



2020 Summer Water Temperature and Flow Management Project

Nechako Fisheries Conservation Program

TRITON
Environmental Consultants

Revision History and Approvals			
Project Name		Summer Water Temperature and Flow Management Project	
Project Number		10696	
Report Title		2020 Summer Water Temperature and Flow Management Project	
Document #		P5035	
Report Author(s)		Jen Bond, B.Sc.	
Date	Version	Review Type	Reviewed by
March 4, 2021	Draft	Document	Jennifer Johnson
March 15, 2021	Draft	Senior Review	A.C. Mitchell, M. Eng., P. Eng.
March 18, 2021	Draft	Revisions	Jen Bond, B.Sc.
March 24, 2021	Draft	Senior Review	A.C. Mitchell, M. Eng., P. Eng.

Executive Summary

The 2020 Nechako River Summer Water Temperature and Flow Management Project (“STMP” or “the 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 2020, mean daily water temperatures in the Nechako River above the Stuart River confluence did not exceed 20.0°C during the control period (July 20 to August 20).

Over the duration of the 2020 Summer Water Temperature and Flow Management Project (July 10 to August 20), the total volume of water released was 7,628 m³/s-d, and the average release during the Project was 181.6 m³/s.

DRAFT

Disclaimer

This report is rendered solely for the use of the Nechako Fisheries Conservation Program (NFCP) in connection with the 2020 Summer Water Temperature and Flow Management Project (the 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 period during which we conducted this analysis. However, the results, our opinions, or recommendations may change if new information becomes available or if the 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 the NFCP or 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.

TABLE OF CONTENTS

Executive Summary	ii
Disclaimer	iii
1.0 Introduction	1
2.0 Methods	3
3.0 Results	7
4.0 Discussion	14
4.1 Recorded Data	14
4.2 Volume of Water Used	14
4.3 Application of the STMP Release Criteria	15
4.3.1 Reservoir Management	15
4.4 Project Summary	16
5.0 References	19

LIST OF FIGURES

Figure 1. Project location	2
Figure 2. Recorded mean daily temperatures in the Nechako River above the Stuart River confluence	12
Figure 3. Skins Lake Spillway releases and flows in the Nechako River below Cheslatta Falls and at Vanderhoof	13
Figure 4. Flows in the Nechako River below Cheslatta Falls resulting from Skins Lake spillway releases	15
Figure 5. Historical Total Volume Released and number of exceedances of 20°C in the Nechako River above Stuart River	18

LIST OF TABLES

Table 1. Daily operations to manage water temperatures in the Nechako River above the Stuart River confluence	4
Table 2. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 2020)	9
Table 3. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (August 2020)	10
Table 4. Recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 10, 2020 to August 20, 2020)	11

LIST OF APPENDICES

- Appendix 1. Numerical Example of Water Temperature Trend Calculation
- Appendix 2. Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2020
- Appendix 3. Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2020
- Appendix 4. Recorded and Forecast Meteorological Data
- Appendix 5. Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2020

DRAFT

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 2019) 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 2020 STMP and includes:

- An outline of the method for determining SLS releases and summaries of the 2020 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 2020 STMP.

Figure 1. Project location

DRAFT

2.0 Methods

Management of the Nechako River water temperatures and flows relied on 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 to 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 retrieved daily via the Environment Canada Water Survey of Canada (WSC) website at https://wateroffice.ec.gc.ca/search/real_time_e.html, as obtained by 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). 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. The 2020 spring base release as directed by NFCP was 49.0 m³/s. Upon commencement of the operational period on July 10, the recorded flow in the NRBCF was 49 m³/s. The SLS was first increased to 136 m³/s on July 11 and then 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				

* 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.

Predicted water temperatures for the five-day forecast period were checked each day, 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 m³/s and 283 m³/s, as required, and flow in the Nechako River above the Stuart River confluence (as measured at Vanderhoof) does not exceed 340 m³/s. The flow in the NRBCF is adjusted to be no less than 170 m³/s by the beginning of the control period and is reduced to approximately 32.0 m³/s by September 1.

3. At any time, increase the SLS release from the current level to 453 m³/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 m³/s.

DRAFT

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 not exceed 20.0°C during the 2020 STMP. The respective maximum and minimum mean daily water temperatures recorded during the control period were 19.2°C on August 1 and 15.4°C on August 13. 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 2.

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 3). Changes in Skins Lake Spillway releases during the STMP were made on the following dates:

- July 11 – Increase to 136 m³/s to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
- July 13 – Increase to 226.5 m³/s to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
- July 19 – Increase to 276 m³/s to increase flow in the Nechako River below Cheslatta Falls as directed by Rio Tinto for reservoir management.
- July 25 – Decrease to 200 m³/s to decrease flow in Nechako River below Cheslatta Falls in response to a cooling trend and for reservoir management.
- July 26 – Increase to 453.1 m³/s to ensure flow in the Nechako River below Cheslatta Falls in response to warming trend.
- July 28 – Decrease to 283 m³/s to limit flow in Nechako River below Cheslatta Falls to a maximum of 283 m³/s.
- July 31 – Decrease to 14.2 m³/s to decrease flow in the Nechako River below Cheslatta Falls in response to cooling trend.
- August 3 – Increase to 170 m³/s to increase flow in Nechako River below Cheslatta Falls to a minimum of 170 m³/s.
- August 16 – Decrease to 14.2 m³/s to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend and prepare for fall spawning flows.
- August 29 – Increase to 32 m³/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 298 m³/s on July 30 and a minimum of 115 m³/s

on August 20. Flows measured in the Nechako River at Vanderhoof ranged between a maximum of 369 m³/s on July 31 and a minimum of 192 m³/s on August 20.

DRAFT

Table 2. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 2020)

Date	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
5th Days Predicted Water Temperature at Date + 4 Days					20.0	18.0	17.7	18.2	18.0	18.5	19.1	18.6	17.4	18.8	17.7	17.0	17.9	19.0	20.2	20.0	19.5	19.5
4th Days Predicted Water Temperature at Date + 3 Days				18.9	17.4	18.1	17.9	16.9	17.4	18.8	18.3	17.5	18.5	18.5	18.1	17.2	17.8	19.3	19.7	19.4	19.2	19.7
3rd Days Predicted Water Temperature at Date + 2 Days			16.9	16.8	18.2	18.1	16.8	16.3	17.9	17.9	17.1	18.4	19.0	19.2	18.0	17.0	17.5	18.8	19.6	19.4	19.5	19.8
2nd Days Predicted Water Temperature at Date + 1 Day		16.7	16.7	17.8	17.8	17.7	16.3	17.2	18.0	16.3	17.9	18.7	19.1	18.7	17.4	15.9	17.0	18.8	19.7	18.9	18.8	19.2
Current Days Predicted Water Temperature at Date	17.0	17.4	17.6	16.7	17.7	17.0	17.0	17.8	17.3	16.7	18.1	18.5	18.7	18.3	16.5	15.9	17.1	19.0	18.9	18.5	18.7	19.4
Previous Days Calculated Water Temperature at Date - 1 Day	18.9	17.8	16.8	16.8	17.2	17.0	17.2	17.8	17.1	16.8	17.8	18.4	18.4	17.8	16.5	16.0	17.2	18.5	18.6	18.5	18.8	18.9
Previous Days Recorded Water Temperature at Date - 1 Day	17.8	17.5	17.4	17.4	16.4	16.7	16.8	17.1	17.1	16.9	16.8	17.9	18.6	18.7	18.3	17.1	16.2	17.0	18.3	19.1	18.8	18.9
Current Day's Skins Lake Spillway Release at Date (m³/s)	49	49	136	136	226.5	226.5	226.5	226.5	226.5	226.5	275.0	275	275	275	275	275	200	453	453	283	283	283
		to		to						to						to	to	to	to		to	
		136		226.5						276						200	453	283	283		14.2	
		@		@					@						@	@	@	@	@		@	
		0800		0800					1600						1600	1600	0800	0800		1600		

Table 3. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (August 2020)

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
5th Days Predicted Water Temperature at Date + 4 Days	19.7	20.8	19.8	19.2	19.6	19.0	17.6	17.5	17.6	17.8	17.6	16.7	16.9	16.7	16.8	16.5	18.6	19.6	18.6	18.6	
4th Days Predicted Water Temperature at Date + 3 Days	20.6	20.0	19.1	19.5	19.3	18.3	17.8	17.5	17.2	16.9	17.2	16.7	16.9	16.8	16.4	17.2	18.7	19.1	18.5	18.7	
3rd Days Predicted Water Temperature at Date + 2 Days	19.9	19.7	19.6	19.4	18.8	18.5	17.8	17.1	16.6	16.8	16.4	17.0	16.6	16.1	15.6	16.9	18.6	18.6	19.0	18.5	
2nd Days Predicted Water Temperature at Date + 1 Day	19.9	19.4	19.4	18.9	18.5	18.3	17.4	16.7	16.6	15.9	16.5	16.7	16.1	15.0	15.9	16.9	17.8	18.1	18.5	18.1	
Current Days Predicted Water Temperature at Date	19.0	19.3	18.8	18.3	18.5	18.2	17.2	16.8	16.0	16.0	16.5	16.1	15.2	15.2	16.0	16.6	16.7	18.4	18.1	17.9	
Previous Days Calculated Water Temperature at Date - 1 Day	18.9	18.9	18.5	18.3	18.3	17.8	17.2	16.4	15.9	16.0	16.0	15.4	15.1	15.2	15.7	16.8	17.8	18.0	17.9		
Previous Day's Recorded Water Temperature at Date - 1 Day	19.1	19.2	19.0	18.8	18.2	18.5	18.1	17.3	16.6	16.2	16.1	16.0	15.9	15.4	15.6	16.0	17.6	18.1	17.9	17.8	
Current Days Skins Lake Spillway Release at Date (m ³ /s)	14.2	14.2	14.2 to 170 @ 1600	170	170	170	170	170	170	170	170	170	170	170	170	170	14.2 to 14.2 @ 1600	14.2	14.2	14.2	14.2

Table 4. Recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 10, 2020 to August 20, 2020)

Date	Water Temperature (°C)	Date	Water Temperature (°C)
10-Jul	17.5	1-Aug	19.2
11-Jul	17.4	2-Aug	19.0
12-Jul	17.4	3-Aug	18.8
13-Jul	16.4	4-Aug	18.2
14-Jul	16.7	5-Aug	18.5
15-Jul	16.8	6-Aug	18.1
16-Jul	17.1	7-Aug	17.3
17-Jul	17.1	8-Aug	16.6
18-Jul	16.9	9-Aug	16.2
19-Jul	16.8	10-Aug	16.1
20-Jul	17.9	11-Aug	16.0
21-Jul	18.6	12-Aug	15.9
22-Jul	18.7	13-Aug	15.4
23-Jul	18.3	14-Aug	15.6
24-Jul	17.1	15-Aug	16.0
25-Jul	16.2	16-Aug	17.6
26-Jul	17.0	17-Aug	18.1
27-Jul	18.3	18-Aug	17.9
28-Jul	19.1	19-Aug	17.8
29-Jul	18.8	20-Aug	17.8
30-Jul	18.9		
31-Jul	19.1		

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

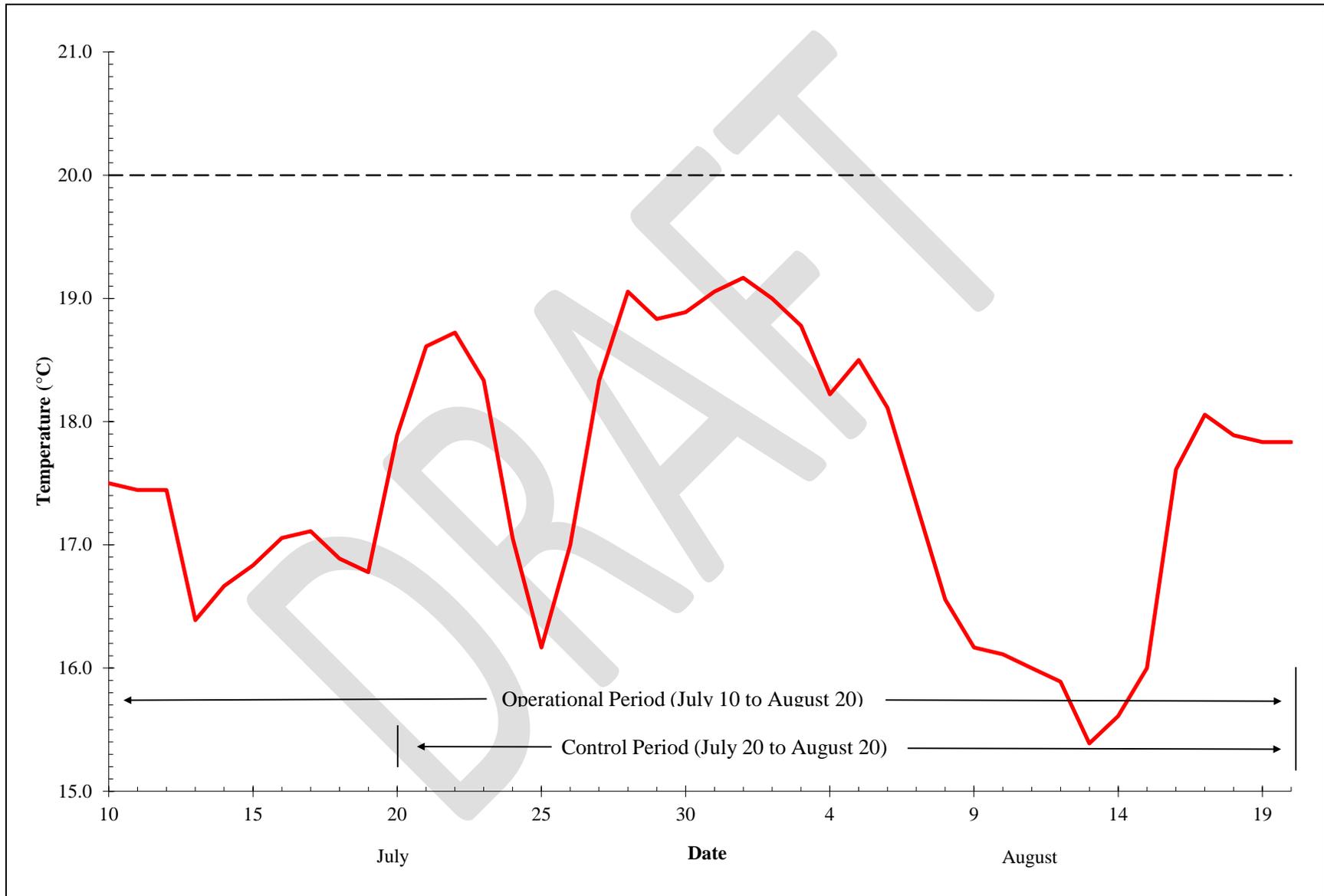
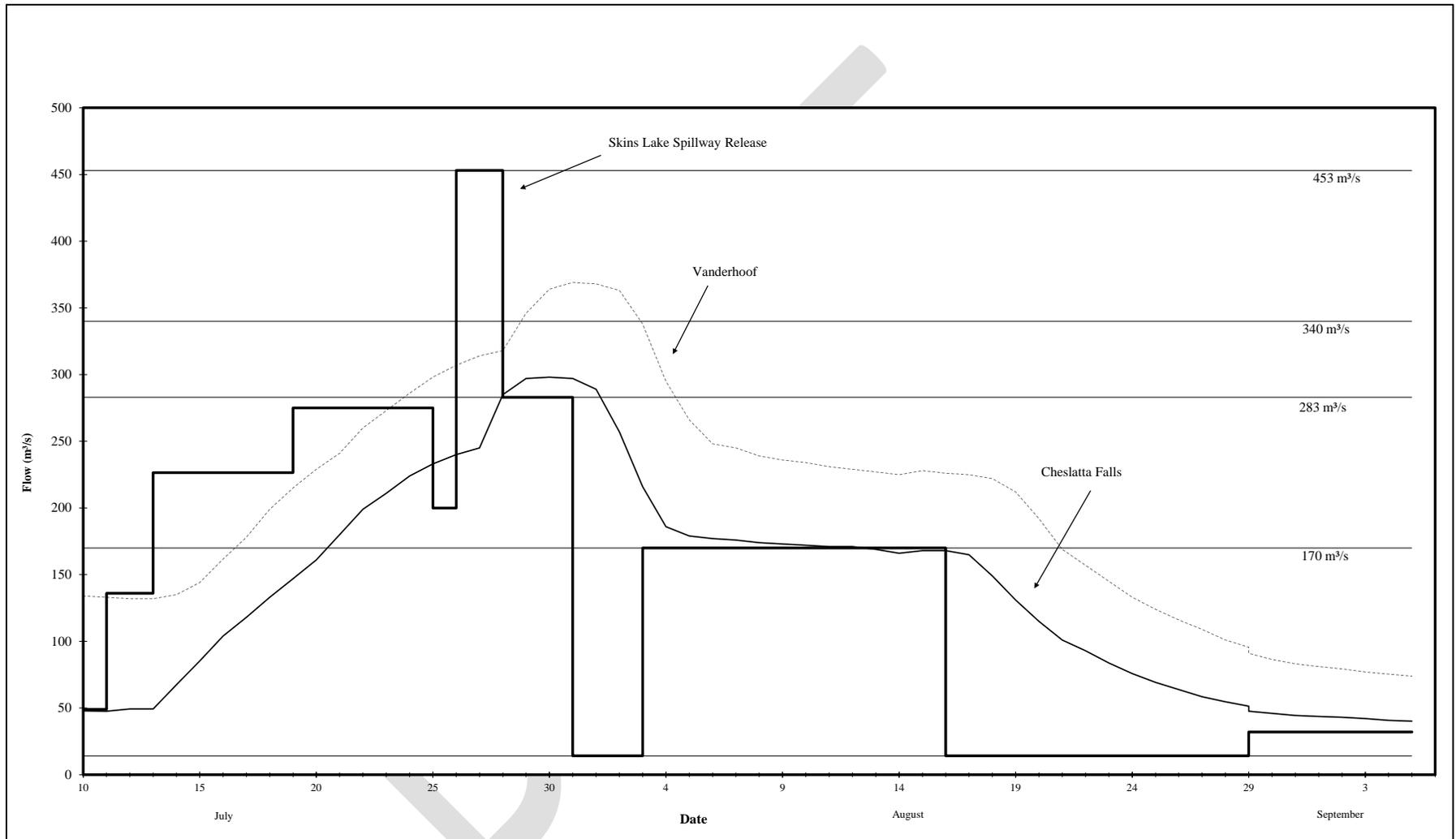


Figure 3. Skins Lake Spillway releases and flows in the Nechako River below Cheslatta Falls and at Vanderhoof



4.0 Discussion

The discussion of the 2020 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 2020 STMP. The third section provides a brief discussion of the application of the Project release criteria.

4.1 Recorded Data

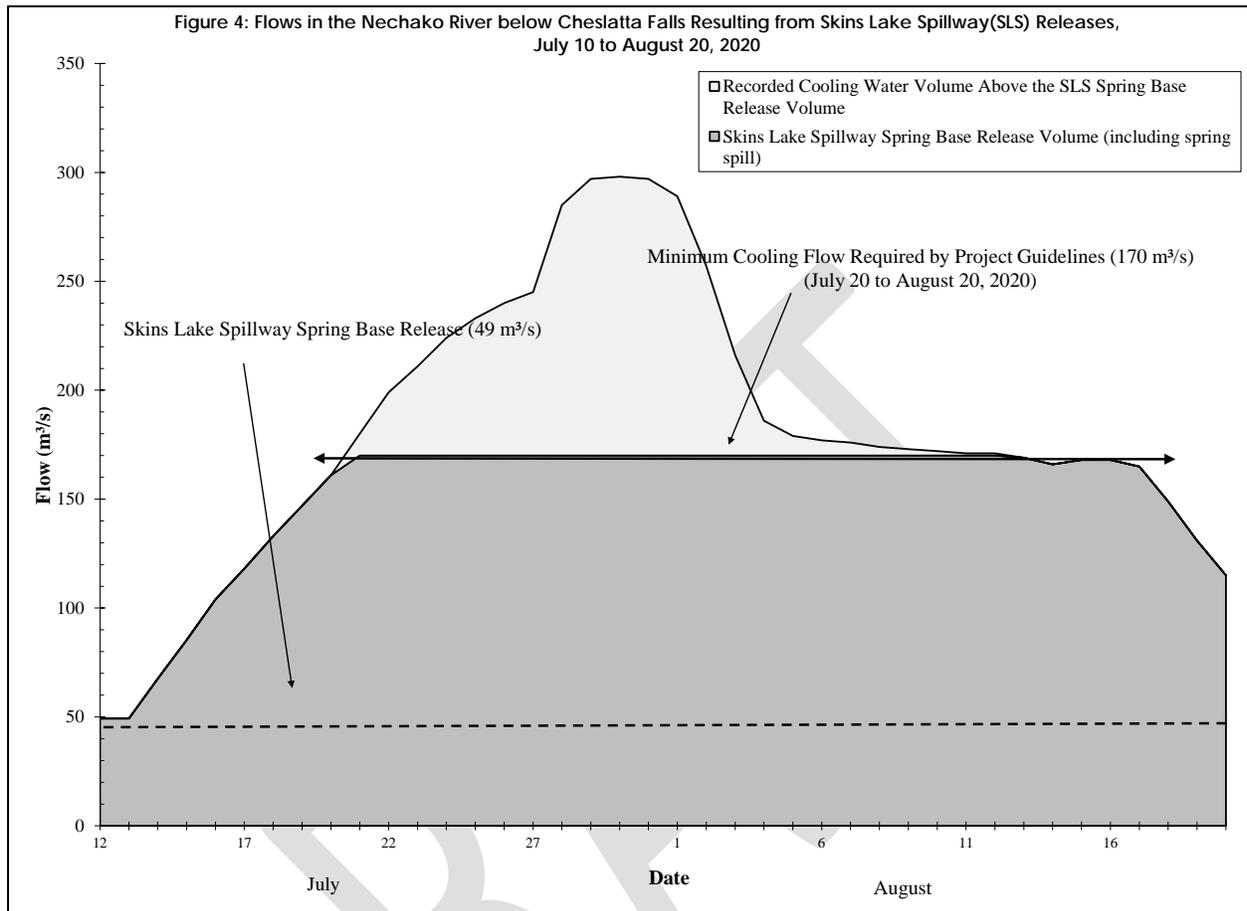
In 2020, river discharges in the NRBCF and at Vanderhoof, as recorded by the Water Survey of Canada, changed as expected in response to SLS releases (Figure 3). The hourly stage data from the gauging station located on the NRBCF proved useful in verifying the daily predictions of the flow routing model 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 2020 STMP are shown in Figure 4. Also indicated is the minimum cooling flow of 170 m³/s in the Nechako River below Cheslatta Falls, and the Skins Lake Spillway spring base release of 49.0 m³/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 2020 STMP operational period was 7,628.4 m³/s-d. The volume released for cooling purposes was 5,758.8 m³/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 m³/s for the period July 10 to August 16, inclusive, with a reduction to 14.2 m³/s until August 20. The average release during the operational period was 181.6 m³/s. Volume calculations are presented in Appendix 6.

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 STMP flow release decisions can be sensitive to the accuracy of meteorological forecasting. If an increase or decrease in temperature occurs over a prolonged period (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 STMP release criteria using the three water temperature trends. This judgment is based on experience gained in the operation of the STMP since 1984 and may result in exceptions to the decision based on strict adherence to the release criteria. No exceptions were made to the application during normal STMP operations in 2020.

4.3.1 Reservoir Management

Higher than normal water levels were observed in the Nechako Reservoir at the beginning of the STMP. As a result, a number of exceptions were made to the release criteria and are summarized below.

On July 19, 2020, all 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). Following these release criteria under these conditions, the release from SLS could have been decreased from the current release of 283 m³/s to 14.2 m³/s. However, as the additional release of water was required for reservoir management, flows were increased to 276 m³/s.

From July 20 to July 24, STMP daily operations by Triton followed the protocol defined in the Settlement Agreement (Anon. 1987). For each day, 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 SLS could have been decreased from the current release of 276 m³/s to 14.2 m³/s; however SLS releases were maintained at 276 m³/s as required for reservoir management.

On July 25, 2020, 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 SLS could have been decreased from the current release of 276 m³/s to 14.2 m³/s. However, as the additional release of water was still required for reservoir management, flows were decreased slightly to 200 m³/s.

4.4 Project Summary

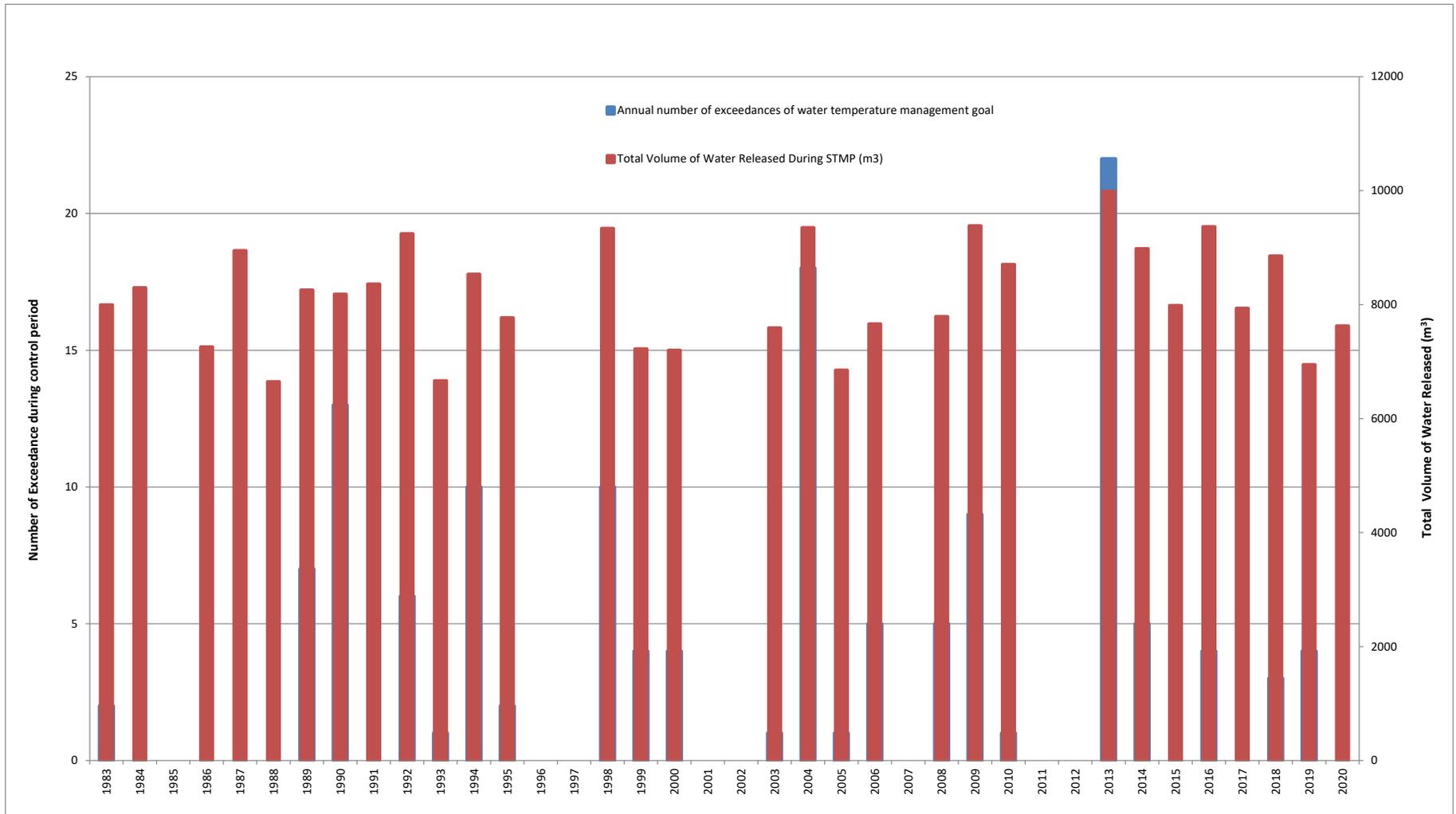
In 2020, mean daily water temperatures in the Nechako River above the Stuart River confluence did not exceed 20.0°C. Over the duration of the 2020 STMP operational period, the total volume of water released was 7,628.4 m³/s-d, and the average release during the Project was 181.6 m³/s. The total volume of water released in 2020 was below the calculated average between 1983 and 2020 (8,183.9 m³/s-d) but above the minimum total volume released (6,649.6 m³/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 m³/s-d and no water temperature exceedances were recorded that year. The maximum amount of water released during the STMP was in 2013, which had the greatest number of water temperature exceedances recorded during the control period (23 occurrences). It should be noted that in several 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 m³/s-d total volume.

Typically, weather conditions that increase Nechako River water temperatures, cycle over relatively short periods (periods of warming over 4 to 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 of 20°C in the Nechako River above Stuart River



5.0 References

Anon. 1987. The 1987 Settlement Agreement between Alcan Aluminium Ltd. and Her Majesty the Queen in Right of Canada, represented by the Minister of Fisheries and Oceans, and her Majesty the Queen in Right of the Province of British Columbia, represented by the Ministry of Energy, Mines and Petroleum Resources.

Envirocon. 1984a. Documentation of the Nechako River Water Temperature Model. Technical Memorandum 1957/1. Prepared for Alcan Smelters and Chemicals Ltd.

Envirocon. 1984b. Documentation of the Nechako River Unsteady State Water Temperature Model. Technical Memorandum 1957/2. Prepared for Alcan Smelters and Chemicals Ltd.

Envirocon. 1984c. Documentation of the Users guide to the 1984 Nechako River Hydrothermal Model. Technical Memorandum 1957/3. Prepared for Alcan Smelters and Chemicals Ltd.

Envirocon Limited. 1985. Review of the 1984 Nechako River Hydrothermal Monitoring and Control Program. Technical Memorandum 1941/C. Chapter 2.0, Methods. Prepared for Alcan Smelters and Chemicals Ltd.

[NFCP] Nechako Fisheries Conservation Program Technical Committee. 2016. Historical Review of the Nechako Fisheries Conservation Program: 1987-2015. Available online at: [NFCP History Report July 2016.pdf](#)

[Triton] Environmental Consultants Ltd. 1995. The 1988-1995 Summer Water Temperature and Flow Management Project. Nechako Fisheries Conservation Program Technical Report.

[Triton] Environmental Consultants Ltd. 1996-2006, 2008-2010, 2013-2019. The Summer Water Temperature and Flow Management Project. Nechako Fisheries Conservation Program Technical Report.

APPENDIX 1

NUMERICAL EXAMPLE OF WATER TEMPERATURE TREND CALCULATION

DRAFT

Appendix A

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, 2019

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	136.0 to 226.5 @ 0800 hrs	136.0 to 226.5 @ 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, 2020

DRAFT

Date	Nechako River			Nautley	Date	Nechako River			Nautley
	Cheslatta Falls (°C)	Fort Fraser (°C)	above the Stuart River (°C)	Fort Fraser (°C)		Cheslatta Falls (°C)	Fort Fraser (°C)	above Stuart River (°C)	Fort Fraser (°C)
10-Jul	17.8	20.1	20.3	17.7	1-Aug	16.9	17.6	17.6	17.5
11-Jul	18.4	18.8	20.1	18.1	2-Aug	16.7	17.2	17.2	17.2
12-Jul	19.1	19.7	20.1	18.7	3-Aug	17.1	17.7	17.7	18.0
13-Jul	19.2	20.6	20.4	19.3	4-Aug	17.3	18.4	18.3	19.2
14-Jul	19.0	20.8	20.8	19.6	5-Aug	17.7	19.1	19.5	20.1
15-Jul	18.4	20.2	21.0	19.3	6-Aug	18.2	19.6	20.5	21.9
16-Jul	18.5	19.6	21.1	19.6	7-Aug	18.7	19.9	21.2	21.2
17-Jul	18.2	19.6	20.3	19.3	8-Aug	18.9	20.3	21.4	21.7
18-Jul	17.5	18.3	19.1	16.9	9-Aug	18.9	20.3	21.0	21.7
19-Jul	17.2	17.4	17.8	15.8	10-Aug	18.4	18.8	20.0	17.4
20-Jul	17.5	18.2	17.6	17.9	11-Aug	18.2	19.3	19.1	18.6
21-Jul	17.6	18.9	18.4	18.8	12-Aug	18.3	19.1	19.2	18.7
22-Jul	17.7	18.7	19.3	19.3	13-Aug	18.1	19.1	19.4	20.0
23-Jul	18.1	19.3	19.7	19.8	14-Aug	18.2	19.1	19.4	19.7
24-Jul	18.0	19.2	19.7	18.4	15-Aug	18.2	18.6	16.3	18.6
25-Jul	17.7	18.6	19.3	18.2	16-Aug	17.8	18.4	18.7	17.4
26-Jul	17.7	18.4	19.0	18.8	17-Aug	17.5	18.0	18.1	17.7
27-Jul	17.4	18.2	18.5	18.2	18-Aug	17.6	18.0	17.9	17.6
28-Jul	17.4	18.1	18.3	18.0	19-Aug	17.3	18.1	17.8	18.1
29-Jul	17.4	18.5	18.6	18.1	20-Aug	18.1	18.6	17.8	20.3
30-Jul	17.3	18.2	18.4	17.9					
31-Jul	17.2	18.0	18.3	18.1					

APPENDIX 3

MEAN DAILY SKINS LAKE SPILLWAY RELEASES AND FLOWS IN THE NECHAKO AND NAUTLEY RIVERS, 2020

DRAFT

Date	Skins Lake	Nechako River		Nautley River
	Spillway Release (m ³ /s)	Cheslatta Falls (m ³ /s)	At Vanderhoof (m ³ /s)	Fort Fraser (m ³ /s)
10-Jul	49	47.8	134	61.6
11-Jul	49 to 136 @ 0800 hrs	47.6	134	61.6
12-Jul	136	49.3	133	61.9
13-Jul	136 to 226.5 @ 0800 hrs	49.3	133	61.9
14-Jul	226.5	67.5	132	61.8
15-Jul	226.5	85.3	132	61.8
16-Jul	226.5	104	132	61.8
17-Jul	226.5	118	132	61.8
18-Jul	226.5	133	135	59.1
19-Jul	226.5 to 275 @ 1900 hrs	147	135	59.1
20-Jul	275	161	144	58.5
21-Jul	275	180	144	58.5
22-Jul	275	199	162	58.5
23-Jul	275	211	162	58.5
24-Jul	275	224	178	58.6
25-Jul	275 to 200 @ 1600 hrs	233	178	58.6
26-Jul	200 to 453.1 @ 1600	240	199	56
27-Jul	453.1	245	199	56
28-Jul	453.1 to 283 @ 1600 hrs	285	215	57.1
29-Jul	283	297	215	57.1
30-Jul	283	298	229	55.7
31-Jul	283 to 14.2 @ 1600 hrs	297	229	55.7
1-Aug	14.2	289	241	55
2-Aug	14.2	257	241	55
3-Aug	14.2 to 170 @ 1600	216	260	54.6
4-Aug	170	186	260	54.6
5-Aug	170	179	273	54.0
6-Aug	170	177	273	54.0
7-Aug	170	176	286	51.9
8-Aug	170	174	286	51.9
9-Aug	170	173	298	50.3
10-Aug	170	172	298	50.3

Date	Skins Lake	Nechako River		Nautley River
	Spillway Release (m ³ /s)	Cheslatta Falls (m ³ /s)	At Vanderhoof (m ³ /s)	Fort Fraser (m ³ /s)
11-Aug	170	171	307	49.5
12-Aug	170	171	307	49.5
13-Aug	170	169	314	48
14-Aug	170	166	314	48
15-Aug	170	168	318	47.3
16-Aug	170 to 14.2 @ 1600	168	318	47.3
17-Aug	14.2	165	346	46.5
18-Aug	14.2	149	346	46.5
19-Aug	14.2	131	364	45.6
20-Aug	14.2	115	364	45.6

APPENDIX 4
RECORDED AND FORECAST METEOROLOGICAL DATA

DRAFT

Recorded and Forecast Meteorological Data 2020

13.92	806.88	0.6	8	9.17	93.6	49.2	09 07 20
13.92	196.94	0.87	12.98	3.61	93.14	95.31	10 07 20
15.99	606.12	0.37	11.33	7.87	93.55	76.66	
16.67	669.22	0.07	10.08	6.56	93.5	67.05	
17.72	583.17	0.27	10.66	4.47	93.16	64.71	
17.32	640.54	0.41	9.76	7.96	93.08	62.2	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 10/20							

12.45	344.17	0.76	9.22	5.21	93.25	83.84	10 07 20
12.45	344.17	0.76	9.22	5.21	93.25	83.84	11 07 20
12.34	559.27	0.27	5.01	11.46	93.38	63.37	
14.18	664.44	0.15	5.39	8.94	93.57	56.09	
15.05	554.49	0.37	6.26	7.53	93.58	56.04	
16.45	468.45	0.66	11.32	7.12	93.6	74.36	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 11/09							

15.54	427.75	0.76	9.98	9.15	93.25	62.25	11 07 20
12.79	653.92	0.23	5.85	10.86	93.35	62.27	12 07 20
14.35	698.85	0.03	5.72	8.4	93.56	56.87	
15.06	587.95	0.27	6.24	7.62	93.58	55.88	
14.87	286.81	0.82	11.7	8.02	93.22	84.14	
14.49	401.53	0.56	9.87	5.51	93.04	76.41	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 12/20							

11.27	486.9	0.6	5.73	17.85	93.35	72.33	12 07 20
13.99	780.11	0	5.38	8.81	93.56	56.98	13 07 20
14.95	577.44	0.22	6.96	7.71	93.67	60.04	
15.69	248.57	0.74	11.37	6.58	93.51	78.42	
15.1	363.29	0.72	12.64	6.29	93.02	87.72	
16.21	602.29	0.36	11.26	7.05	93.37	75.25	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 13/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

14.04	649.23	0.2	6.23	6.25	93.56	60.96	13 07 20
13.44	495.22	0.38	7.3	6.67	93.68	69.33	14 07 20
13.92	269.6	0.71	11.25	5.33	93.59	86.66	
13.87	258.13	0.81	11.94	7.21	93.04	90.36	
15.75	659.66	0.24	10.53	7.2	93.36	73.88	
16.41	669.22	0.07	9.63	6.85	93.73	66.09	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 14/20							

12.54	353.72	0.6	8.1	2.42	93.68	77.79	14 07 20
13.33	206.5	0.69	11.68	6.04	93.56	91.73	15 07 20
13.94	290.63	0.75	11.55	7.23	93.01	88.06	
14.72	659.66	0.05	8.34	8.72	93.32	68.07	
16.03	669.72	0.04	8.38	7.42	93.72	61.77	
16.77	669.22	0.03	9.76	5.57	93.89	64.92	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 15/20							

13.59	197.41	0.6	11.34	1.8	93.56	88.79	15 07 20
15.28	489.48	0.47	11.27	8.99	93	79.96	16 07 20
15.19	586.04	0.18	8.13	8.31	93.4	64.7	
16.16	597.51	0.14	8.74	6.97	93.73	62.91	
17.41	669.22	0.03	10.67	6.13	93.9	66.3	
17.01	363.29	0.44	11.61	6.16	93.68	73	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 16/20							

15.12	390.44	0.6	10.98	4.38	93	72.79	16 07 20
14.6	623.33	0.24	7.96	8.48	93.44	66.83	17 07 20
15.58	423.52	0.32	9.51	6.74	93.83	69.65	
17.23	664.44	0.1	10.87	6.78	93.91	68.19	
17.07	411.09	0.41	11.5	5.98	93.57	72.14	
17.04	630.98	0.34	10.93	6.2	92.94	69.48	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 17/20							

15.8	547.35	0.3	8.18	7	93.44	61.92	17 07 20
14.69	413	0.48	9.15	6.94	93.81	72.3	18 07 20
16.72	629.06	0.09	10.14	7.21	93.97	67.1	
17.63	497.13	0.33	11.92	3.5	93.7	71.43	
16.31	296.37	0.65	13.84	4.53	93.1	87.64	
15.89	554.49	0.36	10.42	3.37	92.94	72.64	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 18/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

14.17	314	0.6	10.26	2	93.81	80.42	18 07 20
16.09	692.16	0.11	10.25	7.33	93.94	70.84	19 07 20
16.54	464.63	0.35	11.42	2.98	93.74	74.4	
16.43	449.33	0.52	12.03	6.18	93.11	78	
16.18	564.05	0.39	11.17	3.77	92.87	74.93	
16.2	640.54	0.17	8.77	8.79	92.9	62.83	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 19/20							

16.47	531.44	0.2	10.54	3.75	93.94	70.38	19 07 20
16.98	544.93	0.35	11.37	3.86	93.76	71.96	20 07 20
18.47	568.83	0.53	10.5	8.11	93.02	60.15	
15.71	501.91	0.34	9.43	4.65	92.87	68.6	
15.18	468.45	0.39	7.86	7.77	92.93	63.4	
14.18	468.45	0.36	5.37	10.57	93.09	55.95	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 20/20							

16.14	401.96	0.3	11.3	1.54	93.76	75.83	20 07 20
17.94	638.62	0.38	11.88	5.26	92.98	69.73	21 07 20
17.15	613.77	0.21	9.95	4.51	92.81	63.97	
15.85	506.69	0.36	8.68	7.73	92.8	64.14	
11.87	229.45	0.68	6.29	11.8	93.02	72.13	
14.9	583.17	0.46	7.31	9.6	93.51	62.05	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 21/20							

16.98	454.66	0.3	11.96	2.83	92.98	74.88	21 07 20
16.82	682.6	0.19	10.16	5.23	92.78	66.68	22 07 20
15.18	474.19	0.32	7.91	8.63	92.77	63.66	
11.92	219.89	0.82	6.88	10.93	93.01	74.79	
14.36	630.98	0.05	7.03	8.18	93.55	63.32	
16.16	602.29	0.08	9.42	5.26	93.86	66.31	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 22/20							

15.92	442.11	0.3	9.13	3.21	92.78	66.08	22 07 20
14.93	548.76	0.38	8.17	8.77	92.84	66.16	23 07 20
12.17	273.42	0.74	7.63	9.53	93.05	77.28	
14.61	621.41	0.03	7.78	6.99	93.67	65.82	
16.61	650.1	0.01	10.64	3.14	93.99	70.16	
18.45	602.29	0.05	13.29	3.59	93.57	74.21	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 23/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

12.94	282.01	0.4	7.52	3.67	92.84	72.92	23 07 20
11.32	196.94	0.82	8.26	8.47	93.11	84.68	24 07 20
13.87	596.56	0.1	7.96	7.19	93.73	70.42	
16.86	640.54	0	11.53	3.3	94.03	73.36	
18.77	630.98	0.06	13.65	3.79	93.54	74.4	
17.45	478.01	0.32	12.48	2.53	93.01	75.16	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 24/20							

12.27	206.78	0.6	7.18	5.63	93.11	74.54	24 07 20
14.02	688.34	0.11	7.18	6.67	93.77	68.96	25 07 20
17.5	640.54	0	11.85	3.77	93.96	71.73	
18.48	611.85	0.09	12.97	3.21	93.42	72.46	
17.92	554.49	0.26	11.02	2.82	93.02	65.52	
19.24	564.05	0.41	13.55	3.14	92.97	71.55	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 25/20							

14.73	542.19	0.3	7.85	15.6	93.77	65.63	25 07 20
17.47	715.11	0.06	12.11	3.77	93.88	73.32	26 07 20
18.69	623.33	0.07	13.44	3.79	93.32	73.75	
17.1	506.69	0.48	9.34	3.79	93.07	61.21	
17.12	602.29	0.15	10.55	4.98	93.31	67.17	
19.27	621.41	0.06	13.26	3.34	93.26	69.95	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 26/20							

18.43	603.32	0.1	12.11	4.05	93.88	68.42	26 07 20
18.81	676.86	0.15	13.16	3.64	93.31	71.75	27 07 20
18.06	527.72	0.54	9.7	4.06	93	58.21	
17.13	554.49	0.22	10.06	3.79	93.32	64.68	
19.61	630.98	0.12	12.82	3.79	93.53	66.05	
18.92	439.77	0.32	16.19	3.68	92.99	86.34	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 27/20							

18.09	465.67	0.2	11.5	9.45	93.31	67.04	27 07 20
18.36	575.53	0.54	9.29	3.36	93	54.65	28 07 20
16.98	600.38	0.16	8.67	3.88	93.42	58.44	
18.98	573.61	0.34	11.28	4.6	93.75	61.49	
19.62	401.53	0.35	14.78	3.37	93.2	75.8	
17.59	506.69	0.58	13.6	5.64	93.43	80.06	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 28/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

16.53	400.75	0.2	10.61	10.61	93	70.38	28 07 20
16.65	608.03	0.29	9.37	4.26	93.38	63.6	29 07 20
18.76	606.12	0.3	11.21	5.09	93.83	62.25	
20.99	621.41	0.03	14.19	4.92	93.42	66	
19.19	592.73	0.23	15.07	4.62	93.53	79.43	
19.39	516.25	0.44	13.82	4.28	93.42	72.15	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 29/20							

15.67	456.3	0.2	9.22	4.8	93.38	67.75	29 07 20
19.15	638.62	0.4	11.74	4.83	93.85	62.98	30 07 20
19.32	518.16	0.16	14.75	4.45	93.46	77.16	
19.1	501.91	0.37	15.07	4.36	93.52	79.88	
17.97	492.35	0.44	14.03	3.57	93.34	80.33	
16.43	602.29	0.38	10.29	6.74	93.7	69.3	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 30/20							

18.96	541.16	0	12.66	1.8	93.85	68.5	30 07 20
20.19	550.67	0.31	13.97	3.23	93.42	68.88	31 07 20
19.35	491.4	0.36	14.56	4.83	93.48	76.04	
17.05	248.57	0.72	14.03	4.06	93.34	84.9	
15.9	544.93	0.19	11	7.8	93.49	75.51	
15.71	592.73	0.03	7.71	5.68	93.82	59.96	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 31/20							

18.37	277.97	0.1	14.48	4.8	93.41	80.54	31 07 20
19.74	683.62	0.17	14.44	4.69	93.43	73.49	01 09 20
18.41	307.84	0.7	13.31	4.75	93.39	74.5	
16.95	482.79	0.56	11.34	8.77	93.61	71.96	
15.95	597.51	0.07	7.4	4.27	93.88	57.22	
17.29	506.69	0.52	11.02	3.88	93.11	68.67	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 01/20							

18.93	545.54	0	12.87	9.9	93.43	69.71	01 08 20
18.64	504.78	0.47	11.26	4.13	93.35	63.22	02 08 20
16.84	489.48	0.34	10.4	9.03	93.52	67.81	
16.6	564.05	0.11	7.72	4.53	93.75	55.6	
16.18	411.09	0.35	11.64	4.24	93.01	77.31	
13.49	525.81	0.49	8.23	7.95	93.83	73.73	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 02/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

15.97	342.03	0.3	11.32	3.75	93.35	76.75	02 08 20
16.92	594.65	0.22	9.89	9.13	93.51	64.81	03 08 20
16.51	571.7	0.16	7.23	5.93	93.72	53.59	
14.9	329.83	0.48	10.91	4.47	93.12	80.03	
13.09	425.43	0.68	8.24	6.97	92.79	75.76	
11.96	363.29	0.35	6.4	9.73	93.11	72.21	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 03/20							

15.11	368.08	0.4	12.3	12.3	93.51	73.08	03 08 20
15.8	619.5	0.12	7.34	5.18	93.73	57.71	04 08 20
15.97	446.46	0.37	10.71	3.66	93.03	73.73	
13.2	301.15	0.78	9.22	6.02	92.8	80.12	
12.11	391.97	0.29	6.21	8.47	93.27	70.48	
12.55	525.81	0.3	4.5	4.5	93.69	59.78	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 04/20							

14.31	493.78	0.1	8.49	4.35	93.73	70.92	04 08 20
15.99	535.37	0.26	10.52	4.56	92.97	72.62	05 08 20
13.02	344.17	0.72	9.1	6.31	92.82	80.37	
12.29	425.43	0.23	6.06	7.75	93.32	68.85	
13.16	587.95	0.07	5.01	9.35	93.79	59.3	
13.32	420.65	0.47	7.04	8.52	93.61	68.63	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 05/20							

13.9	407.63	0.1	9.91	7.05	92.97	80.08	05 08 20
13.62	367.11	0.68	10.23	5.34	92.74	83.05	06 08 20
12.04	354.68	0.29	6.47	8.02	93.24	72.16	
12.98	583.17	0.12	4.65	9.26	93.82	58.32	
14.39	348.95	0.52	7	6.29	93.95	63.05	
16.28	372.85	0.52	11.8	8.79	93.38	77.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 06/20							

12.79	369.11	0.4	8.07	9.75	92.74	76.38	06 08 20
12.13	413.48	0.31	6.44	8.23	93.18	71.54	07 08 20
13.04	537.76	0.21	4.39	12.32	93.68	56.79	
12.42	377.63	0.34	6.45	6.88	94.12	70.14	
13.73	592.73	0.05	7.3	6.74	93.76	67.88	
12.4	587.95	0.13	4.36	6.9	93.08	59.77	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 07/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

11.08	413.48	0.4	7.48	8.23	93.18	82	07 08 20
13.09	636.71	0.18	4.38	11.56	93.7	56.45	08 08 20
12.01	352.77	0.35	6.35	6.58	94.07	71.69	
12.81	583.17	0.09	7.33	7.37	93.79	72.59	
11.58	578.39	0.1	3.69	8.72	93.24	60.58	
12.03	420.65	0.43	3.15	9.93	92.96	55.58	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 08/20							

13.29	449.76	0.3	5.96	21.75	93.7	63.38	08 08 20
11.21	307.84	0.35	7.24	5.28	94	80.19	09 08 20
12.65	595.6	0.1	6.23	8.21	93.73	67.88	
11.49	444.55	0.27	3.73	8.94	93.2	61.17	
12.28	583.17	0.03	3.66	9.2	93.03	56.88	
12.46	554.49	0.15	3.85	6.78	93.33	56.98	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 09/20							

10.27	218.57	0.4	7	4.95	94	83.63	09 08 20
12.7	657.74	0.03	6.12	8	93.78	67.12	10 08 20
11.74	565.97	0.18	4.33	8	93.17	62.95	
12.32	587.95	0.01	4.07	8.18	93.05	58.78	
12.16	434.99	0.36	3.59	6.76	93.35	57.17	
12.32	497.13	0.35	5.55	5.98	93.49	66.13	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 10/20							

13.6	530.58	0.4	6.02	16.65	93.78	62.08	10 08 20
11.68	617.59	0.17	4.22	6.65	93.78	67.12	11 08 20
12.14	347.99	0.64	4.72	9.33	93.17	62.95	
13.38	544.93	0.41	4.48	7.48	93.05	58.78	
13.13	458.89	0.42	7.74	8.56	93.35	57.17	
12.23	315.49	0.55	6.46	3.59	93.49	66.13	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 11/20							

10.5	416.49	0.3	4.44	13.8	93.78	69.67	11 08 20
11.68	617.59	0.17	4.22	6.65	93.06	62.72	12 08 20
12.14	347.99	0.64	4.72	9.33	93.04	62.91	
13.38	544.93	0.41	4.48	7.48	93.39	55.46	
13.13	458.89	0.42	7.74	8.56	93.35	73.08	
12.23	315.49	0.55	6.46	3.59	93.75	71.41	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 12/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

10.75	198.36	0.6	4.94	16.65	93.06	70.92	12 08 20
12.79	619.5	0.22	4.03	8.14	93.5	56.21	13 08 20
11.35	140.54	0.82	9.19	4.94	93.73	89.22	
15.88	387.19	0.62	12.5	6.15	93.69	83.1	
16.01	535.37	0.07	12.66	3.43	93.69	83.26	
17.4	449.33	0.23	15.4	2.96	93.48	90.01	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 13/20							

13.51	466.7	0.4	5.46	20.7	93.5	59.75	13 08 20
12.25	191.2	0.85	9.93	5.46	93.61	88.38	14 08 20
16.17	391.97	0.68	12.58	6.99	93.51	82.02	
16.76	599.27	0.12	12.84	3.23	93.39	80.39	
18.16	540.15	0.01	13.72	2.42	93.39	82.82	
18.79	449.33	0.36	14.76	3.61	93.62	79.86	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 14/20							

12.77	142.21	0.6	9.92	4.05	93.61	85.75	14 08 20
16.6	451.24	0.56	12.66	7.06	93.5	80.32	15 08 20
17.23	552.58	0.18	13.44	3.3	93.32	81.05	
18.47	549.71	0.01	14.45	2.01	93.4	79.9	
17.71	415.87	0.29	13.86	3.7	93.55	80.76	
15.02	315.49	0.4	11.94	2.65	93.4	84.59	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 15/20							

15.25	171.79	0.4	12.79	3.3	93.5	87.71	15 08 20
17.63	585.09	0.25	13.55	3.14	93.27	79.6	16 08 20
18.34	552.58	0.25	13.23	2.55	93.32	74.45	
15.27	368.07	0.14	12.24	4.83	93.65	84.9	
14.22	501.91	0.24	10.45	4.03	93.41	81.18	
16.76	449.33	0.49	11.99	4.67	92.87	76.19	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 16/20							

17.11	515.71	0.2	12.19	1.8	93.27	75.42	16 08 20
19.29	609.94	0.1	12.46	3.74	93.24	65.82	17 08 20
15.71	398.66	0.24	10.96	5.03	93.55	76.23	
14.73	487.57	0.25	9.3	3.77	93.38	72.83	
16.35	348.95	0.79	11.94	3.91	92.77	77.96	
15.64	305.93	0.73	13.63	3.64	92.42	89.93	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 17/20							

Appendix 4 (continued)
Recorded and Forecast Meteorological Data 2020

17.79	440.22	0.1	12.19	5.17	93.24	72	17 08 20
16.64	460.8	0.22	10.71	5.7	93.37	70.33	18 08 20
13.75	428.3	0.27	5.52	3.97	93.37	58.84	
17.08	463.67	0.51	9.66	2.71	92.73	62.89	
14.64	176.86	0.63	12.36	5.89	92.41	88.59	
12.7	420.65	0.33	8.25	5.7	93.46	77.76	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 18/20							

14.99	327.67	0.4	9.79	9.15	93.37	74	18 08 20
14.28	506.69	0.27	7.52	3.5	93.3	66.18	19 08 20
15.02	368.07	0.49	12.09	3.7	92.75	85.33	
14.31	229.45	0.58	12.95	7.16	92.32	93.23	
12.67	310.71	0.73	8.15	11.69	93.09	77.41	
13.89	487.57	0.36	7.54	5.1	93.69	68.22	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 19/20							

12.89	407.8	0.2	7.24	4.95	93.3	71.71	19 08 20
15.5	378.59	0.76	11.14	4.15	92.66	78.17	20 08 20
13.93	204.59	0.66	12.47	3.41	92.32	92.74	
12.76	329.83	0.65	8.1	14.82	92.97	76.74	
11.69	530.59	0.03	6.29	3.64	93.67	73.03	
11.2	325.05	0.52	7.86	2.58	93.27	83.31	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 20/20							

APPENDIX 5

SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT RESERVOIR RELEASE VOLUME CALCULATIONS FOR JULY 10 TO AUGUST 20, 2020

DRAFT

Skins Lake Spillway base release for the period July 10 (191) to August 20 (232) = 49.0 m³/s

Summer Water Temperature and Flow Management Project Base Release Volume = (JD 228 - JD 191) * 49.0 + (JD 232 - JD 228) * 14.16 = 1,869.6 m³/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 19 (200) @ 1900 hrs	155	226.5	35,107
July 19 (200) @ 1900 hrs to July 25 (206) @ 1600 hrs	141	275	38,775
July 25 (206) @ 1600 hrs to July 26 (207) @ 1600 hrs	24.0	200.0	4,800
July 26 (207) @ 1600 hrs to July 28 (209) @ 0800 hrs	40.0	453.1	18,124
July 28 (209) @ 0800 hrs to July 31 (212) @ 1600 hrs	80.0	283.0	22,640
July 31 (212) @ 1600 hrs to Aug 3 (215) @ 1600 hrs	72.0	14.2	1,022
Aug 3 (215) @ 1600 hrs to Aug 16 (228) @ 1600 hrs	312.0	170.0	53,040
Aug 16 (228) @ 1600 hrs to Aug 20 (232) @ 2400 hrs	104.0	14.2	1,477
	Total	1,008 (42.0 days)	183,082

Total Release Volume

= 183,082 m³/s*hrs
 = 7,628.4 m³/s*days
 = 269,397 cfs*days

Volume Released for Cooling Purposes

= Total Volume - Base Volume
 = 7,628.4 - 1,800.0
 = 5,828.4 m³/s*days
 = 205,832 cfs*days

Average Release over Summer Management Period
 (July 10 to August 20)

= 7,628.4 m³/s*days / 42 days
 = 181.6 m³/s
 = 6,414.2 cfs