THE 2013 SUMMER WATER TEMPERATURE AND FLOW MANAGEMENT PROJECT

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ABSTRACT

The 2013 Nechako River Summer Water Temperature and Flow Management Project (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 (68.0°F) 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 2013, mean daily water temperatures in the Nechako River above the Stuart River confluence did exceed 20.0°C (68.0°F) on July 10, July 17 through July 26, and August 1 through August 15 reaching a maximum temperature of 21.6°C (71.0°F) on August 11. The first four exceedances occurred prior to the water temperature control period and the latter exceedances occurred when the river discharge was at the maximum permitted under the operating protocol.

Over the duration of the 2013 Summer Water Temperature and Flow Management Project (July 10 to August 20), the total volume of water released was 9,989.8 m^3/s-d, (352,790 cfs-d), and the average release during the Project was 237.9 m^3/s (8,399.6 cfs).

INTRODUCTION

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

The objective of the Project is to attempt to prevent mean daily water temperatures in the Nechako River above the Stuart River confluence (at Finmoore) from exceeding 20.0°C (68.0°F) by regulating releases from the Skins Lake Spillway to control flows in the Nechako River below Cheslatta Falls and at Vanderhoof. 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). These dates may vary as directed by the NFCP in accordance with the timing of sockeye runs in the system, but were followed in 2013. At the completion of the STMP, flows in the Nechako River at Cheslatta Falls 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 made at Finmoore (the closest readily accessible location) while river discharge measurements are made at Vanderhoof (at the Water Survey of Canada discharge measuring site).

This report reviews the 2013 Summer Water Temperature and Flow Management Project and includes:

- An outline of the method for determining Skins Lake Spillway releases and summaries of the 2013 Skins Lake Spillway 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 2013 Summer Water Temperature and Flow Management Project.

METHODS

Management of the Nechako River flows and water temperatures used water temperature predictions based on five-day meteorological forecasts provided by Environment Canada to determine the schedule of Skins Lake Spillway releases required to meet project objectives. The Summer Water Temperature and Flow Management 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 entire operational period (Envirocon Limited, 1984a,b,c and 1985).

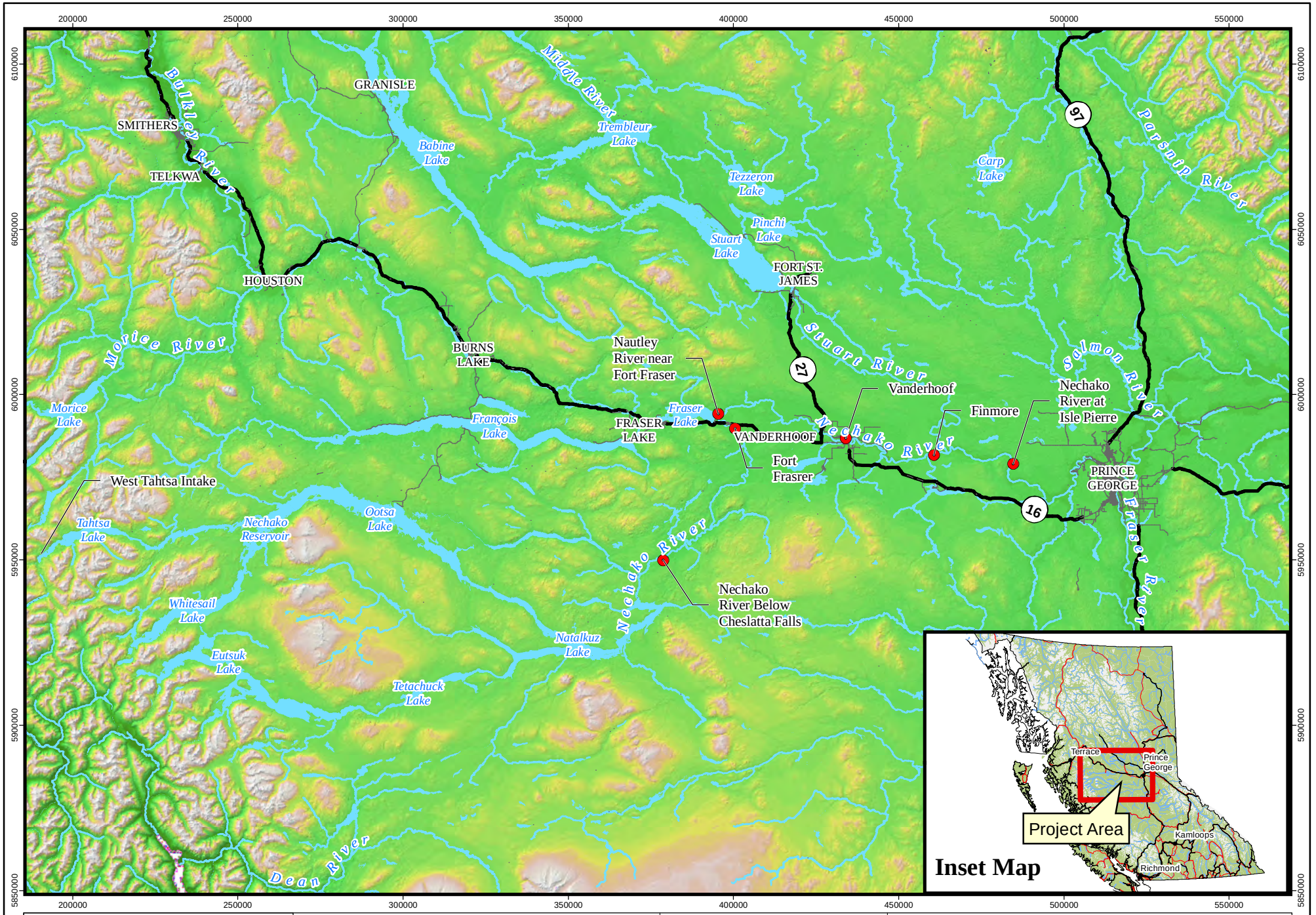
Daily operations followed the protocol defined in the Settlement Agreement (Anon. 1987), and involved collection of water temperature and river stage data from several locations in the study area, as well as development of five-day meteorological forecasts.

Water temperatures were obtained daily from temperature loggers maintained in the Nechako River below Cheslatta Falls (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 Nechako River below Cheslatta Falls 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 which were then downloaded via satellite from the Rom Communications website. In addition, spot temperatures measured with a calibrated mercury thermometer (+/-0.1°C) were collected on a number of occasions in the Nechako River at Fort Fraser and in the Nechako River above the Stuart River confluence to ensure the Unidata temperature probe was calibrated correctly.

River stages were obtained daily from Water Survey of Canada recorders maintained in the Nechako River below Cheslatta Falls, in the Nechako River at Vanderhoof, and in the Nautley River, and were obtained daily via the Environment Canada (Water Survey of Canada, WSC) website (www.wateroffice.ec.gc.ca). 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 Skins Lake Spillway releases, and to increase flows in the Nechako River from spring flows to the minimum cooling flow of 170 m^3/s (6,000 cfs) below Cheslatta Falls. The 2013 Skins Lake Spillway spring base release as directed by the NFCP was 49.0 m^3/s (1,730 cfs). Upon commencement of the operational period on July 10, the recorded flow in the Nechako River below Cheslatta Falls was 52.3 m^3/s (1,847 cfs). The Skins Lake Spillway was increased to 136 m^3/s (4,802 cfs) on July 11 and to 226.5 m^3/s (8,000 cfs) on July 12 to ensure flows in the Nechako River below Cheslatta Falls reached the minimum cooling flow of 170 m^3/s (6,000 cfs) 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



Nechako Fisheries Conservation Program

Figure 1. Nechako River Study Area

Legend

- WSC Sites
- Stream
- Road
- Waterbody
- Highway

0 5 10 20 30 40 50 Kilometers

Scale: 1:1,500,000

N W E S

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

TRITON ENVIRONMENTAL CONSULTANTS LTD.

Table 1

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.

These trends are the same as those used in the water temperature and flow management projects since 1984 (Envirocon Ltd. 1985), and are best explained through reference to Table 1.

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 Skins Lake Spillway release required to meet Project objectives.

The following three trends in water temperature changes were reviewed on a day-by-day basis:

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 predicted temperature to determine the trend in forecasted temperatures.

A numerical example of how the trends are calculated is presented in Appendix A.

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 (67.0°F) then an increase in the Skins Lake Spillway release was required. When this occurred the current day's release was revised and the flow and temperature models were rerun 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 potentially the water temperature could exceed 19.4°C (67.0°F), increase the Skins Lake Spillway release according to criteria 2 and 3 below.

2. Operate Skins Lake Spillway such that flow in the Nechako River below Cheslatta Falls ranges between 170 m^3/s (6,000 cfs) and 283 m^3/s (10,000 cfs) as required, and flow in the Nechako River above the Stuart River confluence (as measured at Vanderhoof) does not exceed 340 m^3/s (12,000 cfs). It is understood that the flow in the Nechako River below Cheslatta Falls is to be not less than 170 m^3/s (6,000 cfs) by the beginning of the control period, and is to be reduced to approximately 31.9 m^3/s (1,124 cfs) by September 1.

3. At any time, increase the Skins Lake Spillway release from the current level to 453 m^3/s (16,000 cfs) 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 potentially the water temperature could drop below 19.4°C (67.0°F) within the forecast period (five days), reduce the Skins Lake Spillway release from the current level to 14.2 m^3/s (500 cfs).

RESULTS

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

Mean daily water temperatures recorded during the control period in the Nechako River above the Stuart River confluence (Figure 2 and Table 3) exceeded 20.0°C (68.0°F) on a number of occasions (July 20 through July 26 and August 1 through August 15). The respective maximum and minimum mean daily water temperatures recorded during the control period were 21.6°C (71.0°F) on August 11 and 17.7°C (66.5°F) on August 20. Mean daily water temperatures in the Nechako River below Cheslatta Falls, near Fort Fraser and above the Stuart River confluence, and in the Nautley River near Fort Fraser are presented in Appendix B.

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

1. July 11 – Increase to 136 m^3/s – to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
2. July 12 – Increase to 226.5 m^3/s – to increase flow in Nechako River below Cheslatta Falls to STMP base flow by July 20.
3. July 16 – Increase to 453 m^3/s – to increase flow in Nechako River below Cheslatta Falls in response to warming trend.
4. July 19 – Decrease to 283 m^3/s – to limit flow in Nechako River below Cheslatta Falls to a maximum or 283 m^3/s.
5. July 23 – Decrease to 14.2 m^3/s – to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
6. July 26 – Increase to 453 m^3/s – to increase flow in Nechako River below Cheslatta Falls in response to warming trend.
7. July 29 – Decrease to 283 m^3/s – to limit flow in the Nechako River below Cheslatta Falls to maximum or 283 m^3/s.
8. August 14 – Decrease to 14.2 m^3/s – to decrease flow in Nechako River below Cheslatta Falls in response to cooling trend.
9. August 16 – Increase to 170 m^3/s – to ensure flow in Nechako River below Cheslatta Falls is maintained at summer base flow.
10. August 18 – decrease to 14.2 m^3/s – to ensure flow in Nechako River below Cheslatta Falls is maintained at fall spawning flow.
11. September 1 – increase to 31.85 m^3/s – to ensure flow in Nechako River below Cheslatta Falls is maintained at fall spawning flow.

During the control period, measured flows in the Nechako River below Cheslatta Falls (based on preliminary WSC data from the WSC data collection platform at Bert Irvine's Lodge) ranged between a maximum of 291 m^3/s (10,277 cfs) on August 14 and a minimum of 172 m^3/s (6,074 cfs) on August 20. Flows measured in the Nechako River at Vanderhoof ranged between a maximum of 339 m^3/s (11,972 cfs) on August 14 and 15 and a minimum of 238 m^3/s (8,405 cfs) on July 28.

DISCUSSION

The discussion of the 2013 Summer Water Temperature and Flow Management Project 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 2013 Summer Water Temperature and Flow Management Project. The third section provides a brief discussion of the application of the Project release criteria.

Recorded Data

The modelling procedure was initialized using recorded conditions. The quality of the field data used in the modelling process directly affects the accuracy of the computed water temperatures. Therefore, data must be collected accurately and consistently to ensure that random errors are kept to a minimum. Further, consistency in data collection techniques also ensures that, if a bias exists in the data, it remains relatively constant throughout the project.

In 2013, river discharges in the Nechako River below Cheslatta Falls and at Vanderhoof as recorded by the Water Survey of Canada changed as expected in response to Skins Lake Spillway releases (Figure 3). The hourly stage data from the gauging station located on the Nechako River below Cheslatta Falls proved very 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.

As previously stated, water temperatures recorded by data loggers were obtained daily from the Rom Communications website for the Nechako River at Fort Fraser and in the Nechako River above the Stuart River confluence.

Recorded water temperatures in the Nechako River above the Stuart River confluence did exceed 20°C on twenty-six occasions. The first four (July 10, July 17 - 19) occurred prior to the water temperature control period (July 20 to August 20). The remaining exceedances occurred during the water temperature control period (August 1 - 15). However, the increase in water temperature was predicted by the water temperature model and the river discharge in the Nechako River below Cheslatta Falls increased to the maximum allowed under the operating protocol (283 m^3/s) prior to the occurances.

Volume of Water Used

The recorded flows in the Nechako River below Cheslatta Falls for the 2013 Summer Water Temperature and Flow Management Project are shown in Figure 4. Also indicated is the minimum cooling flow of 170 m^3/s (6,000 cfs) in the Nechako River below Cheslatta Falls, and the Skins Lake Spillway spring base release of 49.0 m^3/s (1,730 cfs) 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 2013 STMP operational period was 9,989.8 m^3/s-d, (352,790 cfs-d). The volume released for cooling purposes was 8,050.5 m^3/s-d (284,303 cfs-d), and is based on an assumed Skins Lake Spillway release of 49.0 m^3/s (1,730 cfs) for the period July 10 to August 16, inclusive, with a reduction to 14.2 m^3/s (500 cfs) until August 20. The average release during the operational period was 237.9 m^3/s (8,399.8 cfs). Volume calculations are presented in Appendix E.

The total volume of water released during the 2013 STMP operational period was 9,989.8 m^3/s-d, (352,790 cfs-d) which was the highest recorded release since the program was initiated in 1983 (Figure 5). Since project inception the average amount of total water released during the operational period has been 8155.9 m^3/s-d (287,983 cfs-d) and a minimum amount of total water released in 1988 of 6649.6 m^3/s-d (234,797 cfs-d).

Table 2

Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2013

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					17.4	18.6	18.9	20.4	20.6	20.6	20.1	19.9	19.5	20.1	20.4	19.9	20.0	19.7	18.2	18.2	19.6	20.9
4th Day's Predicted Water Temperature at Date + 3 Days				17.7	17.4	17.3	18.9	20.0	20.6	20.3	20.4	20.2	20.5	20.3	19.9	20.0	20.4	19.4	18.2	18.9	20.3	20.3
3rd Day's Predicted Water Temperature at Date + 2 Days			19.0	17.0	16.6	17.4	19.0	20.3	20.8	20.6	20.5	21.0	20.7	20.2	19.9	20.7	20.3	19.5	19.0	19.6	19.5	20.0
2nd Day's Predicted Water Temperature at Date + 1 Day		21.0	17.8	16.7	16.7	18.1	19.8	21.1	21.0	20.7	21.4	21.2	20.6	20.0	20.9	20.4	20.6	19.9	19.0	18.7	19.4	19.5
Current Day's Predicted Water Temperature at Date	21.7	19.5	17.6	17.2	17.7	19.0	20.4	21.2	21.1	21.2	21.4	20.9	20.3	21.0	20.2	20.7	20.4	19.3	18.2	18.6	18.7	20.0
Previous Day's Calculated Water Temperature at Date - 1 Day	21.1	19.2	17.7	17.4	17.7	19.1	20.3	21.1	21.1	21.1	21.1	20.5	20.6	20.6	20.1	20.5	20.0	18.8	18.1	18.2	18.8	19.8
Previous Day's Recorded Water Temperature at Date - 1 Day	21.2	20.5	19.3	18.1	17.5	17.7	18.3	19.4	20.2	20.7	20.7	20.9	20.8	20.4	20.2	20.3	20.6	20.2	19.1	18.3	18.3	18.9
Current Day's Skins Lake Spillway Release at Date (m^3/s)	49	49 to 136 @ 0800 hrs	136 to 226.5 @ 0800 hrs	226.5	226.5	226.5	226.5 to 453 @ 1600 hrs	453	453	453 to 283 @ 1600 hrs	283	283	283	283 to 14.2 @ 1600 hrs	14.2	14.2	14.2 to 453 @ 1600 hrs	453	453	453 to 283 @ 1600 hrs	283	283

Table 2 (continued)

AUGUST

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5th Day's Predicted Water Temperature at Date + 4 Days	21.0	20.9	20.9	20.7	20.1	20.6	20.1	20.2	20.0	20.2	21.0	21.3	21.2	21.1	20.4	20.0	19.7	18.8	18.3	17.7
4th Day's Predicted Water Temperature at Date + 3 Days	20.5	20.8	20.8	20.6	20.6	20.6	20.6	20.0	20.1	20.5	21.1	21.4	21.2	19.3	20.3	20.1	19.2	18.7	18.0	17.5
3rd Day's Predicted Water Temperature at Date + 2 Days	20.4	20.9	21.0	20.3	20.8	20.9	20.4	20.3	20.2	20.7	21.4	21.6	21.0	20.9	20.4	19.5	19.5	18.8	17.8	17.6
2nd Day's Predicted Water Temperature at Date + 1 Day	20.8	20.9	20.2	20.7	21.0	20.9	20.6	20.5	20.4	21.2	21.8	21.7	21.5	20.9	20.2	20.0	19.3	18.5	18.2	18.1
Current Day's Predicted Water Temperature at Date	20.6	20.3	20.6	20.8	21.0	20.7	20.8	20.6	20.9	21.4	21.7	21.9	21.3	20.7	20.1	19.8	19.1	19.0	18.6	17.8
Previous Day's Calculated Water Temperature at Date - 1 Day	20.3	20.3	20.5	20.7	20.8	20.7	20.8	20.7	20.9	21.3	21.6	21.6	21.1	20.3	19.9	19.6	19.2	19.0	18.4	
Previous Day's Recorded Water Temperature at Date - 1 Day	19.6	20.7	20.8	20.8	20.4	20.5	20.7	20.4	20.8	20.8	21.2	21.7	21.6	21.3	20.6	20.2	19.9	19.4	19.2	
Current Day's Skins Lake Spillway Release at Date (m^3/s)	283	283	283	283	283	283	283	283	283	283	283	283	283	283 to 14.2 @ 1600 hrs	14.2	14.2 to 170 @ 1600 hrs	170	170 to 14.2 @ 1600 hrs	14.2	14.2

Table 3

Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, July 10 to August 20, 2013

Date	Water Temperature (°C)	Date	Water Temperature (°C)
10-Jul	21.2	01-Aug	19.6
11-Jul	20.5	02-Aug	20.7
12-Jul	19.3	03-Aug	20.8
13-Jul	18.1	04-Aug	20.8
14-Jul	17.5	05-Aug	20.4
15-Jul	17.7	06-Aug	20.5
16-Jul	18.3	07-Aug	20.7
17-Jul	19.4	08-Aug	20.4
18-Jul	20.2	09-Aug	20.8
19-Jul	20.7	10-Aug	20.8
20-Jul	20.7	11-Aug	21.2
21-Jul	20.9	12-Aug	21.7
22-Jul	20.8	13-Aug	21.6
23-Jul	20.4	14-Aug	21.3
24-Jul	20.2	15-Aug	20.6
25-Jul	20.3	16-Aug	20.2
26-Jul	20.6	17-Aug	19.9
27-Jul	20.2	18-Aug	19.4
28-Jul	19.1	19-Aug	19.2
29-Jul	18.3	20-Aug	
30-Jul	18.3		
31-Jul	18.9		

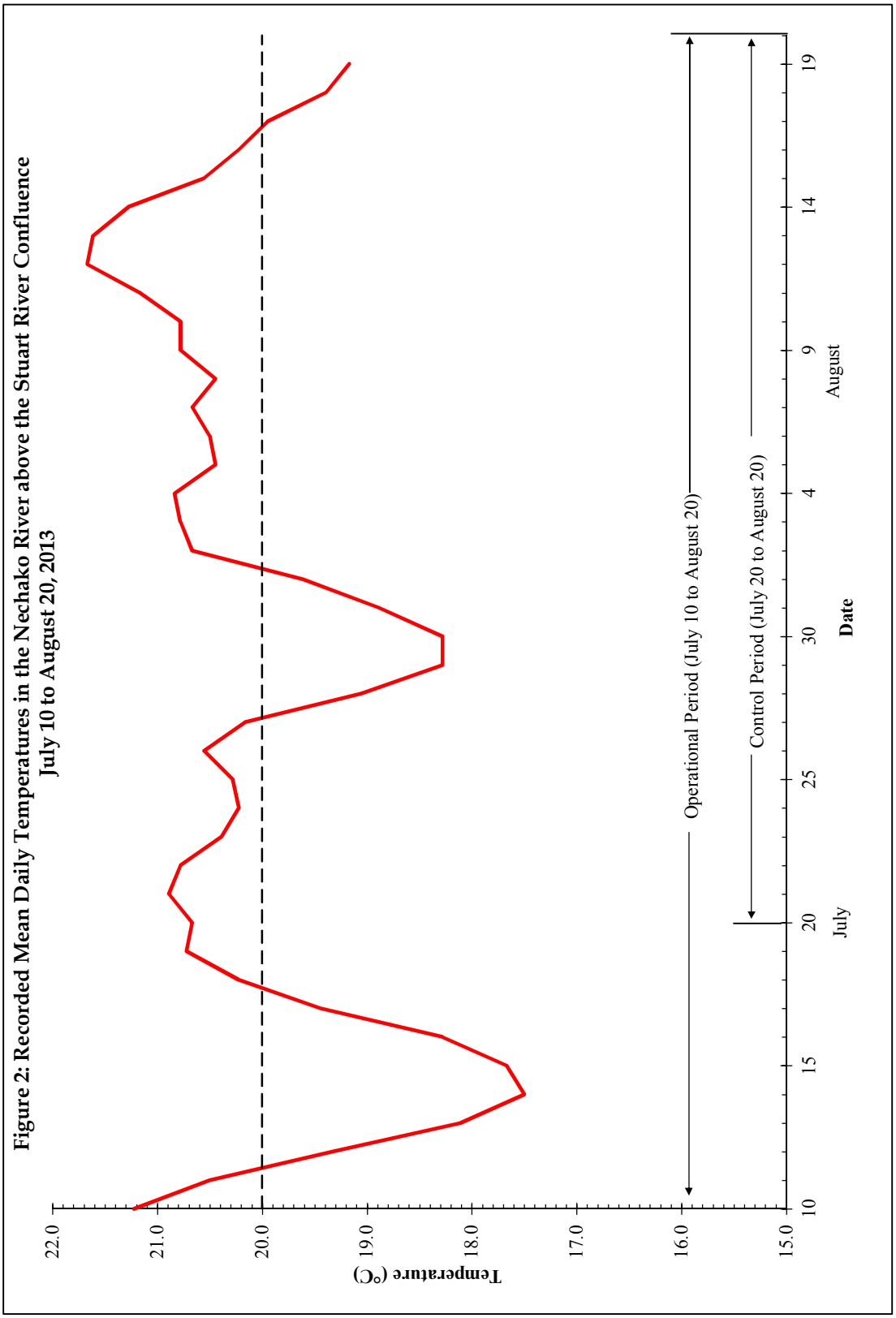


Figure 2: Recorded Mean Daily Temperatures in the Nechako River above the Stuart River Confluence
July 10 to August 20, 2013
Temperature (°C)
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
Operational Period (July 10 to August 20)
Control Period (July 20 to August 20)
10
15
20
25
30
4
9
14
19
July
August
Date

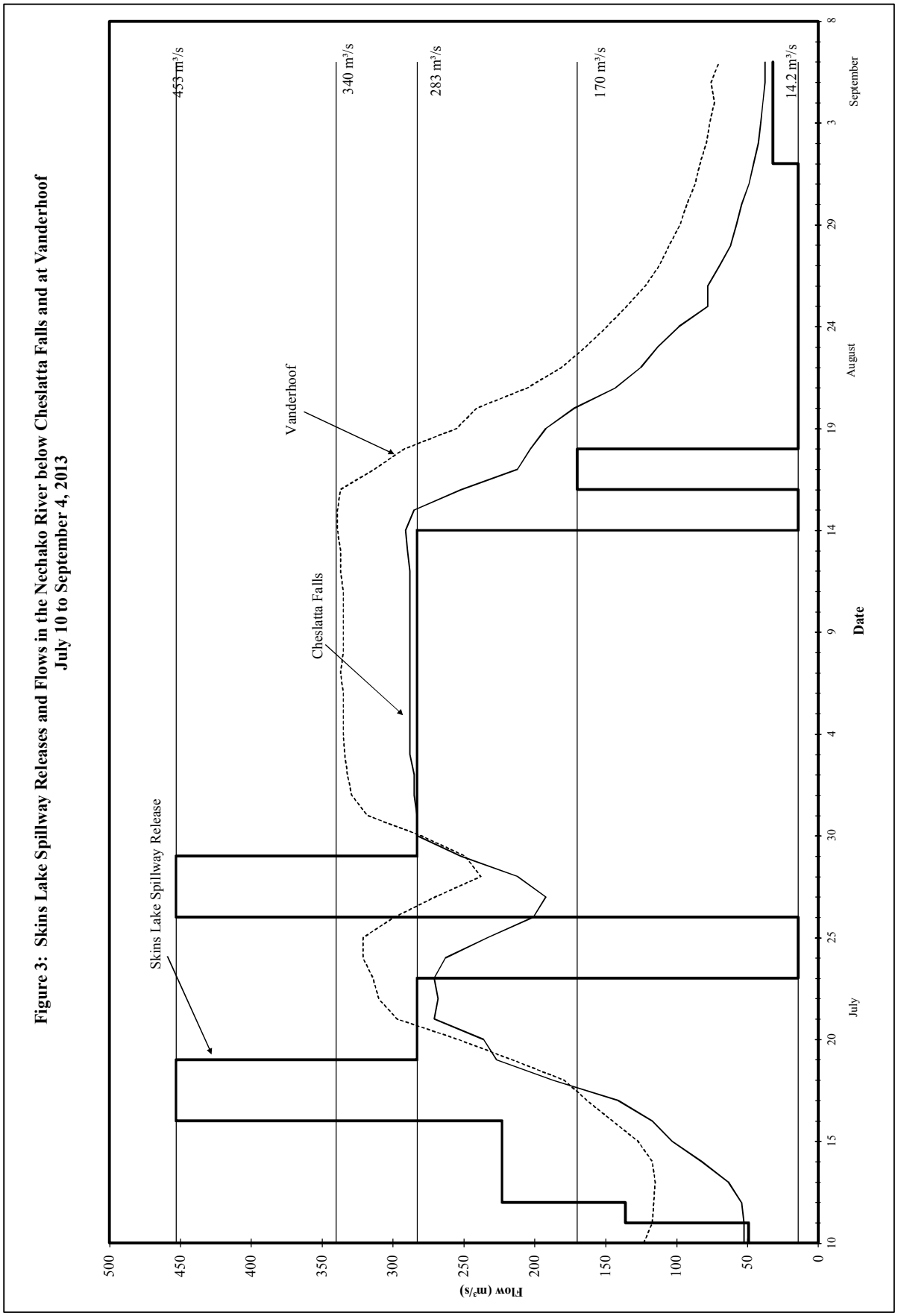
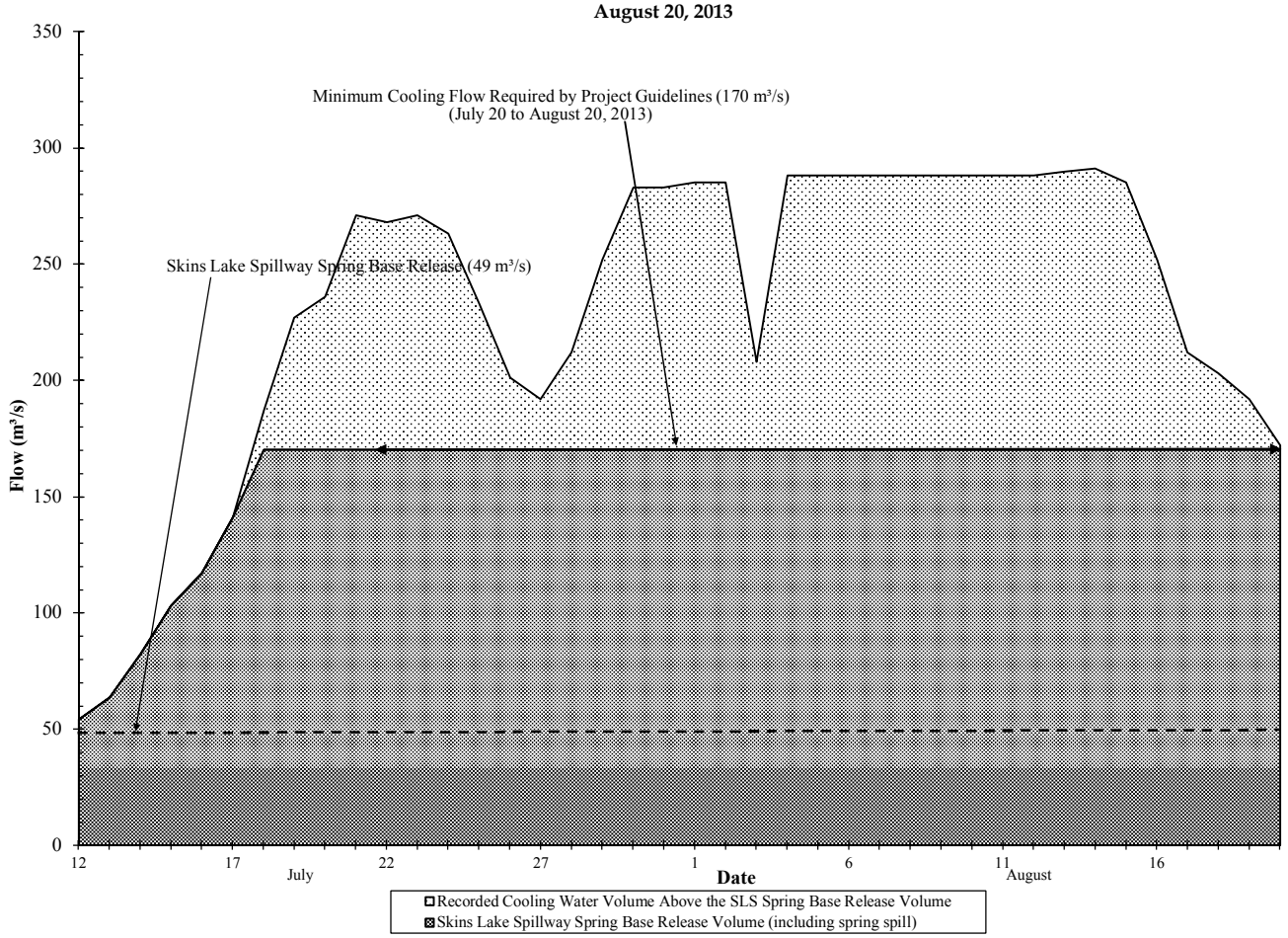


Figure 3: Skins Lake Spillway Releases and Flows in the Nechako River below Cheslatta Falls and at Vanderhoof
July 10 to September 4, 2013
453 m³/s
340 m³/s
283 m³/s
170 m³/s
14.2 m³/s
Vanderhoof
Cheslatta Falls
Skims Lake Spillway Release
Flow (m³/s)
Date
July
August
September

Figure 4: Flows in the Nechako River below Cheslatta Falls Resulting from Skins Lake Spillway Releases, July 10 to August 20, 2013



Application of the Summer Water Temperature and Flow Management Project Release Criteria

The Summer Water Temperature and Flow Management Project is very 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 predict the reversal of the temperature change prematurely.

In these instances, it may be required to exercise judgment when applying the Summer Water Temperature and Flow Management Project release criteria used with the three water temperature trends. This judgment is based on experience gained in the operation of the Summer Water Temperature and Flow Management Project since 1984 and may result in exceptions to the decision based on strict adherence to the release criteria. Exceptions were made to the application of the release criteria in 2013.

On July 13 through 15, 2013 two of three water temperature trends indicated the water temperature could exceed 19.4°C (67°F) in the Nechako River above Stuart River within the forecast period (5 days). The remaining trend, however, showed that the water temperature could be substantially less than 19.4°C (67°F) within the forecast period. Following these release criteria under these conditions, the release from Skins Lake Spillway should have been increased from the current release of 226.5

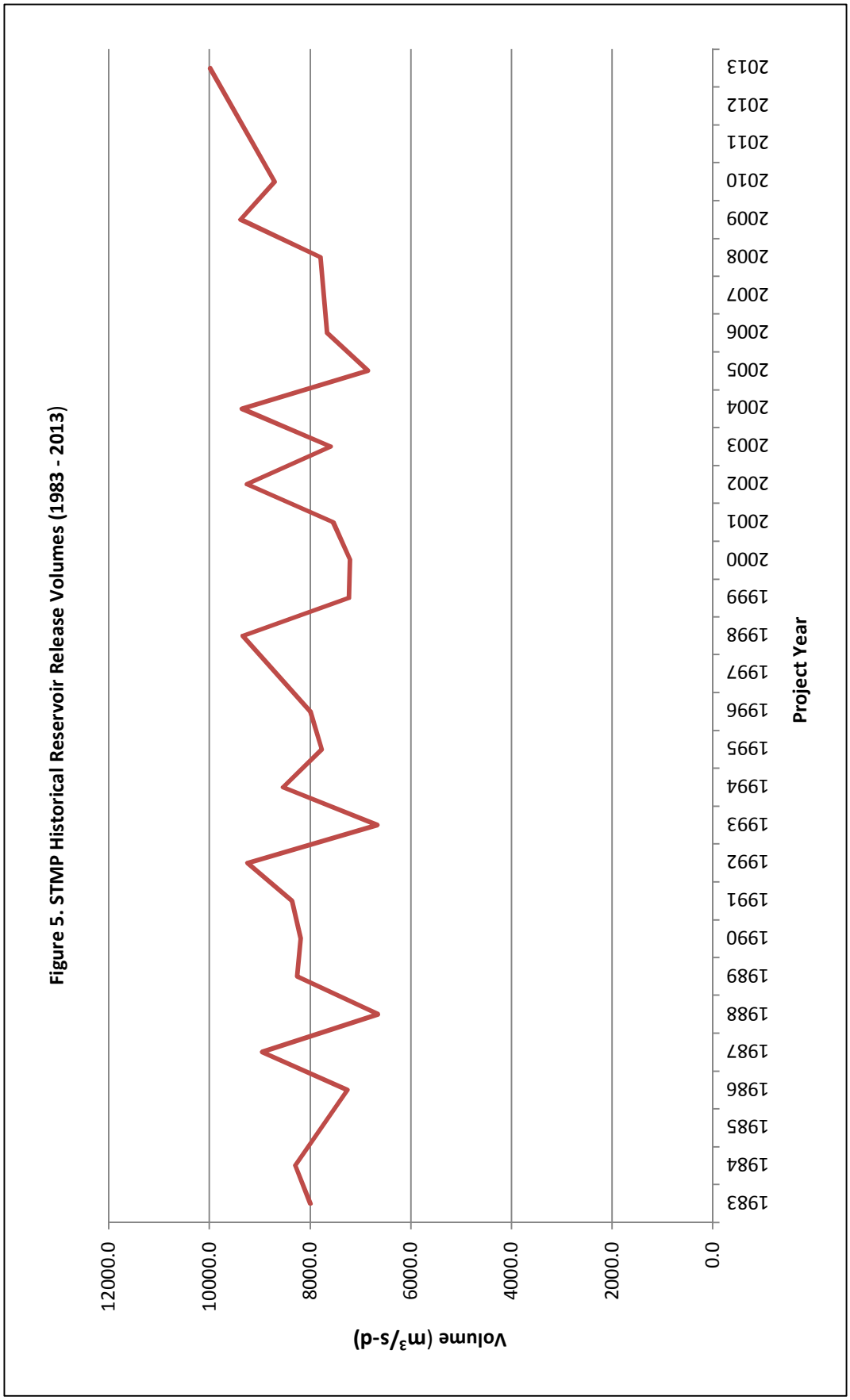


Figure 5. STMP Historical Reservoir Release Volumes (1983 - 2013)
Volume (m³/s-d)
12000.0
10000.0
8000.0
6000.0
4000.0
2000.0
0.0
Project Year
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

m^3/s (8,000 cfs) to 453 m^3/s (16,000 cfs). However, as there was no strong warming trend indicated, rather than increase the discharge it was conservatively decided to maintain the spillway release at 226.5 m^3/s (8,000 cfs). A warming trend was clearly established several days later on July 16.

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APPENDIX A

Numerical Example of Water Temperature Trend Calculation

Appendix A

Numerical Example of Water Temperature Trend Calculation

From data for July 16 date of operation (Table A1).

1. Observed Trend

   The observed trend is up by 0.6°C from 17.9°C (J14) to 18.5°C (J15). Take the previous day's recorded temperature 18.9°C (J15) and extrapolate the trend for five days at +0.6°C. The observed trend shows that the water temperature could potentially reach 17.9°C + 5(+0.6°C) = 20.9°C.

2. Predicted Trend

   The predicted trend is the difference between the previous day's calculated water temperature (J15) and the fifth day predicted water temperature (J20). The predicted trend is down from 18.7°C to 18.5°C with the potential to reach 18.5°C.

3. Forecast Trend

   The forecast trend for the current day of July 16 is based on the first, second and third day forecasts.

July 16	19.2 to 17.6	=	down	1.6°C
July 17	18.8 to 17.8	=	down	1.0°C
July 18	18.9 to 18.0	=	down	0.9°C

Mean of 3 differences = down 1.2°C

This mean of -1.2°C is added to the fifth day predicted water temperature to give 18.5°C + (-1.2°C) = 17.3°C.

Table A1

Predicted and Recorded Mean Daily Water Temperatures in the Nechako River above the Stuart River Confluence, 2010

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

Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2013

Appendix B

Mean Daily Water Temperatures in the Nechako and Nautley Rivers, 2013

	Nechako River			Nautley		Nechako River			Nautley
Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above the Stuart River (°C)	Fort Fraser (°C)	Date	Cheslatta Falls (°C)	Fort Fraser (°C)	above Stuart River (°C)	Fort Fraser (°C)
10-Jul	18.9	20.1	21.2	19.4	01-Aug	17.3	18.7	19.6	21.0
11-Jul	18.2	19.1	20.5	18.5	02-Aug	17.3	19.0	20.7	20.9
12-Jul	17.3	17.9	19.3	17.1	03-Aug	17.6	19.2	20.8	20.7
13-Jul	16.9	16.8	18.1	16.7	04-Aug	17.9	18.9	20.8	22.0
14-Jul	16.8	17.0	17.5	16.9	05-Aug	18.2	19.5	20.4	22.3
15-Jul	16.8	17.4	17.7	17.2	06-Aug	18.4	19.5	20.5	22.4
16-Jul	17.2	18.1	18.3	17.7	07-Aug	18.7	19.8	20.7	22.3
17-Jul	17.3	19.1	19.4	19.1	08-Aug	18.8	19.8	20.4	22.2
18-Jul	17.2	18.8	20.2	18.7	09-Aug	18.9	22.3	20.8	22.3
19-Jul	17.8	19.2	20.7	19.8	10-Aug	18.9	19.9	20.8	22.5
20-Jul	17.8	19.5	20.7	20.7	11-Aug	19.0	20.2	21.2	22.8
21-Jul	17.8	19.4	20.9	20.3	12-Aug	19.1	20.7	21.7	23.6
22-Jul	17.7	19.2	20.8	19.8	13-Aug	18.9	20.1	21.6	23.0
23-Jul	17.8	19.0	20.4	19.8	14-Aug	19.1	20.1	21.3	21.4
24-Jul	17.8	19.2	20.2	20.3	15-Aug	18.9	19.5	20.6	21.2
25-Jul	17.9	19.1	20.3	21.2	16-Aug	18.8	19.3	20.2	21.7
26-Jul	18.2	19.6	20.6	21.3	17-Aug	18.7	19.3	19.9	19.6
27-Jul	18.8	18.8	20.2	19.0	18-Aug	18.6	19.1	19.4	20.4
28-Jul	17.7	17.9	19.1	17.6	19-Aug	18.4	18.8	19.2	19.3
29-Jul	17.6	17.9	18.3	18.8	20-Aug	18.2	18.2	n/a	16.5
30-Jul	17.3	17.9	18.3	18.8					
31-Jul	17.3	18.6	18.9	20.3					

n/a - Temperatures not available.

APPENDIX C

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2013

Appendix C

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2013

Date	Skins Lake Spillway Release (m^3/s)	Nechako River Cheslatta Falls (m^3/s)	Nechako River At Vanderhoof (m^3/s)	Nautley River Fort Fraser (m^3/s)
10-Jul	49	52.3	123.0	53.2
11-Jul	49 to 136 @ 0800 hrs	52.3	117.0	50.1
12-Jul	136 to 223 @ 0800 hrs	54.1	116.01	49.1
13-Jul	223.0	63.5	114.9	49.1
14-Jul	223.0	82.2	117.0	48.0
15-Jul	223.0	103.0	127.0	48.0
16-Jul	223 to 453 @ 1600 hrs	117.0	145.0	45.9
17-Jul	453.0	141.0	162.9	44.9
18-Jul	453.0	187.0	178.9	44.9
19-Jul	453 to 283 @ 1600 hrs	227.0	216.0	43.9
20-Jul	283	263.0	254.0	42.9
21-Jul	283	270.9	297.0	41.9
22-Jul	283	267.9	310.0	40.0
23-Jul	283 to 14.2 @ 1600 hrs	270.9	314	39.0
24-Jul	14.2	263	321	38.1
25-Jul	14.2	232.9	321.0	38.1
26-Jul	14.2 to 453 @ 1600 hrs	200.9	299.0	36.3
27-Jul	453	191.9	270.0	36.3
28-Jul	453	212.0	238.0	34.5
29-Jul	453 to 283 @ 1600 hrs	251.9	248.9	33.7
30-Jul	283	283.0	279.9	32.8
31-Jul	283	283.0	318.0	39.0
01-Aug	283	285.0	329.0	32.0
02-Aug	283	285.0	332.0	31.1
03-Aug	283	288.0	333.9	30.3
04-Aug	283	288.0	335.0	29.5
05-Aug	283	288.0	335.0	28.7
06-Aug	283	288.0	355.0	28.7
07-Aug	283	288.0	337.0	27.2
08-Aug	283	288.0	335.0	26.4
09-Aug	283	288.0	335.0	26.4
10-Aug	283	288.0	335.0	25.7
11-Aug	283	288.0	335.0	25.7

Appendix C (continued)

Mean Daily Skins Lake Spillway Releases and Flows in the Nechako and Nautley Rivers, 2013

Date	Skins Lake Spillway Release (m^3/s)	Nechako River Cheslatta Falls (m^3/s)	Nechako River At Vanderhoof (m^3/s)	Nautley River Fort Fraser (m^3/s)
12-Aug	283	288.0	337.0	25.7
13-Aug	283	289.6	337.0	25.0
14-Aug	283 to 14.2 @ 1600 hrs	291.0	339.0	24.3
15-Aug	14.2	285.0	339.0	23.6
16-Aug	14.2 to 170 @ 1600 hrs	252.0	337.0	23.6
17-Aug	170	212.0	313.0	22.2
18-Aug	170 to 14.2 @ 1600 hrs	203.0	292.0	22.2
19-Aug	14.2	191.9	254.9	21.5
20-Aug	14.2	171.9	241	22.2

APPENDIX D
Recorded and Forecast Meteorological Data

16.5	390.1	0.7	8.8	7.6	94.0	58.6	09 07 13
13.7	615.7	0.5	3.4	6.3	91.3	48.0	10 07 13
11.5	479.0	0.5	2.9	9.0	92.0	57.0	
11.2	349.0	0.6	3.1	9.1	91.3	59.0	
12.7	315.5	0.8	4.4	6.1	91.7	58.0	
11.4	420.7	0.6	6.4	5.0	92.1	75.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 10/13

11.9	412.0	0.5	6.3	5.4	91.3	71.8	10 07 13
11.1	489.5	0.5	2.6	9.9	91.0	57.0	11 07 13
11.5	404.4	0.8	2.7	9.3	91.3	56.0	
11.4	349.0	0.8	6.1	7.0	91.8	73.0	
12.4	640.5	0.4	6.8	4.3	92.2	72.0	
14.7	707.5	0.1	5.9	4.2	92.2	56.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 11/13

12.0	300.8	0.5	5.0	14.1	91.0	65.1	11 07 13
10.6	374.8	0.8	4.0	8.9	91.3	66.0	12 07 13
12.8	433.1	0.7	5.6	6.3	91.9	64.0	
11.7	310.7	0.7	9.2	4.5	92.1	87.0	
15.1	697.9	0.1	8.0	4.6	92.1	64.0	
17.5	697.9	0.1	8.9	4.4	91.7	57.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 12/13

11.4	278.3	0.8	6.1	9.7	91.3	73.1	12 07 13
11.1	535.4	0.6	5.1	6.3	92.0	70.4	13 07 13
11.5	387.2	0.6	8.2	4.7	92.2	83.5	
14.5	702.7	0.1	7.2	4.4	92.1	63.3	
17.5	707.5	0.1	8.7	3.7	91.9	56.0	
19.4	717.0	0.1	8.4	4.2	91.6	45.1	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 13/13

Appendix D (continued)
Recorded and Forecast Meteorological Data 2013

11.5	384.5	0.7	6.9	6.3	93.3	76.8	13 07 13
11.3	499.0	0.6	7.3	5.9	92.1	80.2	14 07 13
13.9	705.5	0.1	6.5	4.2	92.2	62.8	
16.6	717.0	0.0	7.8	4.5	92.0	56.0	
18.7	659.7	0.1	8.2	4.9	91.7	47.5	
19.6	697.9	0.0	7.6	9.9	91.8	40.2	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 14/13

11.5	384.5	0.7	6.9	6.3	92.1	76.8	14 07 13
14.0	801.2	0.1	5.8	4.4	92.1	59.0	15 07 13
16.8	714.2	0.1	7.5	4.1	92.0	53.7	
18.6	683.6	0.1	7.9	4.5	91.7	46.8	
19.1	631.0	0.1	7.0	8.7	91.9	39.4	
19.1	688.3	0.1	6.7	10.0	91.7	38.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 15/13

14.8	660.2	0.1	7.7	4.2	92.1	64.7	15 07 13
17.4	808.8	0.1	7.3	4.2	92.0	49.7	16 07 13
19.0	706.5	0.1	7.5	4.6	91.7	42.3	
19.9	664.4	0.1	6.8	10.1	92.0	34.2	
20.0	688.3	0.1	7.5	7.2	91.9	37.3	
19.8	611.9	0.1	9.2	9.2	91.2	46.8	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 16/13

16.9	650.6	0.1	9.2	2.6	92.0	61.4	16 07 13
19.2	638.6	0.4	7.9	5.2	91.7	43.8	17 07 13
20.5	695.0	0.1	7.1	11.2	91.9	32.8	
20.4	693.1	0.1	7.4	6.7	91.9	35.2	
19.4	592.7	0.1	8.6	9.1	91.3	45.9	
16.8	640.5	0.1	4.4	12.4	91.0	38.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 17/13

20.2	473.2	0.1	11.0	3.6	91.7	54.1	17 07 13
20.8	766.7	0.1	6.9	9.9	91.9	30.7	18 07 13
20.7	686.4	0.1	7.9	6.9	91.8	35.8	
20.7	688.3	0.1	8.3	10.6	91.3	38.1	
18.7	688.3	0.1	4.6	11.3	91.1	29.8	
16.8	449.3	0.4	3.4	7.3	91.3	36.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 18/13

20.7	604.4	0.1	10.2	9.0	91.9	47.8	18 07 13
21.1	785.9	0.1	6.8	7.2	91.8	28.6	19 07 13
21.1	686.4	0.1	7.7	9.9	91.3	33.1	
20.6	688.3	0.1	4.9	8.9	91.2	21.5	
19.0	669.2	0.2	1.8	8.9	91.4	13.8	
19.1	688.3	0.1	2.7	7.7	91.8	17.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 19/13

21.1	604.4	0.1	10.2	9.0	91.9	47.8	19 07 13
20.7	774.4	0.1	7.8	9.9	91.4	35.4	20 07 13
20.5	659.7	0.1	5.1	8.7	91.2	22.7	
19.4	678.8	0.1	2.2	8.3	91.4	14.1	
19.5	659.7	0.2	5.6	5.4	91.7	30.6	
19.6	611.9	0.2	8.1	4.2	91.6	42.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 20/13

18.6	633.7	0.1	10.7	10.4	91.4	60.7	20 07 13
18.9	764.8	0.1	5.0	7.7	91.2	30.5	21 07 13
17.8	688.3	0.1	3.0	6.8	91.4	26.1	
17.6	554.5	0.4	5.7	4.7	91.8	40.3	
18.0	621.4	0.2	7.7	5.8	91.7	48.6	
17.0	525.8	0.5	7.3	5.8	91.7	51.5	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 21/13

16.8	388.2	0.1	9.4	6.9	91.2	63.1	21 07 13
17.3	740.0	0.1	3.8	7.2	91.4	32.6	22 07 13
17.4	517.2	0.6	7.8	4.2	91.8	52.1	
17.5	549.7	0.3	11.0	4.5	91.8	67.6	
15.7	525.8	0.5	11.6	3.7	91.9	79.6	
14.3	602.3	0.3	6.7	6.4	92.0	61.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 22/13

19.3	725.1	0.1	8.5	9.6	91.4	46.1	22 07 13
17.9	676.9	0.4	7.8	4.7	91.9	49.6	23 07 13
19.0	647.2	0.1	10.3	3.5	91.8	56.6	
18.3	626.2	0.1	10.5	5.2	91.7	61.0	
16.0	669.2	0.1	3.3	8.8	92.0	36.7	
13.6	372.9	0.5	6.1	6.0	92.0	62.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 23/13

Appendix D (continued)
Recorded and Forecast Meteorological Data 2013

17.4	504.9	0.1	10.5	3.9	91.9	65.4	23 07 13
18.8	688.3	0.3	9.2	4.6	91.9	51.7	24 07 13
18.5	540.2	0.3	8.8	5.4	91.8	51.9	
14.9	645.3	0.2	5.9	8.4	91.9	55.1	
13.0	296.4	0.6	7.0	7.5	91.9	70.2	
13.7	248.6	0.9	10.2	7.6	91.9	82.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 24/13

18.5	540.2	0.3	8.8	5.4	91.8	51.9	24 07 13
18.6	692.2	0.2	7.1	6.2	91.8	42.7	25 07 13
16.1	622.4	0.1	3.1	9.7	91.9	34.8	
13.2	186.4	0.8	6.8	7.1	91.9	67.7	
13.7	401.5	0.6	8.6	6.2	91.9	74.9	
15.1	602.3	0.2	5.7	6.5	91.8	53.2	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 25/13

19.4	559.9	0.3	9.8	10.6	91.8	51.9	25 07 13
16.0	726.6	0.1	2.5	10.1	92.0	32.4	26 07 13
14.9	382.4	0.5	3.8	8.8	91.9	44.6	
15.4	497.1	0.5	6.4	6.6	91.8	54.6	
15.3	678.8	0.1	3.9	5.8	92.0	43.3	
18.2	611.9	0.1	6.5	3.5	92.0	41.5	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 26/13

14.5	504.2	0.3	6.1	10.6	92.0	57.7	26 07 13
14.4	541.1	0.3	4.2	7.8	92.0	48.7	27 07 13
15.3	625.2	0.2	6.5	6.6	91.9	56.2	
16.0	659.7	0.1	5.4	6.6	92.0	47.2	
18.5	640.5	0.1	7.7	4.5	92.0	46.4	
18.9	602.3	0.1	9.4	3.8	92.0	52.1	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 27/13

13.4	190.7	0.8	7.9	8.9	92.0	72.6	27 07 13
14.9	619.5	0.5	7.5	7.1	92.0	62.8	28 07 13
15.4	656.8	0.1	5.1	6.0	92.0	48.6	
18.2	654.9	0.1	7.8	4.3	92.0	48.0	
20.2	611.9	0.1	9.2	4.1	92.0	44.7	
20.6	640.5	0.1	11.3	5.2	91.9	53.5	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 28/13

13.0	432.3	0.3	8.8	3.0	92.0	79.0	28 07 13
15.3	657.7	0.2	7.1	4.1	92.0	59.0	29 07 13
17.9	652.0	0.1	9.8	4.9	92.1	59.6	
19.3	640.5	0.1	10.3	4.2	92.2	55.2	
21.0	631.0	0.1	11.8	4.9	91.8	54.0	
20.9	611.9	0.1	12.6	4.1	91.6	58.2	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 29/13

13.5	355.3	0.5	7.8	3.2	92.0	71.4	29 07 13
17.0	701.7	0.1	10.1	4.3	92.1	65.3	30 07 13
19.3	646.3	0.1	11.1	4.1	92.1	59.0	
20.3	602.3	0.1	12.5	4.3	91.7	60.8	
19.7	621.4	0.1	13.3	5.3	91.5	67.9	
20.4	621.4	0.1	12.3	5.0	91.5	59.8	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 30/13

16.1	595.8	0.3	9.7	2.1	92.1	67.9	30 07 13
19.1	732.3	0.1	10.9	3.8	92.2	59.3	31 07 13
20.6	634.8	0.1	11.9	4.3	91.7	56.7	
21.0	621.4	0.1	11.5	4.6	91.4	52.5	
19.6	602.3	0.1	13.0	4.3	91.5	67.0	
19.2	525.8	0.2	13.7	3.3	91.6	72.3	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED JUL 31/13

18.9	513.9	0.3	12.6	2.6	92.0	51.0	31 07 13
21.0	544.9	0.1	12.5	4.5	91.5	57.5	01 08 13
19.6	506.7	0.2	13.7	4.4	91.7	70.6	
20.4	621.4	0.1	12.6	4.0	91.7	60.9	
20.7	631.0	0.1	9.8	4.3	91.5	45.4	
20.2	573.6	0.2	10.5	4.1	91.5	51.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 01/13

19.9	491.0	0.2	13.3	3.4	92.0	67.3	01 08 13
19.4	657.7	0.2	13.0	4.2	91.7	67.9	02 08 13
20.3	570.8	0.0	13.0	3.5	91.8	63.8	
20.1	607.1	0.0	12.7	3.9	91.5	63.3	
18.3	497.1	0.2	13.1	4.7	91.4	73.8	
18.9	516.3	0.2	9.0	4.7	91.5	53.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 02/13

19.9	491.0	0.2	13.3	3.4	92.0	67.3	02 08 13
19.4	657.7	0.2	13.0	4.2	91.7	67.9	03 08 13
20.3	570.8	0.0	13.0	3.5	91.8	63.8	
20.1	607.1	0.0	12.7	3.9	91.5	63.3	
18.3	497.1	0.2	13.1	4.7	91.4	73.8	
18.9	516.3	0.2	9.0	4.7	91.5	53.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 03/13

20.1	581.6	0.2	11.9	7.6	92.0	58.7	03 08 13
19.1	692.2	0.1	11.7	4.6	91.7	62.9	04 08 13
21.2	593.7	0.1	9.9	5.3	91.5	43.2	
21.2	611.9	0.2	8.6	7.1	91.5	37.0	
20.5	444.6	0.6	7.3	5.9	91.5	33.9	
20.2	554.5	0.5	8.5	5.4	91.6	41.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 04/13

19.8	582.5	0.2	12.1	3.0	92.0	61.6	04 08 13
21.3	608.0	0.3	8.7	4.8	91.5	36.8	05 08 13
21.0	544.0	0.3	6.0	5.4	91.5	24.9	
19.8	535.4	0.2	3.1	6.4	91.5	16.3	
18.8	540.2	0.3	6.4	4.9	91.6	37.8	
19.3	544.9	0.2	10.1	4.7	91.5	54.1	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 09/13

19.6	508.2	0.1	11.6	4.4	91.5	59.8	05 08 13
21.0	533.5	0.5	6.0	4.8	91.5	25.0	06 08 13
20.0	532.5	0.2	8.9	5.0	91.6	44.8	
18.9	473.2	0.4	9.8	5.0	91.6	54.5	
19.1	411.1	0.7	12.8	4.3	91.6	68.4	
18.6	564.1	0.2	10.8	4.3	91.5	61.0	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 06/13

21.4	407.7	0.3	12.2	3.3	91.5	54.0	06 08 13
20.3	499.0	0.4	8.6	4.6	92.6	41.7	07 08 13
20.7	351.8	0.7	8.8	4.1	91.7	40.8	
20.4	554.5	0.2	9.8	4.5	91.6	47.0	
21.6	602.3	0.0	9.1	4.6	91.5	37.7	
21.9	535.4	0.1	10.6	3.8	91.5	43.5	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 07/13

18.6	498.4	0.3	10.9	3.6	91.6	61.4	07 08 13
19.3	386.2	0.8	10.2	4.7	91.7	54.2	08 08 13
20.3	455.1	0.6	12.1	4.5	91.7	59.1	
21.6	573.6	0.1	11.2	4.5	91.6	47.9	
21.8	554.5	0.2	10.5	3.5	91.6	43.7	
20.6	525.8	0.2	13.3	3.3	91.5	63.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 09/13

17.8	438.4	0.3	11.5	3.9	91.7	68.1	08 08 13
20.3	609.9	0.2	10.1	4.8	91.7	48.6	09 08 13
21.8	599.4	0.0	9.7	4.4	91.5	39.6	
22.8	602.3	0.0	9.1	4.7	91.5	31.5	
22.2	501.9	0.3	9.5	3.6	91.5	36.7	
19.3	497.1	0.3	14.5	4.2	91.6	75.8	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 09/13

18.5	541.0	0.2	12.2	2.3	91.7	68.7	09 08 13
21.7	667.3	0.0	11.9	4.1	91.5	50.7	10 08 13
23.0	585.1	0.1	9.9	4.1	91.5	34.5	
19.9	458.9	0.3	13.5	4.9	91.6	68.0	
19.8	554.5	0.3	11.7	4.2	91.8	59.3	
20.0	583.2	0.0	7.2	5.9	91.9	35.8	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 10/13

20.5	537.6	0.1	13.3	2.6	91.5	63.9	10 08 13
23.1	673.0	0.1	6.9	5.3	91.6	50.7	11 08 13
21.2	498.1	0.3	11.4	6.1	91.5	50.8	
17.3	267.7	0.8	14.0	4.9	91.7	83.6	
19.0	540.2	0.5	9.9	5.2	91.7	54.7	
18.7	353.7	0.6	10.5	4.9	91.7	59.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 11/13

21.3	526.2	0.1	13.7	4.5	91.6	61.9	11 08 13
21.0	539.2	0.3	11.3	5.5	91.6	51.7	12 08 13
17.5	464.6	0.5	12.9	5.9	91.7	76.9	
17.7	492.4	0.3	11.2	3.9	91.6	67.4	
15.8	329.8	0.6	12.8	4.0	91.5	84.7	
16.1	554.5	0.3	9.6	6.1	91.3	67.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 12/13

Appendix D (continued)
Recorded and Forecast Meteorological Data 2013

18.7	341.4	0.2	14.7	2.9	91.6	79.5	12 08 13
17.9	588.9	0.4	12.3	4.2	91.7	72.0	13 08 13
17.5	462.7	0.3	11.0	4.1	91.5	67.3	
16.1	444.6	0.4	12.7	4.7	91.2	83.2	
15.5	521.0	0.3	10.1	5.2	91.4	72.8	
14.4	229.5	0.8	10.7	4.3	91.4	81.7	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 13/13

17.6	339.8	0.2	13.4	2.9	91.7	79.0	13 08 13
16.9	514.3	0.1	10.9	4.4	91.3	70.0	14 08 13
15.0	317.4	0.6	12.6	4.8	91.2	87.8	
13.7	396.8	0.4	11.4	4.7	91.3	88.8	
14.6	415.9	0.4	10.1	5.8	91.3	77.6	
13.0	277.3	0.4	8.9	7.1	91.2	79.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 14/13

16.0	234.6	0.2	11.9	1.4	91.3	79.5	14 08 13
18.4	609.9	0.3	9.5	6.2	91.1	55.3	15 08 13
15.5	365.2	0.6	9.6	5.0	91.4	70.8	
14.2	282.0	0.7	10.9	5.5	91.3	83.2	
12.9	291.6	0.6	9.6	6.1	91.2	83.5	
12.3	478.0	0.3	4.6	8.5	91.5	61.3	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADAFORECAST ISSUED AUG 15/13

16.0	357.0	0.3	10.8	4.8	91.1	73.9	15 08 13
13.8	393.9	0.6	11.1	4.1	91.3	86.4	16 08 13
14.8	423.5	0.4	9.5	5.3	91.4	73.5	
12.9	277.3	0.5	9.1	5.2	91.3	81.0	
12.5	329.8	0.5	4.9	9.3	91.2	61.7	
11.6	554.5	0.1	4.7	10.4	91.6	65.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 16/13

14.9	220.3	0.4	10.0	6.9	91.3	75.4	16 08 13
14.8	423.5	0.4	9.5	5.3	91.4	73.5	17 08 13
12.9	277.3	0.5	9.1	5.2	91.3	81.0	
12.5	329.8	0.5	4.9	9.3	91.2	61.7	
11.6	554.5	0.1	4.7	10.4	91.6	65.6	
13.3	554.5	0.0	4.4	5.7	92.0	55.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 17/13

Appendix D (continued)
Recorded and Forecast Meteorological Data 2013

15.0	311.1	0.6	10.0	4.9	91.4	75.3	17 08 13
12.5	353.7	0.6	9.1	6.2	91.3	82.9	18 08 13
11.4	387.2	0.4	4.7	9.9	91.3	66.4	
12.4	544.9	0.1	2.4	11.1	91.8	50.1	
13.0	540.2	0.1	3.6	5.9	91.9	52.9	
13.5	401.5	0.3	5.8	6.9	91.4	61.4	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 18/13

13.6	330.9	0.5	8.9	6.2	91.3	76.4	18 08 13
11.4	457.0	0.5	4.8	6.2	91.3	66.8	19 08 13
12.4	546.9	0.0	2.4	9.9	91.8	50.3	
10.9	210.3	0.6	6.1	11.1	91.7	76.1	
12.5	315.5	0.7	9.8	5.9	91.2	86.5	
12.2	401.5	0.4	4.4	6.9	91.3	60.6	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 19/13

12.8	315.3	0.5	6.5	13.1	91.3	68.1	19 08 13
12.6	627.2	0.1	1.8	12.4	91.8	45.7	20 08 13
12.3	386.2	0.4	3.9	5.5	91.9	58.3	
13.8	258.1	0.7	9.0	4.6	91.3	76.1	
12.3	516.3	0.1	5.3	6.6	91.2	65.2	
12.9	468.5	0.2	4.1	6.0	91.4	55.9	
ATEMP(C)	RAD(LY)	CC(TTHS)	DPT(C)	SPD(KH)	SPR(KPA)	RH(%)	DD MM YY

ENVIRONMENT CANADA FORECAST ISSUED AUG 20/13

APPENDIX E

Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2013

Appendix E

Summer Water Temperature and Flow Management Project Reservoir Release Volume Calculations for July 10 to August 20, 2013

Skins Lake Spillway base release for the period July 10 (191) to August 20 (232) = 49.0 m^3/s
Summer Water Temperature and Flow Management Project Base Release Volume = (JD 230 - JD 191) * 49.0 + (JD 232 - JD 230) * 14.16 = 1,939.3 $m^3/s*days$

Time period (Julian Day)	Time (hrs)	Flow Rate (m^3/s)	Volume ($m^3/s*hrs$)
July 10 (191) @ 2400 hrs to July 11 (192) @ 0800 hrs	32.0	49.0	1,568
July 11 (192) @ 0800 hrs to July 12 (193) @ 0800 hrs	24.0	136.0	3,264
July 12 (193) @ 0800 hrs to July 16 (197) @ 1600 hrs	104.0	223.0	23,192
July 16 (197) @ 1600 hrs to July 19 (200) @ 1600 hrs	72.0	453.0	32,616
July 19 (200) @ 1600 hrs to July 23 (204) @ 1600 hrs	96.0	283.0	27,168
July 23 (204) @ 1600 hrs to July 26 (207) @ 1600 hrs	72.0	14.2	1,022
July 26 (213) @ 1400 hrs to July 29 (210) @ 1600 hrs	72.0	453.0	32,616
July 29 (210) @ 1600 hrs to August 14 (226) @ 1600 hrs	384.0	283.0	108,672
August 14 (226) @ 1600 hrs to August 16 (228) @ 1600 hrs	48.0	14.2	682
August 16 (228) @ 1600 hrs to August 18 (230) @ 1600 hrs	48.0	170.0	8,160
August 18 (230) @ 1600 hrs to August 20 (232) @ 2400 hrs	56.0	14.2	795
Total	1,008 (42.0 days)		239,755

Total Release Volume
= 239,755 $m^3/s*hrs$
= 9,989.8 $m^3/s*days$
= 352,790 $cfs*days$

Volume Released for Cooling Purposes
= Total Volume - Base Volume
= 9,989.8 - 1,939.3
= 8,050.5 $m^3/s*days$
= 284,303 $cfs*days$

Average Release over Summer Management Period (July 10 to August 20)
= 9,989.8 $m^3/s*days$ / 42 days
= 237.9 m^3/s
= 8,399.8 cfs