From: McKinney, Charlie (ECY)
To: Steinmetz, Marcie
Cc: Peterschmidt, Mark F. (ECY)
Subject: RE: DRAFT 2015 Total Dissolved Gas Annual Report
Date: Wednesday, November 25, 2015 12:16:13 PM

November 25, 2015

To: Marcie Steinmetz, Public Utility District No. 1 of Chelan County

From: Charlie McKinney, WA Department of Ecology

Thank you for the Draft 2015 Total Dissolved Gas Annual Report for the Rocky Reach (FERC Proj. No. 2145) and Rock Island (FERC Proj. No. 943) Hydroelectric Projects. Ecology has reviewed the Report and hereby gives our approval. We have determined that this Report complies with the requirement in the Section 401 Water Quality Certifications for these projects.

Please contact me if you have any questions.

Charlie McKinney
Water Quality Section Manager
Central Region Office, Yakima
Washington Dept. of Ecology
509-457-7107

APPENDIX E: RESPONSE TO COMMENTS

Ecology was sent a Draft Gas Abatement Plan for Rock Island on February 26, 2016 for review and comment. In an email to Chelan PUD dated March 25, 2016, Ecology stated that they did not have any comments or questions regarding the Rock Island Total Dissolved Gas Abatement Plan.

From: Peterschmidt, Mark F. (ECY)
To: Steinmetz, Marcie
Cc: Bowen, David (ECY); Brown, Chad (ECY)
Subject: RE: DRAFT 2016 Gas Abatement Plans for Rocky Reach and Rock Island
Date: Friday, March 25, 2016 4:46:28 PM

March 25, 2016

To: Marcie Steinmetz, Public Utility District No. 1 of Chelan County

From: Mark Peterschmidt, WA Department of Ecology

Thank you for the Draft 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach (FERC Project No. 2145) and Rock Island (FERC Project No. 943) Hydroelectric Projects. I have reviewed these plans and have no questions of comments to make.
Please contact me if you have any questions.

Mark Peterschmidt
Watershed Unit Supervisor
Water Quality Program, Central Region
509.454.7843 Desk
509.731.7252 Cell

Ecology's Central Regional Office has moved to a new location. The new address is:
1250 W. Alder Street, Union Gap, WA 98903.

From: Steinmetz, Marcie [mailto:Marcie.Steinmetz@chelanpud.org]
Sent: Friday, February 26, 2016 3:47 PM
To: McKinney, Charlie (ECY); Peterschmidt, Mark F. (ECY)
Cc: Smith, Michelle; Sokolowski, Rosana; Bitterman, Deborah; Osborn, Jeff; Steinmetz, Marcie
Subject: DRAFT 2016 Gas Abatement Plans for Rocky Reach and Rock Island

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To: Charlie McKinney, Washington State Department of Ecology

Mark Peterschmidt, Washington State Department of Ecology

From: Marcie Steinmetz, Water Resource Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: DRAFT 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach and Rock Island projects

Mr. McKinney and Mr. Peterschmidt:

Attached for your review and comment are the DRAFT 2016 Total Dissolved Gas Abatement Plans for the Rocky Reach and Rock Island projects.
Please review and submit any comments you may have on or before 5:00 p.m. March 28, 2016 to me via email at marcie.steinmetz@chelanpud.org.

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

Thank you,

Marcie Steinmetz | **Water Resource Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c)| marcie.steinmetz@chelanpud.org

APPENDIX H: COMMENTS

Ecology was sent a Draft Total Dissolved Gas Annual Report for Rocky Reach and Rock Island on January 19, 2017 for review and comment. On February 28, 2017, Ecology sent Chelan PUD an email stating that they had no comments and had approved the Gas Abatement Plan. Both emails are included.

From:	Zimmerman, Breean (ECY)
To:	Clement, Marcie
Cc:	Bitterman, Deborah; Sokolowski, Rosana; Osborn, Jeff; Smith, Michelle; Peterschmidt, Mark F. (ECY)
Subject:	RE: DRAFT 2016 Total Dissolved Gas Annual Report
Date:	Tuesday, February 28, 2017 4:05:48 PM

Marcie,

Thank you for providing the Draft 2016 Total Dissolved Gas Annual Report. Ecology has **no comments** to this draft report. Your coordination is much appreciated.

Breean Zimmerman | **Hydropower Projects Manager**
Water Quality Program | Central Regional Office
(509) 575-2808 (w) | (509) 406-5130 (c) | bzim461@ecy.wa.gov

From: Clement, Marcie [mailto:Marcie.Clement@chelanpud.org]
Sent: Thursday, January 19, 2017 9:46 AM
To: Zimmerman, Breean (ECY) <bzim461@ECY.WA.GOV>
Cc: Bitterman, Deborah <Deborah.Bitterman@chelanpud.org>; Sokolowski, Rosana <Rosana.Sokolowski@chelanpud.org>; Osborn, Jeff <Jeff.Osborn@chelanpud.org>; Smith, Michelle <michelle.smith@chelanpud.org>; Peterschmidt, Mark F. (ECY) <MAPE461@ECY.WA.GOV>
Subject: DRAFT 2016 Total Dissolved Gas Annual Report

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To: Breean Zimmerman, Hydropower Projects Manager
Water Quality Program, Central Regional Office

From: Marcie Clement, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: DRAFT 2016 Total Dissolved Gas Annual Report for Rocky Reach and Rock Island Hydroelectric Projects

Ms. Zimmerman:

Attached for your review and comment are the DRAFT 2016 Total Dissolved Gas Annual Report and

Appendices for Rocky Reach and Rock Island Hydroelectric Projects. Please note Appendix F and G; Rocky Reach and Rock Island Gas Abatement Plans, are not attached to this email as they are too large to send and have previously been sent to Ecology.

Please review and submit any comments you may have on or before 5:00 p.m. February 20, 2016 to me via email at marcie.clement@chelanpud.org.

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

Thank you,

Marcie Clement | **Water Resources Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c) | marcie.clement@chelanpud.org

APPENDIX C: 2016 TOTAL DISSOLVED GAS DATA (NON-FISH SPILL PERIOD)

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
1-Jan-16	94.3	95.4
2-Jan-16	94.7	95.8
3-Jan-16	95.5	96.7
4-Jan-16	96.1	96.9
5-Jan-16	96.2	97.0
6-Jan-16	96.0	96.8
7-Jan-16	95.7	96.5
8-Jan-16	95.1	96.4
9-Jan-16	94.9	96.3
10-Jan-16	94.5	95.8
11-Jan-16	94.8	96.1
12-Jan-16	96.4	97.5
13-Jan-16	96.9	97.9
14-Jan-16	96.2	97.3
15-Jan-16	96.0	97.1
16-Jan-16	96.3	97.0
17-Jan-16	96.4	97.1
18-Jan-16	96.1	96.7
19-Jan-16	96.9	101.5
20-Jan-16	96.5	102.4
21-Jan-16	96.7	97.6
22-Jan-16	97.2	98.5
23-Jan-16	97.5	98.5
24-Jan-16	97.0	97.5
25-Jan-16	96.1	103.4
26-Jan-16	96.4	97.4
27-Jan-16	97.2	98.2
28-Jan-16	97.9	98.9
29-Jan-16	98.3	99.3
30-Jan-16	97.9	98.9
31-Jan-16	97.3	98.3
1-Feb-16	96.8	97.8
2-Feb-16	96.5	97.5
3-Feb-16	96.6	97.6
4-Feb-16	96.5	97.6

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
5-Feb-16	97.2	98.1
6-Feb-16	97.1	98.0
7-Feb-16	96.3	97.2
8-Feb-16	96.6	97.6
9-Feb-16	97.7	98.7
10-Feb-16	97.9	98.8
11-Feb-16	98.3	99.3
12-Feb-16	98.9	99.9
13-Feb-16	99.3	100.1
14-Feb-16	99.5	100.4
15-Feb-16	99.8	100.6
16-Feb-16	99.9	100.8
17-Feb-16	101.9	102.2
18-Feb-16	102.0	102.6
19-Feb-16	100.5	101.3
20-Feb-16	99.3	100.6
21-Feb-16	98.8	99.6
22-Feb-16	98.6	99.4
23-Feb-16	99.1	99.9
24-Feb-16	99.0	99.8
25-Feb-16	99.1	100.0
26-Feb-16	100.7	101.4
27-Feb-16	100.7	101.5
28-Feb-16	101.2	101.9
29-Feb-16	100.1	100.8
1-Mar-16	102.4	103.3
2-Mar-16	100.7	101.6
3-Mar-16	100.6	101.5
4-Mar-16	101.7	102.4
5-Mar-16	103.1	103.8
6-Mar-16	103.3	104.0
7-Mar-16	101.9	102.6
8-Mar-16	101.4	102.1
9-Mar-16	102.0	102.7
10-Mar-16	102.1	103.0
11-Mar-16	102.1	102.8
12-Mar-16	102.2	102.9
13-Mar-16	102.6	103.2
14-Mar-16	101.9	115.0

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
15-Mar-16	100.5	118.4
16-Mar-16	100.7	108.6
17-Mar-16	100.6	113.9
18-Mar-16	101.3	102.2
19-Mar-16	103.4	104.1
20-Mar-16	103.0	103.7
21-Mar-16	103.8	104.4
22-Mar-16	103.5	104.5
23-Mar-16	103.0	103.6
24-Mar-16	103.1	103.7
25-Mar-16	103.1	103.7
26-Mar-16	103.9	104.4
27-Mar-16	104.3	104.7
28-Mar-16	103.9	104.4
29-Mar-16	103.9	104.4
30-Mar-16	104.0	104.5
31-Mar-16	104.0	104.5
1-Sep-16	103.1	103.0
2-Sep-16	102.8	102.7
3-Sep-16	102.2	102.0
4-Sep-16	102.3	102.0
5-Sep-16	102.9	102.2
6-Sep-16	103.3	102.0
7-Sep-16	102.9	102.3
8-Sep-16	102.3	101.9
9-Sep-16	101.0	101.1
10-Sep-16	103.0	102.2
11-Sep-16	103.1	102.1
12-Sep-16	102.6	102.0
13-Sep-16	103.3	102.7
14-Sep-16	102.8	102.9
15-Sep-16	103.1	102.5
16-Sep-16	102.9	102.6
17-Sep-16	103.1	102.7
18-Sep-16	102.4	102.1
19-Sep-16	101.1	101.2
20-Sep-16	100.6	100.9
21-Sep-16	101.3	101.4
22-Sep-16	101.5	101.1

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
23-Sep-16	100.8	100.7
24-Sep-16	99.8	99.7
25-Sep-16	100.0	99.7
26-Sep-16	100.9	100.8
27-Sep-16	101.3	100.9
28-Sep-16	101.0	101.0
29-Sep-16	101.4	101.2
30-Sep-16	101.4	101.4
1-Oct-16	101.0	100.7
2-Oct-16	100.5	100.7
3-Oct-16	100.4	100.6
4-Oct-16	100.3	100.2
5-Oct-16	99.8	99.6
6-Oct-16	99.0	99.4
7-Oct-16	99.2	99.1
8-Oct-16	99.2	99.5
9-Oct-16	99.1	99.2
10-Oct-16	98.6	99.0
11-Oct-16	97.5	97.7
12-Oct-16	97.9	98.5
13-Oct-16	99.9	100.6
14-Oct-16	100.0	102.1
15-Oct-16	99.6	99.9
16-Oct-16	99.1	99.4
17-Oct-16	99.0	99.4
18-Oct-16	97.2	97.8
19-Oct-16	96.5	97.0
20-Oct-16	97.0	97.7
21-Oct-16	97.3	97.9
22-Oct-16	97.3	97.9
23-Oct-16	97.6	98.2
24-Oct-16	98.2	98.8
25-Oct-16	98.1	98.7
26-Oct-16	97.7	98.3
27-Oct-16	97.8	98.4
28-Oct-16	97.3	97.6
29-Oct-16	97.0	97.8
30-Oct-16	98.2	98.8
31-Oct-16	98.1	103.8

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
1-Nov-16	97.3	101.1
2-Nov-16	96.3	97.0
3-Nov-16	95.9	96.7
4-Nov-16	96.7	97.3
5-Nov-16	97.6	98.2
6-Nov-16	97.4	98.1
7-Nov-16	96.4	108.9
8-Nov-16	96.4	111.1
9-Nov-16	96.7	108.0
10-Nov-16	96.8	105.7
11-Nov-16	97.5	98.1
12-Nov-16	97.6	98.5
13-Nov-16	96.9	97.6
14-Nov-16	97.1	101.9
15-Nov-16	97.8	100.9
16-Nov-16	97.5	97.5
17-Nov-16	96.5	96.7
18-Nov-16	96.6	97.5
19-Nov-16	96.9	97.7
20-Nov-16	97.1	97.9
21-Nov-16	96.9	97.6
22-Nov-16	96.5	97.2
23-Nov-16	96.6	97.4
24-Nov-16	97.3	97.7
25-Nov-16	97.2	97.7
26-Nov-16	98.3	99.0
27-Nov-16	98.1	98.8
28-Nov-16	98.1	113.4
29-Nov-16	96.1	113.8
30-Nov-16	96.5	114.1
1-Dec-16	96.1	112.3
2-Dec-16	96.0	114.1
3-Dec-16	96.3	98.4
4-Dec-16	96.7	97.2
5-Dec-16	96.0	109.7
6-Dec-16	96.0	97.8
7-Dec-16	94.7	95.0
8-Dec-16	95.2	109.5
9-Dec-16	96.0	112.8

Daily Maximums		
Date	Rocky Reach Tailrace	Rock Island Forebay
10-Dec-16	96.2	96.8
11-Dec-16	95.7	96.2
12-Dec-16	95.3	95.6
13-Dec-16	94.4	94.8
14-Dec-16	95.4	95.7
15-Dec-16	95.5	95.9
16-Dec-16	95.2	104.7
17-Dec-16	93.9	94.9
18-Dec-16	93.7	94.0
19-Dec-16	94.5	95.7
20-Dec-16	95.1	95.5
21-Dec-16	94.7	109.7
22-Dec-16	96.1	96.3
23-Dec-16	96.7	97.0
24-Dec-16	96.3	96.6
25-Dec-16	95.3	105.1
26-Dec-16	95.0	97.2
27-Dec-16	95.4	95.8
28-Dec-16	94.8	102.3
29-Dec-16	95.5	98.9
30-Dec-16	95.8	96.2
31-Dec-16	96.6	96.8

APPENDIX D: 2016 DAILY MAXIMUM TEMPERATURE AND 7-DADMAX TEMPERATURES

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
1-Apr	6.900	6.900	6.900				
2-Apr	7.000	7.400	7.200				
3-Apr	7.200	7.400	7.400				
4-Apr	7.200	7.600	7.500				
5-Apr	7.000	8.100	8.500				
6-Apr	7.000	7.400	7.500				
7-Apr	7.100	7.500	7.500		7.057	7.471	7.500
8-Apr	7.500	7.500	7.500		7.143	7.557	7.586
9-Apr	7.600	7.800	7.800		7.229	7.614	7.671
10-Apr	7.800	8.000	8.000		7.314	7.700	7.757
11-Apr	7.900	8.100	8.100		7.414	7.771	7.843
12-Apr	7.900	8.200	8.300		7.543	7.786	7.814
13-Apr	7.600	8.300	8.300		7.629	7.914	7.929
14-Apr	7.600	8.100	8.100		7.700	8.000	8.014
15-Apr	7.600	7.900	7.900		7.714	8.057	8.071
16-Apr	7.800	8.000	8.000		7.743	8.086	8.100
17-Apr	8.200	8.100	8.200		7.800	8.100	8.129
18-Apr	8.500	8.500	8.600		7.886	8.157	8.200
19-Apr	8.700	8.800	8.900		8.000	8.243	8.286
20-Apr	9.000	9.100	9.100		8.200	8.357	8.400
21-Apr	9.100	9.300	9.300		8.414	8.529	8.571
22-Apr	9.200	9.400	9.500		8.643	8.743	8.800
23-Apr	9.300	9.700	9.600		8.857	8.986	9.029
24-Apr	9.400	9.700	9.700		9.029	9.214	9.243
25-Apr	9.400	9.800	9.800		9.157	9.400	9.414
26-Apr	9.600	9.800	9.800		9.286	9.543	9.543
27-Apr	9.800	9.900	10.000		9.400	9.657	9.671
28-Apr	9.900	10.200	10.100		9.514	9.786	9.786
29-Apr	10.200	10.400	10.300		9.657	9.929	9.900
30-Apr	10.500	10.700	10.700		9.829	10.071	10.057
1-May	10.700	10.900	10.900		10.014	10.243	10.229
2-May	10.800	11.200	11.200		10.214	10.443	10.429
3-May	11.100	11.400	12.500		10.429	10.671	10.814
4-May	11.300	11.500	11.600		10.643	10.900	11.043
5-May	11.200	11.600	11.700		10.829	11.100	11.271
6-May	11.300	11.800	11.800		10.986	11.300	11.486
7-May	11.600	12.000	11.900		11.143	11.486	11.657
8-May	11.700	12.300	12.200		11.286	11.686	11.843
9-May	11.600	12.200	12.200		11.400	11.829	11.986

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
10-May	11.600	12.200	12.200		11.471	11.943	11.943
11-May	11.800	12.100	12.100		11.543	12.029	12.014
12-May	11.400	12.400	12.400		11.571	12.143	12.114
13-May	12.000	12.200	12.200		11.671	12.200	12.171
14-May	12.400	12.200	12.200		11.786	12.229	12.214
15-May	12.200	12.500	12.500		11.857	12.257	12.257
16-May	12.500	12.600	12.600		11.986	12.314	12.314
17-May	13.000	12.900	12.900		12.186	12.414	12.414
18-May	12.800	13.300	13.300		12.329	12.586	12.586
19-May	12.800	13.300	13.300		12.529	12.714	12.714
20-May	12.600	13.200	13.200		12.614	12.857	12.857
21-May	13.000	13.000	12.900		12.700	12.971	12.957
22-May	13.100	13.500	13.100		12.829	13.114	13.043
23-May	13.000	13.400	13.400		12.900	13.229	13.157
24-May	12.700	13.400	13.400		12.857	13.300	13.229
25-May	13.000	13.300	13.300		12.886	13.300	13.229
26-May	13.200	13.400			12.943	13.314	13.217
27-May	13.200	13.500	13.500		13.029	13.357	13.267
28-May	13.400	13.400	13.500		13.086	13.414	13.367
29-May	13.600	14.000	13.800		13.157	13.486	13.483
30-May	13.900	14.000	14.000		13.286	13.571	13.583
31-May	13.900	14.200	14.200		13.457	13.686	13.717
1-Jun	13.900	14.300	14.300		13.586	13.829	13.883
2-Jun	14.000	14.300	14.300		13.700	13.957	13.943
3-Jun	14.100	14.600	14.500		13.829	14.114	14.086
4-Jun	14.700	14.700	14.700		14.014	14.300	14.257
5-Jun	14.800	15.100	15.200		14.186	14.457	14.457
6-Jun	14.600	15.600	15.500		14.286	14.686	14.671
7-Jun	15.000	15.400	15.400		14.443	14.857	14.843
8-Jun	15.100	15.600	15.600		14.614	15.043	15.029
9-Jun	15.000	15.600	15.700		14.757	15.229	15.229
10-Jun	15.000	15.600	15.700		14.886	15.371	15.400
11-Jun	14.800	15.500	15.500		14.900	15.486	15.514
12-Jun	14.700	15.300	15.400		14.886	15.514	15.543
13-Jun	14.700	15.200	15.200		14.900	15.457	15.500
14-Jun	14.700	15.100	15.100		14.857	15.414	15.457
15-Jun	14.500	14.800	14.900		14.771	15.300	15.357
16-Jun	14.900	14.800	14.800		14.757	15.186	15.229
17-Jun	14.600	15.000	14.900		14.700	15.100	15.114

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
18-Jun	14.400	15.000	15.000		14.643	15.029	15.043
19-Jun	14.500	14.900	14.800		14.614	14.971	14.957
20-Jun	14.900	14.800	14.900		14.643	14.914	14.914
21-Jun	15.200	15.200	15.200		14.714	14.929	14.929
22-Jun	15.200	15.600	15.600		14.814	15.043	15.029
23-Jun	15.700	15.700	15.700		14.929	15.171	15.157
24-Jun	15.600	15.900	15.900		15.071	15.300	15.300
25-Jun	15.600	16.000	15.900		15.243	15.443	15.429
26-Jun	15.900	16.100	16.100		15.443	15.614	15.614
27-Jun	16.000	16.400	16.400		15.600	15.843	15.829
28-Jun	16.400	16.600	16.600		15.771	16.043	16.029
29-Jun	16.600	16.900	16.900		15.971	16.229	16.214
30-Jun	16.600	17.200	17.200		16.100	16.443	16.429
1-Jul	16.600	17.300	17.300		16.243	16.643	16.629
2-Jul	16.600	17.400	17.200		16.386	16.843	16.814
3-Jul	16.900	17.300	17.300		16.529	17.014	16.986
4-Jul	16.700	17.100	17.100		16.629	17.114	17.086
5-Jul	16.800	17.200	17.100		16.686	17.200	17.157
6-Jul	16.600	17.100	17.100		16.686	17.229	17.186
7-Jul	16.200	17.100	17.100		16.629	17.214	17.171
8-Jul	15.900	16.900	17.000		16.529	17.157	17.129
9-Jul	16.200	16.800	16.700		16.471	17.071	17.057
10-Jul	16.500	16.700	16.500		16.414	16.986	16.943
11-Jul	16.800	16.700	16.600		16.429	16.929	16.871
12-Jul	16.900	17.400	16.800		16.443	16.957	16.829
13-Jul	16.900	17.300	17.200		16.486	16.986	16.843
14-Jul	16.800	17.400	17.300		16.571	17.029	16.871
15-Jul	17.000	17.500	17.400		16.729	17.114	16.929
16-Jul	17.100	17.300	17.300		16.857	17.186	17.014
17-Jul	17.200	17.300	17.300		16.957	17.271	17.129
18-Jul	17.100	17.300	17.400		17.000	17.357	17.243
19-Jul	16.900	17.400	17.400		17.000	17.357	17.329
20-Jul	17.200	17.500	17.400		17.043	17.386	17.357
21-Jul	17.700	18.100	17.500		17.171	17.486	17.386
22-Jul	17.400	18.000	17.700		17.229	17.557	17.429
23-Jul	17.300	18.200	18.000		17.257	17.686	17.529
24-Jul	17.300	18.500	18.100		17.271	17.857	17.643
25-Jul	18.400	18.400	18.300		17.457	18.014	17.771
26-Jul	18.000	18.700	18.600		17.614	18.200	17.943

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
27-Jul	18.000	18.900	18.800		17.729	18.400	18.143
28-Jul	17.900	18.700	18.800		17.757	18.486	18.329
29-Jul	18.500	18.700	18.600		17.914	18.586	18.457
30-Jul	18.800	18.800	18.700		18.129	18.671	18.557
31-Jul	18.900	19.100	19.000		18.357	18.757	18.686
1-Aug	18.900	19.400	19.200		18.429	18.900	18.814
2-Aug	18.800	19.300	19.200		18.543	18.986	18.900
3-Aug	18.500				18.614	19.000	18.917
4-Aug	18.400	19.100	19.100		18.686	19.067	18.967
5-Aug	18.600	19.000	19.000		18.700	19.117	19.033
6-Aug	18.600	18.800	18.800		18.671	19.117	19.050
7-Aug	18.500	19.100	18.900		18.614	19.117	19.033
8-Aug	18.400	18.800	18.800		18.543	19.017	18.967
9-Aug	18.500	18.700	18.700		18.500	18.917	18.883
10-Aug	18.500	18.800	18.700		18.500	18.900	18.857
11-Aug	18.500	19.000	19.000		18.514	18.886	18.843
12-Aug	18.800	19.400	19.100		18.543	18.943	18.857
13-Aug	18.900	19.200	19.000		18.586	19.000	18.886
14-Aug	19.100	19.500	19.400		18.671	19.057	18.957
15-Aug	19.300	19.500	19.400		18.800	19.157	19.043
16-Aug	19.300	19.600	19.500		18.914	19.286	19.157
17-Aug	19.400	20.000	19.700		19.043	19.457	19.300
18-Aug	19.300	19.900	19.700		19.157	19.586	19.400
19-Aug	19.400	19.700	19.700		19.243	19.629	19.486
20-Aug	19.500	19.800	19.600		19.329	19.714	19.571
21-Aug	19.300		19.700		19.357	19.750	19.614
22-Aug	19.200	19.700	19.700		19.343	19.783	19.657
23-Aug	19.000	19.700	19.600		19.300	19.800	19.671
24-Aug	19.000	19.600	19.500		19.243	19.733	19.643
25-Aug	19.000	19.400	19.400		19.200	19.650	19.600
26-Aug	18.700	19.300	19.300		19.100	19.583	19.543
27-Aug	18.600	19.400	19.300		18.971	19.517	19.500
28-Aug	18.600	19.200	19.200		18.871	19.471	19.429
29-Aug	18.700	19.000	19.000		18.800	19.371	19.329
30-Aug	18.800	18.900	18.800		18.771	19.257	19.214
31-Aug	18.900	18.900	18.800		18.757	19.157	19.114
1-Sep	18.630	18.900	18.900		18.704	19.086	19.043
2-Sep	18.305	18.900	18.900		18.648	19.029	18.986
3-Sep	18.303	18.700	18.700		18.605	18.929	18.900

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
4-Sep	18.439	18.500	18.500		18.582	18.829	18.800
5-Sep	18.658	18.600	18.300		18.576	18.771	18.700
6-Sep	18.725	18.600	18.300		18.566	18.729	18.629
7-Sep	18.586	18.700	18.400		18.521	18.700	18.571
8-Sep	18.445	18.600	18.500		18.494	18.657	18.514
9-Sep	18.260	18.500	18.500		18.488	18.600	18.457
10-Sep	18.240	18.800	18.500		18.479	18.614	18.429
11-Sep	18.330	18.700	18.500		18.463	18.643	18.429
12-Sep	18.380	18.400	18.400		18.424	18.614	18.443
13-Sep	18.570	18.400	18.300		18.402	18.586	18.443
14-Sep	18.680	18.200	18.200		18.415	18.514	18.414
15-Sep	18.940	18.600	18.500		18.486	18.514	18.414
16-Sep	18.760	18.700	18.700		18.557	18.543	18.443
17-Sep	18.520	18.800	18.800		18.597	18.543	18.486
18-Sep	18.360	18.800	18.800		18.601	18.557	18.529
19-Sep	18.450	18.700	18.700		18.611	18.600	18.571
20-Sep	18.520	18.400	18.400		18.604	18.600	18.586
21-Sep	18.450	18.100	18.100		18.571	18.586	18.571
22-Sep	18.640	18.400	18.300		18.529	18.557	18.543
23-Sep	18.460	18.300	18.300		18.486	18.500	18.486
24-Sep	18.250	18.300	18.300		18.447	18.429	18.414
25-Sep	18.170	18.500	18.400		18.420	18.386	18.357
26-Sep	18.430	18.500	18.400		18.417	18.357	18.314
27-Sep	18.670	18.500	18.400		18.439	18.371	18.314
28-Sep	18.560	18.300	18.300		18.454	18.400	18.343
29-Sep	18.480	18.510	18.500		18.431	18.416	18.371
30-Sep	18.450	18.510	18.510		18.430	18.446	18.401
1-Oct	18.411	18.500	18.500		18.453	18.474	18.430
2-Oct	18.347	18.400	18.400		18.478	18.460	18.430
3-Oct	18.192	18.200	18.200		18.444	18.417	18.401
4-Oct	18.079	18.100	18.100		18.360	18.360	18.359
5-Oct	17.988	18.000	18.000		18.278	18.317	18.316
6-Oct	17.794	17.800	17.900		18.180	18.216	18.230
7-Oct	17.724	17.700	17.600		18.076	18.100	18.100
8-Oct	17.558	17.600	17.600		17.955	17.971	17.971
9-Oct	17.400	17.500	17.500		17.819	17.843	17.843
10-Oct	17.310	17.300	17.400		17.693	17.714	17.729
11-Oct	17.050	17.100	17.100		17.546	17.571	17.586
12-Oct	16.920	17.200	16.900		17.394	17.457	17.429

	Daily Maximum Temperatures				7-Day Average of Daily Maximum Temperatures		
Date	Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace		Wells Tailrace	Rocky Reach Forebay	Rocky Reach Tailrace
13-Oct	16.890	16.700	16.700		17.265	17.300	17.257
14-Oct	16.720	16.500	16.500		17.121	17.129	17.100
15-Oct	16.540	16.300	16.400		16.976	16.943	16.929
16-Oct	16.330	16.200	16.300		16.823	16.757	16.757
17-Oct	16.320	16.100	16.100		16.681	16.586	16.571
18-Oct	16.390	16.100	16.100		16.587	16.443	16.429
19-Oct	16.280	16.000	16.000		16.496	16.271	16.300
20-Oct	16.240	15.900	15.900		16.403	16.157	16.186
21-Oct	16.190	15.900	15.900		16.327	16.071	16.100
22-Oct	16.010	15.900	15.900		16.251	16.014	16.029
23-Oct	16.040	15.800	15.800		16.210	15.957	15.957
24-Oct	16.050	15.800	15.800		16.171	15.914	15.914
25-Oct	16.010	15.700	15.800		16.117	15.857	15.871
26-Oct	16.010	15.700	15.800		16.079	15.814	15.843
27-Oct	15.950	15.600	15.700		16.037	15.771	15.814
28-Oct	15.730	15.600	15.600		15.971	15.729	15.771
29-Oct	15.670	15.520	15.570		15.923	15.674	15.724
30-Oct	15.510	15.320	15.370		15.847	15.606	15.663
31-Oct	15.280	15.270	15.300		15.737	15.530	15.591

APPENDIX E: CONSULTATION RECORD

Ecology was provided a Draft Annual Water Quality Monitoring Report on March 10, 2017 for review and comment. Ecology did not have any additional comments. Ecology's review and approval email is included below.

From:	Zimmerman, Breean (ECY)
To:	Clement, Marcie
Subject:	FW: DRAFT 2016 Annual Water Quality Report
Date:	Friday, April 14, 2017 1:07:18 PM
Attachments:	Appendix A Final RR QAPP.pdf 2016 DRAFT Annual Water Quality Monitoring Report.docx

Marcie,

Thank you for the opportunity to review the Draft 2016 Annual Water Quality Report. Washington State Department of Ecology (Ecology) has reviewed this draft report and we have **no comments.**

Thank you,

Breean Zimmerman ¦ **Hydropower Projects Manager**
Water Quality Program | Central Regional Office
(509) 575-2808 (w) | (509) 406-5130 (c) | bzim461@ecy.wa.gov

From: Clement, Marcie [mailto:Marcie.Clement@chelanpud.org]
Sent: Friday, March 10, 2017 7:23 AM
To: Zimmerman, Breean (ECY) <bzim461@ECY.WA.GOV>
Cc: Sokolowski, Rosana <Rosana.Sokolowski@chelanpud.org>; Bitterman, Deborah <Deborah.Bitterman@chelanpud.org>; Osborn, Jeff <Jeff.Osborn@chelanpud.org>; Smith, Michelle <michelle.smith@chelanpud.org>
Subject: DRAFT 2016 Annual Water Quality Report

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

To: Breean Zimmerman, Hydropower Projects Manager
Water Quality Program, Central Regional Office

From: Marcie Clement, Water Resources Specialist
Public Utility District No. 1 of Chelan County (Chelan PUD)

Re: DRAFT 2016 Annual Water Quality Report for the Rocky Reach Project

Ms. Zimmerman:

Attached for your review and comment are the DRAFT 2016 Annual Water Quality Report and Appendices for the Rocky Reach Project. Please note Appendix B, 2016 Annual Total Dissolved Gas Report, is not attached to this email as it is too large to send. Appendix B can be accessed on our website at http://www.chelanpud.org/departments/licensingCompliance/rr_implementation/ResourceDocuments/50120.pdf.

Please review and submit any comments you may have on or before 5:00 p.m. April 10, 2017 via email at

marcie.clement@chelanpud.org.

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

Thank you,

Marcie Clement | **Water Resources Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c) | marcie.clement@chelanpud.org

Sokolowski, Rosana

From: Zimmerman, Breean (ECY) [bzim461@ECY.WA.GOV]
Sent: Wednesday, February 22, 2017 12:45 PM
To: Clement, Marcie
Cc: Sokolowski, Rosana; Smith, Michelle
Subject: RE: Extension Request - Draft Annual Water Quality Monitoring Report

Hi Marcie,

Your request for a new proposed schedule for the submittal of the TDG Annual Monitoring Report and the Annual Water Quality Monitoring Report for this year is accepted.

Thank you,

Breean Zimmerman | **Hydropower Projects Manager**
Water Quality Program | Central Regional Office
(509) 575-2808 (w) | (509) 406-5130 (c) | bzim461@ecy.wa.gov

From: Clement, Marcie [mailto:Marcie.Clement@chelanpud.org]
Sent: Wednesday, February 22, 2017 11:46 AM
To: Zimmerman, Breean (ECY) <bzim461@ECY.WA.GOV>
Cc: Sokolowski, Rosana <Rosana.Sokolowski@chelanpud.org>; Smith, Michelle <michelle.smith@chelanpud.org>
Subject: Extension Request - Draft Annual Water Quality Monitoring Report

Breean,

Chelan PUD would like to request an extension for the submittal of our Draft Water Quality Monitoring Report. This report is due to Ecology as a Draft on March 1, 2017. Appended to this report is the Final TDG Annual Monitoring Report, which Chelan PUD has extended Ecology's comment period to March 7.

In order to allow time for finalization of the TDG Annual Monitoring Report for appending to the Annual Water Quality Monitoring Report, Chelan PUD is requesting that the Draft Annual Water Quality Monitoring Report be submitted to Ecology on March 10th as opposed to March 1st.

The following is the proposed extension schedule for both reports.

Report	Draft	Comment Period	Final
TDG Annual Monitoring Report	Submitted 1/19/2017	**1/19 – 2/28**	**3/7/2017**
Annual Water Quality Monitoring Report	**3/10/2017**	**3/10 – 4/10**	**5/1/2017** – finalized version is submitted to FERC and Ecology

Please let us know if this request is acceptable and don't hesitate to call me if you have any questions.

Sincerely,

Marcie Clement | **Water Resources Specialist**
Public Utility District No.1 of Chelan County | 327 N. Wenatchee Ave. | Wenatchee, WA 98801
509.661.4186 (w) | 509.280.1955 (c) | marcie.clement@chelanpud.org