THE 2018 SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT

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Executive Summary

The 2018 Nechako River Summer Water Temperature and Flow Management Project was undertaken to attempt to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C between July 20 and August 20. Water temperatures were managed by regulating Skins Lake Spillway releases to control flows in the Nechako River below Cheslatta Falls and at Vanderhoof. In 2018, mean daily water temperatures in the Nechako River above the Stuart River confluence did exceed 20.0°C during the control period (July 20 – August 20) on three occasions, reaching a maximum temperature of 20.6°C.

Over the duration of the 2018 Summer Water Temperature and Flow Management Project (July 10 to August 20), the total volume of water released was 8,853.9 m^3/s-d, and the average release during the Project was 211 m^3/s.

Disclaimer

This report is rendered solely for the use of the Nechako Fisheries Compensation Program (NFCP) in connection with the 2018 Summer Water Temperature and Flow Management Project, and no person may rely on it for any other purpose without Triton Environmental Consultants Ltd.'s prior written approval. Should a third party use this report without Triton's approval, they may not rely upon it. Triton accepts no responsibility for loss or damages suffered by any third party as a result of decisions made or actions taken based on this report.

- This report is based on facts and opinions contained within the referenced documents, including the results of any data collection programs carried out in relation to this report. We have attempted to identify and consider facts and documents relevant to the scope of work, accurate as of the time period during which we conducted this analysis. However, the results, our opinions, or recommendations may change if new information becomes available or if information we have relied on is altered.
- We applied accepted professional practices and standards in developing and interpreting data. While we used accepted professional practices in interpreting data provided by third party sources, we did not verify the accuracy of any such data.
- This report must be considered as a whole; selecting only portions of this report may result in a misleading view of the results, our opinions, or recommendations.

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1.0 Introduction

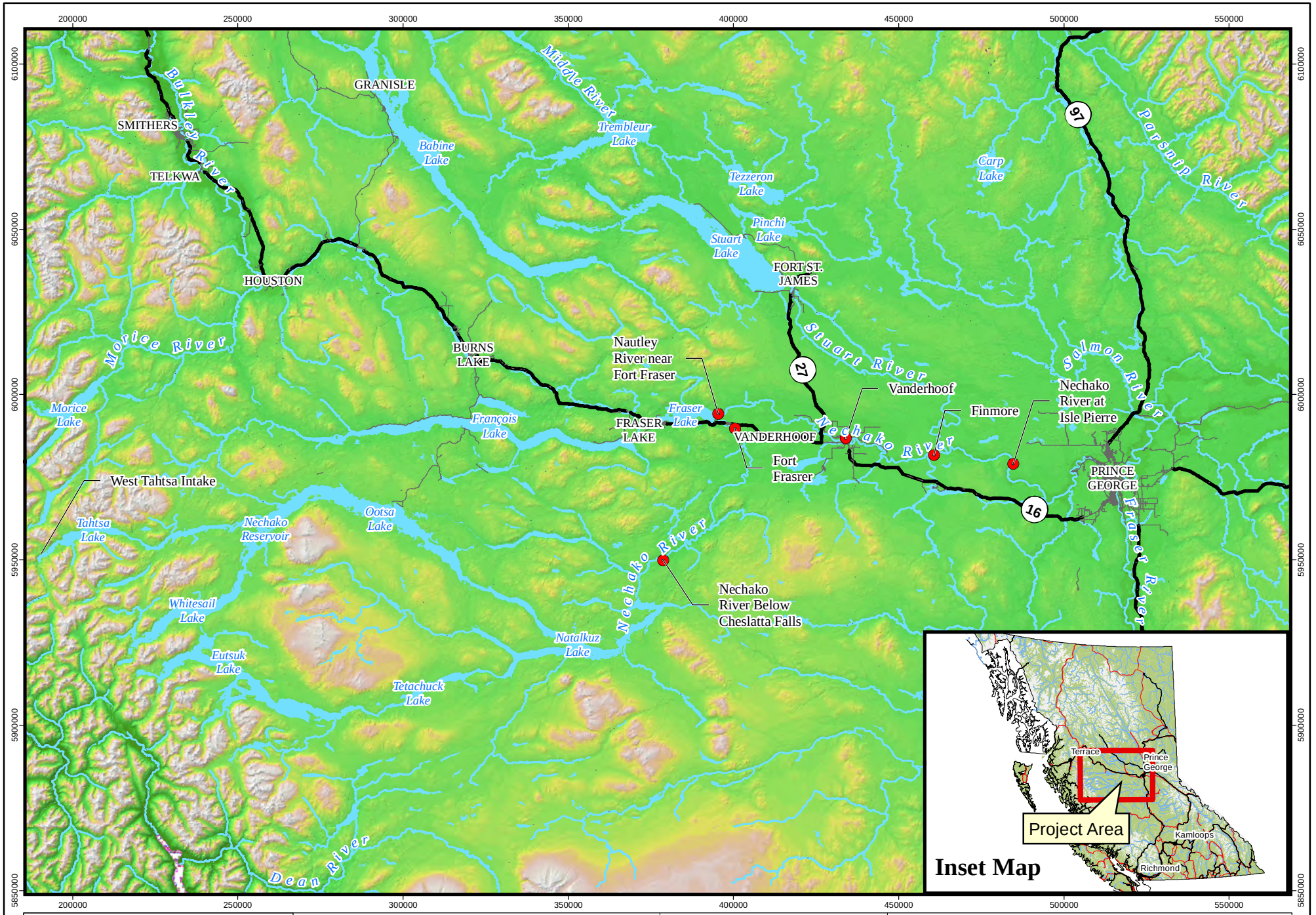
The Nechako River Summer Water Temperature and Flow Management Project (STMP; the Project) was designed and developed in 1982 and has been successfully implemented since 1983. Since 1988, water temperature and flow management projects (Triton 1988 through 1995; Triton 1996 through Triton 2010; Triton 2013 through Triton 2017) have been carried out under the auspices of the Nechako Fisheries Conservation Program (NFCP; NFCP 2016).

The objective of the Project is to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C by regulating releases from the Skins Lake Spillway (SLS). The Project operates from July 10 to August 20 (the operational period) with the goal of managing water temperatures in the Nechako River at Finmoore between July 20 and August 20 (the water temperature control period, hereafter referred to as the control period). At the completion of the Project, flows in the Nechako River below Cheslatta Falls (NRBCF) are reduced to fall spawning flows by early September.

The Project study area is shown in Figure 1. Unless otherwise stated, references to water temperature, flow (including releases), and meteorological data are mean daily values. Note that water temperature measurements for the Nechako River above the Stuart River confluence are taken at Finmoore and NRBCF (the closest readily accessible locations), while river discharge measurements are taken at Vanderhoof (at the Water Survey of Canada discharge measuring site).

This report reviews the 2018 STMP and includes:

- An outline of the method for determining SLS releases and summaries of the 2018 SLS releases for the period July 10 to August 20 inclusive;
- Recorded flows and water temperatures (July 10 to August 20) at various locations along the Nechako River; and
- The volume of cooling water used in the 2018 STMP.



Nechako Fisheries Conservation Program

Figure 1. Nechako River Study Area

Legend

- WSC Sites
- Stream
- Road
- Waterbody
- Highway

0 5 10 20 30 40 50 Kilometers

Scale: 1:1,500,000

N W E S

File No: N:\ACTIVE\4927__MoE\MXD\RalphsMaps\Figure_1.mxd

Project No:	4801
Date:	Nov 15, 2013
Basemap Source:	Orthophoto
Map Datum:	NAD 1983 UTM Zone 10N

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2.0 Methods

Management of the Nechako River flows and water temperatures relied upon water temperature predictions based on five-day meteorological forecasts provided by Environment Canada to determine the schedule of SLS releases required to meet project objectives. The Project uses an unsteady-state flow routing model and an unsteady-state water temperature prediction model designed to compute daily flows and water temperatures in the Nechako River during the operational period of July 20 – August 20 (Envirocon Limited 1984a,b,c, and 1985).

Daily operations followed the protocol defined in the Settlement Agreement (Anon., 1987), and involved collection of water temperature and river stage and discharge data from five locations in the study area, as well as development of five-day meteorological forecasts.

Water temperatures were obtained daily from temperature loggers maintained in the NRBCF (at Bert Irvine's Lodge), in the Nechako River at Fort Fraser (upstream of the Nautley River), in the Nechako River above the Stuart River confluence, and in the Nautley River. Water temperature data for the NRBCF and the Nautley River were provided by Water Survey of Canada. Water temperature data in the Nechako River at Fort Fraser and in the Nechako River above the Stuart River confluence were obtained using Unidata 6570A temperature probes and downloaded from the Rom Communications (RomComm) website (http://www.romcomm.com/).

River stages were obtained daily from Water Survey of Canada recorders maintained in the NRBCF (Station 08JA017), in the Nechako River at Vanderhoof (Station 08JC001), and in the Nautley River (08JB003), and were obtained daily via the Environment Canada (Water Survey of Canada (WSC) website https://wateroffice.ec.gc.ca/search/real_time_e.html). Five-day meteorological forecasts were downloaded daily from Environment Canada's server.

The first 10 days of the operational period, July 10 to July 19, were utilized for system start-up, for initialization of the database required to schedule SLS releases, and to increase flows in the Nechako River from spring flows to the minimum cooling flow of 170 m³/s below Cheslatta Falls. Due to higher than normal reservoir levels and estimated snowpack, discharge at the SLS at the start of the operational period was higher than typical years (144 m³/s). Upon commencement of the operational period on July 10, the recorded flow in the NRBCF was 134 m³/s. The SLS was increased to 226.5 m³/s on July 13 to ensure flows in the NRBCF reached the minimum cooling flow of 170 m³/s by July 20 (the beginning of the water temperature control period).

Throughout the operational period, water temperatures in the Nechako River were calculated daily for the previous day, the current day, and each of the next four days using the unsteady-state flow routing and water temperature prediction models. These calculations were based on recorded and five-day forecast meteorological data, recorded water temperature, and computed flow data. Forecast water temperature

predictions were tabulated and reviewed daily to identify trends in water temperature changes.

These trends are the same as those used in the water temperature and flow management projects since 1984 (Envirocon Ltd. 1985), as illustrated by Table 1.

Table 1. Daily operations to manage water temperatures in the Nechako River above the Stuart River confluence

Daily Operations to Manage Water Temperatures in the Nechako River above the Stuart River Confluence

Date	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul*	17-Jul	18-Jul	19-Jul	20-Jul
Fifth Day's Predicted Water Temperature @ Date + 4 Days								a5	b5	c5
Fourth Day's Predicted Water Temperature @ Date + 3 Days							a4	b4	c4	
Third Day's Predicted Water Temperature @ Date + 2 Days						a3	b3	c3		
Second Day's Predicted Water Temperature @ Date + 1 Day					a2	b2	c2			
Current Day's Predicted Water Temperature @ Date				a1	b1	c1				
Previous Day's Calculated Water Temperature @ Date - 1 Day			as	bs	cs					
Previous Day's Recorded Water Temperature @ Date - 1 Day			ao	bo	co					
Current Day's Release @ Date				ra	rb	rc				

observed trend

predicted trend

forecast trend

* The current day (i.e., the day of operation) for this example is July 16.

Assuming the current day is July 16, entries corresponding to the current day's operation are represented by the letter *c*. Entries *co* and *cs* represent the recorded and calculated water temperatures, respectively, for the previous day (July 15).

Entries *c1* through *c5* represent predicted water temperatures computed using the current day's five-day meteorological forecast and an assumed current day's flow regime. The entry *rc* represents the current day SLS release required to meet Project objectives.

The following three trends in water temperature changes were reviewed on a day-by-day basis (shown numerically in Appendix 1):

1. Observed trend – developed from recorded mean daily water temperatures measured in the Nechako River above the Stuart River confluence each day (*bo* and *co* in Table 1). The difference in recorded water temperatures for the previous two days is extrapolated over the next five days to determine the observed water temperature trend.
2. Predicted trend – developed from the predicted water temperatures for the previous day and the following five days (*cs, c1, c2, c3, c4, c5*, in Table 1). These data represent the predicted trend.
3. Forecast trend – developed from the difference between the current five-day and previous five-day predictions for the same calendar days (*c3* and *b4, c2* and *b3, c1* and *b2* in Table 1). Differences between forecasted data on coincident dates for the current day and the next two days only are averaged and added to the fifth day's predicted temperature to determine the trend in forecasted temperatures.

Each day, predicted water temperatures for the five-day forecast period were checked and the three trends calculated. If two of the three trends indicated that the water temperature in the Nechako River above the Stuart River confluence could potentially exceed 19.4°C, then an increase in the SLS release was required. When this occurred, the current day's release was revised, and the flow and temperature models were re-run using the modified flow regime. Results of each day's final computer run were subsequently used to initialize water temperatures for the following day's computations. Entries in Table 1 represent each day's final cooling water release and resultant predicted water temperatures.

The following release criteria were used with the three trends identified above to determine the timing and magnitude of Skins Lake Spillway releases:

1. When two of the three trends show an increase in water temperature in the Nechako River above the Stuart River confluence, and these trends show that the water temperature could potentially exceed 19.4°C, increase the SLS release according to criteria 2 and 3 below.
2. Operate SLS such that flow in the NRBCF ranges between 170 m^3/s and 283 m^3/s, as required, and flow in the Nechako River above the Stuart River confluence (as measured at Vanderhoof) does not exceed 340 m^3/s. The flow in the NRBCF is adjusted to be no less than 170 m^3/s by the beginning of the control period and is reduced to approximately 31.9 m^3/s by September 1.
3. At any time, increase the SLS release from the current level to 453 m^3/s to achieve the flow changes in the Nechako River as quickly as possible.

4. During cooling periods when two of three trends in forecasted water temperatures are decreasing and these trends indicate that the water temperature could potentially drop below 19.4°C within the forecast period (five days), reduce the SLS release from the current level to 14.2 m^3/s.

3.0 Results

Predicted and recorded mean daily water temperatures for the Nechako River above the Stuart River confluence, SLS releases, and changes in SLS releases over the duration of the Project operational period are summarized in Table 2 and Table 3.

Mean daily water temperatures recorded during the control period in the Nechako River above the Stuart River confluence (Figure 2 and Table 4) did exceed 20.0°C on three occasions (July 30, July 31, and August 1) during the 2018 STMP. The respective maximum and minimum mean daily water temperatures recorded during the control period were 20.6°C on July 31 and 17.0°C on August 19. Mean daily water temperatures in the NRBCF, near Fort Fraser and above the Stuart River confluence, and in the Nautley River near Fort Fraser are presented in Appendix B.

Skins Lake Spillway releases and their corresponding flows in the Nechako River below Cheslatta Falls and at Vanderhoof are plotted in Figure 3 (source data are provided in Appendix C). Changes in Skins Lake Spillway releases during the STMP were made on the following dates:

1. July 11 – Increase to 136 m^3/s – to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
2. July 13 – Increase to 226.5 m^3/s – to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
3. July 20 – Increase to 453.1 m^3/s – to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
4. July 23 – Decrease to 283 m^3/s – to limit flow in Nechako River below Cheslatta Falls to a maximum of 283 m^3/s.
5. July 30 – Decrease to 14.2 m^3/s – to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
6. August 1 – Increase to 453.1 m^3/s – to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
7. August 3 – Decrease to 283 m^3/s – to limit flow in Nechako River below Cheslatta Falls to a maximum of 283 m^3/s.
8. August 8 – Decrease to 14.2 m^3/s – to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
9. August 10 – Increase to 453.1 m^3/s – to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
10. August 12 – Decrease to 14.2 m^3/s – to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
11. August 14 – Increase to 32 m^3/s – to set flows at estimated fall spawning flows due to evacuation order at the SLS.

12. August 15 – Decrease to 27 m^3/s – to prepare for fall spawning flows as a result of the evacuation order.
13. September 7 – Increase to 30.9 m^3/s – to ensure flow in Nechako River below Cheslatta Falls is maintained at fall spawning flow.

During the control period, measured flows in the Nechako River below Cheslatta Falls (based on preliminary WSC data from the WSC data collection platform at Bert Irvine's Lodge) ranged between a maximum of 294 m^3/s on August 8 and a minimum of 102 m^3/s on August 20. Flows measured in the Nechako River at Vanderhoof ranged between a maximum of 349 m^3/s on July 27 and a minimum of 156 m^3/s on August 20.

Table 2. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 2018)

JULY

Date	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
5th Day's Predicted Water Temperature at Date + 4 Days					20.0	19.1	20.7	20.0	20.5	19.8	18.9	17.3	16.8	19.1	19.7	19.1	20.0	21.1	20.8	20.7	20.9	20.9
4th Day's Predicted Water Temperature at Date + 3 Days				20.3	19.2	20.4	20.0	20.5	20.3	20.1	18.7	16.7	17.7	19.1	18.7	19.4	20.2	20.4	20.5	20.7	20.8	20.6
3rd Day's Predicted Water Temperature at Date + 2 Days			20.6	19.8	19.9	20.0	20.1	20.5	20.9	20.1	18.4	17.0	17.8	18.5	18.8	19.3	19.9	20.1	20.3	20.5	20.8	20.9
2nd Day's Predicted Water Temperature at Date + 1 Day		21.5	20.3	20.2	19.9	20.1	20.6	21.0	20.8	20.0	17.8	17.2	17.8	18.5	18.6	19.3	19.4	19.6	19.9	20.2	20.8	20.9
Current Day's Predicted Water Temperature at Date	20.4	20.5	20.0	20.1	19.8	20.4	20.7	21.0	20.8	19.5	18.4	17.4	18.3	18.4	18.4	18.6	18.9	19.1	19.4	19.9	20.4	20.8
Previous Day's Calculated Water Temperature at Date - 1 Day	20.3	19.8	19.9	19.9	19.6	20.2	20.6	21.0	20.4	19.6	18.3	17.6	18.0	18.2	18.1	18.4	18.6	18.9	19.2	19.7	20.2	20.5
Previous Day's Recorded Water Temperature at Date - 1 Day	18.7	19.4	19.3	19.3	19.1	19.1	20.8	20.1	20.4	20.4	19.9	18.5	17.9	18.6	18.2	17.9	18.2	18.6	18.8	19.1	19.5	20.2
Current Day's Skins Lake Spillway Release at Date (m^3/s)	49	49 to 136 @ 0800 hrs	136	136 to 226.5 @ 0800 hrs	226.5	226.5	226.5	226.5	226.5	226.5	226.5 to 453 @ 1600 hrs	453	453	453 to 283 @ 1600 hrs	283	283	283	283	283	283	283 to 14.2 @ 1600 hrs	14.2

Table 3. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (August 2018)

	AUGUST																				
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
5th Day's Predicted Water Temperature at Date + 4 Days	20.2	19.6	18.7	19.9	20.1	20.3	20.6	20.0	20.0	19.4	19.3	19.5	19.7	19.4	19.1	19.3	18.7	19.0	18.8	19.0	
4th Day's Predicted Water Temperature at Date + 3 Days	20.4	19.3	20.2	19.9	19.9	20.2	20.1	20.0	19.7	20.5	19.6	19.5	19.7	19.5	19.4	19.0	19.2	18.8	18.8	19.2	
3rd Day's Predicted Water Temperature at Date + 2 Days	20.4	20.6	20.0	20.1	19.9	19.9	20.2	19.9	20.5	20.2	19.5	19.7	19.0	19.4	19.3	19.3	18.8	18.9	18.8	19.2	
2nd Day's Predicted Water Temperature at Date + 1 Day	21.0	20.2	20.7	20.3	19.5	20.4	19.9	20.3	20.3	19.8	19.7	18.6	18.8	19.0	19.1	18.5	19.0	18.6	18.5	18.7	
Current Day's Predicted Water Temperature at Date	20.3	20.5	20.2	19.5	20.0	20.1	19.8	19.8	19.6	19.5	18.9	18.3	18.3	18.1	17.9	18.4	18.1	17.8	17.6	18.0	
Previous Day's Calculated Water Temperature at Date - 1 Day	20.2	19.9	19.7	19.6	19.8	20.0	19.6	19.3	19.3	19.2	18.6	17.9	17.7	17.5	17.7	17.7	17.8	17.2	17.1		
Previous Day's Recorded Water Temperature at Date - 1 Day	20.6	20.3	19.7	19.5	19.4	19.7	19.8	19.2	19.2	19.4	19.3	18.6	18.1	17.7	17.5	17.8	17.6	17.6	17.5	17.1	
Current Day's Skins Lake Spillway Release at Date (m^3/s)	14.2 to 453 @ 1600 hrs	453	453 to 283 @ 1600 hrs	283	283	283	283	283 to 14.2 @ 1600 hrs	14.2	14.2 to 453 @ 1600 hrs	453	453 to 14.2 @ 1600 hrs	14.2	14.2 to 32 @ 1600 hrs	32	32	32	32	32	32	

Table 4. Recorded mean daily water temperatures in the Nechako River above the Stuart River confluence

Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2018

Date	Water Temperature (°C)	Date	Water Temperature (°C)
10-Jul	19.4	01-Aug	20.3
11-Jul	19.3	02-Aug	19.7
12-Jul	19.3	03-Aug	19.5
13-Jul	19.1	04-Aug	19.4
14-Jul	19.1	05-Aug	19.7
15-Jul	20.8	06-Aug	19.8
16-Jul	20.1	07-Aug	19.2
17-Jul	20.4	08-Aug	19.2
18-Jul	20.4	09-Aug	19.4
19-Jul	19.9	10-Aug	19.3
20-Jul	18.5	11-Aug	18.6
21-Jul	17.9	12-Aug	18.1
22-Jul	18.6	13-Aug	17.7
23-Jul	18.2	14-Aug	17.5
24-Jul	17.9	15-Aug	17.8
25-Jul	18.2	16-Aug	17.6
26-Jul	18.6	17-Aug	17.6
27-Jul	18.8	18-Aug	17.5
28-Jul	19.1	19-Aug	17.0
29-Jul	19.5	20-Aug	17.1
30-Jul	20.2		
31-Jul	20.6		

Figure 2. Recorded mean daily temperatures in the Nechako River above the Stuart River confluence

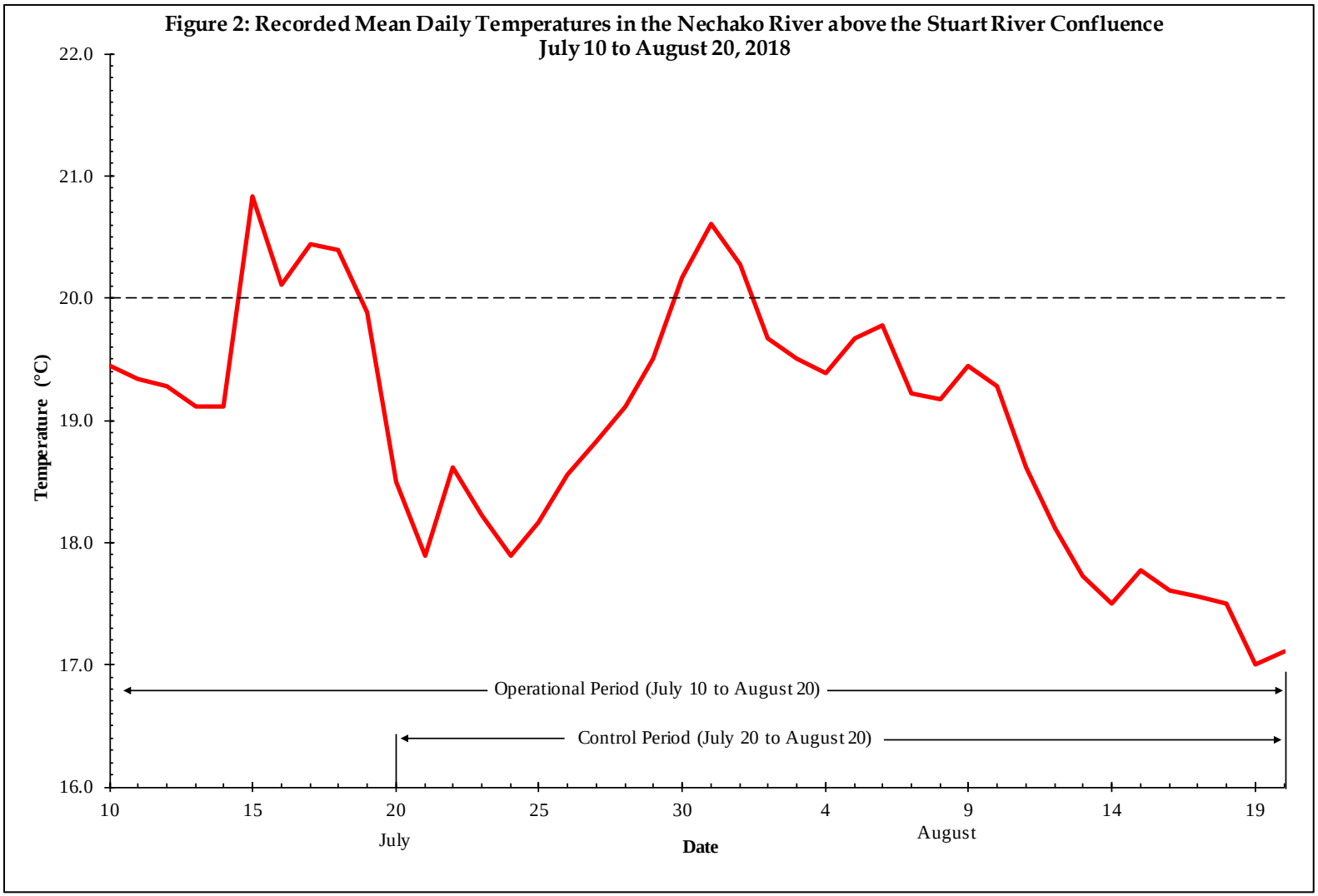
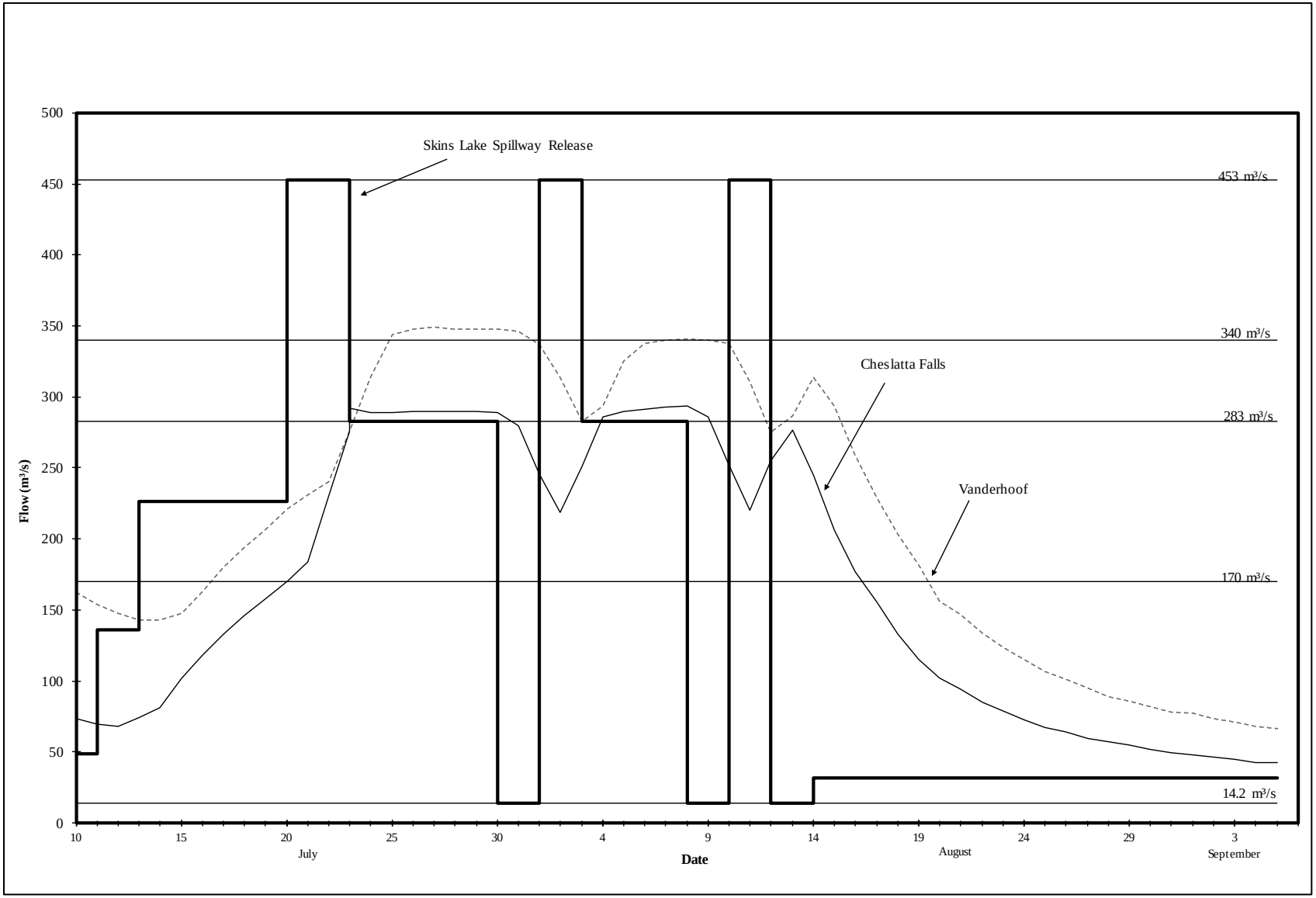


Figure 3. Skins Lake Spillway releases and flows in the Nechako River below Cheslatta Falls and at Vanderhoof



4.0 Discussion

The discussion of the 2018 STMP has been divided into three sections. The first section reviews the collection and use of recorded field data, including water temperature, flow, and meteorological data (recorded and forecast). The second section discusses the volume of water used during the 2018 STMP. The third section provides a brief discussion of the application of the Project release criteria.

4.1 Recorded Data

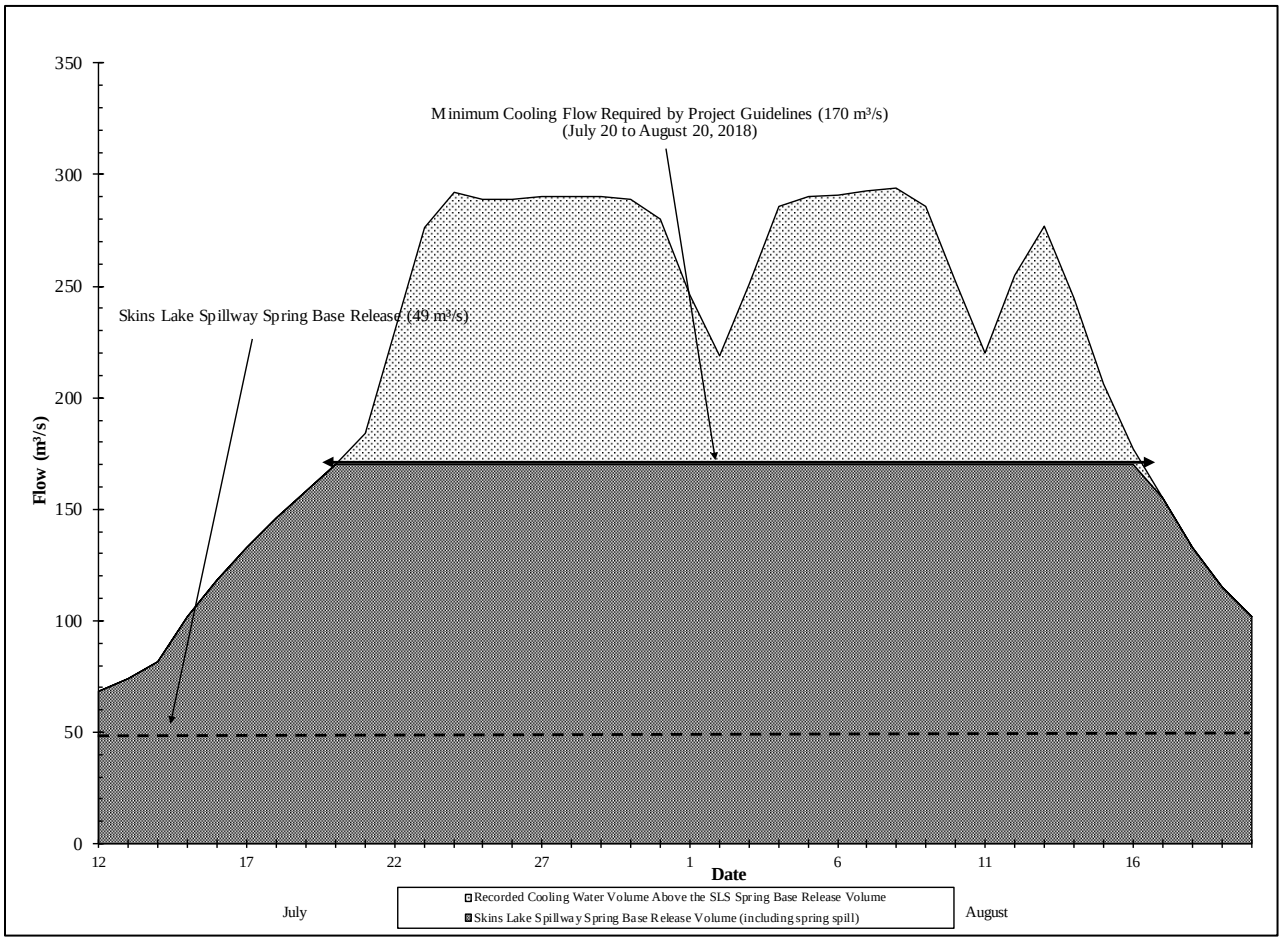
In 2018, river discharges in the NRBCF and at Vanderhoof, as recorded by the Water Survey of Canada, changed as expected in response to SLS releases (Figure 3). The hourly stage data from the gauging station located on the NRBCF proved useful in verifying the daily predictions of the flow routing model and to account for changes in the local inflow to the Cheslatta/Murray Lakes system (Figure 1).

4.2 Volume of Water Used

The recorded flows in the NRBCF for the 2018 STMP are shown in Figure 4. Also indicated is the minimum cooling flow of 170 m^3/s in the Nechako River below Cheslatta Falls, and the Skins Lake Spillway spring base release of 49.0 m^3/s, as determined by the NFCP Technical Committee as part of the "Annual Water Allocation" defined in the 1987 Settlement Agreement (Anon., 1987).

The total volume of water released during the 2018 Summer Water Temperature and Flow Management Project operational period was 8,853.9 m^3/s-d. The volume released for cooling purposes was 7,123.6 m^3/s-d, and is based on the assumed Skins Lake Spillway minimum release for fish protection purposes (part of the Annual Water Allocation) of 49.0 m^3/s for the period July 10 to August 15, inclusive, with a reduction to 14.2 m^3/s until August 20. The average release during the operational period was 211 m^3/s. Volume calculations are presented in Appendix E.

Figure 4. Flows in the Nechako River below Cheslatta Falls resulting from Skins Lake Spillway releases



4.3 Application of the STMP Release Criteria

The Summer Water Temperature and Flow Management Project flow release decisions can be sensitive to the accuracy of meteorological forecasting. If an increase or decrease in temperature occurs over a prolonged period of time (three or four days), inaccurate meteorological forecasts may prematurely predict water temperature fluctuations.

In these instances, it may be required to exercise judgment when applying the Summer Water Temperature and Flow Management Project release criteria using the three water temperature trends. This judgment is based on experience gained in the operation of the Summer Water Temperature and Flow Management Project since 1984 and may result in exceptions to the decision based on strict adherence to the release criteria. One exception was made to the application of the release criteria in 2018.

On July 29, 2018, two of three water temperature trends indicated the water temperature would not exceed 19.4°C in the Nechako River above Stuart River within the forecast

period (5 days). The remaining trend, however, showed that the water temperatures could be more than 19.4°C within the forecast period. Following these release criteria under these conditions, the release from Skins Lake Spillway could have been decreased from the current release of 283 m³/s to 14.2 m³/s. However, as there was no strong cooling trend indicated, rather than decrease the discharge, it was conservatively decided to maintain the spillway release at 283 m³/s. A cooling trend was established on July 30 and releases were then decreased in accordance with the Protocol.

4.4 Project Summary

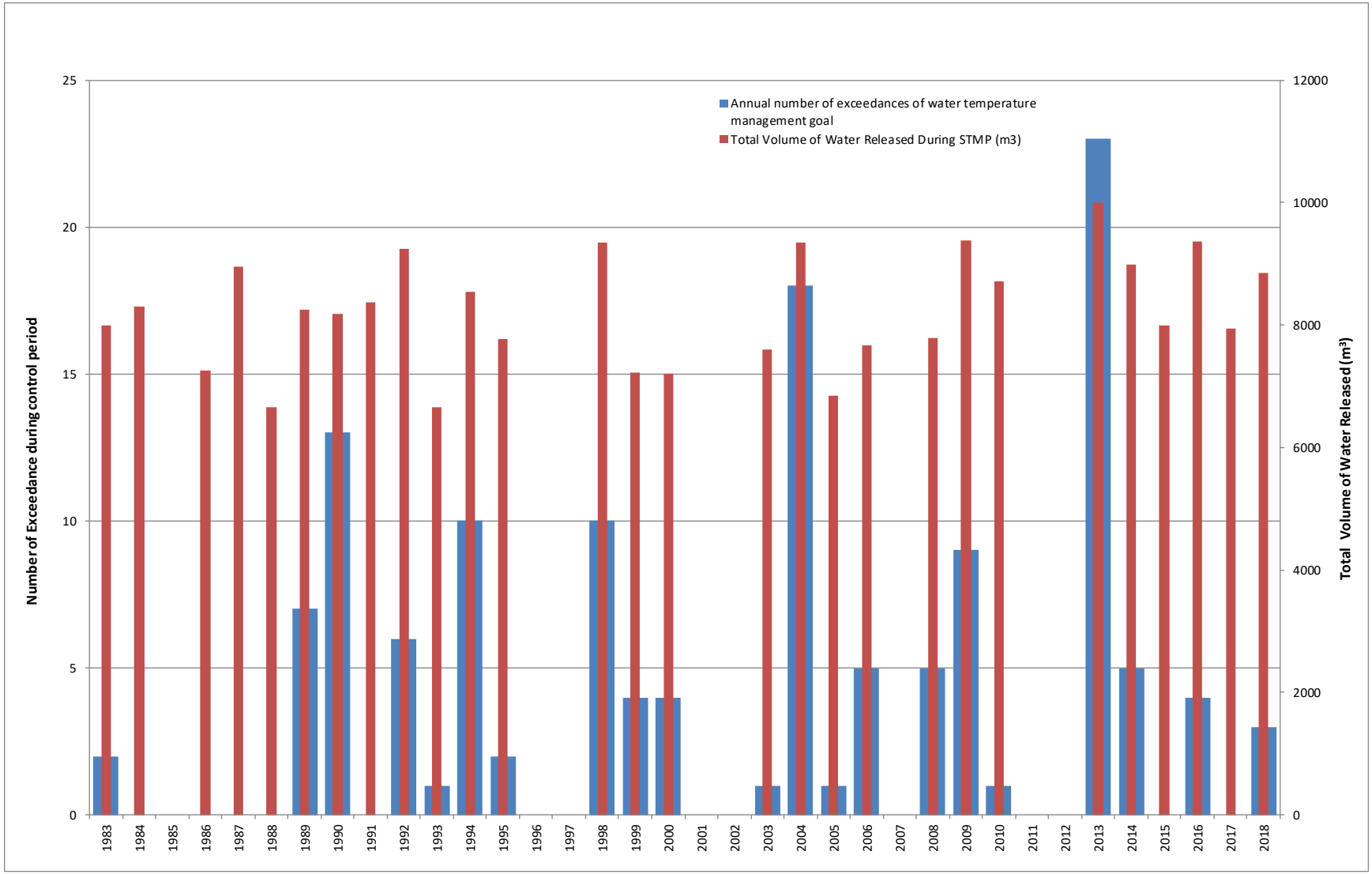
In 2018, mean daily water temperatures in the Nechako River above the Stuart River confluence did exceed 20.0°C. Over the duration of the 2018 STMP operational period, the total volume of water released was 8,853.9 m^3/s-d, and the average release during the Project was 210 m^3/s. The total volume of water released in 2018 was above the calculated average between 1983 and 2018 (8,228.2 m^3/s-d).

Figure 5 Illustrates the total volume of water used each year the STMP has been implemented, and the number of exceedances at the Nechako River above Stuart River during the operational period since the project was initiated in 1983. As shown in Figure 5, the minimum amount of water released during the STMP was in 1988 at 6,649.6 m^3/s-d and no exceedances were recorded that year. The maximum amount of water released during the STMP was in 2013, which had the highest number of exceedances recorded during the control period (23 occurrences). It should be noted that in a number of years (1985, 1991, 1996, 1997, 2001, 2002, 2007, 2011, and 2012), because of the need to release excess water from the reservoir that equaled or exceeded the STMP maximum flow criteria in the NRBCF, no annual water release was attributed to the STMP.

It was first assumed that there would be a correlation between the number of exceedances of the water temperature management goal (20°C) and the total volume of water released during the control period; however, as shown in Figure 5, that assumption does not hold true. For example, in 1990 there were a total of 13 exceedances during the control period with 8,184.9 m^3/s-d total volume.

Typically, weather conditions that increase Nechako River water temperatures cycle over relatively short periods (periods of warming over 4-5 days followed by a cooling trend). Water temperature increases are anticipated by the model predictions and increased releases from the reservoir are initiated followed by decreases as the weather cools. However, in some years, even though the model predicts the possibility of warmer weather and increased water temperatures (and thus reservoir releases are increased to maximum values), if the duration of the warm (hot) weather continues past approximately one week, water temperatures will exceed the temperature management goal. Thus, the number of exceedances of the temperature management goal is more closely correlated with the duration of the warm weather periods (high pressure systems) occurring over the Nechako watershed during the control period.

Figure 5. Historical Total Volume Released and Number of Exceedances in the Nechako River above Stuart River



5.0 References

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APPENDIX 1

NUMERICAL EXAMPLE OF WATER TEMPERATURE TREND CALCULATION

Numerical Example of Water Temperature Trend Calculation

Table A1
Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, 2018

	JULY										
Date	10	11	12	13	14	15	16	17	18	19	20
5th Day's Predicted Water Temperature at Date + 4 Days					17.6	18.9	20.2	19.4	20.2	19.3	18.5
4th Day's Predicted Water Temperature at Date + 3 Days				18.3	18.0	19.6	19.0	19.6	18.9	18.4	
3rd Day's Predicted Water Temperature at Date + 2 Days			19.6	18.3	18.9	18.3	19.2	18.8	18.0		
2nd Day's Predicted Water Temperature at Date + 1 Day		20.5	19.9	19.0	17.6	18.7	19.2	17.8			
Current Day's Predicted Water Temperature at Date	20.8	21.3	20.1	17.3	18.1	19.3	17.6				
Previous Day's Calculated Water Temperature at Date - 1 Day	20.9	21.5	20.0	17.2	18.2	18.7					
Previous Day's Recorded Water Temperature at Date - 1 Day	21.1	21.6	21.6	19.7	17.9	18.5					
Current Day's Skins Lake Spillway Release at Date (m^3/s)	49.0	49.0 to 136.0 @ 0800 hrs	###	### to ### @ 0800 hrs	226.5	226.5	226.5	226.5	226.5	226.5 to 453.0 @ 0800 hrs	453.0

APPENDIX 2

MEAN DAILY WATER TEMPERATURES IN THE NECHAKO AND NAUTLEY RIVERS, 2018

Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2018

	Nechako River			Nautley		Nechako River			Nautley
Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above the Stuart River (°C)	Fort Fraser (°C)	Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above Stuart River (°C)	Fort Fraser (°C)
10-Jul	16.6	18.2	19.4	18.2	01-Aug	18.4	19.9	20.3	19.9
11-Jul	15.9	17.7	19.3	18.2	02-Aug	18.2	19.6	19.7	20.8
12-Jul	16.0	17.2	19.3	18.2	03-Aug	18.2	19.2	19.5	19.5
13-Jul	16.2	17.4	19.1	18.3	04-Aug	17.8	19.2	19.4	19.8
14-Jul	16.2	17.3	19.1	18.3	05-Aug	17.1	18.9	19.7	20.8
15-Jul	16.4	19.3	20.8	18.8	06-Aug	17.9	19.0	19.8	21.1
16-Jul	17.3	18.2	20.1	18.8	07-Aug	17.9	18.9	19.2	19.9
17-Jul	17.1	18.9	20.4	18.6	08-Aug	17.9	19.1	19.2	20.5
18-Jul	17.1	18.2	20.4	18.8	09-Aug	18.1	19.1	19.4	20.8
19-Jul	17.2	18.0	19.9	18.4	10-Aug	17.9	18.8	19.3	20.4
20-Jul	16.4	17.1	18.5	18.2	11-Aug	17.4	18.1	18.6	19.1
21-Jul	16.6	17.4	17.9	18.6	12-Aug	17.4	17.6	18.1	18.7
22-Jul	16.6	17.7	18.6	18.7	13-Aug	17.5	18.1	17.7	19.1
23-Jul	16.3	17.3	18.2	18.2	14-Aug	17.7	18.2	17.5	18.6
24-Jul	16.2	17.3	17.9	19.2	15-Aug	17.6	18.6	17.8	17.8
25-Jul	16.1	17.7	18.2	19.3	16-Aug	17.3	17.9	17.6	17.6
26-Jul	15.9	17.4	18.6	20.0	17-Aug	17.4	17.9	17.6	17.6
27-Jul	16.2	17.1	18.8	20.8	18-Aug	17.4	17.9	17.5	17.6
28-Jul	16.9	17.5	19.1	21.6	19-Aug	17.1	17.6	17.0	17.4
29-Jul	17.6	18.3	19.5	22.6	20-Aug	17.1	17.3	17.1	17.4
30-Jul	18.2	18.8	20.2	23.2					
31-Jul	18.4	19.6	20.6	20.8					

APPENDIX 3

MEAN DAILY SKINS LAKE SPILLWAY RELEASES AND FLOWS IN THE NECHAKO AND NAUTLEY RIVERS, 2018

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2018

Date	Skins Lake Spillway Release (m^3/s)	Nechako River Cheslatta Falls (m^3/s)	Nechako River At Vanderhoof (m^3/s)	Nautley River Fort Fraser (m^3/s)
10-Jul	49	74	162	59
11-Jul	49 to 136 @ 0800 hrs	70	154	59
12-Jul	136.0	68	148	36
13-Jul	136 to 226.5 @ 0800 hrs	74	143	36
14-Jul	226.5	82	143	52
15-Jul	226.5	102	148	50
16-Jul	226.5	118	163	49
17-Jul	226.5	133	180	48
18-Jul	226.5	146	194	47
19-Jul	226.5	158	206	47
20-Jul	226.5 to 453.1 @ 1600 hrs	170	221	47
21-Jul	453.1	184	231	44
22-Jul	453.1	230	240	44
23-Jul	453.1 to 283 @ 1600 hrs	276	276	44
24-Jul	283	292	314	43
25-Jul	283	289	344	42
26-Jul	283	289	348	41
27-Jul	283	290	349	39
28-Jul	283	290	348	39
29-Jul	283	290	348	38
30-Jul	283 to 14.2 @ 1600 hrs	289	348	37
31-Jul	14.2	280	346	35
01-Aug	14.2 to 453.1 @ 1600 hrs	246	337	35
02-Aug	453.1	219	314	34
03-Aug	453.1 to 283 @ 1600 hrs	251	283	34
04-Aug	283	286	294	33
05-Aug	283	290	325	32
06-Aug	283	291	338	31
07-Aug	283	293	340	30
08-Aug	283 to 14.2 @ 1600 hrs	294	341	29
09-Aug	14.2	286	340	28
10-Aug	14.2 to 453.1 @ 1600 hrs	252	338	28
11-Aug	453.1	220	311	27
12-Aug	453.1	255	275	27

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2018

Date	Skins Lake Spillway Release (m^3/s)	Nechako River Cheslatta Falls (m^3/s)	Nechako River At Vanderhoof (m^3/s)	Nautley River Fort Fraser (m^3/s)
13-Aug	453.1	277	287	26.1
14-Aug	453.1 to 32 @ 1600 hrs	245	314	25.5
15-Aug	32	206	294	24.5
16-Aug	32	177	259	24.0
17-Aug	32	155	229	24.5
18-Aug	32	133	203	22.8
19-Aug	32	115	182	22.1
20-Aug	32	102	156	21.1

APPENDIX 4

RECORDED AND METEOROLOGICAL DATA

Recorded and Forecast Meteorological Data 2018

16.92	806.88	0.3	8	9.17	93.6	49.2	09 07 18
16.92	806.88	0.23	6.71	9.17	91.72	48.94	10 07 18
16.47	670.17	0.07	7.33	8.66	91.99	54.34	
15.61	664.44	0.18	6.28	8.93	91.72	53.35	
14.12	707.46	0.05	2.71	7.9	91.81	42.96	
14.33	726.58	0.01	5.01	4.44	92.25	53.37	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 10/18

16.92	806.88	0.3	8	9.17	93.6	49.2	10 07 18
15.84	684.51	0.1	7.44	9.04	92.01	58.02	11 07 18
15.58	649.14	0.25	6.68	8.42	91.8	55.05	
13.2	511.47	0.33	4.26	8.55	91.73	55.29	
13.49	726.58	0.12	5.76	4.34	92.29	61.39	
15.21	535.37	0.41	6.52	6.69	91.79	56.54	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 11/18

16.2	427.8	0.6	8.89	15.91	92.01	63.42	11 07 18
15.26	734.23	0.22	6.56	8.11	91.77	56.54	12 07 18
14.49	723.71	0.01	3.8	7.54	91.81	46.57	
15.49	721.8	0	5.78	4.27	92.19	51.45	
17.23	697.9	0.07	6.56	5.33	91.75	46.66	
17.95	707.46	0	7.73	7.24	91.54	48.88	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 12/18

16.48	541.85	0.3	8.32	4.88	92.08	59.25	12 07 18
14.22	806.88	0.03	4.27	7.62	91.77	50.26	13 07 18
15.52	722.75	0.05	4.49	5.08	92.13	44.88	
17.39	630.98	0.28	5.83	6.61	91.69	42.36	
18.55	669.22	0.08	8.92	6.94	91.37	51.85	
16.81	583.17	0.44	7.35	9.07	91.33	52.72	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 13/18

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

14.48	614.5	0.6	6.57	4.54	91.77	60.46	13 07 18
15.12	808.8	0.04	3.84	5.13	92.1	43.59	14 07 18
17.03	606.12	0.3	5.73	7.4	91.63	43.48	
18.57	697.9	0	8.3	7.76	91.6	48.61	
19.3	697.9	0.07	10	5.24	91.63	53.5	
18.38	420.65	0.04	12.54	3.57	91.35	70.77	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 14/18							
13.93	646.66	0.1	6.95	2.55	92.19	65.08	14 07 18
17.44	780.11	0.17	5.4	7.54	91.62	30.8	15 07 18
18.91	692.16	0.02	8.44	8.79	91.53	47.65	
19.26	669.22	0.17	9.3	6.63	91.46	50.2	
18	564.05	0.3	8.89	7.35	91.33	54.43	
15.01	678.78	0.1	3.78	7.46	91.43	43.85	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 15/18							
17.47	567.6	0.1	8.72	8.24	91.62	56.25	15 07 18
19.17	774.38	0	8.6	8.88	91.55	47.12	16 07 18
20.1	621.41	0.44	10.37	7	91.45	51.36	
17.4	669.22	0.04	7.98	8	91.49	52.87	
14.49	430.21	0.45	4.69	5.51	91.64	51.01	
13	525.81	0.37	4.47	6.77	91.62	57.37	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 16/18							
19.83	625.7	0	10.58	15.01	91.55	53.75	16 07 18
20.05	554.49	0.53	10.75	5.38	91.44	53.49	17 07 18
17.68	697.9	0	7.81	9.29	91.47	50.65	
14.8	372.85	0.51	5.34	5.24	91.59	52.67	
12.65	391.97	0.63	5.74	8.41	91.68	65.43	
11.88	133.84	0.83	9.46	7.01	91.78	87.91	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 17/18							
20.17	486.99	0.5	12.59	6.9	91.44	62.08	17 07 18
16.62	751.43	0.01	9.1	7.45	91.49	62.37	18 07 18
14.18	376.67	0.56	5.46	5.19	91.56	56.41	
10.75	219.89	0.61	6.95	7.37	91.67	81.03	
12.17	172.08	0.88	11.21	5.34	91.78	95.22	
14.8	583.17	0.18	10.97	4.83	92.46	80.87	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 18/18							

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

18.82	522	0.2	9.64	17.39	91.49	54.13	18 07 18
13.41	441.68	0.51	6.14	5.03	91.52	63.63	19 07 18
10.82	198.47	0.92	7.98	8.99	91.51	85.75	
15.01	396.75	0.72	10.31	8.34	91.98	76.47	
15.88	592.73	0.18	11.07	5.39	92.39	75.94	
16.36	688.34	0	8.94	6.24	92.4	62.93	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 19/18							
14.02	492.32	0.5	6.87	16.8	91.52	64.25	19 07 18
10.15	151.05	0.92	8.64	9.22	91.53	92.48	20 07 18
15.35	518.16	0.55	9.99	7.8	91.91	73.23	
16.96	554.49	0.4	10.59	4.5	92.21	68.13	
14.69	678.78	0.06	7.46	6.5	92.47	63.86	
15.44	688.37	0	6.88	4.74	92.21	57.2	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 20/18							
11.92	293.28	0.6	8.22	20.4	91.53	81.5	20 07 18
15.24	579.35	0.51	9.91	5.49	91.9	73.33	21 07 18
15.26	510.52	0.38	11.28	4.9	92.28	80.08	
13.68	688.34	0.03	5.38	6.77	92.5	58.5	
15.43	678.78	0	6.52	4.26	92.32	55.44	
17.78	678.78	0.01	8.76	3.98	92.21	54.9	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 21/18							
16.96	463.35	0.3	11.32	18.9	91.9	71.83	21 07 18
14.64	514.34	0	11.28	5.89	92.25	83.18	22 07 18
13.55	690.25	0	5.24	6.27	92.56	58.43	
15.87	688.34	0	6.67	3.98	92.33	54.04	
18.34	678.78	0	8.99	4.03	92.18	53.25	
20.74	659.66	0	10.88	4.14	92.92	50.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 22/18							
15.85	382.8	0.5	11.39	25.92	92.25	77.79	22 07 18
13.63	680.69	0.08	6.06	6.37	92.52	62.15	23 07 18
15.74	676.86	0.02	7.11	4.39	92.28	56.85	
17.99	688.34	0	9.1	3.69	92.17	55.55	
20.06	650.1	0.03	10.64	4.27	92.01	52.9	
21.69	659.66	0.03	11.62	4.25	91.74	49.64	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 23/18							

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

12.74	461.2	0.2	7.39	5.4	92.52	73.25	23 07 18
16.06	755.26	0.03	6.7	4.37	92.27	53.21	24 07 18
18.08	683.56	0	7.76	3.65	92.16	48.42	
19.89	683.56	0	9	4.18	92	45.58	
21.55	674	0	9.34	4.29	91.74	38.96	
22.74	669.22	0	9.84	4.18	91.67	35.49	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 24/18							
14.09	511.6	0.1	8.89	2.56	92.27	73.96	24 07 18
17.75	780.11	0	8	3.83	92.19	53.21	25 07 18
19.8	673.04	0	9.33	4.38	92.04	48.42	
21.63	669.22	0	9.81	4.21	91.77	45.58	
23.02	669.22	0	9.09	4.27	91.69	38.96	
23.99	669.22	0	8.3	5.99	91.6	35.49	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 25/18							
16.02	530.3	0	10.28	0.45	92.19	71.29	25 07 18
19.2	770.55	0	9.59	4.21	92.09	51.97	26 07 18
20.79	677.82	0	9.79	4.21	91.83	45	
22.42	664.44	0	10.3	4.18	91.72	39.38	
23.98	659.66	0.04	10.58	5.05	91.64	32.99	
23.28	650.1	0.2	7.64	6.44	91.42	21.81	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 26/18							
17.14	556.6	0	11	0.58	92.09	69.32	26 07 18
20.78	764.82	0	9.88	4.11	91.82	45.49	27 07 18
22.3	664.44	0	10.37	4.38	91.69	40.35	
23.36	669.22	0	9.1	5.78	91.72	28.7	
23.09	654.88	0	9.29	4.68	91.68	30.96	
22.12	659.66	0.12	10.37	4.63	91.43	43.07	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 27/18							
18.17	543.05	0	11.42	3.15	91.82	66.25	27 07 18
21.97	755.26	0	10.18	4.13	91.66	45.49	28 07 18
23.34	659.66	0.01	10.51	4.8	91.73	40.35	
23.1	645.32	0.04	10.33	4.86	91.64	28.7	
20.41	492.35	0.28	14.1	4.12	91.56	30.96	
19.02	554.49	0.44	14.8	3.87	91.3	43.07	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 28/18							

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

19.9	529.98	0	13.06	3.15	91.66	65.79	28 07 18
23.57	745.7	0	11.6	4.53	91.73	40.14	29 07 18
23.38	659.66	0.02	8.75	5.6	91.6	26.84	
20.81	602.29	0.22	12.82	5.79	91.63	60.02	
18.89	478.01	0.34	12.81	4.61	91.36	68.61	
16.56	458.89	0.48	9.49	8.55	91.15	64.66	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 29/18

22.27	568.7	0	13.89	7.49	91.73	58.08	29 07 18
23.63	741.87	0.01	9.48	4.96	91.63	29.25	30 07 18
20.63	429.25	0.39	13.83	4.65	91.57	66.01	
17.07	301.15	0.62	14.54	4.29	91.18	87.35	
15.45	229.45	0.78	14.05	4.4	90.83	92.98	
15.93	420.65	0.69	10.26	8.5	90.86	71.66	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 30/18

21.51	550.36	0	13.68	2.7	91.63	60.88	30 07 18
21.6	636.71	0.23	12.09	5.03	91.5	52.44	31 07 18
18.23	467.5	0.52	12.6	6.2	91.17	71.89	
18.65	473.23	0.43	9.9	6.32	90.89	56.25	
18.09	564.05	0.16	8.5	10.55	90.96	52.05	
17.65	411.09	0.48	8.12	5.81	90.64	52.36	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 31/18

21.05	397.83	0.1	13.95	2.25	91.5	64.5	31 07 18
18.15	426.39	0.68	13.9	4.56	91.14	78.76	01 08 18
17.77	496.18	0.59	10.81	7.44	90.85	65.18	
17.69	587.95	0.17	8.25	10.62	91.03	52.81	
17.44	630.98	0.01	8.13	6.3	91.42	53.47	
18.11	611.85	0	10.48	4.88	91.37	61.86	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 01/18

18.5	359.7	0.2	13.01	1.66	91.14	72.54	01 08 18
18.78	676.86	0.25	8.42	9.2	90.87	48.2	02 08 18
18.16	589.87	0.27	8.54	11.5	91.07	51.93	
17.2	501.91	0.4	9.32	4.04	91.47	60.6	
18.85	602.29	0.06	11.13	4.03	91.41	61.36	
19.48	611.85	0	12.48	6.38	91.44	65.02	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 02/18

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

18.1	368.6	0.03	11.16	14.26	90.87	65.3	02 09 18
17.42	642.45	0.33	7.9	11.02	91.08	52.41	03 09 18
17.5	509.56	0.52	8.54	6.12	91.43	55.2	
18.68	530.59	0.32	11.15	4.23	91.56	62.32	
19.77	621.41	0	11.64	6.05	91.7	59.33	
19.92	630.98	0	8.8	7.99	91.84	44.41	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 03/18							
17.83	505.48	0.2	9.77	24.15	91.08	59.75	03 08 18
16.17	489.48	0.43	8.01	6.32	91.51	59.22	04 08 18
17.51	619.5	0	10.43	4.36	91.62	64.61	
18.86	626.2	0.04	9.38	8.16	91.62	52.58	
18.82	635.76	0	4.91	9.4	91.67	30.41	
18.99	611.85	0	7.68	6.82	91.47	43.45	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 04/18							
17.35	460.59	0	10.26	8.55	91.51	64.54	04 08 18
17.9	707.46	0	9.38	4.3	91.61	57.38	05 08 18
18.9	640.54	0.02	7.33	8.66	91.57	42.15	
19.62	626.2	0	5.63	8.93	91.59	30.05	
20.14	607.07	0.03	9.77	6.62	91.3	48.15	
20.22	430.21	0.58	9.71	7.08	91.22	47.47	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 09/18							
17.26	467.47	0	11.03	3.75	91.61	68.83	05 08 18
19.05	705.54	0.09	5.77	9.7	91.6	33.62	06 08 18
20.2	618.55	0.17	5.97	9.28	91.59	28.86	
20.61	616.83	0	9.1	7.72	91.24	42.45	
20.83	430.21	0.64	9.28	7.24	91.23	42.28	
20.41	458.89	0.66	6.63	5.78	91.15	31.11	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 06/18							
18.53	688.34	0.2	10.07	15.3	91.6	57.71	06 08 18
20.15	688.34	0.07	5.95	9.09	91.57	28.96	07 08 18
20.47	607.07	0.07	9.19	6.52	91.33	43.6	
22.1	559.27	0.29	9.63	4.54	91.27	37.66	
19.96	497.13	0.39	10.14	6.54	90.64	50.87	
11.71	162.52	0.61	7.8	12.91	90.85	80.46	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 07/18							

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

20.79	432.14	0.01	10.33	3.63	91.57	47.71	07 08 18
20.48	682.6	0.05	8.57	6.23	91.29	40.41	09 08 18
21.46	521.99	0.35	9.31	5.92	91.29	39.23	
19.79	387.19	0.62	5.84	8.01	91.29	30.23	
17.32	597.51	0.1	3.92	5.8	91.54	32.98	
17.76	592.73	0.07	4.24	5.35	91.321	32.43	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 09/18

17.39	385.02	0.01	11.16	5.1	91.29	68.83	08 08 18
21.46	521.99	0.35	9.31	5.92	91.29	39.23	09 08 18
19.79	387.19	0.62	5.84	8.01	91.29	30.23	
17.32	597.51	0.1	3.92	5.8	91.29	32.98	
17.76	592.73	0.07	4.24	5.35	91.32	32.43	
18.85	564.05	0.19	6.06	7.99	91.4	36.08	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 09/18

18.63	348.99	0	11.76	8.1	91.29	65.63	09 08 18
18.41	514.34	0.45	7.16	6.01	91.29	43.75	10 08 18
16.83	589.87	0.1	6.02	5.01	91.49	45.96	
16.49	607.07	0	7.19	5.33	91.7	53.33	
17.68	592.73	0.02	8.45	4.77	91.71	53.86	
16.73	325.05	0.3	8.92	9.07	91.04	60.95	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 10/18

18	303.51	0	10.12	7.5	91.29	60.63	10 08 18
15.49	367.11	0.55	6.15	5.47	91.42	53.31	11 08 18
15.79	603.25	0	6.97	5.23	91.71	55.91	
17.34	597.51	0	8.9	4.59	91.76	57.78	
18.05	554.49	0.11	8.51	9.31	91.24	52.3	
15.74	382.41	0.38	8.6	8.55	91.07	64.29	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 11/18

13.02	194.31	0.5	7.53	6.6	91.42	72.58	11 08 18
15.89	657.74	0	7.92	5.14	91.65	60.17	12 08 18
17.36	589.87	0	9.88	5.22	91.78	62.59	
18.82	568.83	0.06	8.97	8.77	91.3	50.74	
16.91	497.13	0.29	7.51	5.78	91.34	53	
16.06	583.17	0.02	8	4.64	91.69	59.65	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 12/18

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

12.54	310.04	0.45	7.99	0.45	91.65	77.25	12 08 18
17.41	653.92	0.06	9.22	5.41	91.76	59.04	13 08 18
18.84	531.55	0.23	8.47	9.79	91.28	48.13	
17.18	535.37	0.19	7.3	6.32	91.26	50.6	
15.25	468.45	0.32	6.37	6.84	91.52	55.58	
16.02	583.17	0	5.58	9.04	91.94	47.83	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 13/18

15.01	271.7	0.3	9.64	4.65	91.76	73.13	13 08 18
19.15	613.77	0.19	7.65	8.57	91.24	59.04	14 08 18
16.93	590.82	0.06	6.45	6.27	91.28	48.13	
16.17	592.73	0.01	5.71	5.38	91.5	50.6	
15.97	573.61	0.02	4.78	7.42	91.87	55.58	
16.1	573.61	0.01	7.7	4.83	92.06	47.83	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 14/18

16.89	182.19	0.2	9.67	5.25	91.24	63.92	14 08 18
15.75	520.08	0.28	6.97	5.33	91.3	56.08	15 08 18
15.83	584.13	0	7.68	5.05	91.49	59.26	
15.19	583.17	0	3.96	8.52	91.91	43.89	
16.01	540.15	0.13	6.25	7.15	92.23	51.24	
15.84	564.05	0.16	6.18	5.08	92.36	51.72	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 15/18

15.95	301.02	0.2	8.6	4.5	91.3	63.25	15 08 18
16.03	619.5	0.07	6.87	5.19	91.42	54.22	16 08 18
15.38	585.09	0	3.29	8.57	91.82	39.6	
14.99	583.17	0	4.51	6.07	92.27	47.62	
14.95	564.05	0	6.6	3.6	92.25	58.26	
16.06	564.05	0	7.73	3.96	92.08	58.35	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 16/18

12.31	281.07	0.2	6.5	2.55	91.42	70.96	16 08 18
16.14	648.18	0.09	4.58	9.02	91.83	42.2	17 08 18
15.32	575.53	0	5.55	5.99	92.3	51.11	
15.26	564.05	0	7.69	3.78	92.27	62.14	
16.12	564.05	0	8.5	3.94	92.21	61.93	
16.93	564.05	0	9.79	3.93	91.62	64.27	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 17/09

Appendix D (continued)
Recorded and Forecast Meteorological Data 2018

15.89	441.68	0.01	6.59	4.25	91.83	53.54	17 08 18
14.81	642.45	0	4.85	5.88	92.36	50.2	18 08 18
14.97	557.36	0.01	8.04	4.06	92.3	65.37	
15.85	568.83	0	9.16	3.89	92.32	66.54	
16.76	564.05	0.01	10.1	4.34	91.73	66.7	
17.34	544.93	0.04	9.88	6.06	90.99	62.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 18/18

15.33	336.61	0.01	6.95	11.25	92.36	58.08	18 08 18
15.02	632.89	0	7.21	4.09	92.23	60.91	19 08 18
15.59	571.7	0	7.71	3.84	92.38	60.64	
16.58	564.05	0	9.3	4.95	91.88	63.61	
17.75	544.93	0.04	6.97	7.83	91.34	46.13	
15.58	535.37	0.08	4.99	8.46	91.1	47.07	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 19/18

15.33	336.61	0.01	6.95	11.25	92.36	58.08	19 08 18
15.02	632.89	0.00	7.21	4.09	92.23	60.91	20 08 18
15.59	571.70	0.00	7.71	3.84	92.38	60.64	
16.58	564.05	0.00	9.30	4.95	91.88	63.61	
17.75	544.93	0.04	6.97	7.83	91.34	46.13	
15.58	535.37	0.08	4.99	8.46	91.10	47.07	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 20/18

APPENDIX 5

SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT RESERVOIR RELEASE VOLUME CALCULATIONS FOR JULY 10 TO AUGUST 20, 2018

Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2018

Skins Lake Spillway base release for the period July 10 (191) to August 20 (232) = 49.0 m^3/s
STMP Base Release Volume = (JD 224 - JD 191) * 49.0 + (JD 232 - JD 224) * 14.16 = 1,730.3 $m^3/s*days$

Time period (Julian Day)	Time (hrs)	Flow Rate (m^3/s)	Volume ($m^3/s*hrs$)
July 10 (191) @ 2400 hrs to July 11 (192) @ 0800 hrs	32	49	1,568
July 11 (192) @ 0800 hrs to July 13 (194) @ 0800 hrs	48	136	6,528
July 13 (194) @ 0800 hrs to July 20 (201) @ 1600 hrs	176	226.5	39,864
July 20 (201) @ 1600 hrs to July 23 (204) @ 1600 hrs	72	453.1	32,623
July 23 (204) @ 1600 hrs to July 30 (211) @ 1600 hrs	168.0	283.0	47,544
July 30 (211) @ 1600 hrs to Aug 1 (213) @ 1600 hrs	48.0	14.2	0,682
Aug 1 (213) @ 1600 hrs to Aug 3 (215) @ 1600 hrs	48.0	453.1	21,749
Aug 3 (215) @ 1600 hrs to Aug 8 (220) @ 1600 hrs	120.0	283.0	33,960
Aug 8 (220) @ 1600 hrs to Aug 10 (222) @ 1600 hrs	48.0	14.2	0,682
Aug 10 (222) @ 1600 hrs to Aug 12 (224) @ 1600 hrs	48.0	453.1	21,749
Aug 12 (224) @ 1600 hrs to Aug 14 (226) @ 1600 hrs	48.0	14.2	0,682
Aug 14 (226) @ 1600 hrs to Aug 20 (232) @ 2400 hrs	152.0	32.0	4,864
Total	1,008 (42.0 days)		212,494

Total Release Volume
= 212,494 $m^3/s*hrs$
= 8,853.9 $m^3/s*days$
= 312,675 $cfs*days$

Volume Released for Cooling Purposes
= Total Volume - Base Volume
= 8,853.9 - 1,730.3
= 7,123.6 $m^3/s*days$
= 251,571 $cfs*days$

Average Release over Summer Management Period (July 10 to August 20)
= 8,853.9 $m^3/s*days$ / 42 days
= 210.8 m^3/s
= 7,444.7 cfs