
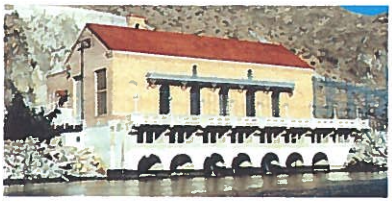


PUBLIC UTILITY DISTRICT NO. 1 *of* CHELAN COUNTY
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(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

May 31, 2017

VIA ELECTRONIC FILING

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

Re: **Lake Chelan Hydroelectric Project No. 637**
Article 405, Article 408, Appendix D – 2016 Annual Flow and Water Temperature Report, including the Water Quality Assessment

Dear Secretary Bose:

On September 10, 2013, the Federal Energy Regulatory Commission (Commission) issued its order[1] revising the reporting date to April 30 of each year for the Annual Flow and Water Temperature pursuant to Articles 405 and 408 of the license, and the Water Quality Certificate Condition V.A.(iii) for the Lake Chelan Hydroelectric Project (Project).

On February 26, 2017, the Public Utility District No. 1 of Chelan County, Washington (Chelan PUD), licensee for the Project, requested an extension of time until June 1, 2017, to file its 2016 report. Chelan PUD indicated that since it experienced delays in compiling the 2016 data, there was not sufficient time to compile the report and provide the stakeholders a 30-day review period by April 30. On March 8, 2017, the Commission issued its order approving Chelan PUD's request for extending the deadline to June 1, 2017.

Chelan PUD hereby files the 2016 Annual Flow and Water Temperature Report, including the water quality assessment data collected in 2016. On April 27, 2017, a final draft of this report was provided to the resource agencies, Tribes and non-governmental organizations specified for 30-day review, which ended May 29, 2017. Please refer to Appendix D for the consultation documentation.

[1] 144 FERC ¶ 62,221

Please contact me or Steve Hays at (509) 661-4181 regarding any questions or comments regarding this request.

Sincerely,

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

Enclosure: 2016 Annual Flow and Water Temperature Report

cc: Erich Gaedeke, FERC Portland Regional Office
Breean Zimmerman, Washington Department of Ecology
Chelan River Fishery Forum

LAKE CHELAN ANNUAL FLOW AND WATER TEMPERATURE REPORT 2016

LICENSE ARTICLES 405 & 408

Final

LAKE CHELAN HYDROELECTRIC PROJECT
FERC Project No. 637

May 31, 2017

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

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EXECUTIVE SUMMARY

Chelan PUD received a new license (License) from the Federal Energy Regulatory Commission (FERC) on November 6, 2006, authorizing Chelan PUD to operate the Lake Chelan Hydroelectric Project for a period of 50 years. The License conditions require that Chelan PUD provide minimum flows to the Chelan River and monitor those flows and water temperatures at various locations. The License required the construction of a Low Level Outlet at Chelan Dam, a Reach 4 Habitat Channel and spawning areas in the tailrace, and operations to protect aquatic life through flow ramping rates and powerhouse operations. The License also requires that Chelan PUD file an Annual Flow and Temperature Report with the FERC documenting compliance with these License requirements.

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3. The runoff forecast for 2016 was 116 percent of average, which is classified as an "average year" for setting minimum flows during the annual runoff cycle. The 2016 minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 Habitat Channel for salmon and steelhead spawning during their respective spawning periods and, to test the potential to trap adult Chinook salmon for broodstock for the Chelan Falls program, one pump was operated from August 3 – August 18. There was one minimum flow deviation in 2016. Flow during the deviation was within 4 cfs of the 80 cfs minimum requirement and lasted for approximately 2 hours. Water levels at the USGS Chelan River gauge dropped no more than one inch during the deviation, and there were no adverse effects on aquatic life (Appendix C).

Flows were released from the spillway, as needed for lake level control, from March 1 – 10, April 27- May 1, and May 3 - July 17. These flow releases were managed to meet lake level target elevations and to avoid high spill levels that could damage the Reach 4 Habitat Channel. Daily average spillway flow releases for lake level control peaked at 9,028 cfs on May 5, with the highest hourly flows of 9,047 cfs also on May 5. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 17-18. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 21.

There were 217 salmon redds with eggs incubating in the tailrace from spawning that occurred in the fall of 2015. Powerhouse operations to maintain minimum generation flows of over 800 cfs for Chinook salmon redd protection were implemented to maintain adequate oxygen levels in Chinook salmon redds. The powerhouse operated with one turbine at full capacity until April 1, by which time emergence of Chinook salmon had concluded.

The powerhouse was operated with at least one turbine at near full capacity, except for some periods of a few hours for maintenance, from April 1 – May 31. Steelhead spawning surveys were conducted from March – May, with two redds counted in the Habitat Channel, but no steelhead spawning was observed in the tailrace in 2016.

During the fall 2016 Chinook salmon spawning period, powerhouse daily average flows were maintained above 2,200 cfs from October 15 –November 30. A total count of 448 Chinook salmon

redds were estimated to have been deposited in the Chelan River, including the Reach 4 Habitat Channel and pool (167), tailrace (207), and downstream in the Chelan/Columbia River confluence and Columbia River (74). Powerhouse flows remained above 2,200 cfs through December.

Water temperatures were monitored at seven locations in the Chelan River and tailrace. Water temperatures neither increased nor decreased during transit through the Reach 4 Habitat Channel. The maximum daily average water temperatures measured from upstream to downstream locations were 23.9 °C at the Low Level Outlet, 23.9 °C at the top of Reach 1, 23.2 °C at the end of Reach 1, 23.2 °C at the end of Reach 3, 23.4 °C at the bottom of Reach 4, and 24.3 °C in the tailrace. The highest hourly temperatures recorded at these locations were 24.2 °C, 24.2 °C, 26.3 °C, 25.8 °C, 26.0 °C and 24.5 °C, respectively. The highest 7-DADMax temperatures recorded were 23.3 °C at the top of Reach 1, 25.5 °C and 25.4 °C at the ends of Reaches 1 and 3, and 25.5 °C at the bottom of Reach 4.

Water quality assessments for dissolved oxygen and pH were made in Reach 4 from January 1 – May 4. Water quality standards were met for these parameters during these monitoring periods. Total dissolved gas percent saturation was measured for spillway flows up to 9,000 cfs. The highest TDG measurement of 106.5 percent was below the maximum criterion of 110 percent.

SECTION 1: INTRODUCTION

The Lake Chelan Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). The Federal Energy Regulatory Commission (FERC) License for operation of this project, issued on November 6, 2006, authorizes Chelan PUD to operate the Lake Chelan dam and powerhouse for a period of 50 years. As part of the normal operation of the Project, Chelan PUD withdraws water from Lake Chelan for power generation and discharges that water through the powerhouse into an excavated tailrace, which leads to the confluence of the Chelan River and the Columbia River. Flows released from the Chelan Dam follow the natural channel of the Chelan River, joining with the powerhouse tailrace flows and discharging to the Columbia River. As a requirement of the new License, minimum flows were established for the Chelan River and that flow was initiated on October 14, 2009.

Chelan PUD filed an Operations Compliance Monitoring Plan (OCMP), as required in License Article 405, which describes how Chelan PUD operates to meet: (1) the instream flows, ramping rates, and tailrace flows as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the Settlement Agreement; (2) and the lake levels as set forth in Article 8 of the Settlement Agreement and Chapter 8 of the Comprehensive Plan. The OCMP includes the specifics of flow measurement techniques, electronic flow data posting, quarterly and annual reporting requirements, and an implementation schedule.

Chelan PUD filed a Threatened and Endangered Species Protection Plan (TESPP), as required in License Article 408, which describes: (1) how Chelan PUD implemented provisions for timely development of a system to release water at the Lake Chelan Dam or pump water from the project powerhouse tailrace to the Chelan River, and subsequent operation of that system to continuously maintain flows equal to or greater than the flows required for Chelan River Reach 4; and (2) methods and schedules for monitoring of flows in the project tailrace and in Reach 4 of the Chelan River and annual reporting of the monitoring results, as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the Settlement Agreement, and (3) methods for timely determination of the need to take actions to improve water quality characteristics adversely affecting anadromous fish, and identification and implementation of appropriate actions.

The OCMP and TESPP were submitted to the FERC on May 4, 2007 and the FERC issued an order approving the TESPP on November 28, 2007 and an order modifying and approving the OCMP on November 30, 2007. Both the OCMP and TESPP require the recording and reporting of flows in the Chelan River, to evaluate meeting minimum flow requirements, protection of fish habitat and protection of salmon and steelhead eggs incubating in the tailrace. The TESPP also includes annual reporting of water temperature monitoring required in the Lake Chelan Settlement Agreement. The order approving the OCMP requires that Chelan PUD shall file an Annual Flow Report with the FERC by February 28 of each year. Due to weather and snow conditions that frequently prevented retrieval of temperature loggers in January and February, the FERC granted a request from Chelan PUD to change the filing date of these annual reports to April 30. Due to a heavy snow year and cold spring, temperature loggers could not be retrieved until the end of March in 2017. This did not allow sufficient time to process and analyze data and still allow for a 30-day

review period. Chelan PUD requested, and FERC granted, a request to extend the filing date of the 2016 annual report until June 1, 2017. This Annual Flow and Temperature Report meets the flow and temperature reporting requirements of License Articles 405 and 408 for 2016.

Chelan PUD manages the level of Lake Chelan and flow releases through the powerhouse and into the Chelan River channel at the dam for power generation and other purposes. License Article 405 requires management of lake levels with priority given to maintaining minimum flows in the Chelan River (initiated in 2009) and reducing high spillway flows into the Chelan River to protect fish habitat. This report includes two sections that correspond to the flow reporting requirements of the FERC order: Section 2, Chelan River Instream Flows and Section 3, Powerhouse Tailrace Security Flows. Section 4 of this report contains the water temperature monitoring that was conducted in 2014. In addition, the FERC order requires that Chelan PUD conduct general water quality assessments in years 6 (2012) and 8 (2014) sufficient to demonstrate that the Chelan River meets water quality standards for dissolved oxygen, total dissolved gas, turbidity and pH. After 2014, additional data was collected to document water quality assessments that further address this requirement by providing monitoring during the winter of 2015-2016 and to monitor a higher spill level. Section 5 of this report discusses information collected in 2016.

SECTION 2: CHELAN RIVER INSTREAM FLOWS

2.1 Chelan River Instream Flows

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3 (Figure 2-1). The runoff forecast for 2016 was 116 percent of average, which is classified as an "average year" for setting minimum flows during the annual runoff cycle. The 2016 minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 Habitat Channel for salmon and steelhead spawning during their respective spawning periods and, to test the potential to trap adult Chinook salmon for broodstock for the Chelan Falls program, one pump was operated from August 3 – August 18. There was one minimum flow deviation in 2016.

Flows were released from the spillway, as needed for lake level control, from March 1 – 10, April 27- May 1, and May 3 - July 17. Due to higher than normal precipitation through the winter, lake levels in spring 2016 were much higher than normal and spill was started early for the purposes of facilitating some shoreline erosion control work above the dam and to avoid high spill levels that could damage the Reach 4 Habitat Channel. Daily average spillway flow releases for lake level control peaked at 9,028 cfs on May 5, with the highest hourly flows of 9,047 cfs also on May 5. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 17-18. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 21.

Spawning flows were provided for steelhead trout from March 15 – May 15 and for Chinook salmon from October 15 - November 30. The Chelan River Fisheries Forum approved testing an alternative spawning flow using four instead of five pumps for both the steelhead and Chinook spawning periods and FERC was notified of this temporary change by Chelan PUD letters dated March 11, 2016 and October 13, 2016. The spawning flows were provided through the combination of the Low Level Outlet flows and Pump Station flows, maintaining flow levels of at least 285 cfs during the spring steelhead spawning period, although flow generally exceeded that level due to spill from late April – May 15. During the Chinook spawning period, the flow ranged from 254 cfs – 302 cfs. At the end of the Chinook spawning period, flows from the Pump Station were ramped down one pump at a time to avoid fish stranding. Steelhead spawning surveys were conducted from March through May, with two steelhead redds confirmed and other possible redds seen in 2016. Chinook fry were observed during monthly snorkel surveys to be rearing in the Reach 4 Habitat Channel as early as late February and were present into May. Chinook spawning began by October 8 and was completed prior to November 19. There were a total of 448 redds counted in the Chelan River Reach 4, the tailrace and Columbia River at the confluence. There were 167 redds in the Reach 4 Habitat Channel and upstream pool, 207 in the tailrace and 74 in the Columbia River in Chelan River currents below the confluence.

A tabulation of average daily flows from the Low Level Outlet, Pump Station, combined flows into Reaches 1-3 and Reach 4, powerhouse discharge, spill discharge and hourly lake levels and powerhouse tailwater levels are presented in Appendix A. Hourly data reported quarterly is available Chelan PUD's web page under Licensing and Compliance, Lake Chelan License Implementation, Resource Documents.

Figure 2-1. Flow Releases to Reaches 1-3 of the Chelan River, 2016.

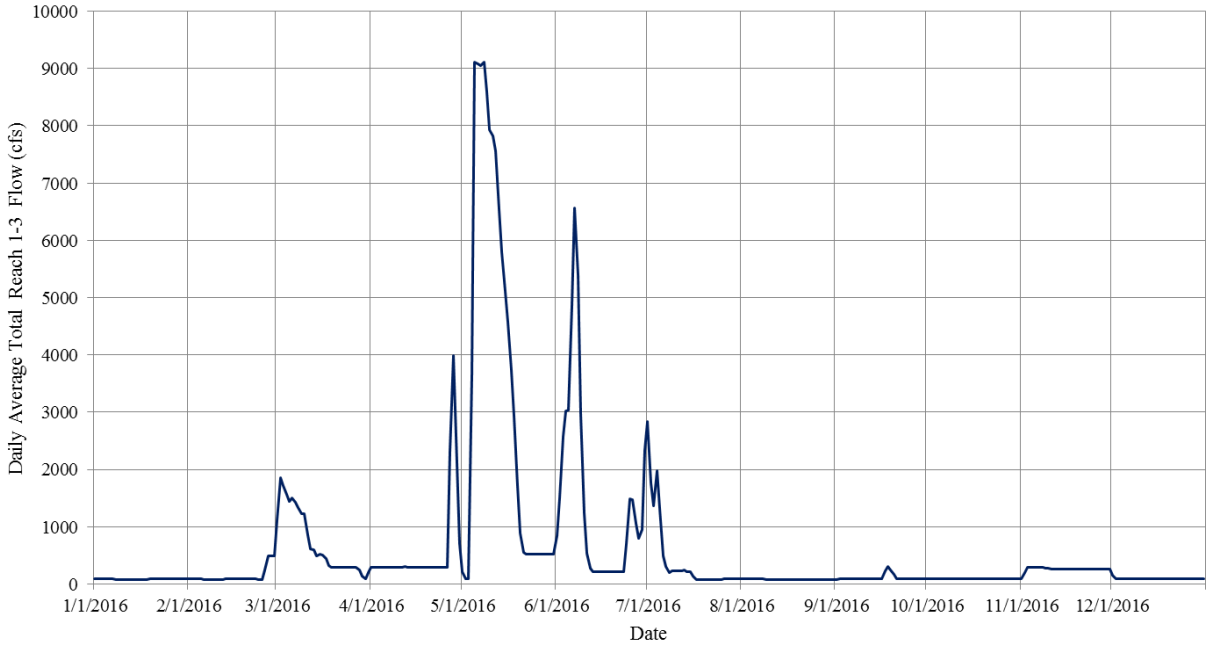
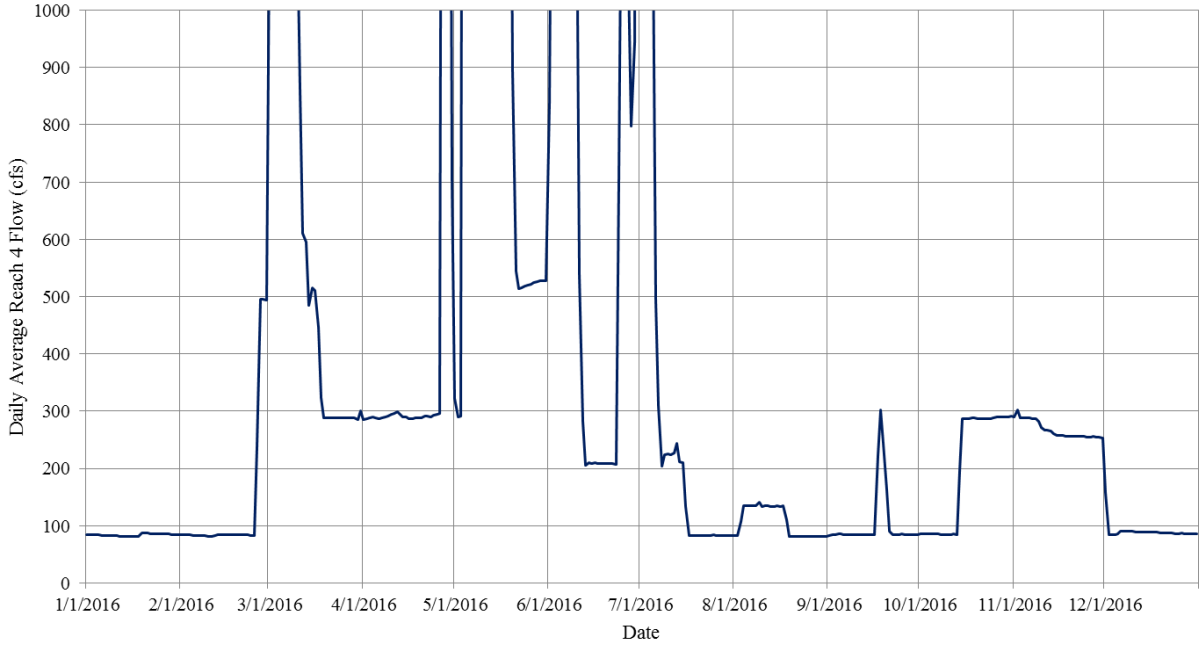


Figure 2-2. Flow Releases to Chelan River Reach 4, 2016.



2.2 Chelan River Ramping Rates

The Lake Chelan Settlement Agreement requires that ramping rates are to be established for the Chelan River to protect aquatic organisms from rapid fluctuations in water levels. The ramping rates for decreases in water levels were initially set at approximately two inches per hour during the period when juvenile salmon and steelhead fry may be present. The OCMP states that the two

inches per hour ramping rates will remain in effect until biological evaluations have determined the actual ramping rates necessary to prevent stranding of fish in the Chelan River. The locations in the Chelan River where water level changes will be measured to determine operating criteria for compliance with ramping rates will be determined in consultation with the Chelan River Fishery Forum.

The year 2016 was the seventh full year of minimum flow operations for the Chelan River since completion of the Low Level Outlet, Reach 4 Habitat Channel, and Pump Station. Biological evaluations of fish populations with snorkel surveys in the Chelan River Reaches 1-3 and Reach 4 began in 2012. Results of those surveys have been provided to the Chelan River Fisheries Forum and were included in the 2017 Biological Objectives Status Report. Observations during the snorkel surveys, steelhead spawning surveys (weekly March 15-June 1), summer observations during temperature logger replacement (monthly July, August, September) and fall during Chinook salmon spawning surveys (weekly October – November) have only observed Chinook salmon fry in the Reach 4 Habitat Channel during the months of February through June. Chinook or steelhead fry have not been observed in significant numbers prior to February and after July. However, ramping rate operations for juvenile fish were followed throughout the year since refinement of ramping rates has not yet concluded.

Chelan PUD continued to implement operating criteria for compliance with the two inches per hour ramping rates that were refined in 2011 and further developed from 2014 - 2016 to improve instructions on the timing of flow changes. These improved instructions are shown in Table 2-1.

Table 2-1. Final Ramping Criteria (2016).

Chelan River Maximum Allowable Spill Reduction Ramping Rates		
Chelan Hydro License Compliance		
Revised 10/10/2016		
Whenever making a change in total spill, enter the table below at the "Total Current Spill" on the left, read "Maximum Allowable Spill Reduction Ramping Rate" on the right. **NOTE – if spill is reduced to a lower bandwidth, the ramp rate will change at the point (i.e. spill starts at 1100 cfs and you want to change to 800 cfs, it would be 200 cfs/hr for 30 minutes (until 1000 cfs is reached), then 100 cfs/hr for 2 hours until 800 cfs is reached).		
Only reduce spill during daylight hours (to aid fish movement from potential entrapment areas).		
Total Current Spill = Spill Gates + Low Level Outlet cfs	Maximum Allowable Spill Reduction Ramping Rate	
	Fry are Present Along Riverbank Mar 15 to Sep 15 cfs/hr	No Fry Are Present Along Riverbank Sep 16 to Mar 14 cfs/hr
1000 < Total Current Spill	200	250
600 < Total Current Spill <= 1000	100	100
500 < Total Current Spill <= 600	50	50
220 < Total Current Spill <= 500	25	30
80 < Total Current Spill <= 220	20	20

SECTION 3: POWERHOUSE TAILRACE SECURITY FLOWS

3.1 Powerhouse Operations

There were 217 salmon redds with eggs incubating in the tailrace from spawning that occurred in the fall of 2015. Powerhouse operations to maintain minimum generation flows of over 800 cfs for Chinook redd protection were implemented to maintain adequate oxygen levels in Chinook salmon redds. The powerhouse operated with one turbine at full capacity until April 1, by which time emergence of Chinook salmon had concluded.

The powerhouse was operated with at least one turbine at near full capacity, except for some periods of a few hours for maintenance, from April 1 – May 31. Steelhead spawning surveys were conducted from March – May, with two redds counted in the Habitat Channel, but no steelhead spawning was observed in the tailrace in 2016.

During the Chinook spawning period, powerhouse daily average flows were maintained above 2,200 cfs from October 15 –November 30. A total count of 448 Chinook redds were estimated to have been deposited in the Chelan River, including the Reach 4 Habitat Channel and pool (167), tailrace (207), and downstream in the Chelan/Columbia River confluence and Columbia River (74).

Powerhouse flows were above 2,200 cfs from December 1 – 31. The daily average powerhouse flows are shown in Figure 3-1.

Water surface elevations in the tailrace can fluctuate by several feet over the course of a day due to changes in Columbia River flows that affect the backwater curve of the Rocky Reach reservoir. The water level fluctuations in the tailrace are reduced when the Chelan Powerhouse is operating. In past years, temporary dewatering of a few Chinook redds in shallow areas had been observed when the powerhouse was not operating and Columbia River flows were low. During tailrace spawning habitat construction in 2008 these areas were graded to prevent dewatering, and this area was again excavated and graded in summers of 2014 and 2016 to remove river gravels that had accumulated since 2008 and in spring 2016. The water levels in the tailrace remained above 708.0 feet most of the time and never dropped below 706.7 feet from January 1 – May 31 and October 15 – December 31. The daily average tailwater levels measured at the powerhouse are shown in Figure 3-2.

Figure 3-1. Chelan Powerhouse Daily Average Flows, 2016.

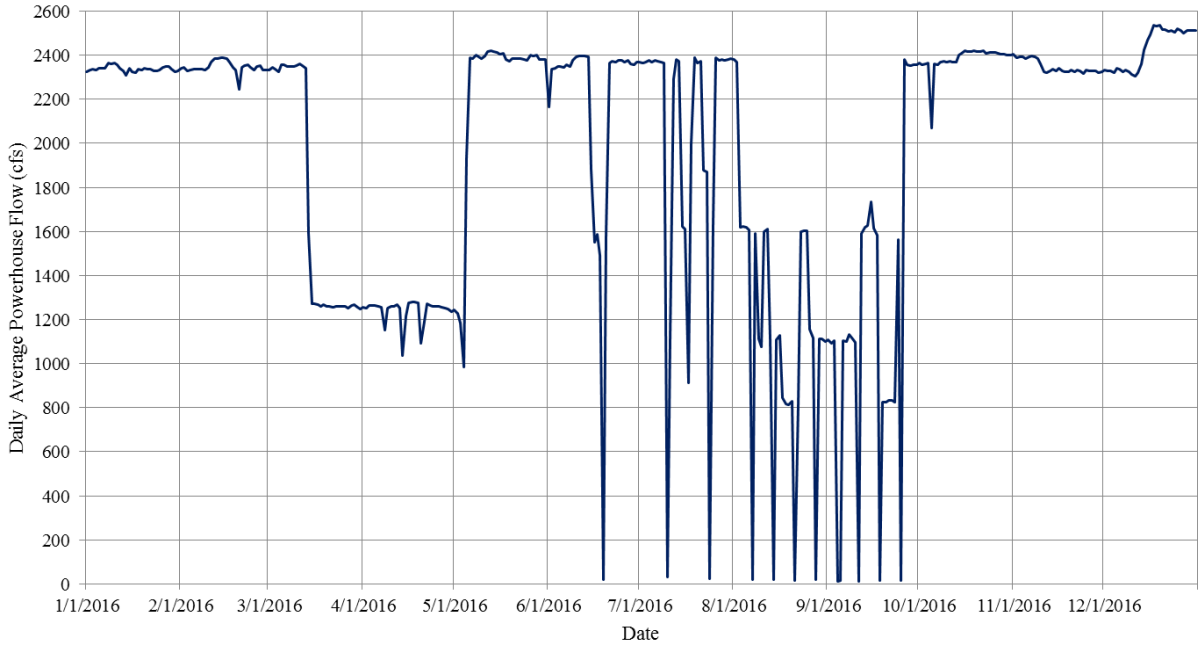
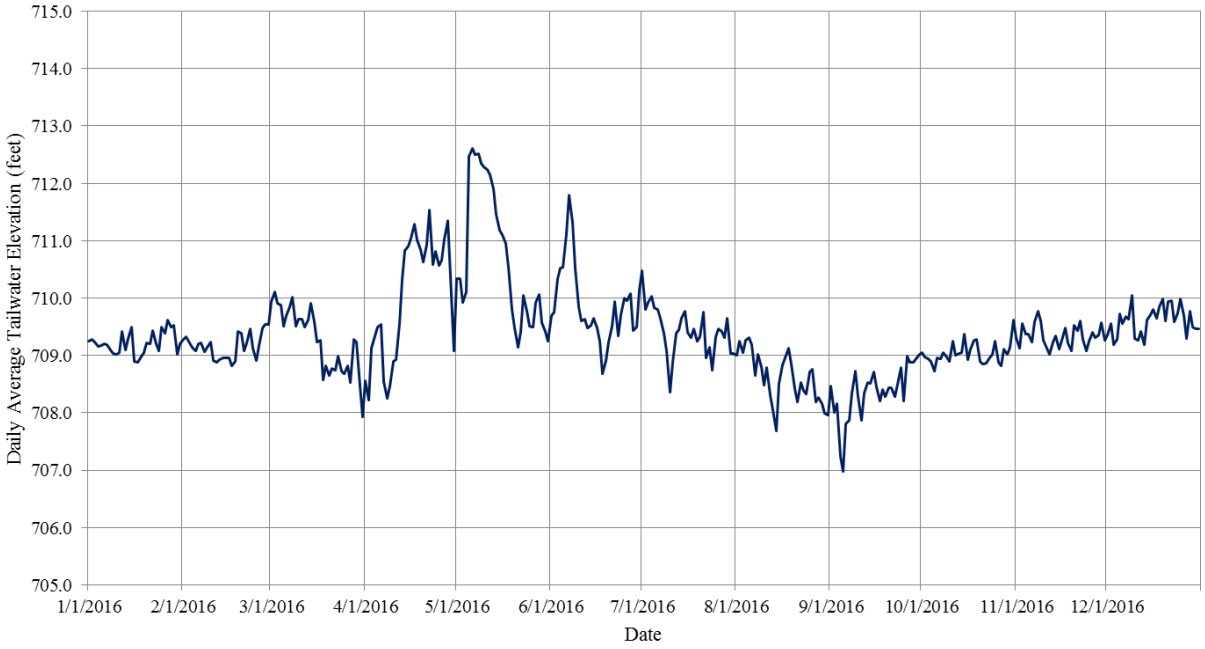


Figure 3-2. Chelan Powerhouse Daily Average Tailwater Elevations, 2016.



SECTION 4: WATER TEMPERATURE MONITORING

4.1 Water Temperatures Released to Chelan River and Tailrace

Automated water temperature monitoring equipment is installed at two locations, within the pipe that draws water from the base of the Chelan Dam and discharges to the Chelan River through the Low Level Outlet and in the Chelan Powerhouse Tailrace from a sensor mounted on the Pump Station intake screens. These monitoring locations measure water temperatures that reflect the coolest water available for the Chelan River (Low Level Outlet temperature) and the average of water temperatures arriving at the face of Chelan Dam as drawn through the powerhouse intakes (Chelan Powerhouse Tailrace). Water temperatures measured in the tailrace also represent the temperature of water that is being discharged to the Reach 4 Habitat Channel when the Pump Station is in operation.

Water temperatures from these sources (Figure 4-1) generally show little stratification in water temperatures at the face of Chelan Dam. The maximum daily average water temperature measured in the Low Level Outlet pipe was 23.9 °C. Hourly water temperatures peaked at 24.2 °C on July 30-31. Tailrace maximum daily average temperature was 24.3 °C, while hourly temperatures peaked at 24.5 °C on July 30.

Figure 4-1. Low Level Outlet and Tailrace Daily Average Water Temperatures.

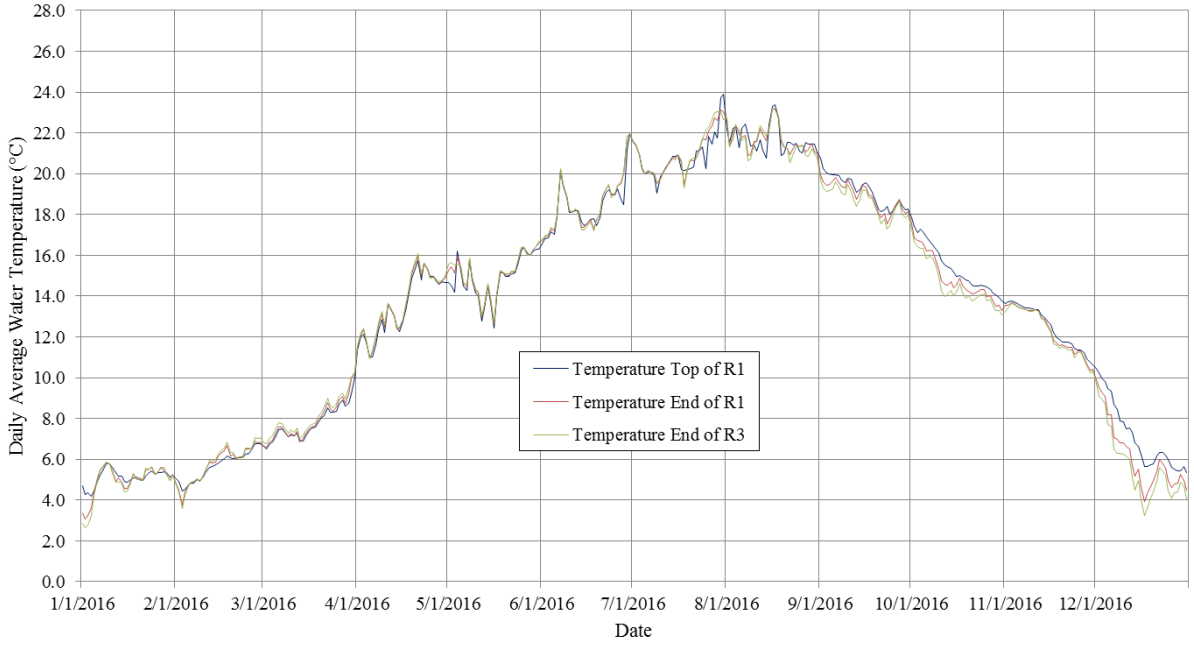
4.2 Water Temperatures in Chelan River Reaches 1-3.

Water temperatures are monitored at three locations with temperature recording data loggers (Onset HOBO Water Temp Pro v2) that are set to record the water temperature at hourly intervals. These locations are at the top of Reach 1, which measures the temperature of water entering the Chelan River from the Low Level Outlet and the spillway. The location of this temperature logger

is set below the mixing zone for these sources of water. The data for this site was lost from October 4 through the end of the year, with Low Level Outlet data substituted for Figure 4-2. The second location is at the end of Reach 1, which is the reach of the Chelan River that has the lowest gradient and least profile shading, thus the greatest potential for water temperature heating during the spring and summer. The third location is at the end of Reach 3, where the Chelan River exits the series of cascades and falls that are the upstream barriers to anadromous fish. The temperature loggers at each location are exchanged several times during the year to retrieve the data. These data are reported quarterly during most of the year, with monthly reporting for July, August and September. These data reports are available on Chelan PUD's web page under Licensing and Compliance, Lake Chelan License Implementation, Resource Documents.

The water temperatures recorded in Reaches 1-3 in 2016 demonstrated small differences in daily average water temperature between Reaches (Figure 4-2), with the greatest differences in the winter due to cooling of the warmer lake water as it moved downstream. In contrast, the daily maximum water temperature increased above the temperature at the Low Level Outlet during summer and decreased during the fall. This is not unexpected because the water exiting Lake Chelan is influenced by the heat sink effect of the lake's large volume. Water in Lake Chelan is still warming from March – August, but then retains this heat through the late summer and fall, thus water exiting the lake is cooler than sustainable at equilibrium with ambient solar and air temperature conditions through the summer, then tends to be warmer than sustainable through fall and winter. The maximum daily average water temperatures recorded in 2016 were 23.9 °C at the top of Reach 1, 23.2 °C at the end of Reach 1, and 23.2 °C at the end of Reach 3. The highest hourly temperatures recorded were 24.2 °C, 26.3 °C, and 25.8 °C, respectively for the top of Reach 1, end of Reach 1 and end of Reach 3. The highest temperature recorded was at the end of Reach 1 on July 30.

Figure 4-2. Chelan River Reaches 1-3 Daily Average Water Temperatures.

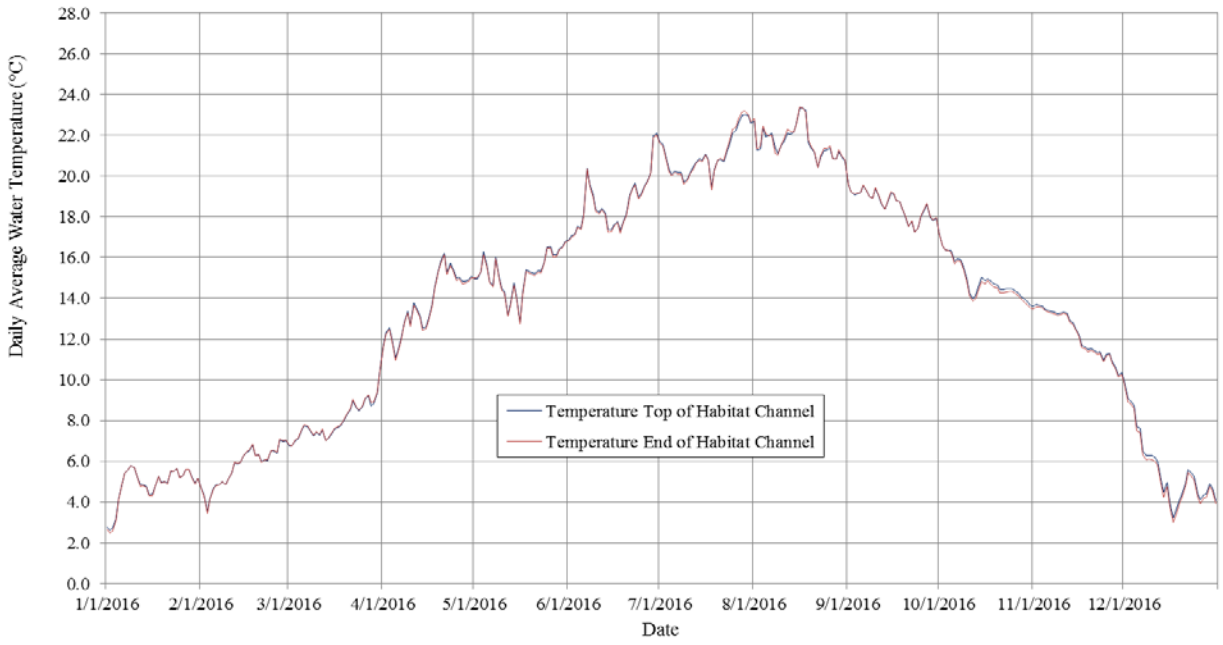


4.3 Water Temperatures in Chelan River Reach 4 Habitat Channel.

Water temperatures are monitored at hourly intervals at two locations (Onset HOBO Water Temp Pro v2), at the upper and lower end of the Habitat Channel. The upper location records either the water temperature exiting from the pool below the end of Reach 3 or the mixed flows from that source and the Pump Station canal outlet, when the pumps are in operation. The monitoring location at the end of the Habitat Channel is at the point where Habitat Channel flows enter into the tailrace, just upstream from where Habitat Channel flow mixes with the tailrace.

The daily average water temperature data from these locations did not show any evidence of heating as water passed through the Habitat Channel (Figure 4-3). Cooler tailrace water from operation of one pump from the Pump Station from August 3 - 18 resulted in lower maximum hourly temperatures than water entering from Reach 3. The maximum daily average temperatures recorded were 23.4 °C at the top and 23.4 °C also at the end of the Habitat Channel. The maximum hourly temperatures were 25.8 °C and 26.0 °C at the upper and lower ends of the Habitat Channel. These peak temperatures were recorded on July 28, 30 and July 4, respectively.

Figure 4-3. Reach 4 Habitat Channel Daily Average Water Temperatures.



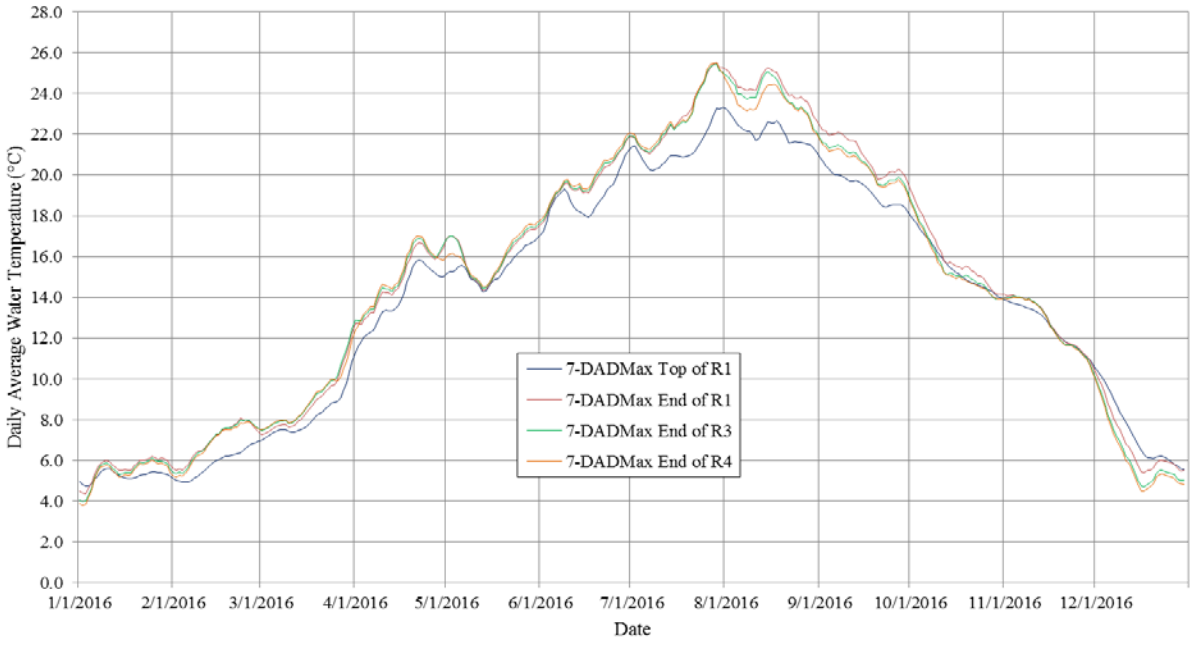
4.4 Chelan River 7-DADMax Water Temperatures Top Reach 1 to Bottom Reach 4.

Washington State water quality standards for temperature establish criteria based on the 7-DADMax (seven day average of daily maximum temperature). The 7-DADMax criterion for the Chelan River is currently 17.5 °C (see Section 5, Table 5-1), with an allowable human effect of 0.3 °C above natural conditions. Natural conditions have not been defined for the Chelan River due to its current status of a river in the initial stages of restoration. However, the temperature of water exiting Lake Chelan is the initial water temperature at the beginning of the Chelan River. This water is either provided exclusively from the Low Level Outlet, which draws the coolest water available at the face of the Chelan Dam, or is from a mix of water from the spillway and the

Low Level Outlet. As water flows through the Chelan River, it either heats or cools, depending on the time of year, since water exiting Lake Chelan is thermally buffered from daily and seasonal environmental influences. The 7-DADMax from the fall through early spring may be warmer at the upper Chelan River (top of Reach 1) than at the lower end where it merges with the tailrace (end of Reach 4). As solar radiation and warmer air temperatures increase from spring through summer, the 7-DADMax will increase as water flows down the Chelan River. The 7-DADMax may be nearly identical at different locations, indicating that the water temperature had reached equilibrium with the external sources of heat gain or loss prior to reaching the downstream monitoring locations.

The 7-DADMax water temperatures from four locations, top of Reach 1, end of Reach 1, end of Reach 3 and end of the Reach 4 Habitat Channel are shown in Figure 4-4. During the periods when flows in Reach 4 are increased for Chinook and steelhead spawning, the water temperatures measured at the end of the Reach 4 Habitat Channel reflects the mix of water from the tailrace and water exiting Reach 3. The difference in temperature is pronounced during the spring when steelhead spawning flows are provided by the pumping station (March 15 – May 15). Prior to and after the spring pumping period, the 7-DADMax at the end of Reach 3 and at the end of the Reach 4 Habitat Channel are nearly identical (Figure 4-4). However, cooler tailrace water provided from August 3 - 18 effectively lowered the 7-DADMax by a small amount. The 7-DADMax at the top of Reach 1 exceeded the 17.5 °C criterion on June 3, with exceedances extending through October 3, reaching a peak of 23.3 °C from July 29 – August 1. The 7-DADMax at the end of Reach 4 exceeded the criterion on May 28, with exceedances continuing through October 4. The highest 7-DADMax reached 25.5 °C on July 28 - 29. The highest 7-DADMax at the ends of Reach 1 and Reach 3 were 25.5 °C and 25.4 °C, respectively.

Figure 4-4. The 7-DADMax Water Temperatures for Reaches 1 – 4.



SECTION 5: WATER QUALITY ASSESSMENT

General water quality assessment data was collected from January – April in 2016 to provide additional continuous monitoring. The requirement for general water quality assessment is that Chelan PUD conduct general water quality assessments in years 6 (2012) and 8 (2014) sufficient to demonstrate that the Chelan River meets water quality standards for dissolved oxygen, total dissolved gas, turbidity and pH. The 401 Certification specifies that this information is to be collected in Reach 4 for dissolved oxygen, turbidity and pH, whereas the total dissolved gas measurements are to be made in Reach 1 below the spillway of the Chelan Dam. Water quality criteria currently applicable to the Chelan River, which has a designated aquatic life use of salmonid spawning, rearing and migration, are shown in Table 5-1.

Table 5-1. Water Quality Criteria for Salmonid Spawning, Rearing and Migration.

	Water Temperature	Dissolved Oxygen	pH	Turbidity	Total Dissolved Gas
Criteria	7-DADMax <=17.5 °C	1 Day Min. 8.0 mg/l	6.5-8.5 Units	-	110 % Saturation
Allowable Human Effect	0.3 °C above natural conditions	0.2 mg/l	< 0.5 Units	5 NTU when Background <= 50 NTU	None

5.1 Assessment of Dissolved Oxygen, pH and Turbidity in Reach 4 Habitat Channel.

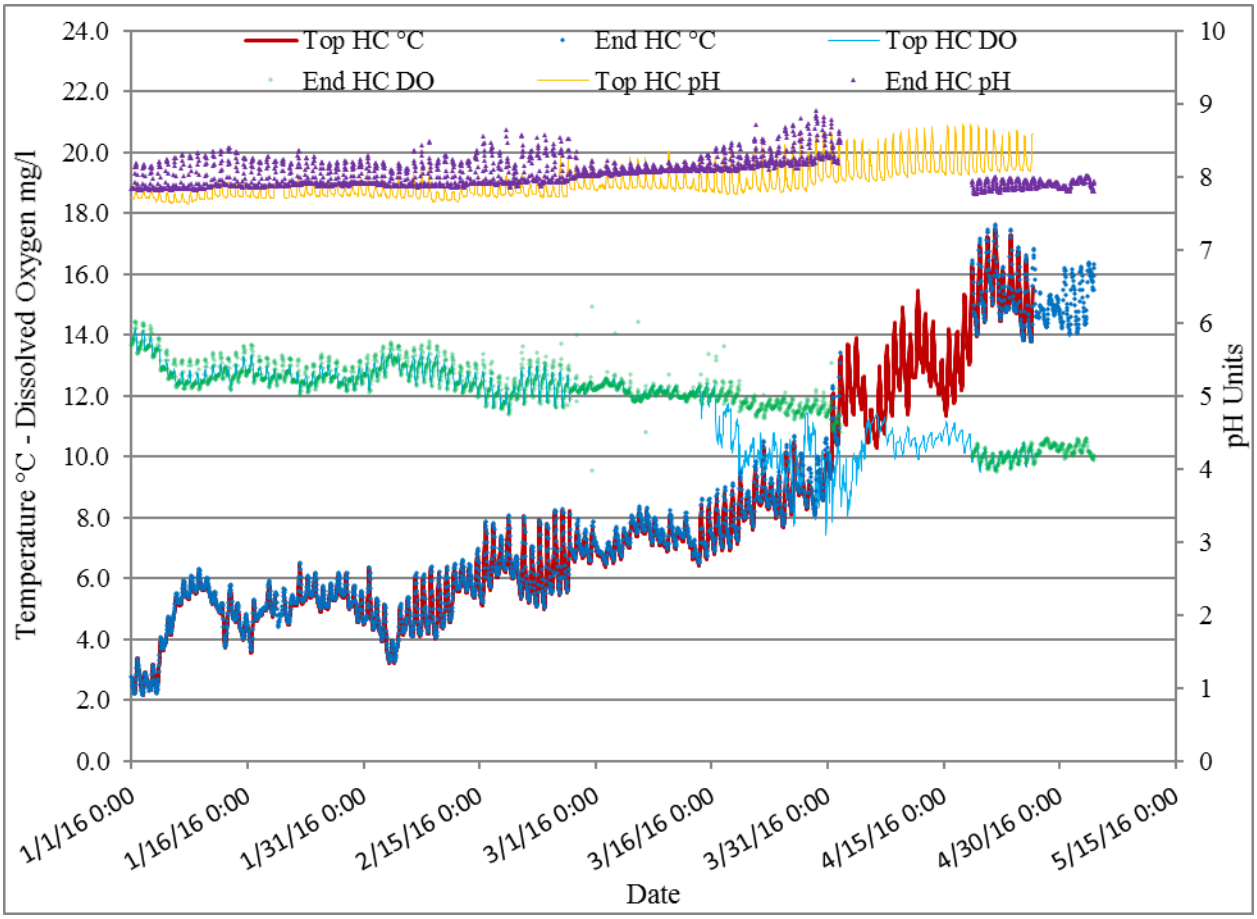
Measurements of water temperature, dissolved oxygen and pH were obtained from two locations in the Reach 4 Habitat Channel from January 1 to May 4, 2016. Measurements were obtained using Hydrolab MS5 Minisondes that were programmed to record data every hour. One Minisonde was attached to the same anchor post that is used for the temperature recording data logger at the upper end of the Habitat Channel. The other Minisonde was attached to the anchor post that is used for the temperature logger at the downstream end of the Habitat Channel.

The dissolved oxygen and pH data collected were within the criteria specified for the current designated uses for the Chelan River (Table 5-1). These data, collected from Minisondes that were continuously deployed since May 2015, were maintained in operation in order to provide data for the January – April time period, which had not been monitored during previous years. The temperature, dissolved oxygen and pH data collected with the Minisondes are shown in Figure 5-1. The dissolved oxygen levels in Figure 5-1 demonstrate that the dissolved oxygen level met the water quality criterion of 8.0 mg/l. Dissolved oxygen readings recorded by the Minisonde at the upper end of the Habitat Channel, which had sporadic high readings in March and some low readings from mid-March into April appear to be from a malfunctioning sensor, which was also observed during monitoring in 2015. The pH readings from both Minisondes at the lower end of the Habitat Channel trended higher than pH recorded at the upper end of the Habitat Channel, however all measurements were within the water quality criteria. The pH from both Minisondes appeared to be drifting into higher values after four to five months of deployment in 2015 and

which continued into 2016, possibly due to depletion of the electrolyte in the reference sensor. While the pH was generally similar for both locations, they should have been in closer agreement during January – February, when there is limited sunlight which would trigger daily pH fluctuations due to photosynthesis by periphyton affecting pH due to carbon dioxide consumption. Future long deployments should be limited to less than four months between replenishment of pH electrolyte and recalibration.

There were no turbidity measurements taken in 2016. Chelan PUD intends to conduct long-term continuous monitoring of turbidity in 2017.

Figure 5-1. January – April 2016, Water Quality Data in Reach 4 Habitat Channel.

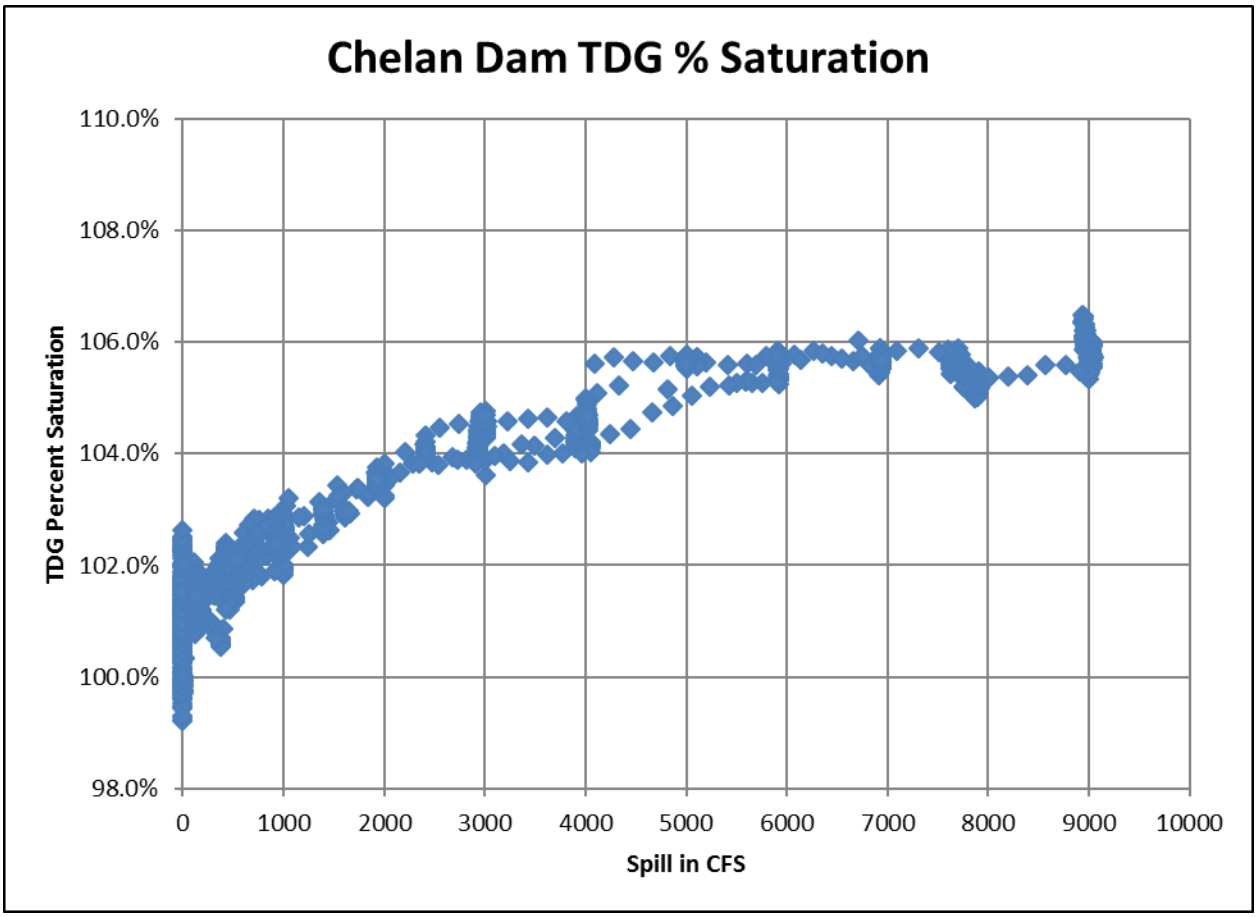


5.2 Assessment of Total Dissolved Gas in Reach 1 Below Chelan Dam Spillway.

A secure and representative method for placing an instrument for measuring total dissolved gas (TDG) was installed in 2014 and hourly monitoring occurred from June 29 – July 10, 2015 and from April 27 – June 25, 2016. The monitoring device began malfunctioning after June 25, 2016. The monitoring data covered a number of hours with no spill, which provides a good baseline for variability in the measurements. The monitoring periods covered a broad range of spill discharges, including 114 hours with spill level of approximately 9,000 cfs. The highest TDG levels observed

were 106.5% during the period when spill was approximately 8,950 cfs. The TDG levels followed a logarithmic pattern with TDG between 105% - 106% for spill levels ranging from 5,000 cfs – 9,000 cfs (Figure 5-2). Since TDG levels can increase when tailwater depth increases, at extreme spill discharges the TDG could rise above 106.5%, but the flat response between 5,000 cfs and 9,000 cfs indicates that spill discharges would have to greatly exceed 9,000 cfs before TDG would even approach the 110% level. Thus, the water quality criterion for TDG is met during spill from the Lake Chelan Dam.

Figure 5-2. Total Dissolved Gas Below Lake Chelan Dam.



SECTION 6: SUMMARY

Flow releases were provided throughout the year from the Low Level Outlet for minimum flows of at least 80 cfs in Reaches 1-3. The runoff forecast for 2016 was 116 percent of average, which is classified as an "average year" for setting minimum flows during the annual runoff cycle. The 2016 minimum flow releases to Reaches 1-3 were at least 200 cfs from May 15 – July 15. Additional flow was provided from the Pump Station to the Reach 4 Habitat Channel for salmon and steelhead spawning during their respective spawning periods and, to test the potential to trap adult Chinook salmon for broodstock for the Chelan Falls program, one pump was operated from August 3 – August 18. There was one minimum flow deviation in 2016. Flow during the deviation was within 4 cfs of the 80 cfs minimum requirement and lasted for approximately 2 hours. Water levels at the USGS Chelan River gauge dropped no more than one inch during the deviation, and there were no adverse effects on aquatic life (Appendix C).

Flows were released from the spillway, as needed for lake level control, from March 1 – 10, April 27- May 1, and May 3 - July 17. These flow releases were managed to meet lake level target elevations and to avoid high spill levels that could damage the Reach 4 Habitat Channel. Daily average spillway flow releases for lake level control peaked at 9,028 cfs on May 5, with the highest hourly flows of 9,047 cfs also on May 5. Flow releases from the Low Level Outlet were also managed to provide whitewater boating flows on September 17-18. Flows were ramped back down to minimum flows following the event, with ramping concluded on September 21.

There were 217 salmon redds with eggs incubating in the tailrace from spawning that occurred in the fall of 2015. Powerhouse operations to maintain minimum generation flows of over 800 cfs for Chinook redd protection were implemented to maintain adequate oxygen levels in Chinook salmon redds. The powerhouse operated with one turbine at full capacity until April 1, by which time emergence of Chinook salmon had concluded.

The powerhouse was operated with at least one turbine at near full capacity, except for some periods of a few hours for maintenance, from April 1 – May 31. Steelhead spawning surveys were conducted from March – May, with two redds counted in the Habitat Channel, but no steelhead spawning was observed in the tailrace in 2016.

During the fall 2016 Chinook spawning period, powerhouse daily average flows were maintained above 2,200 cfs from October 15 –November 30. A total count of 448 Chinook redds were estimated to have been deposited in the Chelan River, including the Reach 4 Habitat Channel and pool (167), tailrace (207), and downstream in the Chelan/Columbia River confluence and Columbia River (74). Powerhouse flows remained above 2,200 cfs through December.

Water temperatures were monitored at seven locations in the Chelan River and tailrace. Water temperatures neither increased nor decreased during transit through the Reach 4 Habitat Channel. The maximum daily average water temperatures measured from upstream to downstream locations were 23.9 °C at the Low Level Outlet, 23.9 °C at the top of Reach 1, 23.2 °C at the end of Reach 1, 23.2 °C at the end of Reach 3, 23.4 °C at the bottom of Reach 4, and 24.3 °C in the tailrace. The highest hourly temperatures recorded at these locations were 24.2 °C, 24.2 °C, 26.3 °C, 25.8 °C,

26.0 °C and 24.5 °C, respectively. The highest 7-DADMax temperatures recorded were 23.3 °C at the top of Reach 1, 25.5 °C and 25.4 °C at the ends of Reaches 1 and 3, and 25.5 °C at the bottom of Reach 4.

Water quality assessments for dissolved oxygen and pH were made in Reach 4 from January 1 – May 4. Water quality standards were met for these parameters during these monitoring periods. Total dissolved gas percent saturation was measured for spillway flows up to 9,000 cfs. The highest TDG measurement of 106.5 percent was below the maximum criterion of 110 percent.

APPENDIX A: DAILY AVERAGE LAKE CHELAN ELEVATIONS, POWERHOUSE FLOWS, TAILWATER ELEVATIONS AND CHELAN RIVER FLOWS FROM SPILL, LOW LEVEL OUTLET AND PUMPING STATION

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
1/1/2016	1092.9	2325	709.3	85	0	85	0	85
1/2/2016	1092.8	2333	709.3	84	0	84	0	84
1/3/2016	1092.6	2337	709.2	84	0	84	0	84
1/4/2016	1092.6	2333	709.2	84	0	84	0	84
1/5/2016	1092.5	2339	709.2	84	0	84	0	84
1/6/2016	1092.4	2340	709.2	83	0	83	0	83
1/7/2016	1092.3	2341	709.2	83	0	83	0	83
1/8/2016	1092.2	2366	709.1	83	0	83	0	83
1/9/2016	1092.1	2362	709.0	83	0	83	0	83
1/10/2016	1092.0	2365	709.0	82	0	82	0	82
1/11/2016	1091.9	2358	709.0	82	0	82	0	82
1/12/2016	1091.8	2343	709.4	82	0	82	0	82
1/13/2016	1091.8	2330	709.1	82	0	82	0	82
1/14/2016	1091.7	2307	709.3	82	0	82	0	82
1/15/2016	1091.6	2341	709.5	81	0	81	0	81
1/16/2016	1091.5	2325	708.9	81	0	81	0	81
1/17/2016	1091.4	2321	708.9	81	0	81	0	81
1/18/2016	1091.3	2337	709.0	81	0	81	0	81
1/19/2016	1091.2	2335	709.0	87	0	87	0	87
1/20/2016	1091.1	2339	709.2	87	0	87	0	87
1/21/2016	1091.0	2338	709.2	87	0	87	0	87
1/22/2016	1091.0	2339	709.4	86	0	86	0	86
1/23/2016	1090.9	2330	709.2	86	0	86	0	86
1/24/2016	1090.8	2328	709.1	86	0	86	0	86
1/25/2016	1090.7	2332	709.5	86	0	86	0	86
1/26/2016	1090.6	2345	709.4	85	0	85	0	85
1/27/2016	1090.5	2351	709.6	85	0	85	0	85
1/28/2016	1090.5	2348	709.5	85	0	85	0	85
1/29/2016	1090.4	2338	709.5	85	0	85	0	85
1/30/2016	1090.4	2325	709.0	85	0	85	0	85
1/31/2016	1090.3	2331	709.2	84	0	84	0	84
2/1/2016	1090.2	2340	709.3	84	0	84	0	84
2/2/2016	1090.1	2345	709.3	84	0	84	0	84
2/3/2016	1090.0	2329	709.2	84	0	84	0	84
2/4/2016	1089.9	2333	709.1	83	0	83	0	83
2/5/2016	1089.8	2336	709.1	83	0	83	0	83
2/6/2016	1089.7	2335	709.2	83	0	83	0	83
2/7/2016	1089.6	2335	709.2	83	0	83	0	83
2/8/2016	1089.5	2336	709.1	82	0	82	0	82
2/9/2016	1089.4	2333	709.1	82	0	82	0	82
2/10/2016	1089.3	2343	709.2	82	0	82	0	82
2/11/2016	1089.2	2368	708.9	81	0	81	0	81
2/12/2016	1089.1	2387	708.9	83	0	83	0	83
2/13/2016	1089.1	2385	708.9	84	0	84	0	84
2/14/2016	1089.0	2389	709.0	84	0	84	0	84
2/15/2016	1089.0	2389	709.0	84	0	84	0	84
2/16/2016	1089.0	2384	709.0	84	0	84	0	84
2/17/2016	1089.0	2369	708.8	84	0	84	0	84

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
2/18/2016	1089.0	2345	708.9	84	0	84	0	84
2/19/2016	1089.1	2335	709.4	84	0	84	0	84
2/20/2016	1089.1	2247	709.4	84	0	84	0	84
2/21/2016	1089.1	2344	709.1	84	0	84	0	84
2/22/2016	1089.0	2352	709.2	84	0	84	0	84
2/23/2016	1089.0	2355	709.5	84	0	84	0	84
2/24/2016	1089.0	2343	709.1	83	0	83	0	83
2/25/2016	1088.9	2334	708.9	83	0	83	0	83
2/26/2016	1088.9	2348	709.2	237	0	237	0	237
2/27/2016	1088.8	2354	709.5	496	0	496	0	496
2/28/2016	1088.7	2334	709.5	495	0	495	0	495
2/29/2016	1088.7	2333	709.5	493	0	493	0	493
3/1/2016	1088.6	2334	709.9	491	632	1123	0	1123
3/2/2016	1088.5	2343	710.1	489	1366	1856	0	1856
3/3/2016	1088.4	2339	709.9	488	1224	1712	0	1712
3/4/2016	1088.3	2327	709.9	486	1083	1569	0	1569
3/5/2016	1088.2	2355	709.5	484	957	1441	0	1441
3/6/2016	1088.2	2356	709.7	483	1017	1500	0	1500
3/7/2016	1088.2	2348	709.8	483	947	1430	0	1430
3/8/2016	1088.1	2349	710.0	481	851	1332	0	1332
3/9/2016	1088.0	2349	709.5	481	752	1233	0	1233
3/10/2016	1088.1	2352	709.6	481	752	1233	0	1233
3/11/2016	1088.0	2362	709.6	458	404	862	0	862
3/12/2016	1088.0	2354	709.5	441	170	611	0	611
3/13/2016	1087.9	2340	709.6	440	155	595	0	595
3/14/2016	1087.9	1593	709.9	361	124	485	0	485
3/15/2016	1087.9	1272	709.6	288	227	515	0	515
3/16/2016	1087.9	1270	709.2	288	223	511	0	511
3/17/2016	1087.9	1268	709.3	288	157	446	0	446
3/18/2016	1087.8	1260	708.6	288	35	323	0	323
3/19/2016	1087.8	1267	708.8	288	0	288	0	288
3/20/2016	1087.8	1261	708.7	288	0	288	0	288
3/21/2016	1087.8	1259	708.8	288	0	288	0	288
3/22/2016	1087.9	1258	708.7	288	0	288	0	288
3/23/2016	1087.8	1260	709.0	288	0	288	0	288
3/24/2016	1087.8	1260	708.7	288	0	288	0	288
3/25/2016	1087.8	1260	708.7	288	0	288	0	288
3/26/2016	1087.8	1260	708.8	288	0	288	0	288
3/27/2016	1087.8	1253	708.5	288	0	288	0	288
3/28/2016	1087.8	1265	709.3	241	0	241	46	288
3/29/2016	1087.8	1267	709.2	135	0	135	152	287
3/30/2016	1087.8	1255	708.5	84	0	84	201	285
3/31/2016	1087.9	1248	707.9	197	0	197	104	301
4/1/2016	1087.9	1256	708.6	285	0	285	0	285
4/2/2016	1088.0	1251	708.2	286	0	286	0	286
4/3/2016	1088.2	1263	709.1	288	0	288	0	288
4/4/2016	1088.5	1264	709.3	290	0	290	0	290
4/5/2016	1088.7	1262	709.5	289	0	289	0	289

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
4/6/2016	1088.8	1262	709.5	287	0	287	0	287
4/7/2016	1089.0	1255	708.5	288	0	288	0	288
4/8/2016	1089.2	1153	708.3	289	0	289	0	289
4/9/2016	1089.5	1252	708.5	291	0	291	0	291
4/10/2016	1089.9	1260	708.9	294	0	294	0	294
4/11/2016	1090.3	1261	708.9	296	0	296	0	296
4/12/2016	1090.7	1267	709.5	299	0	299	0	299
4/13/2016	1091.0	1251	710.3	295	0	295	0	295
4/14/2016	1091.2	1038	710.8	290	0	290	0	290
4/15/2016	1091.5	1215	710.9	289	0	289	0	289
4/16/2016	1091.6	1278	711.0	287	0	287	0	287
4/17/2016	1091.8	1279	711.3	287	0	287	0	287
4/18/2016	1091.9	1279	711.0	288	0	288	0	288
4/19/2016	1092.2	1278	710.8	288	0	288	0	288
4/20/2016	1092.6	1091	710.6	288	0	288	0	288
4/21/2016	1093.1	1193	710.9	292	0	292	0	292
4/22/2016	1093.8	1273	711.5	292	0	292	0	292
4/23/2016	1094.4	1265	710.6	290	0	290	0	290
4/24/2016	1094.9	1261	710.8	293	0	293	0	293
4/25/2016	1095.3	1261	710.6	295	0	295	0	295
4/26/2016	1095.6	1260	710.7	296	0	296	0	296
4/27/2016	1095.8	1256	711.0	193	2120	2313	0	2313
4/28/2016	1095.9	1253	711.4	83	3910	3993	0	3993
4/29/2016	1095.9	1249	710.4	83	2488	2571	0	2571
4/30/2016	1096.1	1237	709.1	83	619	702	0	702
5/1/2016	1096.3	1243	710.3	83	138	221	101	322
5/2/2016	1096.5	1229	710.3	86	0	86	205	291
5/3/2016	1096.9	1186	709.9	89	0	89	203	292
5/4/2016	1097.3	985	710.1	91	3566	3657	120	3776
5/5/2016	1097.5	1934	712.5	89	9028	9118	0	9118
5/6/2016	1097.4	2390	712.6	88	8986	9075	0	9075
5/7/2016	1097.4	2386	712.5	88	8954	9043	0	9043
5/8/2016	1097.5	2400	712.5	88	9016	9104	0	9104
5/9/2016	1097.4	2391	712.3	88	8503	8591	0	8591
5/10/2016	1097.3	2383	712.3	88	7844	7931	0	7931
5/11/2016	1097.1	2397	712.2	87	7729	7816	0	7816
5/12/2016	1096.9	2417	712.2	87	7473	7560	0	7560
5/13/2016	1096.8	2420	711.9	87	6441	6528	0	6528
5/14/2016	1096.8	2417	711.5	87	5703	5790	0	5790
5/15/2016	1096.7	2413	711.2	87	5025	5112	0	5112
5/16/2016	1096.8	2406	711.1	87	4483	4571	0	4571
5/17/2016	1096.9	2408	711.0	86	3642	3728	0	3728
5/18/2016	1097.0	2380	710.5	86	2850	2936	0	2936
5/19/2016	1097.1	2375	709.8	86	1624	1710	0	1710
5/20/2016	1097.2	2383	709.5	86	807	893	0	893
5/21/2016	1097.3	2383	709.1	86	458	544	0	544
5/22/2016	1097.5	2385	709.4	87	427	514	0	514
5/23/2016	1097.6	2387	710.0	87	428	516	0	516

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
5/24/2016	1097.7	2382	709.8	87	430	518	0	518
5/25/2016	1097.8	2375	709.5	88	432	520	0	520
5/26/2016	1097.9	2401	709.5	88	434	522	0	522
5/27/2016	1098.0	2396	709.9	88	436	524	0	524
5/28/2016	1098.0	2400	710.1	88	437	526	0	526
5/29/2016	1098.1	2380	709.6	88	439	527	0	527
5/30/2016	1098.1	2380	709.4	88	439	527	0	527
5/31/2016	1098.2	2380	709.2	88	439	528	0	528
6/1/2016	1098.3	2164	709.7	88	749	838	0	838
6/2/2016	1098.4	2337	709.7	89	1411	1500	0	1500
6/3/2016	1098.5	2341	710.3	86	2488	2574	0	2574
6/4/2016	1098.5	2351	710.5	82	2936	3018	0	3018
6/5/2016	1098.7	2349	710.5	83	2959	3041	0	3041
6/6/2016	1098.9	2343	711.1	83	4785	4868	0	4868
6/7/2016	1099.0	2355	711.8	82	6475	6557	0	6557
6/8/2016	1099.0	2349	711.3	82	5309	5391	0	5391
6/9/2016	1099.0	2378	710.5	82	2897	2979	0	2979
6/10/2016	1099.1	2395	709.8	83	1152	1235	0	1235
6/11/2016	1099.2	2395	709.6	83	456	539	0	539
6/12/2016	1099.2	2396	709.6	83	200	282	0	282
6/13/2016	1099.3	2395	709.5	83	123	206	0	206
6/14/2016	1099.3	2392	709.5	83	127	210	0	210
6/15/2016	1099.3	1882	709.7	83	126	209	0	209
6/16/2016	1099.4	1551	709.5	83	126	209	0	209
6/17/2016	1099.4	1586	709.2	83	125	208	0	208
6/18/2016	1099.4	1491	708.7	83	126	209	0	209
6/19/2016	1099.5	19	708.9	83	125	208	0	208
6/20/2016	1099.6	1580	709.2	83	125	208	0	208
6/21/2016	1099.6	2366	709.5	83	124	208	0	208
6/22/2016	1099.6	2374	709.9	83	124	208	0	208
6/23/2016	1099.6	2368	709.3	84	124	208	0	208
6/24/2016	1099.7	2375	709.7	84	621	704	0	704
6/25/2016	1099.6	2378	710.0	84	1399	1483	0	1483
6/26/2016	1099.6	2370	710.0	84	1394	1477	0	1477
6/27/2016	1099.5	2377	710.1	83	970	1053	0	1053
6/28/2016	1099.6	2362	709.4	83	714	797	0	797
6/29/2016	1099.7	2355	709.5	83	860	943	0	943
6/30/2016	1099.8	2368	710.1	83	2247	2329	0	2329
7/1/2016	1099.8	2367	710.5	82	2755	2837	0	2837
7/2/2016	1099.7	2365	709.8	82	1682	1764	0	1764
7/3/2016	1099.7	2370	709.9	82	1280	1363	0	1363
7/4/2016	1099.7	2375	710.0	82	1896	1979	0	1979
7/5/2016	1099.6	2370	709.8	82	1235	1318	0	1318
7/6/2016	1099.5	2375	709.8	82	414	496	0	496
7/7/2016	1099.5	2371	709.7	82	227	309	0	309
7/8/2016	1099.5	2369	709.4	82	122	204	0	204
7/9/2016	1099.5	2365	709.1	82	142	224	0	224
7/10/2016	1099.6	33	708.4	82	143	225	0	225

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
7/11/2016	1099.7	1114	708.9	81	143	224	0	224
7/12/2016	1099.7	2293	709.4	82	144	226	0	226
7/13/2016	1099.6	2381	709.4	82	161	243	0	243
7/14/2016	1099.6	2375	709.7	82	129	212	0	212
7/15/2016	1099.6	1622	709.8	82	128	210	0	210
7/16/2016	1099.6	1612	709.4	82	52	134	0	134
7/17/2016	1099.6	915	709.3	82	0	82	0	82
7/18/2016	1099.6	1998	709.5	82	0	82	0	82
7/19/2016	1099.6	2390	709.2	82	0	82	0	82
7/20/2016	1099.6	2365	709.3	82	0	82	0	82
7/21/2016	1099.6	2371	709.8	82	0	82	0	82
7/22/2016	1099.6	1877	709.0	82	0	82	0	82
7/23/2016	1099.6	1868	709.1	82	0	82	0	82
7/24/2016	1099.6	22	708.7	83	0	83	0	83
7/25/2016	1099.7	1632	709.3	83	0	83	1	84
7/26/2016	1099.7	2387	709.5	83	0	83	0	83
7/27/2016	1099.7	2378	709.4	83	0	83	0	83
7/28/2016	1099.7	2381	709.3	83	0	83	0	83
7/29/2016	1099.7	2376	709.6	83	0	83	0	83
7/30/2016	1099.7	2379	709.0	83	0	83	0	83
7/31/2016	1099.7	2384	709.0	83	0	83	0	83
8/1/2016	1099.6	2382	709.0	83	0	83	0	83
8/2/2016	1099.6	2369	709.2	83	0	83	0	83
8/3/2016	1099.5	1617	709.0	83	0	83	24	107
8/4/2016	1099.5	1622	709.3	83	0	83	52	135
8/5/2016	1099.4	1621	709.3	83	0	83	52	135
8/6/2016	1099.4	1605	709.2	83	0	83	52	135
8/7/2016	1099.4	20	708.6	83	0	83	51	134
8/8/2016	1099.4	1592	709.0	83	0	83	51	134
8/9/2016	1099.4	1113	708.8	83	0	83	59	142
8/10/2016	1099.4	1077	708.5	82	0	82	51	134
8/11/2016	1099.4	1598	708.8	82	0	82	53	135
8/12/2016	1099.3	1612	708.3	82	0	82	52	134
8/13/2016	1099.3	1113	708.1	82	0	82	51	134
8/14/2016	1099.3	20	707.7	82	0	82	51	133
8/15/2016	1099.4	1110	708.5	82	0	82	52	135
8/16/2016	1099.4	1128	708.8	82	0	82	52	134
8/17/2016	1099.4	844	709.0	81	0	81	53	134
8/18/2016	1099.3	816	709.1	81	0	81	29	111
8/19/2016	1099.3	813	708.9	81	0	81	0	81
8/20/2016	1099.4	829	708.4	81	0	81	0	81
8/21/2016	1099.4	18	708.2	81	0	81	0	81
8/22/2016	1099.4	813	708.5	82	0	82	0	82
8/23/2016	1099.3	1600	708.4	82	0	82	0	82
8/24/2016	1099.3	1602	708.3	82	0	82	0	82
8/25/2016	1099.2	1603	708.7	81	0	81	0	81
8/26/2016	1099.2	1156	708.8	81	0	81	0	81
8/27/2016	1099.1	1115	708.2	81	0	81	0	81

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
8/28/2016	1099.1	20	708.3	81	0	81	0	81
8/29/2016	1099.1	1114	708.2	81	0	81	0	81
8/30/2016	1099.1	1111	708.0	81	0	81	0	81
8/31/2016	1099.0	1100	708.0	81	0	81	0	81
9/1/2016	1099.0	1108	708.5	82	0	82	0	82
9/2/2016	1099.0	1091	708.0	84	0	84	0	84
9/3/2016	1098.9	1105	708.2	85	0	85	0	85
9/4/2016	1098.9	10	707.2	85	0	85	0	85
9/5/2016	1098.9	14	707.0	85	0	85	0	85
9/6/2016	1098.9	1104	707.8	85	0	85	0	85
9/7/2016	1098.9	1099	707.9	84	0	84	0	84
9/8/2016	1098.8	1133	708.3	85	0	85	0	85
9/9/2016	1098.8	1113	708.7	84	0	84	0	84
9/10/2016	1098.7	1095	708.3	84	0	84	0	84
9/11/2016	1098.7	12	707.9	85	0	85	0	85
9/12/2016	1098.7	1592	708.3	84	0	84	0	84
9/13/2016	1098.5	1619	708.5	84	0	84	0	84
9/14/2016	1098.5	1626	708.5	84	0	84	0	84
9/15/2016	1098.4	1733	708.7	84	0	84	0	84
9/16/2016	1098.3	1616	708.4	84	0	84	0	84
9/17/2016	1098.3	1585	708.2	223	0	223	0	223
9/18/2016	1098.3	15	708.4	302	0	302	0	302
9/19/2016	1098.3	824	708.3	243	0	243	0	243
9/20/2016	1098.3	825	708.4	163	0	163	0	163
9/21/2016	1098.3	832	708.4	90	0	90	0	90
9/22/2016	1098.2	835	708.3	85	0	85	0	85
9/23/2016	1098.2	826	708.5	85	0	85	0	85
9/24/2016	1098.1	1563	708.8	85	0	85	0	85
9/25/2016	1098.1	17	708.2	85	0	85	0	85
9/26/2016	1098.0	2382	709.0	85	0	85	0	85
9/27/2016	1097.9	2359	708.9	84	0	84	0	84
9/28/2016	1097.8	2352	708.9	84	0	84	0	84
9/29/2016	1097.7	2359	708.9	84	0	84	0	84
9/30/2016	1097.6	2358	709.0	85	0	85	0	85
10/1/2016	1097.4	2367	709.1	85	0	85	0	85
10/2/2016	1097.3	2356	709.0	85	0	85	0	85
10/3/2016	1097.2	2359	708.9	86	0	86	0	86
10/4/2016	1097.0	2365	708.9	86	0	86	0	86
10/5/2016	1096.9	2071	708.7	85	0	85	0	85
10/6/2016	1096.8	2362	709.0	85	0	85	0	85
10/7/2016	1096.7	2359	708.9	85	0	85	0	85
10/8/2016	1096.6	2370	709.1	85	0	85	0	85
10/9/2016	1096.7	2372	709.0	85	0	85	0	85
10/10/2016	1096.6	2368	708.9	85	0	85	0	85
10/11/2016	1096.5	2372	709.2	85	0	85	0	85
10/12/2016	1096.5	2370	709.0	84	0	84	1	86
10/13/2016	1096.4	2370	709.0	84	0	84	0	84
10/14/2016	1096.3	2401	709.0	84	0	84	110	194

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
10/15/2016	1096.3	2407	709.4	84	0	84	203	287
10/16/2016	1096.3	2419	708.9	84	0	84	202	286
10/17/2016	1096.3	2416	709.1	84	0	84	203	287
10/18/2016	1096.3	2416	709.3	84	0	84	204	288
10/19/2016	1096.2	2421	709.3	84	0	84	204	288
10/20/2016	1096.3	2418	708.9	84	0	84	203	287
10/21/2016	1096.3	2416	708.8	84	0	84	203	287
10/22/2016	1096.3	2420	708.9	84	0	84	203	287
10/23/2016	1096.3	2409	708.9	84	0	84	203	287
10/24/2016	1096.3	2411	709.0	84	0	84	203	287
10/25/2016	1096.2	2411	709.2	85	0	85	204	289
10/26/2016	1096.2	2414	708.9	86	0	86	203	290
10/27/2016	1096.3	2410	708.8	87	0	87	203	289
10/28/2016	1096.3	2407	709.1	87	0	87	204	290
10/29/2016	1096.3	2406	709.0	87	0	87	203	290
10/30/2016	1096.3	2400	709.1	87	0	87	204	290
10/31/2016	1096.3	2400	709.6	86	0	86	204	291
11/1/2016	1096.3	2406	709.3	87	0	87	204	290
11/2/2016	1096.2	2389	709.1	205	0	205	98	302
11/3/2016	1096.2	2394	709.6	289	0	289	0	289
11/4/2016	1096.2	2391	709.4	289	0	289	0	289
11/5/2016	1096.1	2384	709.4	288	0	288	0	288
11/6/2016	1096.1	2394	709.2	288	0	288	0	288
11/7/2016	1096.0	2397	709.6	287	0	287	0	287
11/8/2016	1096.0	2394	709.8	287	0	287	0	287
11/9/2016	1096.0	2386	709.6	282	0	282	0	282
11/10/2016	1095.9	2360	709.3	272	0	272	0	272
11/11/2016	1095.9	2326	709.1	266	0	266	0	266
11/12/2016	1095.9	2320	709.0	266	0	266	0	266
11/13/2016	1095.9	2328	709.2	266	0	266	0	266
11/14/2016	1096.0	2336	709.3	261	0	261	0	261
11/15/2016	1096.0	2328	709.1	258	0	258	0	258
11/16/2016	1096.1	2339	709.3	258	0	258	0	258
11/17/2016	1096.0	2328	709.5	257	0	257	0	257
11/18/2016	1096.0	2326	709.2	257	0	257	0	257
11/19/2016	1096.0	2323	709.1	256	0	256	0	256
11/20/2016	1096.0	2333	709.5	256	0	256	0	256
11/21/2016	1095.9	2325	709.4	256	0	256	0	256
11/22/2016	1095.9	2334	709.6	256	0	256	0	256
11/23/2016	1095.8	2330	709.3	256	0	256	0	256
11/24/2016	1095.8	2315	709.1	255	0	255	0	255
11/25/2016	1095.7	2333	709.3	255	0	255	0	255
11/26/2016	1095.7	2328	709.4	255	0	255	0	255
11/27/2016	1095.6	2328	709.3	256	0	256	0	256
11/28/2016	1095.6	2330	709.4	255	0	255	0	255
11/29/2016	1095.5	2323	709.6	254	0	254	0	254
11/30/2016	1095.4	2325	709.3	254	0	254	0	254
12/1/2016	1095.4	2333	709.4	158	0	158	0	158

Date	Lake Chelan Elevation (ft)	Powerhouse Tailrace Flow (cfs)	Powerhouse Tailwater Elevation (ft)	Low Level Outlet Flow (cfs)	Spill Flow (cfs)	Chelan River Flow Reaches 1-3 (cfs)	Pump Station Flow (cfs)	Chelan River Flow Reach 4 (cfs)
12/2/2016	1095.3	2328	709.6	85	0	85	0	85
12/3/2016	1095.2	2329	709.2	84	0	84	0	84
12/4/2016	1095.2	2320	709.3	84	0	84	0	84
12/5/2016	1095.1	2340	709.7	86	0	86	0	86
12/6/2016	1095.0	2335	709.6	91	0	91	0	91
12/7/2016	1094.9	2326	709.7	90	0	90	0	90
12/8/2016	1094.8	2332	709.6	90	0	90	0	90
12/9/2016	1094.7	2325	710.0	90	0	90	0	90
12/10/2016	1094.6	2312	709.3	90	0	90	0	90
12/11/2016	1094.5	2304	709.3	89	0	89	0	89
12/12/2016	1094.4	2322	709.4	89	0	89	0	89
12/13/2016	1094.3	2360	709.2	89	0	89	0	89
12/14/2016	1094.2	2423	709.6	89	0	89	0	89
12/15/2016	1094.1	2468	709.7	88	0	88	0	88
12/16/2016	1094.0	2494	709.8	88	0	88	0	88
12/17/2016	1093.9	2535	709.6	88	0	88	0	88
12/18/2016	1093.8	2531	709.8	88	0	88	0	88
12/19/2016	1093.7	2538	710.0	88	0	88	0	88
12/20/2016	1093.6	2516	709.6	88	0	88	0	88
12/21/2016	1093.5	2515	709.9	87	0	87	0	87
12/22/2016	1093.4	2510	710.0	87	0	87	0	87
12/23/2016	1093.3	2511	709.6	87	0	87	0	87
12/24/2016	1093.2	2506	709.7	86	0	86	0	86
12/25/2016	1093.1	2520	710.0	87	0	87	0	87
12/26/2016	1092.9	2513	709.7	87	0	87	0	87
12/27/2016	1092.9	2501	709.3	86	0	86	0	86
12/28/2016	1092.8	2512	709.8	86	0	86	0	86
12/29/2016	1092.7	2514	709.5	86	0	86	0	86
12/30/2016	1092.6	2511	709.5	85	0	85	0	85
12/31/2016	1092.4	2511	709.5	85	0	85	0	85

APPENDIX B: DAILY AVERAGE WATER TEMPERATURES

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
1/1/2016	5.0	4.7	3.4	2.9	2.8	2.6	5.0	4.9
1/2/2016	4.6	4.3	3.1	2.6	2.6	2.5	4.6	4.6
1/3/2016	4.6	4.4	3.2	2.8	2.7	2.6	4.5	4.5
1/4/2016	4.4	4.2	3.6	3.2	3.2	3.1	4.3	4.3
1/5/2016	4.6	4.4	4.4	4.2	4.2	4.1	4.6	4.6
1/6/2016	5.0	4.9	5.1	4.9	4.9	4.9	5.1	5.0
1/7/2016	5.3	5.2	5.5	5.4	5.4	5.4	5.5	5.4
1/8/2016	5.6	5.5	5.7	5.6	5.6	5.6	5.8	5.7
1/9/2016	5.8	5.8	5.9	5.8	5.8	5.8	6.0	5.9
1/10/2016	5.9	5.8	5.8	5.8	5.7	5.7	6.0	5.9
1/11/2016	5.7	5.6	5.4	5.3	5.3	5.3	5.8	5.7
1/12/2016	5.5	5.4	4.9	4.9	4.8	4.8	5.6	5.5
1/13/2016	5.3	5.2	5.1	4.9	4.9	4.8	5.3	5.2
1/14/2016	5.3	5.2	4.9	4.8	4.8	4.7	5.3	5.3
1/15/2016	5.1	4.9	4.6	4.4	4.4	4.3	5.1	5.0
1/16/2016	5.0	4.9	4.6	4.4	4.4	4.3	5.1	5.0
1/17/2016	5.1	5.0	4.9	4.8	4.8	4.8	5.2	5.1
1/18/2016	5.2	5.1	5.3	5.3	5.3	5.3	5.2	5.2
1/19/2016	5.2	5.1	5.0	5.0	5.0	4.9	5.3	5.2
1/20/2016	5.1	5.0	5.1	5.1	5.0	5.0	5.2	5.1
1/21/2016	5.1	5.0	5.0	5.0	4.9	4.9	5.2	5.1
1/22/2016	5.3	5.2	5.5	5.5	5.5	5.5	5.4	5.3
1/23/2016	5.4	5.3	5.5	5.5	5.5	5.5	5.5	5.4
1/24/2016	5.5	5.4	5.6	5.6	5.6	5.6	5.6	5.5
1/25/2016	5.3	5.3	5.3	5.3	5.2	5.2	5.5	5.4
1/26/2016	5.4	5.3	5.4	5.3	5.3	5.3	5.5	5.4
1/27/2016	5.4	5.4	5.6	5.6	5.6	5.6	5.5	5.4
1/28/2016	5.5	5.4	5.5	5.6	5.6	5.6	5.6	5.5
1/29/2016	5.4	5.3	5.3	5.3	5.2	5.2	5.5	5.4
1/30/2016	5.3	5.1	4.9	4.9	4.9	4.9	5.3	5.2
1/31/2016	5.3	5.2	5.3	5.2	5.2	5.2	5.4	5.3
2/1/2016	5.1	5.0	4.8	4.7	4.7	4.6	5.2	5.1
2/2/2016	5.1	4.9	4.5	4.4	4.4	4.3	5.1	5.0
2/3/2016	4.6	4.4	3.8	3.6	3.5	3.4	4.6	4.6
2/4/2016	4.7	4.5	4.4	4.2	4.2	4.2	4.7	4.6
2/5/2016	4.8	4.7	4.7	4.7	4.7	4.7	4.9	4.8
2/6/2016	4.9	4.8	4.9	4.9	4.8	4.8	5.0	4.9
2/7/2016	4.9	4.8	4.9	4.9	4.8	4.8	5.0	4.9
2/8/2016	5.1	5.0	5.0	5.0	5.0	5.0	5.2	5.1
2/9/2016	5.0	5.0	4.9	4.9	4.9	4.8	5.1	5.0
2/10/2016	5.2	5.1	5.2	5.2	5.1	5.1	5.3	5.2
2/11/2016	5.4	5.4	5.5	5.5	5.4	5.4	5.6	5.4
2/12/2016	5.6	5.6	5.9	6.0	5.9	5.9	5.7	5.6
2/13/2016	5.7	5.6	5.8	5.9	5.9	5.9	5.8	5.7
2/14/2016	5.7	5.7	5.9	6.0	5.9	6.0	5.9	5.8
2/15/2016	5.8	5.8	6.2	6.3	6.2	6.2	6.0	5.9
2/16/2016	6.0	6.0	6.3	6.5	6.4	6.5	6.2	6.0

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
2/17/2016	6.0	6.0	6.4	6.6	6.5	6.6	6.2	6.1
2/18/2016	6.1	6.2	6.7	6.9	6.8	6.9	6.3	6.2
2/19/2016	6.1	6.1	6.2	6.3	6.3	6.3	6.2	6.1
2/20/2016	6.0	6.0	6.3	6.3	6.3	6.3	6.2	6.1
2/21/2016	6.1	6.1	6.0	6.0	6.0	6.0	6.3	6.1
2/22/2016	6.1	6.1	6.1	6.1	6.1	6.1	6.3	6.1
2/23/2016	6.1	6.1	6.1	6.1	6.0	6.1	6.3	6.1
2/24/2016	6.2	6.2	6.5	6.5	6.5	6.5	6.4	6.3
2/25/2016	6.3	6.3	6.5	6.6	6.5	6.5	6.5	6.4
2/26/2016	6.4	6.4	6.6	6.5	6.4	6.4	6.6	6.5
2/27/2016	6.7	6.7	6.9	7.1	7.0	7.1	6.9	6.8
2/28/2016	6.7	6.8	6.8	7.0	7.0	7.0	6.9	6.8
2/29/2016	6.7	6.8	6.9	7.0	7.0	7.0	7.0	6.8
3/1/2016	6.6	6.6	6.6	6.8	6.8	6.8	6.8	6.7
3/2/2016	6.5	6.5	6.6	6.8	6.8	6.8	6.7	6.5
3/3/2016	6.7	6.7	6.9	7.0	7.0	7.1	6.9	6.8
3/4/2016	6.8	6.8	6.9	7.1	7.1	7.1	7.0	6.9
3/5/2016	7.1	7.1	7.3	7.5	7.5	7.5	7.3	7.2
3/6/2016	7.4	7.5	7.6	7.8	7.8	7.8	7.6	7.4
3/7/2016	7.4	7.5	7.6	7.7	7.7	7.8	7.7	7.5
3/8/2016	7.3	7.3	7.3	7.5	7.5	7.5	7.5	7.3
3/9/2016	7.0	7.1	7.1	7.3	7.3	7.3	7.3	7.1
3/10/2016	7.1	7.2	7.3	7.5	7.4	7.5	7.3	7.2
3/11/2016	7.1	7.1	7.2	7.3	7.3	7.3	7.3	7.2
3/12/2016	7.2	7.3	7.4	7.5	7.5	7.6	7.5	7.3
3/13/2016	6.9	6.9	6.9	7.0	7.0	7.0	7.1	7.0
3/14/2016	6.8	6.9	7.0	7.2	7.1	7.2	7.0	6.9
3/15/2016	7.1	7.1	7.3	7.4	7.4	7.4	7.3	7.1
3/16/2016	7.3	7.4	7.5	7.6	7.6	7.6	7.6	7.4
3/17/2016	7.5	7.5	7.6	7.7	7.7	7.7	7.7	7.5
3/18/2016	7.5	7.6	7.6	7.8	7.7	7.8	7.7	7.6
3/19/2016	7.7	7.8	7.9	8.1	8.0	8.1	8.0	7.8
3/20/2016	8.0	8.0	8.1	8.3	8.3	8.3	8.2	8.0
3/21/2016	8.1	8.2	8.4	8.5	8.5	8.6	8.3	8.1
3/22/2016	8.4	8.5	8.8	9.0	9.0	9.0	8.7	8.5
3/23/2016	8.2	8.3	8.5	8.7	8.6	8.7	8.6	8.3
3/24/2016	8.2	8.3	8.4	8.5	8.5	8.5	8.5	8.2
3/25/2016	8.3	8.4	8.6	8.7	8.7	8.7	8.5	8.3
3/26/2016	8.6	8.7	8.9	9.1	9.0	9.1	8.9	8.6
3/27/2016	8.8	8.9	9.1	9.3	9.2	9.3	9.1	8.9
3/28/2016	8.5	8.6	8.7	8.9	8.7	8.9	8.9	8.6
3/29/2016	8.6	8.7	9.2	9.5	8.8	8.9	8.9	8.7
3/30/2016	9.0	9.2	9.9	10.0	9.4	9.4	9.3	9.1
3/31/2016	9.8	10.0	10.2	10.3	10.5	10.4	10.1	9.8
4/1/2016	11.1	11.3	11.5	11.6	11.7	11.6	11.4	11.1
4/2/2016	11.8	12.1	12.1	12.2	12.3	12.2	12.2	11.7
4/3/2016	11.9	12.1	12.3	12.4	12.6	12.5	12.2	12.0

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
4/4/2016	11.6	11.8	11.8	11.9	12.0	11.9	12.0	11.7
4/5/2016	10.9	11.0	10.9	10.9	11.1	11.0	11.2	11.0
4/6/2016	10.8	11.0	11.3	11.3	11.4	11.4	11.1	11.0
4/7/2016	11.4	11.6	11.9	12.0	12.1	12.1	11.7	11.5
4/8/2016	12.1	12.3	12.6	12.7	12.8	12.7	12.4	12.1
4/9/2016	12.7	12.9	13.1	13.2	13.4	13.3	13.0	12.7
4/10/2016	12.0	12.2	12.5	12.6	12.7	12.7	12.3	12.1
4/11/2016	13.4	13.6	13.6	13.6	13.8	13.7	13.7	13.5
4/12/2016	13.2	13.4	13.4	13.4	13.5	13.4	13.5	13.3
4/13/2016	12.9	13.0	13.0	13.1	13.2	13.1	13.1	13.0
4/14/2016	12.4	12.5	12.4	12.4	12.5	12.4	12.7	12.5
4/15/2016	12.1	12.3	12.4	12.5	12.6	12.5	12.4	12.2
4/16/2016	12.6	12.8	12.8	12.9	13.0	12.9	12.9	12.7
4/17/2016	13.1	13.3	13.5	13.6	13.7	13.6	13.4	13.3
4/18/2016	14.0	14.2	14.4	14.4	14.5	14.5	14.3	14.1
4/19/2016	14.6	14.9	15.1	15.2	15.3	15.3	15.1	14.9
4/20/2016	15.1	15.4	15.6	15.7	15.8	15.8	15.7	15.5
4/21/2016	15.5	15.7	16.0	16.1	16.2	16.1	16.2	16.0
4/22/2016	14.6	14.8	14.9	15.1	15.2	15.2	15.1	15.0
4/23/2016	15.4	15.6	15.6	15.6	15.7	15.6	15.7	15.5
4/24/2016	15.2	15.3	15.3	15.3	15.5	15.4	15.5	15.3
4/25/2016	14.8	15.0	14.9	14.9	15.0	14.9	15.1	14.9
4/26/2016	14.8	14.9	14.9	14.9	15.0	15.0	15.1	14.9
4/27/2016	14.7	14.8	14.7	14.7	14.8	14.7	14.9	14.8
4/28/2016	14.4	14.6	14.6	14.7	14.8	14.7	14.7	14.6
4/29/2016	14.6	14.7	14.8	14.8	14.9	14.8	14.9	14.7
4/30/2016	14.5	14.7	14.9	15.0	15.1	15.0	14.9	14.7
5/1/2016	14.5	14.6	15.2	15.6	14.9	15.0	14.8	14.7
5/2/2016	14.4	14.6	15.4	15.7	15.0	15.0	14.9	14.8
5/3/2016	13.9	14.2	15.1	15.5	15.3	15.3	15.3	15.2
5/4/2016	16.0	16.2	15.9	15.6	16.3	16.2	16.4	16.2
5/5/2016	15.1	15.3	15.4	15.5	15.6	15.5	15.5	15.3
5/6/2016	14.4	14.5	14.6	14.7	14.9	14.8	14.7	14.6
5/7/2016	14.1	14.3	14.5	14.5	14.6	14.6	14.4	14.4
5/8/2016	15.6	15.8	15.8	15.9	16.0	15.9	16.0	15.8
5/9/2016	14.8	14.8	14.9	14.9	15.1	15.0	15.1	14.9
5/10/2016	14.1	14.2	14.3	14.3	14.4	14.4	14.4	14.3
5/11/2016	13.9	14.0	14.2	14.2	14.4	14.3	14.2	14.1
5/12/2016	12.8	12.8	12.9	13.0	13.2	13.1	13.0	12.9
5/13/2016	13.3	13.4	13.5	13.6	13.7	13.6	13.5	13.5
5/14/2016	14.4	14.5	14.6	14.6	14.7	14.6	14.6	14.6
5/15/2016	13.8	13.7	13.8	13.9	14.1	14.0	14.0	13.8
5/16/2016	12.6	12.4	12.6	12.7	12.8	12.8	12.7	12.6
5/17/2016	13.8	14.0	14.1	14.1	14.2	14.2	14.1	14.0
5/18/2016	15.0	15.2	15.2	15.3	15.4	15.3	15.3	15.2
5/19/2016	15.0	15.2	15.2	15.2	15.3	15.2	15.4	15.2
5/20/2016	14.8	15.0	15.1	15.1	15.2	15.2	15.1	15.0

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
5/21/2016	14.8	15.0	15.0	15.1	15.2	15.1	15.1	14.9
5/22/2016	14.9	15.1	15.2	15.2	15.4	15.3	15.2	15.1
5/23/2016	15.0	15.1	15.2	15.2	15.3	15.3	15.2	15.1
5/24/2016	15.4	15.5	15.7	15.7	15.8	15.8	15.6	15.5
5/25/2016	16.0	16.2	16.3	16.4	16.5	16.5	16.2	16.1
5/26/2016	16.2	16.4	16.4	16.4	16.5	16.5	16.5	16.3
5/27/2016	16.0	16.1	16.0	16.0	16.1	16.0	16.3	16.1
5/28/2016	15.9	16.0	16.0	16.0	16.1	16.1	16.1	16.0
5/29/2016	16.0	16.2	16.3	16.3	16.4	16.4	16.3	16.2
5/30/2016	16.2	16.3	16.4	16.4	16.6	16.5	16.4	16.3
5/31/2016	16.1	16.3	16.6	16.7	16.8	16.8	16.4	16.3
6/1/2016	16.4	16.5	16.7	16.8	16.9	16.8	16.6	16.5
6/2/2016	16.7	16.8	16.9	16.9	17.1	17.0	17.0	16.8
6/3/2016	16.7	16.9	17.0	17.0	17.2	17.1	17.0	16.9
6/4/2016	17.2	17.2	17.3	17.4	17.5	17.5	17.3	17.2
6/5/2016	17.2	17.0	17.2	17.3	17.4	17.4	17.1	17.0
6/6/2016	18.1	17.9	18.0	18.0	18.2	18.1	18.1	18.0
6/7/2016	20.0	20.1	20.2	20.3	20.4	20.3	20.5	20.2
6/8/2016	19.3	19.4	19.4	19.5	19.6	19.5	19.6	19.5
6/9/2016	18.7	18.9	18.9	18.9	19.1	19.0	19.1	18.9
6/10/2016	18.0	18.1	18.2	18.2	18.3	18.3	18.2	18.1
6/11/2016	18.0	18.1	18.1	18.1	18.2	18.1	18.3	18.2
6/12/2016	18.0	18.2	18.3	18.3	18.4	18.3	18.3	18.2
6/13/2016	18.1	18.2	18.1	18.1	18.2	18.1	18.3	18.2
6/14/2016	17.6	17.6	17.4	17.2	17.4	17.2	17.7	17.7
6/15/2016	17.4	17.4	17.4	17.2	17.4	17.3	17.5	17.5
6/16/2016	17.5	17.6	17.6	17.5	17.6	17.5	17.6	17.7
6/17/2016	17.7	17.8	17.8	17.7	17.8	17.7	17.8	17.9
6/18/2016	17.7	17.8	17.3	17.2	17.3	17.2	17.8	17.9
6/19/2016	17.3	17.4	17.8	17.7	17.8	17.8	17.8	17.9
6/20/2016	17.7	17.8	18.0	18.0	18.1	18.1	17.9	17.9
6/21/2016	18.5	18.7	18.9	18.9	19.1	19.0	18.6	18.7
6/22/2016	18.9	19.1	19.3	19.3	19.4	19.3	19.1	19.1
6/23/2016	19.0	19.2	19.4	19.5	19.6	19.6	19.2	19.2
6/24/2016	18.9	19.0	19.0	18.8	19.0	18.9	19.0	19.0
6/25/2016	18.8	18.9	19.0	19.0	19.1	19.0	18.9	19.0
6/26/2016	19.1	19.3	19.4	19.4	19.5	19.5	19.2	19.2
6/27/2016	18.5	18.8	19.5	19.6	19.7	19.7	19.1	19.0
6/28/2016	17.8	18.5	20.0	20.0	20.2	20.1	19.4	19.4
6/29/2016	20.5	21.2	21.8	21.8	22.0	21.9	21.5	21.4
6/30/2016	21.7	22.0	21.9	21.9	22.1	22.0	22.0	22.0
7/1/2016	21.3	21.5	21.6	21.6	21.7	21.6	21.6	21.6
7/2/2016	21.2	21.4	21.4	21.4	21.6	21.5	21.4	21.4
7/3/2016	20.8	20.9	20.9	20.9	21.0	20.9	21.0	21.0
7/4/2016	20.2	20.3	20.2	20.2	20.4	20.2	20.3	20.4
7/5/2016	19.9	20.0	20.0	20.0	20.1	20.0	20.0	20.1
7/6/2016	20.0	20.1	20.2	20.1	20.3	20.2	20.0	20.1

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
7/7/2016	20.0	20.1	20.1	20.1	20.2	20.1	20.1	20.1
7/8/2016	19.8	19.9	20.0	20.0	20.2	20.1	19.9	20.0
7/9/2016	18.9	19.1	19.5	19.6	19.7	19.6	19.1	19.3
7/10/2016	19.7	19.8	19.8	19.7	19.8	19.8	20.1	20.2
7/11/2016	19.9	20.0	20.1	20.0	20.1	20.1	20.1	20.1
7/12/2016	20.2	20.4	20.4	20.3	20.4	20.4	20.4	20.4
7/13/2016	20.3	20.5	20.6	20.6	20.7	20.6	20.5	20.5
7/14/2016	20.7	20.8	20.8	20.7	20.8	20.8	20.8	20.8
7/15/2016	20.7	20.8	20.8	20.7	20.8	20.7	20.8	20.8
7/16/2016	20.7	20.9	20.9	21.0	21.1	21.0	20.8	20.9
7/17/2016	20.1	20.2	20.5	20.7	20.8	20.8	20.5	20.5
7/18/2016	20.1	20.2	19.4	19.3	19.4	19.3	20.2	20.2
7/19/2016	20.1	20.2	20.3	20.2	20.3	20.3	20.2	20.2
7/20/2016	20.1	20.2	20.7	20.7	20.8	20.8	20.3	20.4
7/21/2016	20.2	20.3	20.6	20.8	20.8	20.9	20.7	20.7
7/22/2016	21.1	21.1	20.7	20.8	20.7	20.8	21.2	21.2
7/23/2016	21.1	21.2	21.3	21.2	21.1	21.2	21.3	21.3
7/24/2016	21.2	21.3	21.7	21.7	21.7	21.8	21.7	21.8
7/25/2016	20.0	20.2	21.7	22.1	22.1	22.3	21.3	21.2
7/26/2016	21.7	21.8	22.1	22.3	22.2	22.4	22.3	22.3
7/27/2016	21.3	21.5	22.3	22.7	22.6	22.8	21.9	21.8
7/28/2016	22.0	22.1	22.7	23.0	23.0	23.2	22.8	22.7
7/29/2016	21.5	21.8	22.6	23.0	23.0	23.2	23.3	23.1
7/30/2016	23.6	23.7	23.1	23.0	23.0	23.0	24.3	24.2
7/31/2016	23.9	23.9	23.0	22.7	22.6	22.6	24.1	24.0
8/1/2016	22.1	22.2	22.6	22.8	22.7	22.8	23.0	22.9
8/2/2016	21.6	21.5	21.3	21.3	21.3	21.3	22.1	22.1
8/3/2016	22.3	22.2	21.9	21.7	21.3	21.5	22.4	22.3
8/4/2016	22.3	22.3	22.4	22.4	22.4	22.5	22.5	22.4
8/5/2016	21.2	21.3	21.9	22.2	21.9	22.1	21.9	21.8
8/6/2016	22.3	22.2	21.8	21.6	22.0	22.0	22.5	22.3
8/7/2016	22.5	22.4	21.9	21.8	22.1	22.0	22.5	22.4
8/8/2016	22.0	21.9	20.9	20.7	21.4	21.1	22.1	21.9
8/9/2016	21.5	21.4	20.9	20.7	21.1	21.0	21.5	21.5
8/10/2016	21.4	21.4	21.6	21.4	21.5	21.5	21.7	21.6
8/11/2016	21.1	21.1	21.6	21.7	21.7	21.8	21.7	21.7
8/12/2016	21.6	21.7	22.2	22.3	22.1	22.3	22.0	22.0
8/13/2016	21.0	21.1	21.9	22.2	22.1	22.2	22.1	22.0
8/14/2016	20.7	20.7	21.6	21.9	22.1	22.1	22.5	22.6
8/15/2016	22.4	22.4	22.2	22.1	22.6	22.5	23.1	23.0
8/16/2016	23.2	23.3	23.2	23.2	23.3	23.4	23.6	23.5
8/17/2016	23.4	23.4	23.2	23.1	23.4	23.4	23.6	23.5
8/18/2016	22.7	22.7	22.7	22.8	23.2	23.1	23.1	22.9
8/19/2016	20.9	20.9	21.6	21.7	21.6	21.7	21.5	21.4
8/20/2016	21.0	21.0	21.3	21.4	21.3	21.4	21.3	21.3
8/21/2016	21.6	21.5	21.2	21.2	21.1	21.2	21.9	21.8
8/22/2016	21.7	21.5	20.9	20.5	20.4	20.4	21.5	21.4

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
8/23/2016	21.5	21.4	21.3	21.0	20.9	21.0	21.6	21.5
8/24/2016	21.6	21.5	21.4	21.3	21.2	21.3	21.7	21.6
8/25/2016	21.2	21.1	21.3	21.3	21.3	21.3	21.3	21.3
8/26/2016	21.1	21.0	21.4	21.4	21.4	21.5	21.4	21.4
8/27/2016	21.6	21.6	21.1	20.9	20.8	20.9	21.7	21.8
8/28/2016	21.5	21.5	21.2	20.9	20.8	20.8	21.7	21.6
8/29/2016	21.5	21.5	21.5	21.2	21.2	21.3	21.6	21.6
8/30/2016	21.5	21.4	21.0	21.0	20.9	20.9	21.6	21.6
8/31/2016	21.2	21.1	21.0	20.8	20.8	20.8	21.3	21.3
9/1/2016	20.9	20.8	19.9	19.7	19.6	19.6	21.0	21.0
9/2/2016	20.4	20.2	19.6	19.3	19.2	19.2	20.5	20.5
9/3/2016	20.2	20.0	19.4	19.1	19.1	19.1	20.3	20.3
9/4/2016	20.2	20.0	19.5	19.2	19.1	19.2	20.3	20.2
9/5/2016	20.1	20.0	19.6	19.3	19.2	19.2	20.2	20.1
9/6/2016	20.1	20.0	19.8	19.6	19.5	19.5	20.1	20.1
9/7/2016	20.0	19.9	19.5	19.3	19.3	19.3	20.1	20.1
9/8/2016	19.8	19.7	19.4	19.1	19.0	19.0	19.9	19.9
9/9/2016	19.7	19.5	19.3	19.0	18.9	18.9	19.9	19.8
9/10/2016	19.9	19.8	19.7	19.5	19.4	19.4	20.0	20.0
9/11/2016	19.9	19.7	19.4	19.1	19.0	19.0	20.0	19.8
9/12/2016	19.6	19.4	19.1	18.7	18.6	18.6	19.7	19.6
9/13/2016	19.3	19.1	18.7	18.4	18.4	18.4	19.5	19.4
9/14/2016	19.4	19.2	19.1	18.8	18.7	18.8	19.5	19.5
9/15/2016	19.6	19.5	19.4	19.2	19.2	19.2	19.7	19.7
9/16/2016	19.7	19.5	19.4	19.2	19.1	19.2	19.7	19.8
9/17/2016	19.4	19.4	19.0	18.8	18.8	18.8	19.5	19.5
9/18/2016	19.1	19.1	18.9	18.8	18.7	18.8	19.3	19.3
9/19/2016	18.8	18.7	18.5	18.4	18.4	18.4	18.8	18.9
9/20/2016	18.4	18.3	18.1	18.0	18.0	18.0	18.5	18.5
9/21/2016	18.3	18.1	17.9	17.5	17.5	17.5	18.4	18.5
9/22/2016	18.4	18.2	18.0	17.8	17.8	17.8	18.5	18.6
9/23/2016	18.6	18.4	17.5	17.3	17.3	17.2	18.6	18.6
9/24/2016	18.2	18.0	17.8	17.5	17.4	17.4	18.3	18.3
9/25/2016	18.3	18.2	18.2	18.0	18.0	18.0	18.5	18.6
9/26/2016	18.6	18.4	18.5	18.3	18.3	18.4	18.6	18.7
9/27/2016	18.8	18.7	18.7	18.6	18.6	18.7	18.9	18.9
9/28/2016	18.6	18.4	18.3	18.0	18.0	18.0	18.6	18.7
9/29/2016	18.4	18.2	18.1	17.8	17.8	17.8	18.5	18.5
9/30/2016	18.4	18.3	18.1	18.0	17.9	18.0	18.5	18.5
10/1/2016	18.1	17.8	17.5	17.3	17.2	17.2	18.1	18.2
10/2/2016	17.7	17.4	16.9	16.6	16.6	16.6	17.8	17.8
10/3/2016	17.5	17.1	16.7	16.4	16.4	16.4	17.5	17.5
10/4/2016	17.3	N/A	16.7	16.3	16.3	16.4	17.4	17.3
10/5/2016	17.2	N/A	16.6	16.3	16.3	16.3	17.2	17.1
10/6/2016	16.9	N/A	16.2	15.8	15.8	15.7	17.0	16.9
10/7/2016	16.7	N/A	16.2	15.9	16.0	15.9	16.8	16.7
10/8/2016	16.5	N/A	16.2	15.9	15.9	15.8	16.5	16.5

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
10/9/2016	16.3	N/A	15.8	15.5	15.6	15.5	16.4	16.3
10/10/2016	16.1	N/A	15.3	14.9	15.0	14.8	16.2	16.1
10/11/2016	15.7	N/A	14.8	14.2	14.3	14.1	15.8	15.7
10/12/2016	15.5	N/A	14.6	14.0	14.0	13.8	15.6	15.5
10/13/2016	15.4	N/A	14.5	14.1	14.1	14.0	15.5	15.4
10/14/2016	15.3	N/A	14.7	14.3	14.7	14.5	15.4	15.3
10/15/2016	15.2	N/A	14.4	14.0	15.1	14.8	15.3	15.2
10/16/2016	15.0	N/A	14.5	14.2	14.9	14.7	15.0	15.0
10/17/2016	15.0	N/A	14.9	14.6	15.0	14.9	15.1	15.0
10/18/2016	14.9	N/A	14.5	14.2	14.9	14.7	15.0	14.9
10/19/2016	14.8	N/A	14.3	13.9	14.7	14.5	14.9	14.8
10/20/2016	14.8	N/A	14.2	14.0	14.7	14.5	14.8	14.8
10/21/2016	14.5	N/A	14.1	13.8	14.4	14.3	14.6	14.5
10/22/2016	14.5	N/A	14.1	13.8	14.4	14.3	14.6	14.5
10/23/2016	14.5	N/A	14.2	14.0	14.5	14.3	14.6	14.5
10/24/2016	14.5	N/A	14.3	14.1	14.5	14.4	14.6	14.5
10/25/2016	14.5	N/A	14.3	14.1	14.5	14.4	14.6	14.5
10/26/2016	14.4	N/A	14.0	13.7	14.4	14.2	14.5	14.4
10/27/2016	14.3	N/A	14.0	13.9	14.3	14.1	14.4	14.3
10/28/2016	14.2	N/A	13.8	13.5	14.1	13.9	14.3	14.1
10/29/2016	14.1	N/A	13.5	13.3	14.0	13.8	14.2	14.1
10/30/2016	13.9	N/A	13.5	13.3	13.9	13.7	14.0	13.9
10/31/2016	13.8	N/A	13.3	13.1	13.7	13.5	13.9	13.7
11/1/2016	13.6	N/A	13.5	13.2	13.6	13.5	13.8	13.6
11/2/2016	13.7	N/A	13.5	13.4	13.7	13.6	13.9	13.8
11/3/2016	13.7	N/A	13.7	13.6	13.6	13.6	13.9	13.8
11/4/2016	13.7	N/A	13.6	13.6	13.6	13.5	13.9	13.8
11/5/2016	13.6	N/A	13.5	13.4	13.5	13.4	13.8	13.7
11/6/2016	13.5	N/A	13.4	13.4	13.4	13.3	13.7	13.6
11/7/2016	13.5	N/A	13.4	13.4	13.4	13.3	13.6	13.5
11/8/2016	13.4	N/A	13.4	13.3	13.3	13.3	13.6	13.5
11/9/2016	13.4	N/A	13.3	13.2	13.3	13.2	13.6	13.4
11/10/2016	13.4	N/A	13.3	13.3	13.3	13.2	13.6	13.4
11/11/2016	13.3	N/A	13.3	13.3	13.3	13.3	13.5	13.4
11/12/2016	13.3	N/A	13.3	13.3	13.3	13.2	13.5	13.4
11/13/2016	13.1	N/A	13.0	12.9	12.9	12.9	13.3	13.1
11/14/2016	12.9	N/A	12.9	12.8	12.8	12.7	13.1	13.0
11/15/2016	12.8	N/A	12.6	12.5	12.5	12.5	12.9	12.8
11/16/2016	12.6	N/A	12.3	12.2	12.2	12.1	12.7	12.6
11/17/2016	12.2	N/A	11.8	11.7	11.7	11.6	12.4	12.2
11/18/2016	12.0	N/A	11.7	11.6	11.6	11.5	12.1	12.0
11/19/2016	11.9	N/A	11.6	11.5	11.5	11.4	12.0	11.9
11/20/2016	11.7	N/A	11.6	11.5	11.5	11.5	11.9	11.8
11/21/2016	11.7	N/A	11.5	11.4	11.4	11.4	11.9	11.8
11/22/2016	11.8	N/A	11.5	11.3	11.3	11.3	11.9	11.8
11/23/2016	11.6	N/A	11.5	11.4	11.4	11.3	11.8	11.7
11/24/2016	11.4	N/A	11.1	11.0	11.0	10.9	11.6	11.5

Date	Low Level Outlet Pipe -Auto- (Deg. C)	Top of Reach 1 -Logger- (Deg. C))	End of Reach 1 -Logger- (Deg. C)	End of Reach 3 -Logger- (Deg. C)	Top of R4 Habitat Channel -Logger- (Deg. C)	End of R4 Habitat Channel -Logger- (Deg. C)	Tailrace at Pump Intake -Auto- (Deg. C)	Tailrace at Pump Intake -Logger- (Deg. C)
11/25/2016	11.3	N/A	11.3	11.2	11.2	11.2	11.5	11.4
11/26/2016	11.4	N/A	11.3	11.3	11.3	11.2	11.5	11.4
11/27/2016	11.2	N/A	11.0	10.9	10.9	10.8	11.4	11.2
11/28/2016	10.9	N/A	10.7	10.6	10.6	10.5	11.1	11.0
11/29/2016	10.7	N/A	10.4	10.2	10.2	10.2	10.9	10.8
11/30/2016	10.6	N/A	10.4	10.3	10.3	10.3	10.7	10.6
12/1/2016	10.5	N/A	10.0	9.9	9.9	9.8	10.6	10.5
12/2/2016	10.3	N/A	9.5	9.1	9.1	8.9	10.3	10.3
12/3/2016	10.0	N/A	9.3	9.0	9.0	8.8	10.1	10.0
12/4/2016	9.8	N/A	9.1	8.7	8.7	8.6	9.9	9.8
12/5/2016	9.5	N/A	8.2	7.7	7.7	7.5	9.5	9.4
12/6/2016	9.3	N/A	8.2	7.6	7.6	7.4	9.3	9.3
12/7/2016	8.7	N/A	7.1	6.5	6.5	6.3	8.6	8.6
12/8/2016	8.5	N/A	7.0	6.3	6.3	6.1	8.4	8.4
12/9/2016	7.9	N/A	6.8	6.3	6.3	6.1	7.8	7.8
12/10/2016	7.8	N/A	6.8	6.3	6.3	6.1	7.8	7.8
12/11/2016	7.5	N/A	6.6	6.2	6.2	6.0	7.5	7.5
12/12/2016	7.5	N/A	6.5	6.0	6.0	5.8	7.5	7.5
12/13/2016	7.3	N/A	5.7	5.1	5.1	4.9	7.3	7.3
12/14/2016	6.8	N/A	5.2	4.5	4.5	4.3	6.7	6.7
12/15/2016	6.6	N/A	5.5	5.0	5.0	4.8	6.6	6.6
12/16/2016	6.3	N/A	4.6	4.0	4.0	3.8	6.1	6.2
12/17/2016	5.6	N/A	3.9	3.2	3.2	3.0	5.5	5.6
12/18/2016	5.6	N/A	4.3	3.6	3.6	3.4	5.5	5.6
12/19/2016	5.7	N/A	4.6	4.1	4.1	3.9	5.7	5.7
12/20/2016	5.8	N/A	4.9	4.4	4.4	4.2	5.8	5.8
12/21/2016	6.2	N/A	5.4	4.9	4.9	4.8	6.1	6.2
12/22/2016	6.3	N/A	6.0	5.6	5.6	5.5	6.3	6.3
12/23/2016	6.3	N/A	5.8	5.4	5.4	5.3	6.4	6.4
12/24/2016	6.2	N/A	5.5	5.2	5.2	5.1	6.2	6.2
12/25/2016	6.0	N/A	4.9	4.4	4.4	4.3	5.9	6.0
12/26/2016	5.6	N/A	4.6	4.1	4.1	3.9	5.6	5.6
12/27/2016	5.5	N/A	4.8	4.3	4.3	4.2	5.5	5.5
12/28/2016	5.4	N/A	4.8	4.4	4.4	4.2	5.4	5.4
12/29/2016	5.4	N/A	5.2	4.9	4.9	4.8	5.4	5.4
12/30/2016	5.6	N/A	4.9	4.7	4.7	4.6	5.6	5.7
12/31/2016	5.4	N/A	4.5	4.1	4.1	3.9	5.4	5.4

APPENDIX C: MINIMUM FLOW DEVIATION REPORT

February 8, 2017
VIA ELECTRONIC FILING
Honorable Kimberly D. Bose, Secretary
Nathaniel I. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426
RE: Lake Chelan Hydroelectric Project No. 637 (Project)
Report on December 5, 2016 Chelan River Minimum Instream Flow Deviation
Dear Secretary Bose and Deputy Secretary Davis:
This letter is to provide you both notification and reporting regarding a minimum flow deviation that occurred at the Public Utility District No. 1 of Chelan County's (Chelan PUD) Lake Chelan Hydroelectric Project, FERC No. 637 on December 5, 2016. As explained below, Chelan PUD is providing late notification due to delayed communication between operations staff and the Compliance Department regarding the minimum instream flow deviation incident.
License Requirement
Article 405 requires Chelan PUD to implement the instream flows, ramping rates, and tailrace flows as set forth in Article 7 of the Lake Chelan Settlement Agreement and Chapter 7 of the Comprehensive Plan attached to the Settlement Agreement. The specific Chelan River instream flow requirement that is the subject of this deviation report is to maintain a minimum flow of 80 cfs in the Chelan River.
In accordance with FERC's Order Modifying and Approving Operations Compliance and Monitoring Plan, Article 405, issued November 30, 2007, when a minimum instream flow deviation occurs, Chelan PUD is required to notify the Federal Energy Regulatory Commission (Commission) and the Washington Department of Ecology (Ecology) of the deviation within 48 hours of the time that Chelan PUD became aware of the deviation. Following the initial notification, Chelan PUD is required to file a report with the Commission within 30 days of any deviation from minimum flow requirements, lake levels, or ramping rate requirements. The report must, to the extent possible, identify the cause, severity, and duration of the incident, any observed or reported adverse environmental impacts resulting from the incident, a description of any corrective measures implemented at the time of occurrence and the measures implemented or
proposed to ensure that similar incidents do not recur; and comments or correspondence, if any, received from the resource agencies and others regarding the incident.
Summary of Deviation and Review of Environmental Effects
Chelan PUD is required to provide a minimum instream flow of 80 cfs in the Chelan River. As standard procedure, the instream flow is released from the low level outlet (LLO). A flow of approximately 84 cfs had been provided for several days prior to the incident.
The deviation occurred on December 5, 2016 between 1355 hours and 1600 hours. Flow readings from the flow meter on the LLO dropped below 80 cfs on 5
minute reading intervals between the
hours identified previously, except for readings taken at 1505, 1510, and 1515 hours, where these readings were above 80 cfs. The lowest flow, 76.39 cfs, occurred at 1405 hours. Flows during the
two-hour period ranged from 76.39 cfs to 72.58 cfs. All flow prior to 1355 hours on December 5 and after 1600 hours on December 5
have been above the 80 cfs minimum flow requirement.
Chelan PUD compliance staff were notified of the flow deviations on January 16, 2016.

The suspected cause of the flow deviation is that the LLO flow control gate was stuck in a position higher than the gate stem setting due to water pressure from Lake Chelan on the back side of the control gate. Declining lake levels from to generation at the Lake Chelan powerhouse allowed the gate to release and drop due to reduction of water pressure. The linkage controlling the gate has been observed to have some play in the attachment that likely caused the gate to shift
slightly.
Due to the short duration and slight deviation in flow, this incident is unlikely to have caused any ecological damage to the Chelan River, particularly to fish inhabiting the river. Water temperatures in the Chelan River were quite cold, so fish would be exhibiting overwinter behavior by hiding in the substrate. Water levels recorded at the USGS gage downstream of the LLO showed only a one inch drop in elevation at the lowest point during the incident compared to the average water level prior to the incident. Because water surface elevations in the Chelan River Habitat Channel did not drop significantly, Chinook salmon eggs and alevins incubating in redds constructed in the channel during the fall spawning period would have not been affected.
Remedial Action
Chelan PUD compliance and operations staff have investigated the cause of the incident and reason for delayed communication. The following improvements are being implemented:
1. Perform gate linkage improvements to eliminate play in linkage to prevent unintended gate movements in the future;
2. Develop clear protocols for automatic deviation alerts for operations staff and
3. Reinforce with operating personnel the importance of immediate deviation notifications to compliance staff to ensure timely reaction and Commission notification.

Chelan PUD is concurrently providing this letter to the Chelan River Fishery Forum and will provide any comments received to the Commission. Please contact me should you have any questions regarding this incident.
Thank you,
7fefftey G. Osbom
License Compliance Supervisor
jeff.osbomchelanpud.org
(509)661-4176
cc: FERC, Doug Johnson and Erich Gaedeke
Washington Department of Ecology, Breean Zimmerman
Chelan River Fishery Forum

APPENDIX D: CONSULTATION RECORD

On April 27, 2017, Chelan PUD provided a draft of the 2016 Annual Flow Report to the USGS and members of the CRFF and LCRF in accordance with the requirements of the FERC Order Modifying and Approving Operations Compliance and Monitoring Plan, Article 405, under Ordering Paragraph (B):

> "The licensee shall allow the resource agencies, Tribes and non-governmental organizations specified under Article 405, 30 days to provide comments and/or recommendations on their report before filing with the FERC. The filing shall include comments and/or recommendations from the consulted entities and the licensee's response to any comments. If the licensee does not adopt a recommendation, the report shall include the licensee's reasons, based on project-specific information."

The following individuals were sent draft copies for a 30-day review period. No comments were received.

NAME	***AGENCY***	***Comments***
Zimmrman, Breean	Washington State Department of Ecology	-
Peterschmidt, Mark	Washington State Department of Ecology	-
Bowen, David	Washington State Department of Ecology	-
Pacheco, Jim	Washington State Department of Ecology	-
Korth, Jeffrey	Washington State Department of Fish and Wildlife	-
Simon, Graham	Washington State Department of Fish and Wildlife	-
Maitland, Travis	Washington State Department of Fish and Wildlife	-
Grover Wier, Kari	United States Department of Agriculture – Forest Service	-
Willard, Paul	United States Department of Agriculture – Forest Service	-
Johnson, Emily	United States Department of Agriculture – Forest Service	-
Martinez, Alex	United States Department of Agriculture – Forest Service	-
Rawhouser, Ashley	National Park Service	-
Anthony, Hugh	National Park Service	-
Lewis, Steve	United States Fish and Wildlife Service	-
Yeager, Justin	National Marine Fisheries Services	-
Towey, Bill	Confederated Tribes of the Colville Reservation	-
Rose, Bob	Yakama Indian Nation	-
Merkle, Carl	Confederated Tribes of the Umatilla Indian Reservation	-
Cooney, Mike	City of Chelan	-
Archibald, Phil	Lake Chelan Sportsman Association	-
Elwell, Nick	United States Geological Survey	-
Ernsberger, Tom	Washington State Parks and Recreation Commission	-
Snell, Nona	Washington State Recreation and Conservation Office	-
Uhlhorn, Richard	Lake Chelan Recreation Association	-
O'Keefe, Thomas	American Whitewater	-

From: Hays, Steve

Sent: Thursday, April 20, 2017 4:29 PM
To: 'Breean Zimmerman (bzim461@ecy.wa.gov)' <bzim461@ecy.wa.gov>; 'Peterschmidt, Mark F. (ECY) (mape461@ecy.wa.gov)' <MAPE461@ECY.WA.GOV>; 'david.bowen@ecy.wa.gov' <david.bowen@ecy.wa.gov>; 'Jim Pacheco' <jpac461@ecy.wa.gov>; 'Korth, Jeffrey ' <Jeffrey.Korth@dfw.wa.gov>; 'Graham Simon' <Graham.Simon@dfw.wa.gov>; 'travis.maitland@dfw.wa.gov' <travis.maitland@dfw.wa.gov>; 'Kari Grover Wier' <kgroverwier@fs.fed.us>; 'pwillard@fs.fed.us' <pwillard@fs.fed.us>; 'Emily Johnson (ekjohnson@fs.fed.us)' <ekjohnson@fs.fed.us>; 'Alex Martinez (ramartinez@fs.fed.us)' <ramartinez@fs.fed.us>; 'Ashley_Rawhouser@nps.gov' <Ashley_Rawhouser@nps.gov>; 'Hugh_Anthony@nps.gov' <Hugh_Anthony@nps.gov>; 'Steve Lewis (Stephen_Lewis@fws.gov)' <Stephen_Lewis@fws.gov>; 'Justin Yeager (Justin.Yeager@noaa.gov)' <Justin.Yeager@noaa.gov>; 'Bill Towey' <bill.towey@colvilletribes.com>; 'Bob Rose (rosb@yakamafish-nsn.gov)' <rosb@yakamafish-nsn.gov>; 'Carl Merkle (carlmerkle@ctuir.com)' <carlmerkle@ctuir.com>; 'mcooney@cityofchelan.us' <mcooney@cityofchelan.us>; 'Phil Archibald (ndmarkey@gmail.com)' <ndmarkey@gmail.com>; 'Nick Elwell' <'nelwell@usgs.gov'>; 'tom.ernsberger@parks.wa.gov' <tom.ernsberger@parks.wa.gov>; 'nona.snell@rco.wa.gov' <nona.snell@rco.wa.gov>; 'Richard Uhlhorn (richard@richarduhlhorn.com)' <richard@richarduhlhorn.com>; 'Thomas O'Keefe (okeefe@amwhitewater.org)' okeefe@amwhitewater.org

Cc: Osborn, Jeff <Jeff.Osborn@chelanpud.org>; Smith, Michelle <michelle.smith@chelanpud.org>; Sokolowski, Rosana <Rosana.Sokolowski@chelanpud.org>; Clement, Marcie <Marcie.Clement@chelanpud.org>; Bitterman, Deborah <Deborah.Bitterman@chelanpud.org>; Willard, Catherine <Catherine.Willard@chelanpud.org>; Underwood, Alene <Alene.Underwood@chelanpud.org>; Hopkins, Scott <Scott.Hopkins@chelanpud.org>; Von Reis, Charles Charles.VonReis@chelanpud.org

Subject: 30-Day Review and Comment Period - Draft Lake Chelan Annual Flow and Temperature Report 2016

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:
Chelan River Fishery Forum
Washington Department of Ecology
Washington Department of Fish and Wildlife
United States Forest Service
National Park Service
United States Fish and Wildlife Service
National Marine Fisheries Service
CCT (Colville)
YN (Yakama)
CTUIR (Umatilla tribe)
City of Chelan
Lake Chelan Sportsman Association
United States Geological Survey
Washington State Parks and Recreation Commission
Washington State Recreation and Conservation Office
Lake Chelan Recreation Association
American Whitewater

From:
Steven Hays, Fish & Wildlife Senior Advisor
Public Utility District No. 1 of Chelan County (Chelan PUD)
steve.hays@chelanpud.org
(509)661-4181

Re:
Lake Chelan Hydroelectric Project No. 637 (Project)
30 Day Review and Comment Period – Draft Lake Chelan Annual Flow and Temperature Report 2016

Dear Chelan River Fishery Forum and Other Parties:

The Draft Lake Chelan Annual Flow and Temperature Report 2016 is attached for your review and comment. The review period is 30 days.

Please submit your comment letters on or before 5:00 p.m., May 29, 2017, to Steve Hays via email at steve.hays@chelanpud.org. In order to facilitate documentation of your comments and Chelan PUD's responses to comments regarding significant substantive issues, please provide those comments and any supportive rationales or data in a separate document so that it can be incorporated into the record of consultation. I have provided the report in PDF format. However, upon request I will provide a copy in MSWORD if you wish to propose editorial changes using the review features in MSWORD to make your suggested edits.

All comments received will be incorporated into a summary table and appended to the Final Lake Chelan Annual Flow and Temperature Report 2016, with a notation regarding how each comment or recommendation was incorporated in the report, or, if not incorporated, the reasons why the comment was not incorporated.

If you have any questions, please do not hesitate to contact me at (509-661-4181) or by email.

Steven Hays
Fish and Wildlife Senior Advisor
steve.hays@chelanpud.org
(509) 661-4181