

**THE 2019 SUMMER WATER TEMPERATURE
AND FLOW MANAGEMENT PROJECT**



Prepared by:
Triton Environmental Consultants Ltd.

February 2020

Revision History and Approvals			
Project Name		Summer Water Temperature and Flow Management Project	
Project Number		10385	
Report Title		2019 Summer Water Temperature and Flow Management Project	
Document #		P4737	
Report Author(s)		Jen Bond, B.Sc.	
Date	Version	Review Type	Reviewed by
Feb. 2, 2020	Draft	Technical	A.C. Mitchell, M.Eng., P.Eng.
Feb. 6, 2020	Draft	Document	Marilyn Fransen, BA
Feb. 11, 2020	Draft	Client	Justus Benckhuysen (Rio Tinto)

Executive Summary

The 2019 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 2019, mean daily water temperatures in the Nechako River above the Stuart River confluence did exceed 20.0°C during the control period (July 20 to August 20) on four occasions, reaching a maximum mean temperature of 21.4°C.

During the 2019 STMP, a Stop Order was issued by the government of British Columbia in response to the Big Bar landslide on the Fraser River. The Stop Order was officially implemented on August 3, 2019 by the Comptroller of Water Rights and remained in place until its expiry on September 1, 2019.

Over the duration of the 2019 Summer Water Temperature and Flow Management Project (July 10 to August 20), the total volume of water released was 6,946.5 m³/s-d, and the average release during the Project was 161.5 m³/s.

Disclaimer

This report is rendered solely for the use of the Nechako Fisheries Conservation Program (NFCP) in connection with the 2019 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 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 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**

 2.1 Big Bar Landslide Stop Order 6

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 Big Bar Landslide Stop Order 15

 4.4 Project Summary 17

5.0 References..... **20**

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 in the Nechako River above Stuart River 19

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 2019) 9

Table 3. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (August 2019)..... 10

Table 4. Recorded mean daily water temperatures in the Nechako River above the Stuart River confluence 11

LIST OF APPENDICES

- Appendix 1. *Water Sustainability Act* Order - Section 39
- Appendix 2. Numerical Example of Water Temperature Trend Calculation
- Appendix 3. Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2019
- Appendix 4. Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2019
- Appendix 5. Recorded and Forecast Meteorological Data
- Appendix 6. Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2019

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 2018) have been carried out under the auspices of the Nechako Fisheries Conservation Program (NFCP; NFCP 2016).

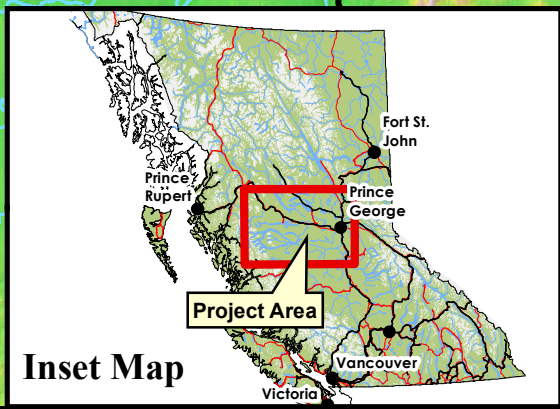
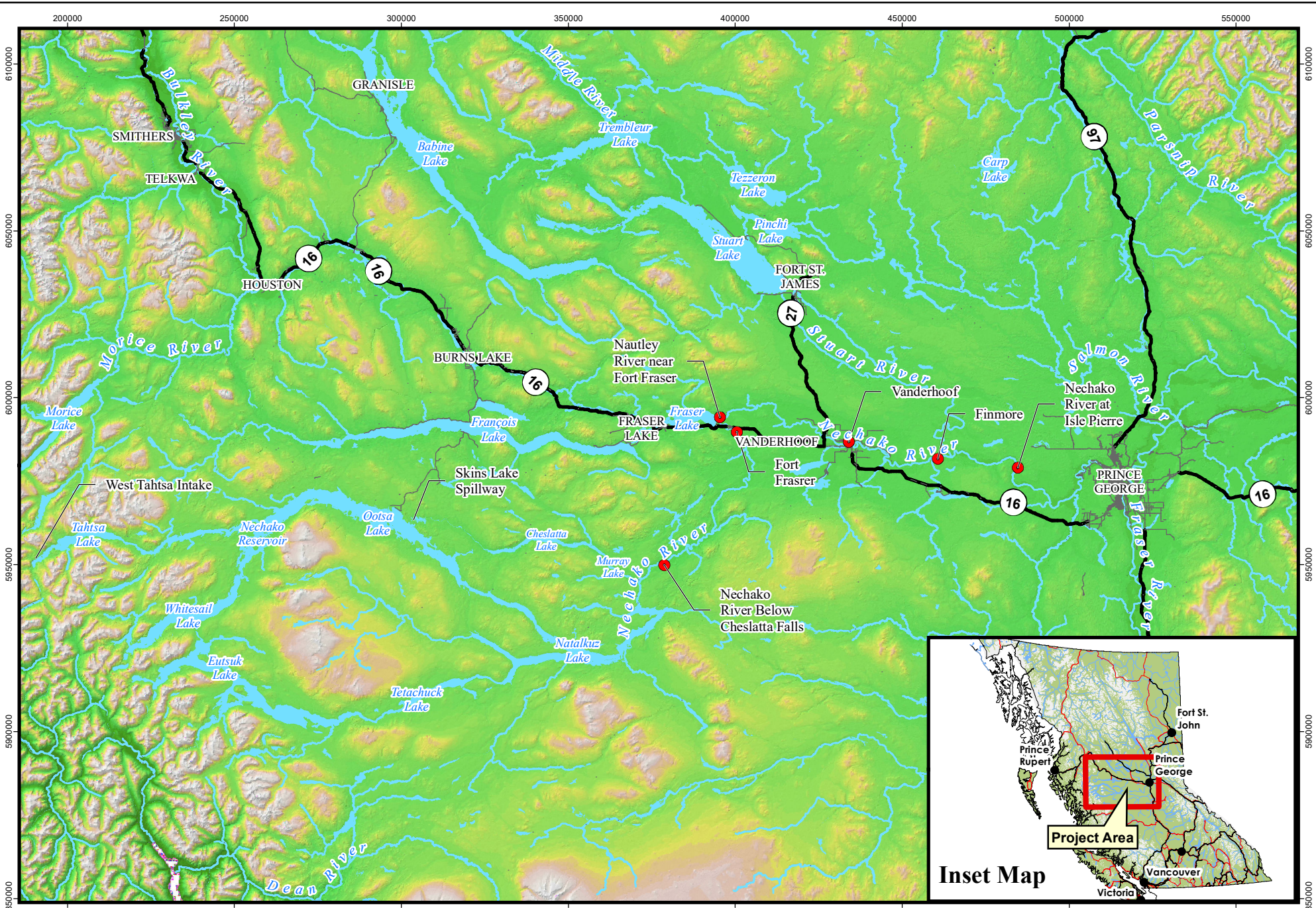
The objective of the Project is to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C by regulating releases from the Skins Lake Spillway (SLS). The Project operates from July 10 to August 20 (the operational period) with the 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.

In late June 2019, a landslide in a remote, rugged canyon along the Fraser River north of Lillooet was reported to Fisheries and Oceans Canada (DFO) and the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD). The landslide created a 5 m waterfall. Based on the magnitude of the obstruction, salmon migrating upstream were impeded from naturally proceeding (BC MOECCS 2019). Efforts to remediate the rock obstruction and assist with the transportation of migrating salmon were initiated in July 2019. It was discovered in late July 2019 that a significant increase in flow at the SLS impacted rescue efforts downstream and Rio Tinto (RT) was contacted to discuss these impacts and the STMP. As a result, under Section 39 of the *Water Sustainability Act*, a suspension to the 2019 STMP was issued on August 3, 2019 by the Comptroller of Water Rights (Appendix 1).

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 2019 STMP and includes:

- An outline of the method for determining SLS releases and summaries of the 2019 SLS releases for the period July 10 to August 20 inclusive, including those impacted by the Big Bar landslide;
- 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 2019 STMP.



Nechako Fisheries Conservation Program

Figure 1. Nechako River Study Area

Legend

- WSC Sites
- Road
- Highway
- Stream
- Waterbody

0 5 10 20 30 40 50 Kilometers

Scale: 1:1,500,000

File No:	N:\ACTIVE\5802_STMP_2017\5802_Fig1_20171101.mxd	
Project No:	5802	
Date:	Nov 01, 2017	
Basemap Source:	BC WMS Imagery	
Map Datum:	NAD 1983 UTM Zone 10N	



2.0 Methods

Management of the Nechako River flows and water temperatures 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 2019 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 47 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 2):

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 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.

2.1 Big Bar Landslide Stop Order

During the suspension of the STMP, daily operations by Triton followed the protocol defined in the Settlement Agreement (Anon. 1987); however, daily updates were provided to the Incident Command (IC) for review, and formal approval on daily recommendations was sent from the Joint Executive Steering Committee (JESC) to Triton. During the initial days of the stop order, the target temperature as directed by the JESC was a maximum of 22°C and flows of 170 m³/s. A summary of the decisions made during this time period can be found in Section 3.0.

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 four occasions (August 6 to August 9, inclusive) during the 2019 STMP. These exceedances occurred during the time period when the stop order was in place and daily operations were approved from the JESC. The respective maximum and minimum mean daily water temperatures recorded during the control period were 21.4°C on August 8 and August 9, and 17.2°C on August 2. 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 3.

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 4). 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 453.1 m³/s to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
- July 21 – Decrease to 14.2 m³/s to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
- July 23 – Increase to 170 m³/s to ensure flow in the Nechako River below Cheslatta Falls does not drop below 170 m³/s.
- July 31 – Increase to 453.1 m³/s to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
- August 1 – Decrease to 14.2 m³/s to decrease flow in the Nechako River below Cheslatta Falls in response to the pending Big Bar Landslide Stop Order.
- August 4 – Increase to 340 m³/s under the Stop Order; increase flow in Nechako River below Cheslatta Falls to 170 m³/s.
- August 5 – Decrease to 170 m³/s under the Stop Order; maintain flow in Nechako River below Cheslatta Falls to a minimum of 170 m³/s.
- August 8 – Increase to 453.1 m³/s under regular STMP operation; increase flow in the Nechako River below Cheslatta Falls in response to warming trend.

- August 9 – Decrease to 14.2 m³/s to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
- August 10 – Increase to 170 m³/s to increase flow in Nechako River below Cheslatta Falls to a minimum of 170 m³/s.
- August 13 – Increase to 453.1 m³/s to increase flow in the Nechako River below Cheslatta Falls in response to warming trend.
- August 14 – 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 27 – 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 238 m³/s on July 22 and a minimum of 107 m³/s on August 20. Flows measured in the Nechako River at Vanderhoof ranged between a maximum of 271 m³/s on July 23 and a minimum of 156 m³/s on August 20.

Table 2. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (July 2019)

	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					21.4	21.3	20.8	20.7	19.0	18.2	18.3	19.4	19.6	20.2	19.9	19.4	19.9	19.0	19.4	19.5	18.3	19.3
4th Day's Predicted Water Temperature at Date + 3 Days				21.0	21.1	21.2	21.5	20.5	19.4	17.9	18.0	18.6	19.3	19.6	19.8	20.2	19.4	19.3	19.2	18.6	19.4	18.3
3rd Day's Predicted Water Temperature at Date + 2 Days			20.7	20.6	21.3	21.7	21.7	20.8	19.1	17.7	17.5	17.9	18.6	20.0	20.1	20.1	19.7	19.1	18.6	19.4	18.7	18.2
2nd Day's Predicted Water Temperature at Date + 1 Day		20.5	20.1	21.1	21.6	22.2	21.8	20.9	19.2	17.8	16.9	18.0	20.1	20.0	20.5	20.1	19.3	18.5	19.2	19.1	18.5	18.1
Current Day's Predicted Water Temperature at Date	20.8	19.9	20.7	21.1	21.4	21.9	21.6	20.7	19.4	17.5	17.3	19.1	19.5	20.2	20.1	19.3	18.8	18.8	18.8	18.6	18.5	18.2
Previous Day's Calculated Water Temperature at Date - 1 Day	20.4	20.0	20.2	20.6	21.0	21.4	21.3	20.6	19.1	17.5	17.5	18.6	19.5	19.9	19.6	19.0	18.6	18.5	18.4	18.4	18.4	17.9
Previous Day's Recorded Water Temperature at Date - 1 Day	20.4	20.3	20.1	20.1	20.4	20.8	21.0	21.1	20.3	19.1	17.8	17.6	18.4	19.3	19.7	19.7	19.3	19.0	18.5	18.3	18.6	18.4
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	453.0	453	500	500	170	170	170	170	170	170	170	170
		to		to						to		to		to								to
		136		226.5						453		500		170								453
		@		@						@		@		@								@
		0800		0800						1600		1600		1600								1600

Table 3. Predicted and recorded mean daily water temperatures in the Nechako River above the Stuart River confluence (August 2019)

	AUGUST																			
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	17.8	18.6	18.3	19.7	20.3	21.2	21.7	20.8	19.8	20.3	19.8	20.1	19.2	19.1	19.6	18.9	19.2	18.9	17.4	17.6
4th Days Predicted Water Temperature at Date + 3 Days	18.5	18.1	18.8	19.0	20.0	21.1	20.8	21.0	21.3	20.2	19.6	19.3	19.2	19.4	19.2	19.1	19.5	17.5	17.2	17.2
3rd Days Predicted Water Temperature at Date + 2 Days	18.1	18.2	17.5	18.5	20.1	20.8	21.4	21.8	21.5	20.0	19.7	19.6	18.8	19.4	19.7	19.7	18.4	17.6	17.3	17.6
2nd Days Predicted Water Temperature at Date + 1 Day	18.2	17.0	17.3	18.8	20.2	21.0	21.6	22.1	21.2	20.2	17.4	18.5	19.2	20.1	20.0	19.2	18.8	17.4	17.5	18.3
Current Days Predicted Water Temperature at Date	17.6	17.2	17.5	18.9	19.8	20.8	21.6	21.8	20.6	21.1	19.2	18.8	19.7	20.0	19.6	19.4	18.1	17.5	18.2	17.8
Previous Days Calculated Water Temperature at Date - 1 Day	17.6	17.1	17.5	18.6	19.6	20.6	21.3	21.3	20.7	20.8	19.1	18.8	19.6	19.8	19.3	19.1	17.9	17.7	17.9	
Previous Days Recorded Water Temperature at Date - 1 Day	18.3	17.6	17.2	17.7	18.3	19.5	20.5	21.2	21.4	21.0	20.0	19.1	19.2	19.4	19.4	19.3	18.7	18.1	17.9	17.8
Current Days Skins Lake Spillway Release at Date (m ³ /s)	453	500	500	500	340	170	170	170	453	14.2	170	170	170	453	14.2	14.2	14.2	14.2	14.2	14.2
	to			to	to			to	to	to			to	to						
	14.2			340	170			453	14.2	170			453	14.2						
	@			@	@			@	@	@			@	@						
	1600			1300	1600			1600	1600	1600			1600	1600						

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, 2019			
Date	Water Temperature (°C)	Date	Water Temperature (°C)
10-Jul	20.3	01-Aug	17.6
11-Jul	20.1	02-Aug	17.2
12-Jul	20.1	03-Aug	17.7
13-Jul	20.4	04-Aug	18.3
14-Jul	20.8	05-Aug	19.5
15-Jul	21.0	06-Aug	20.5
16-Jul	21.1	07-Aug	21.2
17-Jul	20.3	08-Aug	21.4
18-Jul	19.1	09-Aug	21.0
19-Jul	17.8	10-Aug	20.0
20-Jul	17.6	11-Aug	19.1
21-Jul	18.4	12-Aug	19.2
22-Jul	19.3	13-Aug	19.4
23-Jul	19.7	14-Aug	19.4
24-Jul	19.7	15-Aug	19.3
25-Jul	19.3	16-Aug	18.7
26-Jul	19.0	17-Aug	18.1
27-Jul	18.5	18-Aug	17.9
28-Jul	18.3	19-Aug	18.3
29-Jul	18.6	20-Aug	17.9
30-Jul	18.4		
31-Jul	18.3		

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

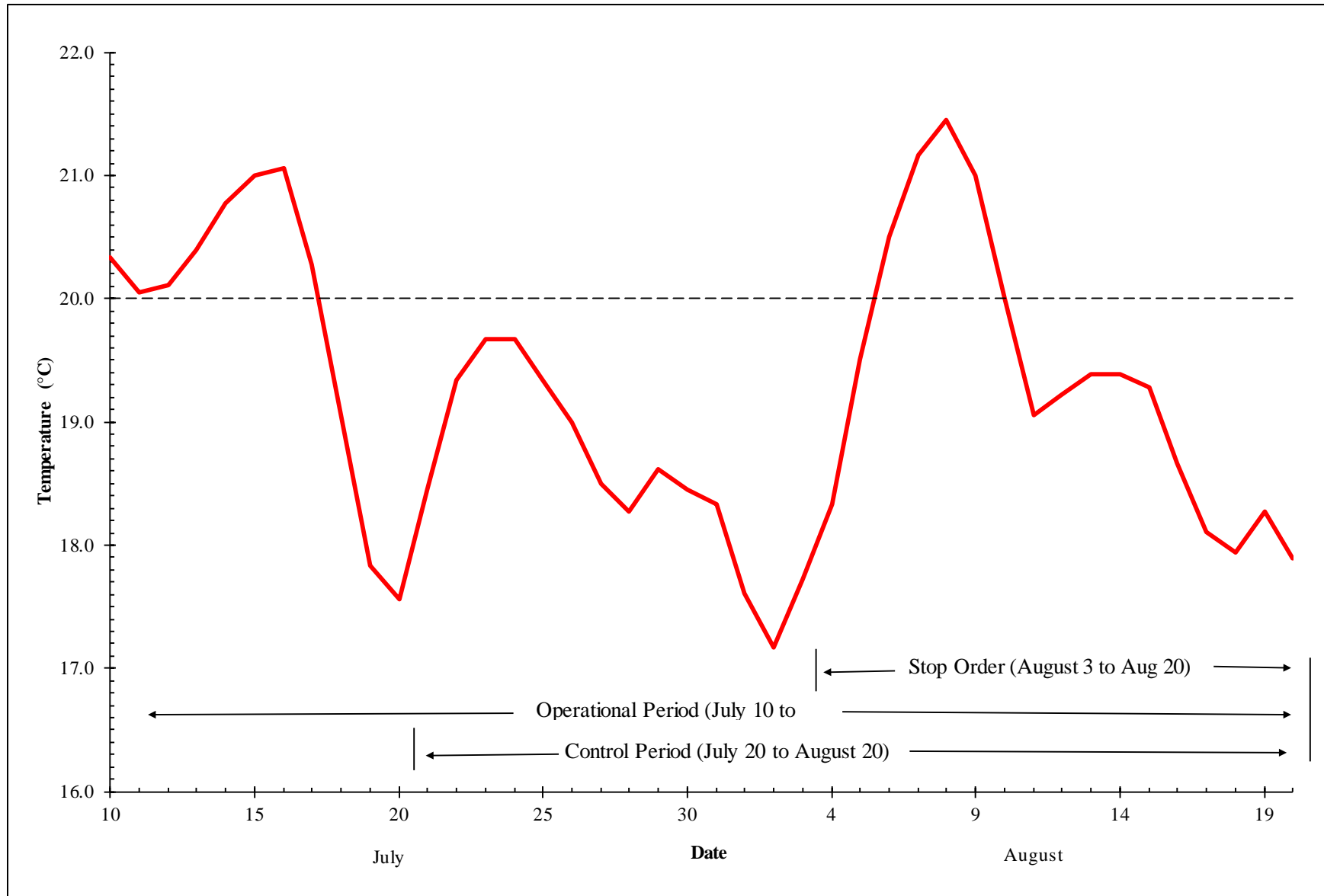
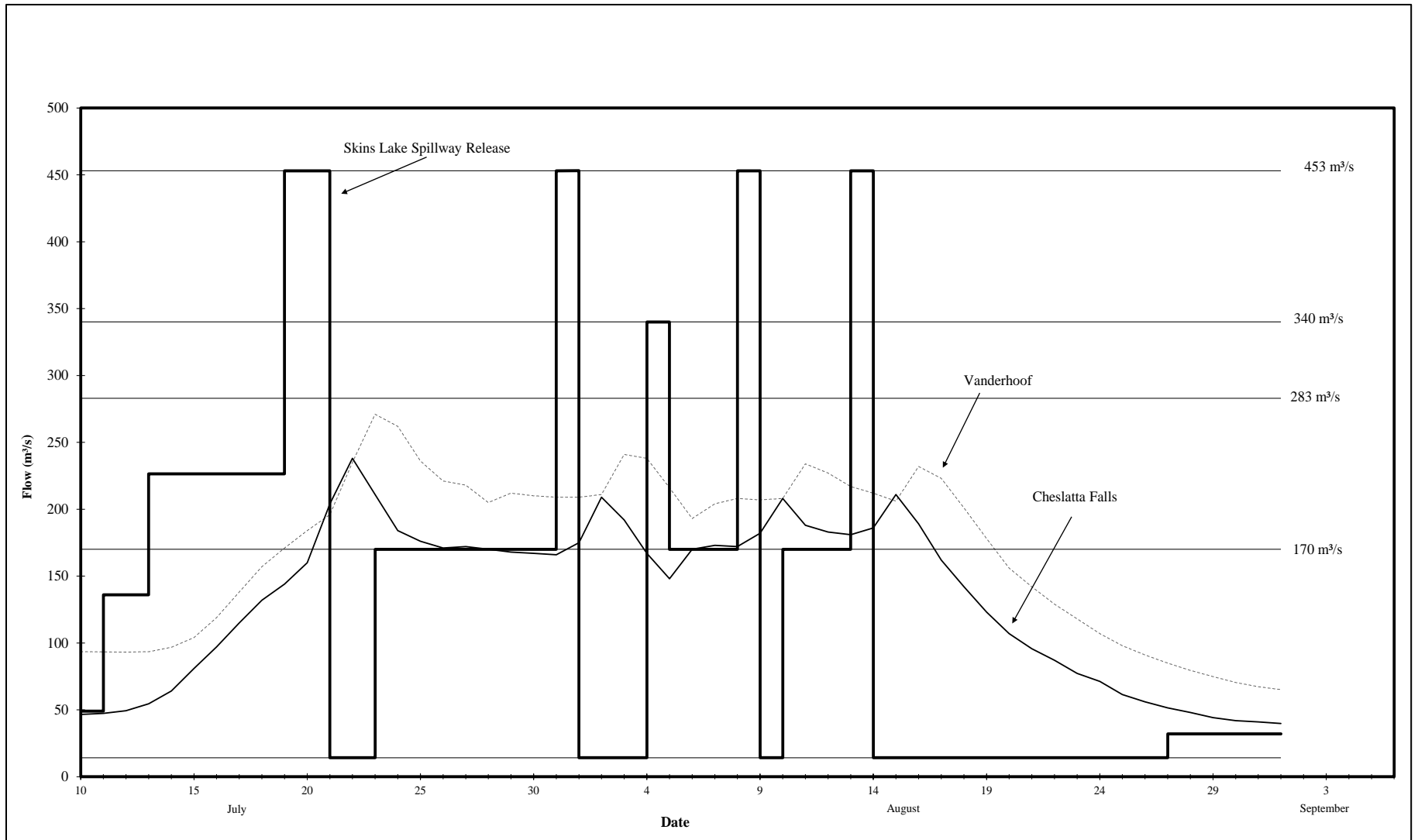


Figure 3. Skins Lake Spillway releases and flows in the Nechako River below Cheslatta Falls and at Vanderhoof



4.0 Discussion

The discussion of the 2019 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 2019 STMP. The third section provides a brief discussion of the application of the Project release criteria, including the Big Bar landslide stop order.

4.1 Recorded Data

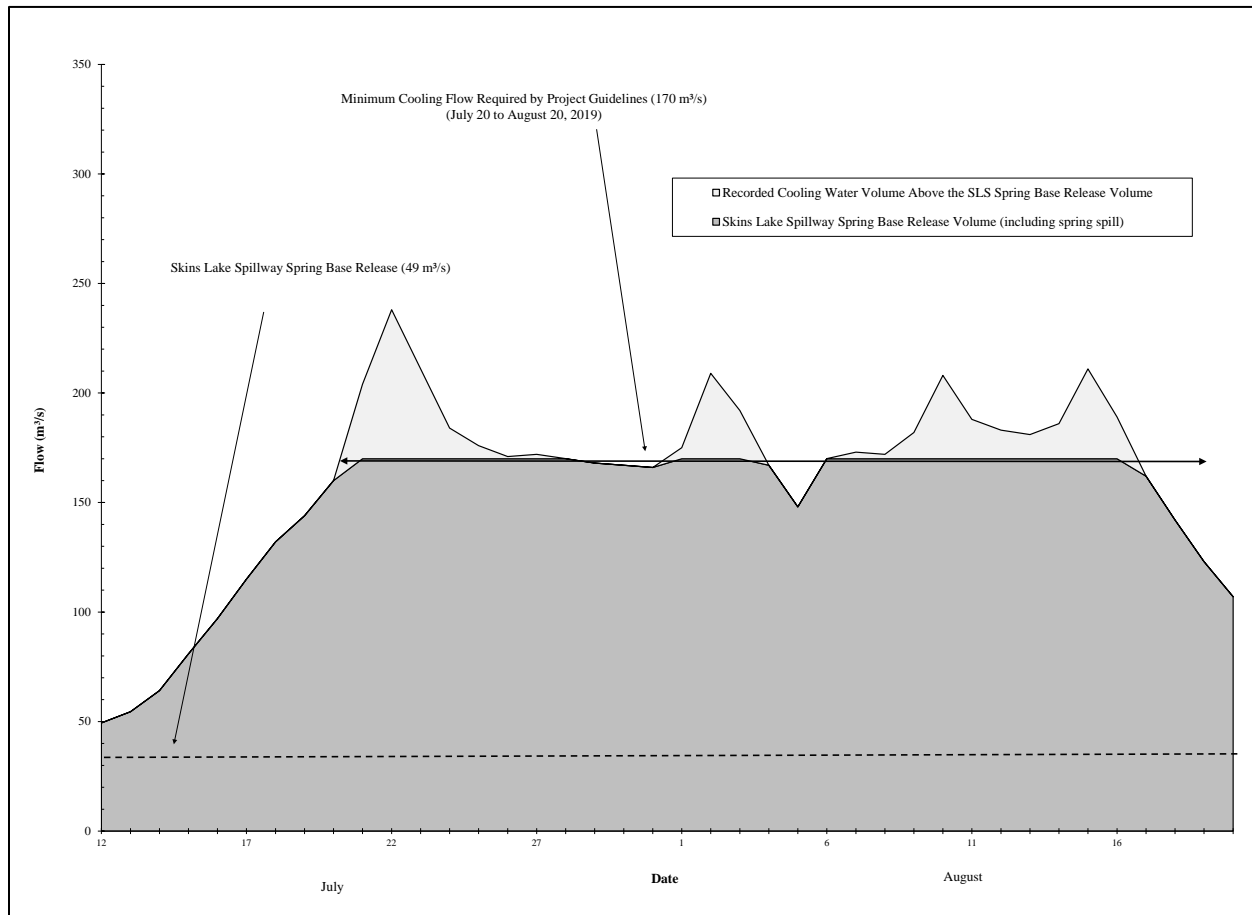
In 2019, river discharges in the NRBCF and at Vanderhoof, as recorded by the Water Survey of Canada, changed as expected in response to SLS releases (Figure 3). The hourly stage data from the gauging station located on the NRBCF proved useful in verifying the daily predictions of the flow routing model 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 2019 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 2019 STMP operational period was 6,946.5 m³/s-d. The volume released for cooling purposes was 5,146.5 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 14, inclusive, with a reduction to 14.2 m³/s until August 20. The average release during the operational period was 161.5 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 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 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 2019.

4.3.1 Big Bar Landslide Stop Order

As mentioned in Section 2.1, daily operations were followed as outlined in the Settlement Agreement (Anon. 1987); however flow release decisions were reviewed and approved

by the JESC. During this time a total of seven exceptions were made to the application of the release criteria.

On August 1, 2019, 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 453 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 453 m³/s. After the decision was made to remain at the current release, RT was contacted by the JESC as the increased flow was impacting remediation and rescue efforts. A decision was made to decrease the current release to 14.2 m³/s. This decision to decrease the current release was within the parameters of the protocol defined in the Settlement Agreement (Anon., 1987).

On August 2, 2019, two of three water temperature trends indicated the water temperatures would 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 would have been increased from the current release of 14.2 m³/s to 453 m³/s; however the spillway release was maintained at 14.2 m³/s due to the pending order to suspend the 2019 STMP.

On August 3, 2019, the official order to suspend the 2019 STMP was received. Two of three water temperature trends indicated the water temperatures would exceed 19.4°C in the Nechako River above Stuart River within the forecast period (5 days) and flows at the Nechako River below Cheslatta Falls were forecasted to fall below the minimum water level of 170 m³/s. Following these release criteria under these conditions, the release from SLS would have been increased from the current release of 14.2 m³/s to 453 m³/s. Approval from the JESC was not received to increase flows and therefore they remained at 14.2 m³/s.

On August 4, 2019, three of three water temperature trends indicated the water temperatures would exceed 19.4°C in the Nechako River above Stuart River within the forecast period (5 days) and flows at the Nechako River below Cheslatta Falls had dropped below the minimum requirement of 170 m³/s to 167 m³/s. Following these release criteria under these conditions, the release from SLS would have been increased from the current release of 14.2 m³/s to 453 m³/s. Under direction of the JESC, flows were increased to 340 m³/s to bring flows at the Nechako River below Cheslatta Falls back to the required minimum of 170 m³/s.

On August 5, 2019, three of three water temperature trends indicated the water temperatures would 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 would have been maintained at the current release of 340 m³/s;

however direction was received by the JESC to decrease the spillway release to 170 m³/s in order to maintain lower flows at the incident site.

On August 6, 2019, three of three water temperature trends indicated the water temperatures would 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 would have been increased from the current release of 170 m³/s to 453 m³/s; however the current release of 170 m³/s was maintained, as directed by the JESC, in order to sustain lower flows at the incident site. .

On August 7, 2019, three of three water temperature trends indicated the water temperatures would 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 would have been increased from the current release of 170 m³/s to 453 m³/s; however flows were maintained at the current release of 170 m³/s as directed by the JESC.

4.4 Project Summary

In 2019, mean daily water temperatures in the Nechako River above the Stuart River confluence did exceed 20.0°C. Over the duration of the 2019 STMP operational period, the total volume of water released was 6,946.5 m³/s-d, and the average release during the Project was 161.5 m³/s. The total volume of water released in 2019 was below the calculated average between 1983 and 2019 (8,183.9 m³/s-d) but above the minimum total volume released (6,649.6 m³/s-d).

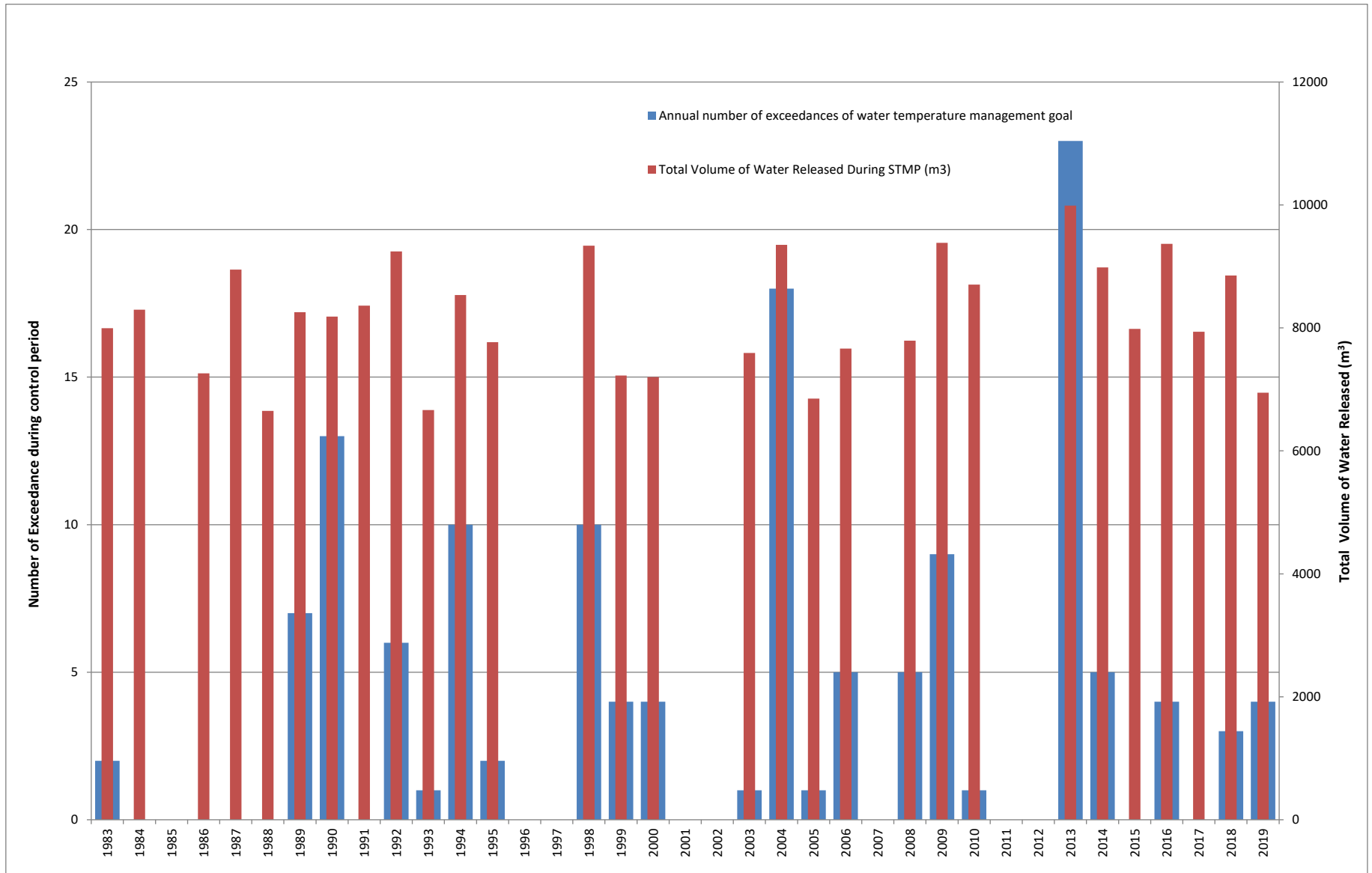
Figure 5 illustrates the total volume of water used each year the STMP has been implemented, and the number of exceedances at the Nechako River above Stuart River during the operational period since the project was initiated in 1983. As shown in Figure 5, the minimum amount of water released during the 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 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 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 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.

[BC MOECCS] BC Ministry of Environment and Climate Change. 2019. Information Bulletin on the Big Bar Landslide Incident. Available online at: <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/fish/fish-passage/big-bar-landslide-incident>

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: http://www.nfcp.org/Current_Reports/NFCP%20History%20Report%20July%202016.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, 2013-2018. The Summer Water Temperature and Flow Management Project. Nechako Fisheries Conservation Program Technical Report.

APPENDIX 1
WATER SUSTAINABILITY ACT ORDER – SECTION 39



August 3, 2019

File: 0179602

Mr. Andrew Czornohalan
Operations Director – Power & Services
Rio Tinto Aluminium, British Columbia Works
1 Smeltersite Road, Box 1800,
Kitimat, B.C., V8C 2H2, Canada

Via Email: andrew.czornohalan@riotinto.com

Dear Mr. Czornohalan:

Re: Suspension of Summer Temperature Management Program for August 2019

Please find enclosed an order regarding the operation the Skins Lake Spillway and the Summer Temperature Management Program for 2019.

There are several activities underway to assist the migration of salmon past the Big Bar Landslide on the Fraser River. The ordered suspension of the Summer Temperature Management Program has been requested as an additional measure to achieve fish passage.

Please review the conditions of the attached order.

Please contact Connie Chapman at 778.698.7332 or Connie.Chapman@gov.bc.ca if you have any questions.

Yours truly,

Ted White
Comptroller of Water Rights

Ministry of Forests, Lands,
Natural Resource Operations
and Rural Development

Resource Stewardship Division

Office of the Comptroller
of Water Rights

Water Management Branch

Mailing Address:
PO Box 9340 Stn Prov Govt
Victoria BC V8W 9M1
Telephone: 778-698-7344
Facsimile: 250-356-0605

Location:
4th Floor, 2957 Jutland Road
Victoria BC V8T 5J9





Cc:

Justus Benckhuysen, Nechako Operations Coordinator, BC Power Operations

Bonnie Antcliffe, Associate Regional Director General Fisheries and Oceans Canada

Jennifer Davis, R.P.Bio. Provincial Director Fish and Aquatic Habitat, FLNRORD

Connie Chapman, Acting Manager Water Allocation and Business Unit, FLNRORD

**Ministry of Forests, Lands,
Natural Resource Operations
and Rural Development**

Resource Stewardship Division

Office of the Comptroller
of Water Rights

Water Management Branch

Mailing Address:
PO Box 9340 Stn Prov Govt
Victoria BC V8W 9M1
Telephone: 778-698-7344
Facsimile: 250-356-0605

Location:
4th Floor, 2957 Jutland Road
Victoria BC V8T 5J9





Province of British Columbia

WATER SUSTAINABILITY ACT
ORDER
Section 93

File No.: 0179602

WHEREAS:

1. Rio Tinto Alcan is the operator of the Nechako Reservoir, for which it holds Final Water Licence 102324.
2. Clause (k) of Final Water Licence 102324 requires the release of water from the Skins Lake Spillway for the protection of sockeye and chinook salmon in accordance with the "Short Term Annual Water Allocation" as defined in section 2.1 A of the 1987 Settlement Agreement, dated 14 September 1987;
3. The "Short Term Annual Water Allocation" requires flow releases from the Skins Lake Spillway in accordance with Schedule "C" of the 1987 Settlement Agreement which includes flows for cooling purposes in the Nechako River.
4. The flows, referred to in Section 2.1 A.b of the 1987 Settlement Agreement, are referred to as the Summer Temperature Management Program (STMP). The STMP requires flows of 170 cubic metres per second (m^3/s) to 283 m^3/s at Cheslatta Falls (Water Survey of Canada hydrometric gauge 08JA017) for the period of July 20 to August 20 to manage water temperature in the Nechako River at or below 20 degrees Celsius;
5. In late 2018 a landslide into the Fraser River occurred near the vicinity of Big Bar (Big Bar Slide) creating a constriction in the river preventing the migration of salmon in 2019.
6. Fisheries agencies have indicated that a reduced flow in the Fraser River at the Big Bar Slide will help support successful fish passage. Fisheries agencies have indicated that a preferred maximum flow target at Cheslatta Falls, for the benefit of fish passage at Big Bar Slide, would be 170 m^3/s ;
7. In an email dated August 2, 2019, Fisheries and Oceans Canada (DFO) and the Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (FLNRORD) Fish and Aquatic Habitat Branch have requested that the STMP be suspended for 2019 to enable passage of salmon at the Big Bar Slide from August 3 to August 20. The rationale is that the early Stewart Sockeye run are not able to pass the Big Bar Slide and suspension of the STMP is expected to improve the flow conditions in the Fraser River for salmon passage.

Ministry of Forests, Lands,
Natural Resource Operations
and Rural Development

Resource Stewardship Division

Office of the Comptroller
of Water Rights

Water Management Branch

Mailing Address:
PO Box 9340 Stn Prov Govt
Victoria BC V8W 9M1
Telephone: 778-698-7344
Facsimile: 250-356-0605

Location:
4th Floor, 2957 Jutland Road
Victoria BC V8T 5J9





8. Suspension of the STMP may have temperature related effects on Sturgeon and resident fish in the Nechako River. Monitoring of forecast air and water temperatures and adjusting the release of flow from the Skins Lake Spillway will mitigate potential risks to Sturgeon and resident fish. Flow adjustments will balance the potential benefits to fish passage at the Big Bar Slide and potential implications for resident fish in the Nechako River.
9. The Carrier Sikani Tribal Council and Upper Fraser Fisheries Alliance have provided endorsement for the suspension of the STMP in 2019 to benefit the passage of salmon at the Big Bar Slide.

I HEREBY DIRECT AS FOLLOWS:

1. The licensee is to suspend the Summer Temperature Management Program for the Nechako River for August 2019.
2. From August 3 to August 20, 2019 the licensee is to operate the Skins Lake Spillway to provide flows at Cheslatta Falls (Water Survey of Canada hydrometric gauge 08JA017) that balance the needs of:
 - Flow required to enable fish passage at the location of the Big Bar Slide on the Fraser River;
 - Water temperature and flow in the Nechako River as measured at Water Survey of Canada hydrometric station 08JA017 required for cooling purposes to protect Chinook and Sockeye Salmon;
 - Water temperature for Sturgeon and other resident fish.
3. Discharge is to reviewed daily and adjusted with input from Fisheries and Oceans Canada (DFO) and Forests, Lands, Natural Resource Operations, and Rural Development (FLNRORD) Fish and Aquatic Habitat Branch.
4. The licensee may operate the works in an alternate manner in the event of an emergency, dam safety requirement, or extreme hydrological event.
5. The licensee will provide a daily report on flows at Cheslatta Falls, gate changes, and rationale for the changes to Fisheries and Oceans Canada (DFO) and Forests, Lands, Natural Resource Operations, and Rural Development (FLNRORD) Fish and Aquatic Habitat Branch and the Comptroller of Water Rights.
6. This order expires on September 1, 2019.

Dated at Victoria, B.C., this 3 day of August, 2019.



Comptroller of Water Rights



APPENDIX 2

NUMERICAL EXAMPLE OF WATER TEMPERATURE TREND CALCULATION

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	136.0	136.0	226.5	226.5	226.5	226.5	226.5	226.5	453.0
		to		to						to	
		136.0		226.5						453.0	
		@		@						@	
		0800		0800						0800	
		hrs		hrs						hrs	

APPENDIX 3

MEAN DAILY WATER TEMPERATURES IN THE NECHAKO AND NAUTLEY RIVERS, 2019

Date	Nechako River				Date	Nechako River			
	Cheslatta Falls	Fort Fraser	above the Stuart River	Nautley Fort Fraser		Cheslatta Falls	Fort Fraser	above the Stuart River	Nautley Fort Fraser
	(°C)	(°C)	(°C)	(°C)		(°C)	(°C)	(°C)	(°C)
10-Jul	17.8	20.1	20.3	17.7	01-Aug	16.9	17.6	17.6	17.5
11-Jul	18.4	18.8	20.1	18.1	02-Aug	16.7	17.2	17.2	17.2
12-Jul	19.1	19.7	20.1	18.7	03-Aug	17.1	17.7	17.7	18.0
13-Jul	19.2	20.6	20.4	19.3	04-Aug	17.3	18.4	18.3	19.2
14-Jul	19.0	20.8	20.8	19.6	05-Aug	17.7	19.1	19.5	20.1
15-Jul	18.4	20.2	21.0	19.3	06-Aug	18.2	19.6	20.5	21.9
16-Jul	18.5	19.6	21.1	19.6	07-Aug	18.7	19.9	21.2	21.2
17-Jul	18.2	19.6	20.3	19.3	08-Aug	18.9	20.3	21.4	21.7
18-Jul	17.5	18.3	19.1	16.9	09-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 4

MEAN DAILY SKINS LAKE SPILLWAY RELEASES AND FLOWS IN THE NECHAKO AND NAUTLEY RIVERS, 2019

Date	Skins Lake Spillway Release (m ³ /s)	Nechako River		Nautley River
		Cheslatta Falls (m ³ /s)	At Vanderhoof (m ³ /s)	Fort Fraser (m ³ /s)
10-Jul	49	46.5	93.5	36.4
11-Jul	49 to 136 @ 0800 hrs	47.3	93.3	38.0
12-Jul	136	49.4	93.2	37.6
13-Jul	136 to 226.5 @ 0800 hrs	54.5	93.4	37.5
14-Jul	226.5	64.1	96.7	37.3
15-Jul	226.5	80.9	104.0	36.7
16-Jul	226.5	97.0	119.0	36.3
17-Jul	226.5	115.0	138.0	35.8
18-Jul	226.5	132.0	157.0	37.6
19-Jul	226.5 to 453.1 @ 1600 hrs	144.0	171.0	37.3
20-Jul	453.1	160.0	184.0	35.6
21-Jul	453.1 to 14.2 @ 1600 hrs	204.0	196.0	34.6
22-Jul	14	238.0	235.0	34.9
23-Jul	14.2 to 170 @ 1600 hrs	211	271.0	34.8
24-Jul	170.0	184	262.0	35.8
25-Jul	170	176.0	236.0	33.6
26-Jul	170	171.0	221.0	33.2
27-Jul	170	172.0	218.0	34.2
28-Jul	170	170.0	205.0	33.4
29-Jul	170	168.0	212.0	32.8
30-Jul	170	167.0	210.0	32.0
31-Jul	170 to 453.1 @ 1600 hrs	166.0	209.0	31.4
01-Aug	453.1 to 14.2 @ 1600 hrs	175.0	209.0	31.4
02-Aug	14.2	209.0	211.0	30.8
03-Aug	14.2	192.0	241.0	30.7
04-Aug	14.2 to 340 @ 1300 hrs	167.0	238.0	29.9
05-Aug	340 to 170 @ 1600 hrs	148.0	216.0	28.1
06-Aug	170	170.0	193.0	27.8
07-Aug	170	173.0	204.0	27.1
08-Aug	170 to 453.1 @ 1600 hrs	172.0	208.0	26.2
09-Aug	453.1 to 14.2 @ 1600 hrs	182.0	207.0	25.2
10-Aug	14.2 to 170 @ 1600 hrs	208.0	208.0	25.2

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	188.0	234.0	24.8
12-Aug	170	183.0	227.0	25.3
13-Aug	170 to 453.1 @ 1600 hrs	181.0	217.0	24.3
14-Aug	453.1 to 14.2 @ 1600 hrs	186.0	212.0	24.2
15-Aug	14.2	211	206	23.7
16-Aug	14.2	189	232	23.3
17-Aug	14.2	162.0	156.0	22.9
18-Aug	14.2	142.0	201	22.5
19-Aug	14.2	123.0	178.0	22.1
20-Aug	14.2	107.0	156.0	21.3

APPENDIX 5
RECORDED AND FORECAST METEOROLOGICAL DATA

Recorded and Forecast Meteorological Data 2019

13.92	806.88	0.6	8	9.17	93.6	49.2	09 07 19
13.92	196.94	0.87	12.98	3.61	93.14	95.31	10 07 19
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 10/19							

13.92	129.92	0.9	11.82	0.9	93.14	90.13	10 07 19
16.61	638.62	0.4	11.58	7.86	93.49	74.83	11 07 19
17.31	690.25	0.05	8.73	6.79	93.42	57.11	
17.53	592.73	0.32	8.81	6.25	93.26	56.4	
17.33	688.34	0.03	8.47	7.84	93.22	55.7	
17.05	669.22	0.08	7.65	8.29	93.51	53.01	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 11/19							

16.07	445.2	0.8	11.51	8.1	93.49	77.21	11 07 19
17.11	770.55	0.04	9.52	6.58	93.42	62.03	12 07 19
17.31	553.54	0.42	9.51	5.84	93.2	61	
17.52	664.44	0.14	8.57	8.41	93.31	55.24	
16.7	678.78	0.06	7.59	7.48	93.58	54.45	
16.04	573.61	0.23	7.84	7.89	93.43	59.02	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 12/19							

16.31	447.87	0.3	10.27	8.7	93.42	69.79	12 07 19
16.71	753.35	0.09	9.41	4.89	93.26	63.46	13 07 19
17.33	632.89	0.21	9.35	7.46	93.25	60.11	
16.47	688.34	0.01	7.74	7.8	93.51	56.32	
16.34	640.54	0.11	8	7.37	93.4	58.29	
13.94	258.13	0.77	9.64	5.18	92.74	78.47	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 13/19							

Recorded and Forecast Meteorological Data 2019

16.16	454.83	0.4	10.89	7.2	93.26	73.63	13 07 19
17.03	766.73	0.05	9.41	7.19	93.32	60.55	14 07 19
16.47	686.42	0	8.41	6.09	93.46	59.7	
16.03	525.81	0.32	8.15	7.75	93.31	60.58	
13.35	353.73	0.69	9.39	7.22	92.8	80.17	
11.2	315.49	0.76	4.32	15.56	92.75	65.59	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 14/19							

17.35	527.92	0.2	9.89	15.9	93.32	62.71	14 07 19
16.4	783.94	0	8.67	5.97	93.51	61.34	15 07 19
15.8	530.59	0.38	8.8	6.11	93.21	65	
12.84	358.51	0.81	10.66	7.8	92.53	89.09	
11.08	353.73	0.61	4.75	12.07	92.89	68.34	
12.22	325.05	0.68	6.64	6.22	93.5	72.06	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 15/19							

15.53	495.33	0.3	9.19	10.35	93.51	68.29	15 07 09
16.16	686.42	0.27	8.07	6.11	93.23	59.55	16 07 09
13.82	417.78	0.77	9.62	9.62	92.36	79.01	
10.19	215.11	0.82	5.35	12.28	92.87	75.8	
12.89	535.37	0.63	8.19	6.18	93.49	76.48	
13.26	430.21	0.48	10.34	4.06	93.77	85.42	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 16/19							

14.88	467.39	0.3	8.98	7.65	93.23	70.5	16 07 09
13.89	397.71	0.82	10.54	7.41	92.23	83.24	17 07 09
11.86	295.41	0.84	5.2	14.26	92.92	66.73	
13.14	358.51	0.71	6.57	7.39	93.49	67.19	
15.17	669.22	0.1	9.86	3.52	93.81	73.44	
16.27	506.69	0.37	12.25	3.57	93.71	79.92	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 17/19							

14.33	373.2	0.8	10.08	11.85	92.23	78.75	17 07 19
12.05	369.02	0.82	5.62	12.95	92.8	67.86	18 07 19
12.42	180.69	0.9	7.51	9.1	93.47	75.45	
15.01	635.76	0.37	9.85	4.1	93.78	74.2	
14.45	420.65	0.54	11.5	3.32	93.39	85.22	
14.77	659.66	0.01	10.51	3	93.6	78.66	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 18/19							

Recorded and Forecast Meteorological Data 2019

12.38	393.3	0.8	6.52	24.45	92.8	70.71	18 07 19
12.69	244.74	0.84	7.18	9.12	93.44	72.45	19 07 19
15.08	500.96	0.54	9.23	3.32	93.77	70.74	
15.45	573.61	0.39	11.7	2.8	93.54	81.26	
17.41	602.29	0.14	12.82	2.94	93.53	77.04	
17.79	611.85	0.15	12.59	4.33	93.56	74.03	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 19/19							

12.87	238.34	0.8	7.8	19.5	93.44	74.67	19 07 19
14.27	642.45	0.29	8.7	3.48	93.88	72.11	20 07 19
14.51	442.64	0.46	11.34	2.66	93.66	84.14	
16.45	578.39	0.21	13.63	3.59	93.48	85.89	
17.46	592.73	0.13	13.81	3.07	93.59	81.79	
15.29	334.61	0.74	11.39	11.1	93.32	80.53	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 20/19							

15.57	461.8	0.3	9.66	2.85	93.88	70.46	20 07 19
16.17	682.6	0.34	11.1	2.4	93.62	74.76	21 07 19
15.76	521.99	0.27	13.26	4.43	93.54	87.53	
16.85	516.25	0.47	13.96	2.71	93.49	85.59	
14.16	621.41	0.3	8.56	12.74	93.47	72.02	
15.05	564.05	0.24	5.39	10.11	93.46	51.68	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 21/19							

15.99	373.4	0.2	11.36	6.91	93.62	76.83	21 07 19
16.38	673.04	0.24	12.58	3.5	93.48	81.01	22 07 19
15.98	493.31	0.35	12.52	4.72	93.54	82.71	
15.09	659.66	0.38	8.82	8.36	93.7	68.66	
15.89	583.17	0.12	7.62	2.84	93.61	58.62	
16.51	325.05	0.64	10.16	6.43	93.22	68.26	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 22/19							

15.43	581.2	0.2	10.65	3.6	93.48	76.08	22 07 19
17.03	667.3	0.24	13.4	4.4	93.4	81.87	23 07 19
14.54	637.67	0.34	8.11	12.07	93.53	67.87	
14.97	616.63	0.15	7	7.33	93.66	60.12	
15.51	305.93	0.52	11.42	3.5	93.44	79.55	
16.5	602.29	0.26	10.4	7.69	93.55	69.51	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 23/19							

Recorded and Forecast Meteorological Data 2019

17.96	539.35	0.2	11.12	13.65	93.4	65.79	23 07 19
14.85	673.04	0.49	8.62	11.15	93.53	68.86	24 07 19
15.54	622.37	0.16	6.91	7.06	93.6	56.83	
15.18	272.47	0.66	11.82	3.41	93.33	83.2	
15.41	621.41	0.14	9.86	9.06	93.73	72.26	
14.84	420.65	0.5	9.16	4.31	93.93	71.61	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 24/19							

15.75	562	0.7	8.33	24.3	93.53	62.62	24 07 19
15.14	613.77	0.38	7.43	6.06	93.61	61.45	25 07 19
15.64	361.38	0.58	12.25	3.47	93.39	83.09	
14.28	468.45	0.6	10.61	10.88	93.55	81.67	
15.18	564.05	0.24	9.22	6.07	93.99	70.17	
14.31	506.69	0.28	8.23	4.22	93.63	69.63	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 25/19							

14.41	331.3	0.5	8.5	5.26	93.61	70.46	25 07 19
15.38	363.29	0.69	11.87	3.18	93.36	82.45	26 07 19
14.42	501.91	0.57	10.42	10.41	93.52	79.98	
15.05	482.79	0.34	9.49	7.05	94.01	72.22	
14.2	420.65	0.4	8.31	3.86	93.59	70.6	
13.48	296.37	0.81	10.95	3.41	93.13	87.34	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 26/19							

14.67	243.93	0.5	11.57	2.97	93.36	84.48	26 07 19
14.96	629.06	0.44	10.66	10.39	93.52	78.51	27 07 19
15.24	542.07	0.23	9.29	6.24	94	70.24	
15.07	549.71	0.34	8.36	3.79	93.46	66.45	
14.18	468.45	0.63	8.88	6.13	93.09	73.5	
13.06	506.69	0.43	9.76	6.29	93.26	83.51	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 27/19							

14.57	392.84	0.6	9.72	4.75	93.52	75.75	27 07 19
15.66	673.04	0.2	8.81	6.79	94.02	65.73	28 07 19
14.55	416.83	0.49	8.04	4.13	93.52	67.44	
14.13	497.13	0.24	6.9	5.23	93.31	63.83	
12.94	420.65	0.54	9.16	2.71	93.57	81.09	
11.88	239.01	0.7	10.18	3.55	93.46	91.48	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 28/19							

Recorded and Forecast Meteorological Data 2019

15.79	444.4	0.3	8.85	13.97	94.02	65.29	28 07 19
14.71	579.35	0.31	7.9	3.43	93.54	65.93	29 07 19
13.47	252.39	0.82	9.78	5.08	93.21	81.55	
12.38	559.27	0.24	8.19	4.89	93.52	79.08	
13.11	626.2	0.18	8.7	3.66	93.65	77.96	
11.12	229.45	0.65	8.88	3.16	93.6	88.81	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 29/19							

14.36	458.6	0.3	7.46	13.97	93.54	65.5	29 07 19
13.92	386.23	0.74	8.12	4.42	93.19	71	30 07 19
12.73	426.39	0.41	8.72	3.39	93.44	79.95	
13.28	564.05	0.39	9.27	3.48	93.51	79.96	
12.05	191.2	0.82	9.91	3.12	93.37	89.29	
15.63	611.85	0.22	11.24	4.79	93.95	78.05	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 30/19							

13.32	312.9	0.6	9.46	7.81	93.19	80.71	30 07 19
14.08	514.34	0.44	8.5	2.76	93.41	72.09	31 07 19
13.21	369.98	0.69	10.1	3.29	93.39	84.48	
13.94	501.91	0.54	8.99	5.28	93.38	75.25	
15.49	621.41	0.15	11.13	4.74	93.88	78.18	
16.94	621.41	0.04	10.99	3.64	93.64	70.21	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED JUL 31/19							

11.57	333.33	0.6	8.96	4.8	93.41	86.96	31 07 19
11.09	290.63	0.66	8.94	1.63	93.51	89.23	01 08 19
13.42	311.66	0.87	9.87	4.62	93.31	82.26	
16.04	621.41	0.25	11.11	6.7	93.84	75.33	
17.35	592.73	0.09	11.42	3.03	93.82	70.34	
19.32	602.29	0.05	13.74	2.4	93.67	72.1	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 01/0919							

11.56	297.32	0.6	9.04	3.45	93.51	87.42	01 08 19
12.36	239.01	0.88	10.9	4.24	93.26	92.68	02 08 19
15.54	611.85	0.24	11.41	4.66	93.88	79.34	
17.18	602.29	0.03	12.2	3.03	93.88	75.1	
18.75	602.29	0.03	13.51	2.29	93.72	73.8	
19.89	602.29	0.01	14.2	2.53	93.47	71.57	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 02/19							

Recorded and Forecast Meteorological Data 2019

12.29	180.3	0.8	10.22	3	93.26	89.67	02 08 19
15.91	623.33	0.32	11.67	5.68	93.89	78.82	03 08 19
17.21	619.5	0	12.23	2.94	93.9	75.09	
18.51	578.39	0.1	13.27	2.04	93.73	73.8	
19.52	626.2	0.03	12.31	4.06	93.34	63.95	
18.77	602.29	0	10.05	5.98	92.85	56.39	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 03/19							

15.52	525.34	0.2	9.97	2.17	93.89	72.25	03 08 19
17.41	673.04	0.01	11.65	3.91	93.84	71.19	04 08 19
19.4	598.47	0.09	13.16	3.5	93.53	68.77	
18.92	521.03	0.2	15.04	3.21	93.51	80.63	
19.95	607.07	0	13.46	5.41	93	67.53	
19.56	592.73	0.04	9.28	7.62	92.7	48.61	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 04/19							

17.71	491.46	0.01	11.9	5.55	93.84	70.92	04 08 09
19.3	673.04	0.05	13.3	3.68	93.58	70.01	05 08 09
19.93	598.47	0.04	14.8	2.73	93.44	74.36	
20.23	607.07	0	13.78	4.58	93.09	67.72	
17.55	501.91	0.32	13.43	5.82	93.03	79.4	
12.67	401.53	0.6	7.19	8.27	93.44	72.61	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 09/19							

19.23	523.2	0.1	12.79	6.16	93.58	67.79	05 08 19
19.69	636.71	0.09	14.28	2.85	93.44	72.97	06 08 19
20.4	596.56	0.01	14.09	3.11	93.08	68.46	
20.05	578.39	0.12	13.02	3.3	93.04	64.83	
16.31	511.47	0.2	10.84	7.19	93.17	72.65	
14.6	497.13	0.37	7.71	6.85	93.43	65.58	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 06/19							

19.13	528	0.1	13.84	3.45	93.44	73.58	06 08 19
20.62	646.27	0.04	14.35	3.05	93.12	68.65	07 08 19
19.53	587	0.03	14.09	5.77	93.08	72.81	
15.1	415.87	0.4	8.84	9.85	93.48	68.67	
15.27	549.71	0.09	8.25	4.69	93.39	64.89	
16.83	592.73	0.05	8.32	5.23	93.28	57.47	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 07/19							

Recorded and Forecast Meteorological Data 2019

19.63	523.96	0.1	13.19	7.8	93.12	67.79	07 08 19
20	673.04	0	12.07	3.68	93.06	60.34	08 08 19
15.38	321.22	0.48	9	9.1	93.43	68.08	
14.98	583.17	0.03	6.83	5.91	93.42	59.26	
17.34	554.49	0.26	9.21	3.45	93.26	59.36	
17.08	573.61	0	7.75	6.81	93.62	53.36	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 08/19							

18.04	481.06	0.1	13.06	3.45	93.06	75.13	08 08 19
15.42	485.66	0.46	8.92	9.98	93.5	67.5	09 08 19
14.69	508.6	0.11	6.87	5.17	93.41	60.91	
16.86	377.63	0.61	10.56	2.08	93.21	68.51	
16.43	234.23	0.88	9.21	6	93.33	63.93	
15.83	525.81	0.27	10.14	6.11	93.53	71.58	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 09/19							

15.24	402.13	0.1	8.64	2.96	93.5	67	09 08 19
14.8	523.9	0.21	7.19	5.15	93.46	61.95	10 08 19
16.69	422.56	0.51	9.99	3.16	93.24	66.51	
16.04	348.95	0.74	11.14	5.66	93.56	75.5	
14.21	224.67	0.78	11.72	2.57	93.76	87.54	
16.42	506.69	0.31	11.78	2.19	93.62	76.84	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 10/19							

12.55	411.16	0.2	6.87	3.75	93.46	71.63	10 08 19
15.56	367.11	0.61	9.65	3.75	93.31	70.47	11 08 19
16.01	416.83	0.5	9.98	5.32	93.62	69.85	
16.12	525.81	0.26	11.06	2.89	93.91	74.69	
17.15	516.25	0.09	11.08	6.09	93.95	69.63	
17.47	487.57	0.19	9.8	5.5	93.86	61.66	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 11/19							

14.39	307.21	0.4	10.42	5.25	93.31	80.17	11 08 19
15.55	447.42	0.56	11.84	3.35	93.66	81.46	12 08 19
15.48	484.7	0.28	11.67	2.89	93.94	80.97	
16.64	454.11	0.34	10.88	7.26	93.89	71.2	
16.89	239.01	0.72	8.71	7.43	93.66	59.09	
17.23	544.93	0.25	8.35	7.26	93.22	55.64	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 12/19							

Recorded and Forecast Meteorological Data 2019

16.3	362.92	0.7	10.31	10.2	93.66	70.08	12 08 19
15.69	598.47	0.12	9.99	2.51	93.93	71.47	13 08 19
17.63	553.54	0.14	10.61	7.69	93.82	64.91	
17.27	282.03	0.45	8.54	8.97	93.66	56.38	
17.15	497.13	0.18	9.33	6.65	93.48	60.87	
17.29	525.81	0.19	8.44	11.11	92.62	55.76	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 13/19							

14.09	511.07	0.5	8.6	6.3	93.93	72.58	13 08 19
17.77	617.59	0.15	9.72	7.55	93.88	59.79	14 08 19
17.8	434.03	0.38	8.52	9.37	93.69	53.63	
18.19	525.81	0.32	10.14	9.06	93.26	59.74	
16.1	344.17	0.6	11.08	6.88	93.83	74.88	
15.55	325.05	0.47	6.12	9.65	92.72	52.89	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 14/19							

17.22	497.31	0.3	10.28	11.4	93.88	65.33	14 08 19
18.07	470.36	0.4	7.97	10.57	93.66	49.49	15 08 19
17.04	332.7	0.42	9.54	5.28	93.56	62.5	
14.58	181.64	0.89	10.01	6.33	92.78	77.16	
13.4	200.76	0.81	9.91	6.58	92.43	82.52	
13.72	478.01	0.54	8.84	2.78	92.99	75.57	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 15/19							

16.8	215.47	0.5	9.49	4.63	93.66	63.46	15 09 09
16.74	594.65	0.13	7.82	5.48	93.68	55.43	16 09 09
14.34	155.83	0.74	8.61	7.55	92.81	71.35	
14.17	277.25	0.72	8.34	10.65	92.26	70.84	
11.92	559.27	0.08	2.92	4.67	93.1	54.99	
15.35	315.49	0.75	6.1	4.55	92.92	53.72	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 16/09							

16.15	389.32	0.1	8.88	4.08	93.68	63.67	16 09 09
14.45	240.92	0.72	7.39	8.11	92.85	64.71	17 09 09
14.81	361.38	0.61	7.92	10.97	92.26	65.52	
13.1	554.49	0.08	3.53	4.27	93.02	52.13	
14.65	219.89	0.75	7.23	7.35	93.09	62.93	
13.47	411.09	0.7	8.13	2.64	93.42	73.33	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 17/09							

Recorded and Forecast Meteorological Data 2019

13.04	134.47	0.7	10.02	1.13	92.85	84.88	17 09 09
13.77	407.27	0.56	9.09	9.3	92.34	76.59	18 09 09
13.89	553.54	0.19	5.69	3.77	93.07	59.02	
15.48	253.35	0.8	8.13	4.49	93.06	63.23	
15.34	334.61	0.65	6.21	13.65	92.77	54.35	
12.94	535.37	0.15	3.66	6.4	93.61	53.63	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 18/09							

14.18	342.11	0.7	9.37	3.33	92.34	75.92	18 09 09
14.08	523.9	0.47	6.15	4.4	93.04	60.34	19 09 09
15.17	264.82	0.83	9.28	3.03	93.09	71.04	
15.13	176.86	0.76	10.21	5.43	92.78	75.45	
13.42	535.37	0.14	8.3	4.94	93.47	74.43	
12.58	267.69	0.73	8.67	4.6	93.16	80.44	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 19/09							

11.48	345.21	0.5	6.5	1.39	93.04	75.09	19 09 09
14.68	315.49	0.74	10.37	2.4	93	78.43	20 09 09
16.43	396.75	0.55	6.52	10.48	92.73	50.44	
13.05	521.03	0.14	3.92	5.17	93.41	54.37	
12.59	325.05	0.66	10.04	4.17	92.9	87.26	
13.05	420.65	0.5	7.65	10.12	92.83	72.99	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY
ENVIRONMENT CANADA FORECAST ISSUED AUG 20/09							

APPENDIX 6

SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT RESERVOIR RELEASE VOLUME CALCULATIONS FOR JULY 10 TO AUGUST 20, 2019

Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations
for July 10 to August 20, 2019

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 226 - JD 191) * 49.0 + (JD 232 - JD 226) * 14.16 = 1,800 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) @ 1600 hrs	152	226.5	34,428
July 19 (200) @ 1600 hrs to July 21 (202) @ 1600 hrs	48	453.1	21,749
July 21 (202) @ 1600 hrs to July 23 (204) @ 1600 hrs	72.0	14.2	1,022
July 23 (204) @ 1600 hrs to July 31 (212) @ 1600 hrs	192.0	170.0	32,640
July 31 (212) @ 1600 hrs to Aug 1 (213) @ 1600 hrs	24.0	453.1	10,874
Aug 1 (213) @ 1600 hrs to Aug 4 (216) @ 1600 hrs	72.0	14.2	1,022
Aug 4 (216) @ 1600 hrs to Aug 5 (217) @ 1600 hrs	24.0	340.0	8,160
Aug 5 (217) @ 1600 hrs to Aug 8 (220) @ 1600 hrs	72.0	170.0	12,240
Aug 8 (220) @ 1600 hrs to Aug 9 (220) @ 1600 hrs	24.0	453.0	10,872
Aug 9 (221) @ 1600 hrs to Aug 10 (222) @ 1600 hrs	24.0	14.2	0,341
Aug 10 (222) @ 1600 hrs to Aug 13 (225) @ 1600 hrs	72.0	170.0	12,240
Aug 13 (225) @ 1600 hrs to Aug 14 (226) @ 1600 hrs	24.0	453.0	10,872
Aug 14 (226) @ 1600 hrs to Aug 20 (232) @ 2400 hrs	152.0	14.2	2,158

Total 1,032 (43.0 days) 166,715

Total Release Volume = 166,715 m³/s*hrs
= 6,946.5 m³/s*days
= 245,314 cfs*days

Volume Released for Cooling Purposes = Total Volume - Base Volume
= 6,946.5 - 1,800.0
= 5,146.5 m³/s*days
= 181,749 cfs*days

Average Release over Summer Management Period (July 10 to August 20) = 6,946.5 m³/s*days / 42 days
= 161.5 m³/s
= 5,705.0 cfs