INTERNATIONAL ST. CROIX RIVER WATERSHED BOARD

ANNUAL REPORT

2016

ST. CROIX RIVER
MAINE AND NEW BRUNSWICK

2016 ANNUAL REPORT

OF THE

INTERNATIONAL ST. CROIX RIVER WATERSHED BOARD

Covering

The Orders of Approval with respect to the control of the discharge of the St. Croix River at Forest City, Vanceboro, and the water levels of East Grand Lake, Spednic Lake, Grand Falls Flowage and Milltown Dam Forebay

&

The Water Quality and Aquatic Ecosystem Health of the St. Croix River Boundary Waters

SUBMITTED TO

THE INTERNATIONAL JOINT COMMISSION

BY

THE INTERNATIONAL ST. CROIX RIVER WATERSHED BOARD

Prepared March 2017

TABLE OF CONTENTS

1.0 GENERAL

1.1 Synopsis for 2016

In 2016, water quality in the system remained in generally good to excellent condition with respect to aquatic life.

In 2016 annual mean river flow as measured at St. Croix River, Baring, Maine (gage) was slightly lower than the long term mean value. Summer daily flows at Baring were below median daily flow values due to below normal summer rainfall.

During the year, reservoir levels and flows were operated within prescribed levels. Reservoir levels and flows in the river provided satisfactory conditions for power generation, canoeing, kayaking and support of aquatic life.

The Board held its annual public meeting on the evening of June 14, 2016 in Calais, Maine. On the same day, the Board held its June Board meeting and partners meeting which included invited guests from the Passamaquoddy Tribe and local organizations. In 2016, the Board continued its interest in supporting water resource and ecosystem restoration research in the St. Croix River watershed.

FIGURE 1. St. Croix River Below Forest City Dam, June 2016

1.2 Board Membership

International St. Croix River Watershed Board - Membership	
Canadian Section	U.S. Section
Bill Appleby, Canadian Co-Chair Director, Prediction Services Operations East, Meteorological Service of Canada Environment & Climate Change Canada Dartmouth, Nova Scotia	Colonel Christopher Barron, U.S. Co-Chair District Engineer U.S. Army Corps of Engineers New England District Concord, Massachusetts
Donald Fox, Ph.D. Provincial Water Quality Specialist New Brunswick Department of Environment & Local Government Fredericton, New Brunswick	Ralph Abele Chief Water Quality Branch EPA New England, Region 1 Boston, Massachusetts
Jessie Davies 4 O'Neill Farm Road St. Andrews, New Brunswick	Susanne Miller, J.D. Regional Director, Eastern Maine Office, Department of Environmental Protection Bangor, Maine
Geoff Mercer Regional Director General, Atlantic and Quebec Regions Environment & Climate Change Canada Dartmouth, Nova Scotia	Oliver Cox Director, Division of Sea Run Fisheries & Habitat Maine Department of Marine Resources Bangor, Maine
Robert Stephenson, Ph.D. Principal Investigator, Canadian Capture Fisheries Research Network Visiting Research Professor, University of New Brunswick Research Scientist, St. Andrews Biological Station, St. Andrews, New Brunswick	Robert Lent, Ph.D. Maine District Chief United States Geology Survey Augusta, Maine
Secretariat	
Kathryn Parlee Regional Analysis & Relations, Atlantic Region Environment & Climate Change Canada Dartmouth, Nova Scotia	Barbara Blumeris U.S. Army Corps of Engineers New England District Concord, Massachusetts

The International St. Croix River Watershed Board (Board) was established to assist the International Joint Commission. The International Joint Commission (Commission) is a binational United States-Canada organization established under the Boundary Waters Treaty of 1909. The Board has ten members with an equal number of members from the United States and Canada. Board members are appointed by the Commission and serve the Commission in their personal and professional capacity and not as representatives of their agencies. Board membership in 2016 is provided on page 2.

1.3 Annual Public Meeting in Basin

FIGURE 2. Annual Public Meeting in Calais, Maine, June 2016

The Board's annual public meeting was held in Calais, Maine at the Washington County Community College on the evening of June 14, 2016. Approximately 20 people were in attendance, and included members from the Passamaquoddy Tribe, representatives from local organizations and local citizens. Commissioner, Richard Moy and Board Co-Chair Colonel Christopher Barron welcomed attendees and provided brief opening remarks. Commissioner Moy noted that the public meeting was an opportunity for the Commissioners to receive local input on the St. Croix River boundary water. Following opening remarks, Colonel Barron provided a presentation that summarized Board activities in calendar year 2015. Next, invited guest speaker Dr. Joseph Zydlewski from U.S. Geological Survey Maine Cooperative Fish and Wildlife Research Unit /University

of Maine gave an informational presentation on “Connectivity, Aquatic Communities and Climate Change. Summary points from the presentation included: migratory fish connect the ocean and freshwater environments providing nutrients, access to habitat is the greatest limitation to recovery of a migratory species, dams may impose both direct mortality and delays, and changing temperature regimes may exacerbate poor fish passage effects at dams. There was general discussion of the information presented. Following the presentations, there was an opportunity for public comment on the St. Croix River boundary water. There were no comments and the meeting adjourned.

1.4 Annual Site Visit of Facilities in the Basin

On June 15, Board members conducted their annual site visit of facilities on the St. Croix River. Board members met with New Brunswick Power Corporation officials on the morning of June 15 to tour the Milltown Dam in St. Stephen, New Brunswick. On the same day, Board members met with Woodland Pulp, LLC officials at the Woodland Mill at Baileyville, Maine and then toured the Grand Falls, Forest City and Vanceboro Dams (visit notes and information describing the dams are provided in Appendix 2).

It is the responsibility of the dam owners, operators and appropriate jurisdictional agencies to conduct the necessary dam inspections and maintenance to ensure the safety and security of the dams.

1.5 Policy of the Board Regarding Dam Regulation

In accordance with its mandate from the IJC, the Board leaves the control of operation of the dams at Forest City, Vanceboro and Grand Falls (owned and operated by Woodland Pulp, LLC) and Milltown (owned and operated by New Brunswick Power) to the owners. During the 2016 reporting period, the Board reviewed conditions prevailing in the river by the following means:

- a continuous record of water elevations of East Grand Lake and a continuous record of discharge below Forest City Dam
- a continuous record of water elevations of Spednic Lake and a continuous record of discharge at Vanceboro
- a continuous record of water levels above the dam at Grand Falls
- a continuous record of discharge at Baring
- monthly reports from New Brunswick Power indicating daily forebay elevations obtained during regular work days at the Milltown Dam
- water level data from a continuous monitoring station in the head pond at Milltown Dam

2.0 MANAGEMENT OF WATER LEVELS AND FLOWS

2.1 Summary

In 2016, the annual mean water level at East Grand Lake was 131.962 meters (432.95 feet), which is higher than the long term mean value of 131.828 meters (432.51 feet).

The annual mean flow from the lake at Forest City Stream was 7.07 m^3/s (250 cfs), 6.0 % higher than the long term mean value of 6.67 m^3/s (235 cfs).

In 2016, the annual mean water level at Spednic Lake was 116.449 meters (382.05 feet), higher than the long term mean value of 116.337 meters (381.68 feet).

The annual mean flow as recorded at Vanceboro was 23.6 m^3/s (833 cfs), 11.8% higher than the long term mean value of 21.1 m^3/s (745 cfs).

In 2016, the annual mean water level at Grand Falls Flowage was 61.727 meters (202.51), which is slightly lower than the long term mean value of 61.764 meters (202.64 feet).

The annual mean flow at Baring was 65.0 m^3/s (2,300 cfs), which is 14.2% lower than the long term mean value at Baring of 75.8 m^3/s (2,680 cfs).

2.2 East Grand Lake Reservoir and Discharges Below Forest City Dam

During the period from January 1 to December 31, East Grand Lake reservoir was operated between a maximum daily mean water level of 132.433 meters (434.49 feet) on April 4th and a minimum daily mean of 131.382 meters (431.04 feet) on November 25th. The maximum water level as prescribed by the Commission's Order is 132.571 meters (434.94 feet); the minimum is 130.436 meters (427.94 feet). The Order was maintained throughout the year. The daily mean water levels are presented in Table I and depicted in Figure I in Appendix 3 and 4.

Table II and Figure II in Appendix 3 and 4 present the daily mean discharges below the Forest City Dam at the outlet of East Grand Lake for 2016. The maximum daily mean flow for the reporting period was 29.2 m^3/s (1,030 cfs) on April 8th and the minimum daily mean was 2.43 m^3/s (85.8 cfs) on November 13th.

The mean discharge for the year was 7.07 m^3/s (250 cfs). The Commission's Order of 2.12 m^3/s (75 cfs) as a minimum flow was maintained throughout the year.

2.3 Spednic Lake Reservoir and Discharges below Vanceboro Dam

During the year, levels in the Spednic Lake reservoir, ranged from a maximum daily mean water level of 117.318 meters (384.90 feet) on April 14th, to a minimum daily mean water level of 115.480 meters (378.87 feet) on November 26th. The maximum limit specified in the Commission's Order is 117.610 meters (385.86 feet). The allowable minimum level is 113.233 meters (371.50 feet) for the period January 1 to April 30 and October 1 to December 31 inclusive, and 114.757 meters (376.50 feet) for the period May 1 to September 30 inclusive. These orders were maintained throughout the year.

The daily mean elevations for the Spednic Lake Reservoir during the year are presented in Table III and depicted in Figure III in Appendix 3 and 4.

The maximum daily mean discharge recorded from the outflow at the reservoir at Vanceboro was 101 m^3/s (3,570 cfs) on April 15th and the minimum daily mean discharge recorded was 8.98 m^3/s (317 cfs), on June 29th. The Commission's Order of a minimum flow of 5.66 m^3/s (200 cfs) was maintained throughout the year.

Daily mean discharges are presented in Table IV and Figure IV in Appendix 3 and 4.

2.4 Water Levels above Grand Falls Dam

Table V and Figure V in Appendix 3 and 4 include water level elevations of the headpond above the Grand Falls Dam. The recorded maximum daily mean elevation was 61.953 meters (203.25 feet) on February 11th and the minimum recorded elevation was 61.477 meters (201.69 feet) on August 13th. The maximum prescribed elevation of 62.106 meters (203.76 feet), as set by the Commission, was maintained throughout the year.

2.5 Discharges at Baring, Maine

Table VI and Figure VI in Appendix 3 and 4 present the daily mean discharges of the St. Croix River at Baring, Maine. The mean discharge for the report period was 65.0 m^3/s (2,300 cfs). The maximum daily mean was 297 m^3/s (10,500 cfs) on February 27th. The minimum daily mean was 25.1 m^3/s (886 cfs) on September 26th.

Woodland Pulp LLC met the minimum flow requirements set at 21.2 m^3/s (750 cfs); this is the minimum flow requirement as considered by the Maine Department of Environmental Protection.

2.6 Headwater Elevations above Milltown Dam

Table VII and Figure VII in Appendix 3 and 4 present and depict daily water elevations in the forebay of the New Brunswick Power Corporation plant at Milltown, New Brunswick. These elevations refer to mean sea level datum. In 2009, Environment Canada established a continuous water-level and water quality monitoring station. The supplied data for 2016 was extracted from this gauging station located on the headpond.

FIGURE 3. St. Croix River Milltown Dam, Headpond above Dam.

3.0 WATER QUALITY

3.1 U.S. Geological Survey (USGS) Milltown Monitor

Water-quality values for the St. Croix River at the Milltown monitor were within the extreme values for the period of daily record during the summer of 2016 based on the record since September 1969. Values were above the water-quality objectives for the river.

TABLE 1

St. Croix River at Milltown, USGS Station # 01021050
Water-Quality Monitor, June – September 2016.

Dissolved Oxygen (mg/L) IJC objective = 5.0 mg/L minimum
Maximum for the season: 9.7 mg/L
Minimum for the season: 6.3 mg/L

	June	July	August	September
Maximum	9.0	8.0	8.2	9.7
Minimum	7.0	6.3	6.7	6.5
Mean	8.2	7.2	7.4	7.8

Water Temperature (degrees Celsius)

	June	July	August	September
Maximum	24.4	27.6	26.7	24.5
Minimum	16.1	19.2	21.1	15.0
Mean	19.6	24.0	24.0	20.3

pH (standard units)

	June	July	August	September
Maximum	7.1	7.2	7.2	7.1
Minimum	6.7	6.8	6.8	6.8
Mean	7.0	6.9	7.0	7.0

Specific conductance (microsiemens per centimeter at 25 C)

	June	July	August	September
Maximum	118	121	107	109
Minimum	55	37	87	31
Mean	90	84	96	83

3.2 Environment and Climate Change Canada Monitoring Stations – Forest City and Milltown

Environment and Climate Change Canada, in partnership with the New Brunswick Department of Environment, maintains two automated real-time water quality monitoring stations on the St. Croix River system. The first station is located at the Milltown Dam in Milltown (St. Stephen), New Brunswick and the second station is located in Forest City, Maine. The Milltown station records hourly measurements of temperature, dissolved oxygen, pH, specific conductance and turbidity while the Forest City station records hourly measurements of temperature and conductivity. In order to re-calibrate the measuring devices and to collect a grab sample for water quality analysis, the sites were visited every 5 to 6 weeks during the warmer months of the year, and less frequently during the colder months when fouling of the sensors is less problematic.

Real time monitoring allows an observer to assess several river water quality parameters quickly at any particular instant in time. This can alert managers to sudden changes in the characteristics of the river and relate them to particular events such as rapid spilling of water, accidental discharges from industry, severe weather events or remote introduction of atmospheric or other pollutants which might threaten the health of aquatic organisms or humans using the river. It could also allow responsible agencies to take rapid intervention to correct the problem.

3.2.1 Interpretation of Real-Time Monitoring Data

Milltown Station 2016

Monthly summaries of the real-time data and annual charts showing daily means, minimums and maximums from the Milltown station for each parameter are presented in Appendix 5. This station, operated by Environment and Climate Change Canada (ECCC), is located just above the Milltown Dam at a depth of 1.8 to 3.0 metres depending on head pond elevation. This station and the USGS station reported in Section 3.1 monitor water quality in the “urban” area below Baileyville but generally above St. Stephen/Calais.

The real-time water quality station at Milltown was operational for the whole 2016 year. However, from Mid-August to early September there was a drainage of the headpond which prevented water quality readings. Also in late September, there was a spill at the Woodland Mill followed by a shutdown of the Mill which had some effect on water quality (see below). The sonde also malfunctioned from December 14-31, 2016.

Temperature

Water temperature at the site increased gradually until it reached its maximum of 27.7°C on July 28. The lowest temperatures registered were in January. The daily mean water temperature stayed over 20°C for 71 days, which is approximately two weeks less than the 2015 data, but similar to the 2012-2014 data. Water temperature was below 5°C for 114 days in 2016, which is 36 days less than the 2015 data. Water temperature at this station averaged 11.81°C. However, the average would be greater if not for the data gap in the summer.

Dissolved Oxygen

Dissolved oxygen readings followed a similar, but inverse, trend to water temperature, reaching the lowest concentration of 7.54 mg/L on July 28, and the highest concentration of 14.45 mg/L on March 3. Dissolved oxygen averaged 10.7 mg/L in 2016. All dissolved oxygen values measured in 2016 were above the minimum Canadian Council of Ministers of the Environment (CCME) Guideline for the Protection of Aquatic Life of 6.5 mg/L. Diurnal changes can be observed at a daily range of values.

pH

As in 2010 to 2014, measurements of pH in 2016 stayed near the CCME guideline for most of the year, except for summer when it was closer to 7 and for parts of autumn when it was below 6.5. The minimum pH measurement was 5.63 pH units, recorded in mid-November; and the maximum pH was 7.42, recorded in mid-October. Average pH at this station was 6.84 for the year of 2016 (with some days omitted due to malfunctions).

Specific Conductance

Specific conductance is a measure of how well water can conduct an electrical current. Specific conductance readings rise with increasing concentration of ions in the water, such as chloride, calcium, magnesium, sodium, nitrate, phosphate, and iron. Specific conductance readings fluctuated moderately between 25.9 and 118.7 µS/cm and averaged 65.2 µS/cm during 2016. These values are very similar to those of 2014-2015. Measurements of specific conductance reached their highest of 118 µS/cm on July 7, and their lowest on January 12. A sharp drop in specific conductance is usually associated with a rise in stream height or volume. Stream height at this location is

controlled by the dam but ion concentrations can change depending on rainfall events. The sharp decrease and subsequence rise in conductance in early October is associated with the spill event at the Woodland pulp mill located upstream (see discussion in Appendix 5). The drop in conductance in mid-July is likely associated with the rain events of more than 10mm that occurred on three separate days in early to mid-July in this area. The decrease in conductance in early December is also closely associated with the large rainfalls (>20mm each) that occurred on November 29 and December 1.

Turbidity

Daily mean turbidity values stayed below 1 NTU close to 50% of measurements (138 days), although turbid events (spikes) occurred once or twice per month (for the period of the record). Turbidity values ranged from 0 to 962 NTU and averaged 35.63 NTU. The bulk of the elevated turbidity measurements occurred in two periods; mid-January and November-December. Significant rainfalls on January 10 (66.7mm), and in the month of November (58.9mm) and December (141mm) could in part explain the increase in turbidity at this location. Furthermore, the sonde as retrieved in mid-December showed a fouling of almost 100NTU, meaning readings were likely overestimating turbidity near the end of the year.

Forest City Station

Monthly summaries of the real-time data and annual charts showing daily means for specific conductance and temperature from the Forest City station for each parameter are presented in Appendix 5. This station, owned by Environment and Climate Change Canada (ECCC), is located immediately downstream of the East Grand Lake Dam in Forest City. The real-time water quality station at Forest City was operational for the whole 2016 year.

Specific conductance

The highest conductivity reading of 88.1 µS/cm was recorded in early May while the lowest of 26.02 µS/cm was recorded in July. An average of 31.43 µS/cm was recorded for the year which is similar to those levels recorded in 2015. The general trend of the specific conductance data is an increasing trend towards the summer months and a decreasing trend in November and December as well as during spring freshet. There were a few spikes of conductivity in the span from April to mid-August which sometimes coincided with periods of low flow at the station.

Temperature

Water temperature at the site increased gradually until it reached its maximum of 26.73°C on August 3rd. Water temperatures above 20°C were recorded on 79 days, between July and September. There were 145 days when water temperature was below 5°C and this is a decrease of 12 and 26 days compared to 2015 and 2014 data respectively.

3.2.2 Interpretation of Grab Samples Results

Seven grab samples at the Milltown station and at the Forest City station were collected in 2016. Samples were analysed at Environment and Climate Change Canada's Atlantic Laboratory for Environmental Testing located in Moncton, NB. That laboratory is accredited by the Canadian Association for Laboratory Accreditation (CALA) for all the parameters reported here.

St. Croix River at Milltown, NB

Results for each sample taken at Milltown are shown in Appendix 5, along with the applicable CCME guideline for the protection of aquatic life. Where no CCME guideline exists for a parameter, the most pertinent guidelines from another province were used as reference. A summary of the parameters analyzed is included below.

- Total aluminum exceeded the CCME guideline of 100 micrograms per litre (µg/L) in four out of seven samples in 2016. Elevated levels of aluminum are fairly common in Atlantic Canada although the aquatic life seems to be in good health. This is believed to be because most of the aluminum in Atlantic Canada rivers is complexed with organic compounds and therefore not bio-available to aquatic life. Dennis and Clair (2012) produced data which supported that theory and developed an algorithm for calculating the amount of complexed aluminum based on measured Total Organic Carbon (TOC) in Atlantic rivers. With TOC values ranging from 5.97 to 11.6 the calculated complexed aluminum concentrations made up a large proportion of the measured total aluminum (at least 75%).

- Four samples slightly exceeded the calculated CCME cadmium guideline, based on water hardness, while the other two detectable values were very near the guideline. Cadmium values at Forest City station were all below the detection limit of the laboratory, indicating that a natural or anthropogenic source of

cadmium is located between the two water quality stations. Major pathways for cadmium to enter the aquatic environment are atmospheric fallout and in effluents from smelting and refining industries (ECCC2015). No smelting or refining facilities are known to be located between the two sites.

- The CCME guidelines for copper, nickel and lead are all based on a formula which uses water hardness to determine guideline concentration and also has a minimum regardless of water hardness. Based on the range of water hardness at the Milltown station, we used the minimum values stated in the CCME guidelines for these metals (Appendix 5). No values exceeded those guidelines.

- Total phosphorus is 2 to 5 times higher at Milltown than at Forest City and three measurements exceeded the Ontario Ministry of the Environment (OMOE, 1994) phosphorus guideline of 0.03 mg/L. Similarly, nitrate is also higher at Milltown than Forest City, although well below the CCME guideline. This indicates sources such as municipal and industrial wastewater are likely contributing nutrient loads that can increase algal production in the downstream reaches of the river.

- pH values were not measured outside the 6.5 to 9 range, recommended by the CCME.

St. Croix River at Forest City, ME

Results for the sample taken at Forest City are shown in Appendix 5, along with the applicable guideline for the protection of aquatic life. Where no CCME guideline exists for a parameter, the most pertinent guidelines from another province were used as reference. No parameters exceeded applicable guidelines in 2016.

Water Quality Index

The CCME water quality index (WQI) is a useful tool to assess water quality at monitoring sites visited regularly. It measures the frequency and extent to which selected parameters exceed water quality guidelines and reports the results as a single score. This allows for a quick assessment of the status of the water body and can be used as an indicator of overall aquatic health. Further analysis should always be completed on individual parameters in addition to other assessments (e.g. biological) for a full evaluation of aquatic health. More information on the CCME WQI is available at: http://www.ccme.ca/ourwork/water.html?category_id=102.

The WQI ratings were calculated each year using samples from the current year and those from the previous two years.[1] Three-year rolling scores dampens strong fluctuations that may result from having small sample sizes and provides a more accurate representation of overall water quality. The parameters and guidelines used in the index are included in Table 2. These are consistent with parameters used by New Brunswick Department of Environment in the Canadian Environmental Sustainability Indicators project with the exception of ammonia as this is not part of the laboratory analysis at these two sites. Guidelines used are for the protection of aquatic life and thus, the WQI scores will reflect this intended water use only. WQI ratings rank from 0 to 100, with higher scores indicating better water quality.

TABLE 2
Parameters and Guidelines used in the WQI Calculations

Parameter	Units	Lower Guideline	Upper Guideline	Guideline Source
Arsenic	µg/L		5	CCME, 1997
Chloride	mg/L		120	CCME, 2011
Copper	µg/L		2, for harness 0 to 82 mg\L	CCREM, 1987
Iron	mg/L		0.3	CCREM, 1987
Nitrate	mg/L as Nitrogen		3	CCME, 2012
Dissolved Oxygen	mg/L	6.5		CCME, 1999a
Phosphorous	mg/L		0.03	OMOE, 1994
pH	pH units	6.5	9.0	CCREM, 1987
Turbidity	NTU		10	CCME, 1999b
Zinc	µg/L		calculated	BC MOE, 1999

Notes: µg/L – micrograms per Litre; mg/L – milligrams per Litre; NTU – nephelometric turbidity units

[1] Forest City was only sampled once in 2011, rather than the typical 6 to 8 per year, due to flooding causing a stoppage of the stream gauge and water quality sonde for part of the year.

At Forest City, WQI scores stayed consistent at 100, or “excellent”, over the entire ten year period with no guideline exceedances.

At Milltown, scores were very consistent from 2007 to 2015 – varying between 82.5 and 82.9, or “good”. However, in 2016, several exceedances of total phosphorus and an elevated turbidity measurement, in addition to some zinc and iron exceedances that typically occur here, resulted in a decreased score of 76.7 or “fair”. Over the ten year record, phosphorus and zinc concentrations exceeded the guideline in 12.2% of samples each, followed by iron in 4.1% and turbidity in 1.4%. Increased levels of zinc, phosphorus and iron between the two stations are indicative of wastewater discharge from municipal and industrial sources.

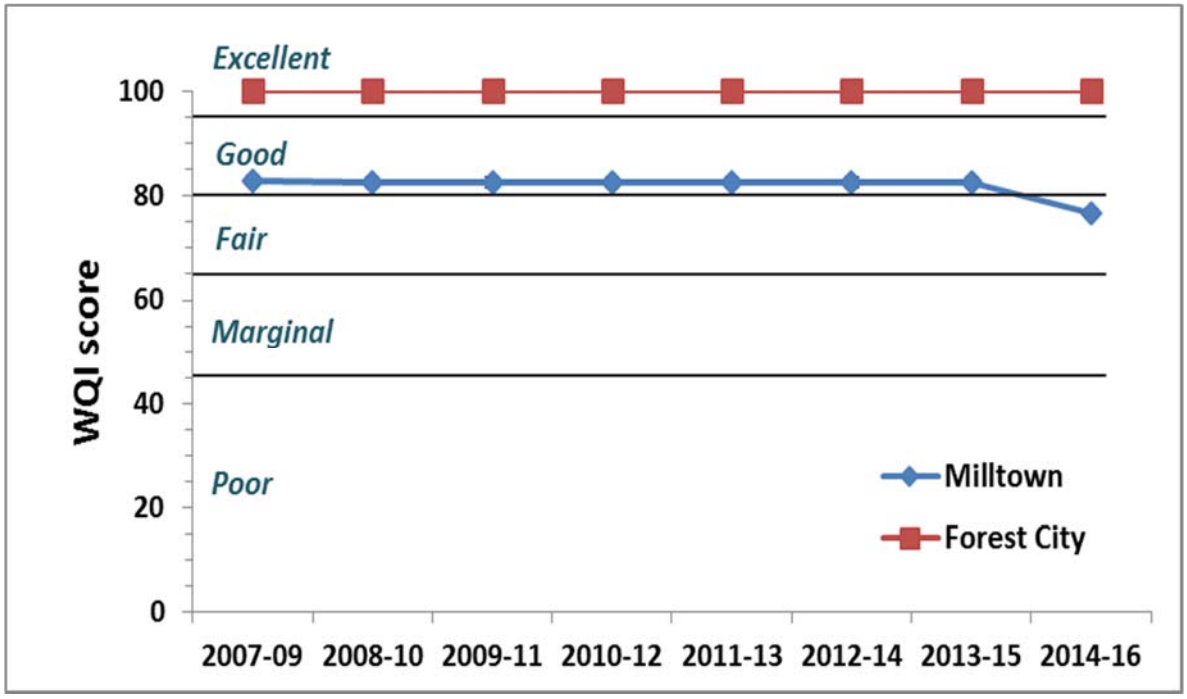


FIGURE 4. Water Quality Index scores, 2007 to 2016

References

[BC MOE] British Columbia Ministry of Environment. 1999. Ambient water quality guidelines for zinc: Overview report.

[CCME] Canadian Council of Ministers of the Environment. 1997. Canadian Water Quality Guidelines for the Protection of aquatic life: Arsenic. In: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba (www.ccme.ca/publications/cegg_rcge.html).

[CCME] Canadian Council of Ministers of the Environment. 1999a. Canadian Water Quality Guidelines for the Protection of aquatic life: Dissolved Oxygen (freshwater). In: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba (www.ccme.ca/publications/cegg_rcqe.html).

[CCME] Canadian Council of Ministers of the Environment. 1999b. Canadian Water Quality Guidelines for the Protection of aquatic life: Turbidity. In: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba (www.ccme.ca/publications/cegg_rcqe.html).

[CCME] Canadian Council of Ministers of the Environment. 2011. Canadian Water Quality Guidelines for the Protection of aquatic life: Chloride. In: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba (www.ccme.ca/publications/cegg_rcqe.html).

[CCME] Canadian Council of Ministers of the Environment. 2012. Canadian Water Quality Guidelines for the Protection of aquatic life: Nitrate. In: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba (www.ccme.ca/publications/cegg_rcqe.html).

[CCREM] Canadian Council of Resource and Environment Ministers. 1987. Canadian water quality guidelines. Task Force on Water Quality Guidelines. Ottawa, Canada.

Dennis IF and Clair TA. 2012. The distribution of dissolved aluminum in Atlantic salmon (Salmo salar) rivers of Atlantic Canada and its potential effect on aquatic populations. Can J Aquat Sci 69:1174-1183.

[ECCC] Environment and Climate Change Canada. 2015. Releases of Cadmium to the Environment. Ottawa, Ontario. https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=7F04A6AB-1. Accessed February 29, 2016.

[OMOE] Ontario Ministry of the Environment. 1994. Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment [reprinted February 1999]. Ontario Ministry of the Environment. 67 pp.

4.0 STATUS OF POLLUTION ABATEMENT

4.1 Maine

Baileyville: The Baileyville Wastewater Treatment Facility did not report any permit violations in 2016. The Maine Department of Environmental Protection's most recent compliance inspection occurred on January 18, 2017. Pump stations were the focus of this inspection and they were all found to be in good working order. The wastewater treatment facility was running well and no significant concerns were identified during the inspection. The town continues to work on removing inflow/infiltration from the collection system and has projects scheduled for 2017.

Calais: The City of Calais Wastewater Treatment Facility continues to report compliance with its wastewater discharge permit. There were no reported numerical permit limitations for 2016. The facility is part of the Maine Department of Environmental Protection's Combined Sewer Overflow (CSO) program and has a Department approved CSO Master Plan which was updated in December 2014. The updated CSO Master Plan lists the many inflow/infiltration projects that have been completed as well as a tentative schedule for completing the projects that remain. The tentative schedule lists projects out to the year 2019.

Woodland Pulp LLC: In 2016 the Woodland Pulp Mill (Mill) in Baileyville was in compliance with its Maine wastewater discharge permit (Permit) except for 2 exceedances and a set of missed tests. A zinc exceedance (34.66/32 pounds/day) occurred in April and the Department issued a compliance letter. A copper exceedance (7.53/3.2 pounds/day) occurred in April and the Department issued a compliance letter. The Mill missed 5 pH tests in May due to operator error and the Department issued a Letter of Warning (LOW).

Four discharge events were reported in 2016. The two most significant events occurred on September 23 and September 28. On September 23 the force main to the secondary treatment lagoons ruptured spilling an estimated 1,000,000 gallons of primary treated wastewater behind the Mill's garage. Mill staff estimated that less than half of that volume made it to the St. Croix River; the remainder was contained on Mill property. The rupture repair was completed September 27. On September 28 the force main to the secondary treatment lagoons ruptured a short distance from the previous rupture. Mill staff estimated 90,000 gallons of primary treated wastewater made it to the St. Croix River. Water that did not drain to surface waters was contained on Mill property. The rupture repairs were completed on October 4. The Department is issuing

a Notice of Violation (NOV) in response to these incidents. The Mill is replacing about 1000 feet of force main in the vicinity of the two ruptures. All other spills were much smaller and were contained on the Mill property.

The Mill is also working with a consultant and the DEP on efforts to pursue site specific water quality criteria for cadmium. The Permit contains a 2018 deadline for complying with cadmium limits already in the Permit or establishing new limitations based on the site specific criteria study.

Two new tissue machines began operation during 2016. This upgrade did not require a modification to the Mill's current permit.

4.2 New Brunswick

McAdam: The McAdam wastewater treatment facility is an oxidation type system that uses an activated sludge process. The McAdam wastewater treatment facility continues to meet the effluent requirements of the Province of New Brunswick.

St. Stephen: The wastewater lagoon system along Dennis Stream continues to meet the effluent requirements of the Province of New Brunswick. In 2016, the Town of St. Stephen has identified all combined sewer overflow (CSO) points and has adhered to their developed CSO plan in consultation with Dillion Consulting Ltd. Over the past year, the town has undertaken projects to remove certain combined sewers, and install baffles in both lift stations and known combined sewers overflows.

Champlain Industrial Park: The extended aeration facility treats the domestic wastewater of its employees as well as the industrial inputs from the industrial park. No recent upgrades to this system have taken place, as their volume of effluent has remained consistent to previous years. The facility struggles to meet the effluent requirements for the Province of New Brunswick for total suspended solids (TSS) of 25 mg/L. Due to the lack of sludge removal from the facility (expensive procedure) the TSS numbers will continue to not meet the effluent requirements. The Province of New Brunswick's Department of Environment and Local Government have been in contact with the owners and operators of the system and they are in the process of developing a compliance plan so that this facility will start meeting the required effluent water quality.

Evergreen Acres: The facultative lagoon treats the domestic wastewater of the 58 mobile homes in the park. The facility discharges treated effluent to the marshy

headwaters of Meadow Brook. In 2015, the new owner made upgrades to both the potable and domestic systems. This facility discharges low volumes of effluent and does not qualify for an Approval with the Department of Environment and Local Government.

Oak Bay Park: When the campground was first built, Oak Bay Campground used a trickling filter system to treat domestic wastewater from 110 campsites prior to discharging the treated, disinfected effluent to Oak Bay. After correspondences between the owner and the Department of Environment and Local Government, it was determined that an upgrade was needed to the system, as it could not meet the required effluent water quality guidelines. The owners completed upgrades to the system by installing a humus tank system and all new drainage fields. With this new upgrade in place, the campground no longer discharges effluent into the Bay.

5.0 FISHERIES

5.1 Anadromous Fisheries

Anadromous fish have been counted at the research trap at the Milltown dam fishway since 1981. The dam, located at the head-of-tide on the St. Croix River between New Brunswick and Maine, is property of the New Brunswick Power Corporation (NB Power). Both the fishway and the research trap are on the Canadian side of the river and are under the jurisdiction of Canada's Department of Fisheries and Oceans (DFO). From 1981 to 2006, the counting facility was operated seasonally for up to seven months each year to document inbound fish, notably Atlantic salmon (Salmo salar) and river herring. River herring is a collective term used for alewives/gaspereau (Alosa pseudoharengus) and blueback herring (Alosa aestivalis). Since 2007, a reduced operation in May to July has focused on documenting the annual river herring run.

In 2016 the St. Croix International Waterway Commission (SCIWC) operated the Milltown research trap and collected relevant data under agreements and partnerships with DFO, NB Power, U.S. Fish & Wildlife Service (USFWS), the International Joint Commission, the Atlantic Salmon Federation, Maine Department of Marine Resources (DMR), and the Pleasant Point Passamaquoddy Tribe Environmental Department.

The Milltown research trap was activated on April 14 and monitored until July 11 when the trap was lifted at the presumed end of the river herring run. NB Power continues to operate the fishway until mid-November, as required by federal agreement, but with no fish count. All fish species captured in the trap are recorded in Table 3.

TABLE 3

Counts of inbound fish at the Milltown fishway research trap, St. Croix River, April 14 to July 11, 2016

Species	2016 trap count
River herring: alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*)	33,016
White sucker (*Catostomus commersonii)*	14
Smallmouth bass *(Micropterus dolomieu)*	24
Brook trout *(Salvelinus fontinalis)*	13
Common shiner (*Luxilus cornutus*)	3

A total of 33,016 river herring were recorded at the Milltown trap in 2016. In 2015 the hydroelectric turbine adjacent to the fishway was offline; however, in 2016 this turbine was back in operation. In 2016, the turbine was occasionally shut down during peak run times (1200h – 2000h) to allow easier passage for fish. No shad were recorded in 2016, after appearing in the St. Croix last season for the first time since 1999.

FIGURE 5. Alewife at Milltown Dam

In addition to the counting operation, Milltown fisheries staff supplied a sample of 60 river herring for a USFWS fish health report. USFWS tested the sample and found no bacterial or viral pathogens.

Fifty-two fish were sampled by the Maine DMR for scale aging. It was found that 42% of the fish were four years of age, and 50% of fish were five years of age. River herring in the St. Croix typically spawn at four and five years of age, and 65% of the fish sampled were spawning for the first time. The average fork length was found to be 251mm. No blueback herring were found in the samples collected in 2016.
The 2016 run of 33,016 river herring was lower than anticipated and approximately one third of what was recorded in 2015. Low water flows, combined with high water temperatures, may have contributed to the low numbers of fish seen at the fishway in 2016. In 2016, the biggest run was seen on June 1 with 10,947 fish entering the fishway, representing 33% of the yearly total. Four freshwater species were also documented at the trap. No Atlantic salmon were recorded.

5.2 Shellfish Harvesting

New Brunswick: Shellfish harvesting occurs principally in Oak Bay, either for direct marketing within areas designated as conditionally approved, or for depuration from areas designated as restricted. Environment and Climate Change Canada sampled St. Croix River and Oak Bay marine water quality stations on five occasions from June 3 to October 27, 2016. Additional water quality sampling was performed as part of the bay's Conditional Management Plan (CMP) which allows shellfish harvesting during dry / low rainfall conditions.

Overall, fecal coliform densities in 2016 were consistent with those observed in previous years (i.e., 2006-2009 & 2011-2015). Bacterial densities ranged from <2 to 33 MPN FC per 100 mL under rainfall conditions ranging from dry to 15 mm within 24 hours of sampling. A rise in bacterial levels was detected at several sampling stations in mid-September 2015, three days following a significant rainfall event (42 mm). This confirms the continued need for a large portion of the bay waters to be managed conditionally based on rainfall.

Maine: The Calais, Robbinston, and Perry, Maine shoreline has limited habitat for commercial shellfish. Most of the area is classified as prohibited to shellfishing by the Maine DMR, Division of Shellfish Management to protect public health. However, there are two small coves opened on a seasonal conditional basis. For more information on these areas refer to notices for Area 62 at link below.
http://www.maine.gov/dmr/shellfish-sanitation-management/closures/pollution.html

6.0 INTERNATIONAL WATERSHED INITIATIVES

The following are projects in the St. Croix Watershed that are supported in part by the International Joint Commission's International Watershed Initiative (IWI) program.

6.1 Ongoing Aquatic Food-Web Study

An ecological assessment of the St. Croix system was initiated in 2013 by the IJC's International Watershed Initiative (IWI) and led by the USGS Maine Cooperative Fish and Wildlife Research Unit at the University of Maine (Orono, Maine). The objective of this study is to explore the effects of marine-derived nutrients on freshwater food webs as alewives return to the St. Croix watershed.

To characterize the presence of marine-derived nutrients, fish, aquatic insect and zooplankton samples were collected from 2013-2015 from seven sites in the St. Croix watershed and from 2014-2015 at two sites in the East Machias watershed, which was included as a reference site based on its large established alewife run. These samples were processed for stable isotope analysis and were used to infer differences between communities with and without direct marine input. There was no detectable influence of marine-derived nutrients in the St. Croix River, though this result was expected as the alewife run is still recovering. Stable isotope analyses do indicate a clear separation between trophic levels at each site. Such information will provide a baseline description of the freshwater food web in the St. Croix prior to the anticipated recovery of the alewife run after fish passage improvements.

A model was developed in 2015-2016 to estimate the net flow of nutrients into and out of the St. Croix watershed. This model explores how changes in passage efficiency at each of the main stem dams might influence the population dynamics and net nutrient balance of the system, and was developed in collaboration with Jamie Gibson (DFO, Maritimes Region). It includes a population component that can be used to address questions related to passage efficiency, as well as an estimate of the relative amount of nitrogen and phosphorus incorporated through adult import and removed via juvenile export in the spawning habitat between each dam. Results from both the food web study and the nutrient modelling are currently being written up as a set of manuscripts to be submitted for publication by July of 2017.

6.2 Alewife Count at Milltown

In 2016, the IWI program continued to provide support for the alewife count at Milltown Dam in partnership with the efforts of government and non-governmental organizations. The collected data is discussed in Section 5.0 of this report and detailed counts over time are presented in Appendix 6.

6.3 Fish Tracking Study

The Sipayik Environmental Department (SED) of the Passamaquoddy Tribe at Pleasant Point, Maine, has undertaken a multi-year study to track the efficiency of fish ladders in the St. Croix Watershed. Efficient fish passage is imperative for migrating fish to reach their spawning grounds in the lakes of the watershed. The SED is looking for areas within the fish ladders that may slow or prevent passage to river herring. The main focus is on fish ladders at the three dams on the mainstem of the St. Croix River. These are Milltown Dam (owned and operated by New Brunswick Power) and Woodland Dam and Grand Falls Dam (both owned and operated by Woodland Pulp, LLC). These dams are the first obstacles that river herring and other fish encounter in the St. Croix Watershed, and are hypothesized to be significant obstacles to their upstream migration.

In spring 2016, the SED installed Passive Integrated Transponder (PIT) antennas on two of the three dams. Antennas were installed at the entrance (bottom) and exit (top) of the fish ladders at Woodland Dam and Grand Falls Dam. They were also installed on baffles at the entrance and exit of resting pools within the fish ladders. This design was chosen to assess overall passage time, use of resting pools, and areas of inefficiency within the fish ladders.

In early June, 2016, the SED collected, PIT tagged and released 104 river herring from the fish trap at Milltown Dam in two tagging events. The river herring were held for 1 hour in a net pen with untagged fish. They were then released 1 kilometer upstream from the tagging site. Each tag has a unique code assigned to individual fish. Of the 104 tagged fish, 12 individuals, or 11.5% of the sample, were detected upstream at Woodland Dam.

Successful passage through the fish ladder was determined by detection on the entrance (bottom) antenna and subsequent detection on the exit (top) antenna. Using this method, a passage success of 75%, or 9 of 12 fish, was calculated for the Woodland Dam fish ladder; however, preliminary results show that river herring

appeared to stay in the ladder for long periods of time, reducing overall passage efficiency. No tagged fish were detected at Grand Falls Dam.

In spring 2017, the SED will install PIT antennas at Milltown Dam, Woodland Dam, and Grand Falls Dam. An electronic fish counter will also be installed at the exit of all three dams, which will provide population estimates of river herring in the St. Croix River. The SED hopes to increase the sample size of tagged river herring for a more comprehensive understanding of fish passage through these ladders. These efforts will help determine if the three dams provide significant obstacles to river herring during their migration to their spawning grounds.

7.0 ADDITIONAL ITEMS TO REPORT

7.1 FERC Dam Relicensing

Vanceboro Dam/Spednic Lake: In March 2011, Woodland Pulp LLC (Woodland) started the re-licensing process for Vanceboro Dam with the U.S. Federal Energy Regulatory Commission (FERC). Docket Number is P-2492. In March 22, 2016 FERC issued a new 30-year license for continued operation of the Vanceboro Dam for hydropower storage.

Forest City Dam/East Grand Lake: The Forest City Dam (Forest City Project) and the West Grand Lake and Sysladobsis and Farm Cove Dams (West Branch Project) also require FERC licenses as they provide upstream storage for hydropower power generation. Docket numbers are P-2660 and P-2618. Woodland, and its predecessors, as licensee of these projects in the past sought to have FERC determine that the projects were not required to be licensed. However, in 2011 FERC ruled that licensing was required. New 30-year licenses were issued in November 2015 to Woodland for continued operation and maintenance of the projects. In December 2015, Woodland filed a request for rehearing of license conditions for both Forest City and West Branch Projects. The rehearing was denied. On December 23, 2016, Woodland filed an application with FERC to surrender the FERC license at Forest City Dam noting that the requirements of the FERC 2015 license rendered the project uneconomical.

***Note**: The above FERC licensing information is provided in the Board's Annual Report for general information purposes only.*

7.2 USGS Tide Gage Station

In October 2015, the USGS established a tide gage station at the international bridge in Calais, Maine. The average daily tide range at the site is about 24 feet. Water level data collected at the tide gage will be extremely useful to document trends over time and capture real time storm surges at the mouth of the river. In 2016 the maximum height measured at the gage was 16.2 ft. NAVD88 on 7 April 2016. This coincided with a storm (April 7-9) that occurred in the region.

The link to the real time data site is:
http://waterdata.usgs.gov/me/nwis/uv/?site_no=01021060&PARAmeter_cd=00065,00060

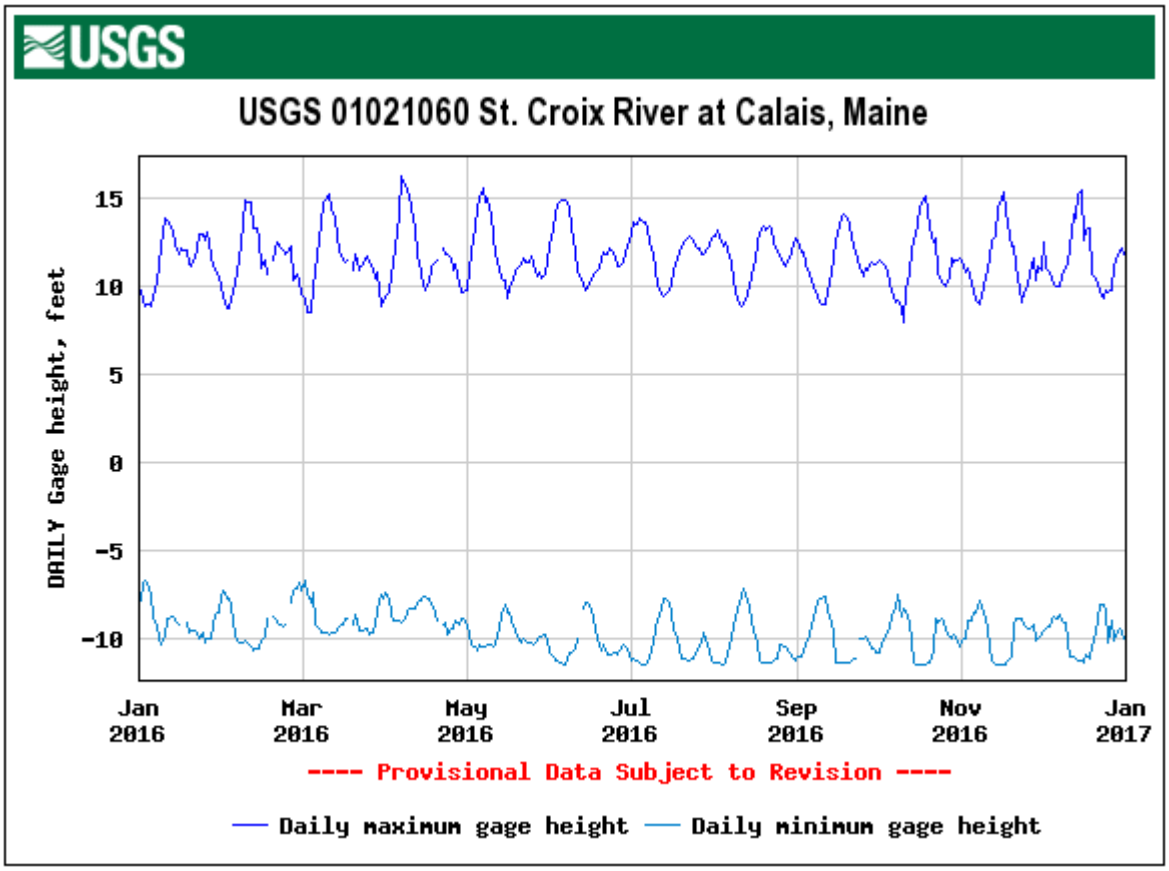


FIGURE 6. USGS tide gage station 01021060 St. Croix River at Calais, Maine

ACKNOWLEDGEMENTS

The International St. Croix River Watershed Board gratefully acknowledges the valuable input and efforts in support of this report provided by the following groups/individuals and without whom the preparation of this report would not be possible.

Tim	Andrews	Environment and Climate Change Canada
Dave	Benoit	Environment and Climate Change Canada
Luc	Bernard	Environment and Climate Change Canada
Simon	Despatie	Environment and Climate Change Canada
Derek	Elliott	Environment and Climate Change Canada
Steven	Falconer	Environment and Climate Change Canada
Benoit	Lalonde	Environment and Climate Change Canada
Vincent	Mercier	Environment and Climate Change Canada
Paul	Noseworthy	Environment and Climate Change Canada
Bernard	Richard	Environment and Climate Change Canada
Kathryn	Parlee	Environment and Climate Change Canada
Asha	Ajmani	Sipayik Environmental Department Passamaquoddy Tribe - Pleasant Point
Susanne	Miller	Maine Department of Environmental Protection
Brad	McPhereson	New Brunswick Department of Environment and Local Government
Donald	Fox	New Brunswick Department of Environment and Local Government
Heather	Almeda	St. Croix International Waterway Commission
Rebecca	Goreham	St. Croix International Waterway Commission
Barbara	Blumeris	U.S. Army Corps of Engineers
Bob	Lent	U.S. Geological Survey
Nick	Stasulius	U.S. Geological Survey
Gregory	Stewart	U.S. Geological Survey
Joseph	Zydlewski	U.S. Geological Survey/ University of Maine, Orono
Betsy	Barber	University of Maine, Orono
Jay	Beaudoin	Woodland Pulp LLC

APPENDIX 1

SUMMARY - ORDERS OF APPROVAL & BASIN MAP

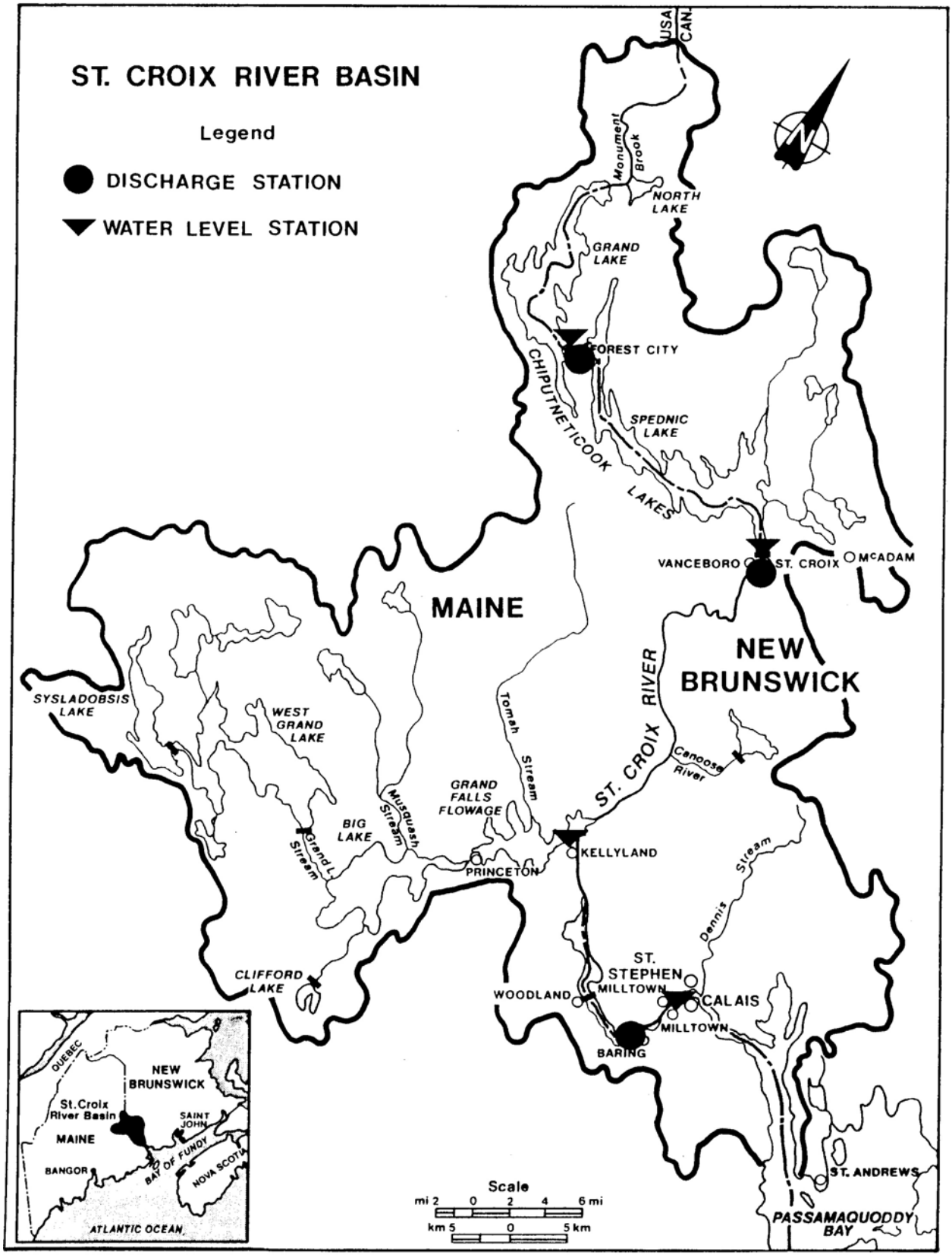
(This page intentionally left blank.)

SUMMARY ST. CROIX RIVER ORDERS OF APPROVAL

INTERNATIONAL JOINT COMMISSION

9 November 1915	For approval of a dam and power canal and the obstruction, diversion and use of the waters of the St. Croix River at Grand Falls in the State of Maine and the Province of New Brunswick: Maximum elevation 202.0 feet m.s.l.
3 October 1923	Erection and repairs of fishways in the St. Croix River at St. Croix Gas and Light and Canadian Cottons Mill Dam. (St. Croix Gas and Light Dam was destroyed by fire in 1924. The Canadian Cotton Mills Dam was reconstructed in 1934 and is known as Milltown Dam.)
6 October 1931	For the obstructions of the waters of the St. Croix River at Grand Falls in the State of Maine and the Province of New Brunswick: Increase in elevation to 203.5 feet m.s.l.
2 October 1934	For the reconstruction of a dam across the St. Croix River from Milltown in the Province of New Brunswick to Milltown in the State of Maine.
15 October 1965	For the construction of a storage dam in the St. Croix River at Vanceboro, Maine and St. Croix, New Brunswick: Discharge from Spednic Lake: 200 cfs (5.66 m3\s) minimum Elevation of Spednic Lake: 385.86 feet (117.611 metres) maximum Between 1 October and 30 April: 371.50 feet (113.233 metres) minimum Between 1 May and 30 September: 376.50 feet (114.759 metres) minimum Discharge from East Grand Lake: 75 cfs (2.12 m3\s) minimum Elevation of East Grand Lake: 434.94 feet (132.571 metres) maximum 427.94 feet (130.438 metres) minimum
16 November 1982	For the reconstruction of the diversion dike in the St. Croix River near Baileyville, Maine.

(This page intentionally left blank.)


ST. CROIX RIVER BASIN
Legend
DISCHARGE STATION
WATER LEVEL STATION
USA
CAN.
Monument Brook
NORTH LAKE
GRAND LAKE
FOREST CITY
CHIPUTNETICOOK LAKES
SPEDNIC LAKE
VANCEBORO
ST. CROIX
McADAM
MAINE
NEW BRUNSWICK
ST. CROIX RIVER
SYSLADOBSIS LAKE
WEST GRAND LAKE
Tomah Stream
Canoose River
GRAND FALLS FLOWAGE
Musquash Stream
Grand L. Stream
BIG LAKE
PRINCETON
KELLYLAND
Dennis Stream
CLIFFORD LAKE
ST. STEPHEN
MILLTOWN
WOODLAND
CALAIS
MILLTOWN
BARING
ST. ANDREWS
PASSAMAQUODDY BAY
Scale
mi 2 0 2 4 6 mi
km 5 0 5 km
QUEBEC
NEW BRUNSWICK
St.Croix River Basin
SAINT JOHN
MAINE
BAY OF FUNDY
BANGOR
NOVA SCOTIA
ATLANTIC OCEAN

(This page intentionally left blank.)

APPENDIX 2

MILLTOWN, GRAND FALLS, VANCEBORO AND FOREST CITY DAMS
2016

(This page intentionally left blank.)

GENERAL DESCRIPTION OF MILLTOWN,
GRAND FALLS, VANCEBORO & FOREST CITY DAMS

Milltown Dam & Fish Passage Facilities

The Milltown facility is located in Milltown, New Brunswick across the river from Calais, Maine and approximately one mile upstream from the international bridge between Calais and St. Stephen, New Brunswick. It consists of a powerhouse with 6 hydroelectric generating units (installed capacity is 3.6 MW), an upstream fish passage facility that goes from the lower pool around the side of the powerhouse to the upper pool. The spillway is located adjacent to the powerhouse and has 6 openings with large wooden stop logs that can be removed or installed via a railed vertical lifting mechanism. Other sections of the spillway have been equipped with wooden flashboards that are meant to fail and increase the spillway's capacity during high flows. At the far end of the spillway, running perpendicular from the spillway to the river bank, is a gatehouse with 5 vertical lift gates used to control the forebay elevation. A wooden-chute downstream fish passage facility is located in the area between the spillway and the gatehouse.

Grand Falls Dam & Fish Passage Facilities

Grand Falls Flowage Dam is approximately 8 miles upstream of the town of Baileyville, Maine and can store approximately 88,000 acre-feet of water. This dam has 9 steel tainter gates on the right (facing downstream) of the spillway, and a concrete emergency spillway approximately 800 to 850 feet in length running from the concrete gatehouse and ending at the left shoreline. The gatehouse is located between the gates and the emergency spillway. A floating walkway allows access to the entire upstream length of the spillway. Lake levels are recorded by a gauging station on the right bank of the dam.

The downstream side of the emergency spillway/dam has a concrete face sloping at an angle of approximately 45 degrees, and supported by concrete buttresses along its length. The space between these buttresses has been enclosed with a pressure-treated timber log system. This log system was installed to minimize the temperature differential in the downstream face area during freezing conditions to reduce possible degradation of the concrete face.

Water is impounded behind Grand Falls Dam and delivered to the hydroelectric plant and fish passage facilities via a channel on the right side of the impoundment, approximately 1000 feet upstream of the dam.

Water flows to the turbines via three steel penstocks. A Denil fishway is located on the side of the hydroelectric plant. It is a concrete structure with a series of bays equipped with guide slots that allow for the installation of wooden V notched weirs to modify flows to levels acceptable for fish migration.

Vanceboro Dam & Fish Passage Facilities

Vanceboro Dam consists of an earth embankment with a concrete gate structure and with rock filled gabions on the upstream face. The concrete structure is 69 feet (21 m) long, and contains a fishway and two tainter gates, each 22’-6” (6.9 m) wide by 14’-6” (4.4 m) high. These gates are operated by electrical cable lifts. The gate structure is located on the International Boundary line between the United States and Canada. Gate sill elevation is at 371.5 feet (113.23 m) NGVD. Normal full pond elevation is at 385.86 feet (117.61 m), with an impounded surface of 20,870 acres (84.5 km2). There are approximately 221,200 acre-feet (0.27 km3) of useable storage at normal full pond. The fishway is a vertical slot fish ladder and is to the left of the tainter gates and consists of 10 bays or pools. There are 5 vertical lift wooden gates to regulate flow through the ladder. There is a steel trash rack on the upstream face of the fish passage.

Forest City Dam & Fish Passage Facilities

Forest City Dam is a small timber crib rock filled structure with three wooden sluice gates operated with a wooden ratchet lever system that lifts the gates using a steel cable or steel chain. These gates have openings of 8'-4" (2.54 m) and a sill elevation of 427.94 feet (130.44 m) NGVD. Full pond elevation is at elevation 434.94 feet (132.57 m) NGVD, and impounds 105,300 acre-feet (0.130 km3) of water. The fishway is located on the right side (facing upstream) of the dam and consists of timber baffle system with an upstream timber trash rack.

FACILITY SITE VISITS IN 2016

Board members met with New Brunswick Power Corporation officials (NB Power) on June 15, 2016 at the Milltown Dam in New Brunswick and participated in a site visit of the facility.

Board members met with Woodland Pulp LLC officials on June 15, 2016 at the Woodland Mill at Baileyville, Maine and then Board members participated in site visits at Grand Falls, Forest City, and Vanceboro Dams.

IJC and Board Participants included in the NB Power and Woodland Pulp LLC meetings and site visits are shown below:

IJC Representatives

Name	Affiliation
Richard Moy	IJC Commissioner, U.S. Section
Camille Mageau	Secretary of the Canadian Section
Glenn Benoy	IJC staff, Canadian Section
Shannon Runyon	IJC staff, US Section

Board Representatives

Colonel Barron	St. Croix Board, Chair, U.S. Section
Bill Appleby	St. Croix Board, Chair, Canadian Section
Ralph Abele	St. Croix Board, U.S. Section
Bob Lent	St. Croix Board, U.S. Section
Jessie Davies	St. Croix Board, Canadian Section
Robert Stephenson	St. Croix Board, Canadian Section
Kathryn Parlee	Secretary, St. Croix Board, Canadian Section
Barbara Blumeris	Secretary, St. Croix Board, U.S. Section

Facility Representatives:

Jeff Babcock	Hydro Manager, NB Power
Ian Campbell	NB Power
Bruce Jones	NB Power
Jay Beaudoin	Environmental Manager, Woodland Pulp LLC
Kevin Dean	Hydro Superintendent, Woodland Pulp LLC

Forest City Dam. Woodland Pulp LLC reported replacing wooden deck on gate structure in 2016. No other changes reported. The US Federal Energy Regulatory Commission (FERC) conducts periodic dam safety inspections at the site.

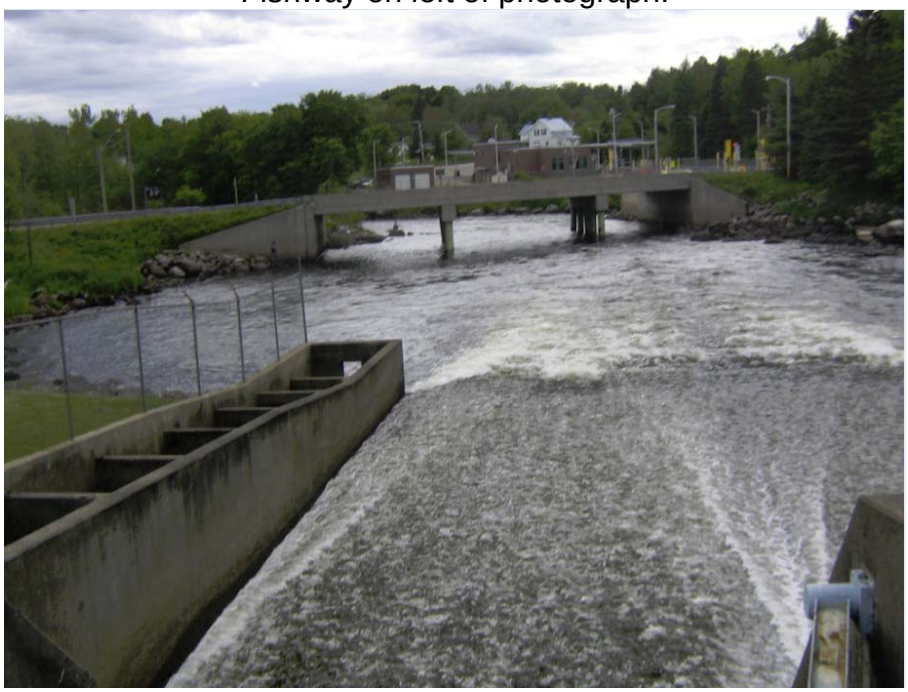
Forest City Dam (6-15-2016) View of Dam from Downstream.

Forest City Dam (6-15-2016) View of Wooden Sluice Gates at Dam (Upstream) and Adjacent Fishway.

Vanceboro Dam. No changes reported in 2016. FERC conducts periodic dam safety inspections at the site.

Vanceboro Dam (6-15-2016) View of Tainter Gates from Below Dam.

Vanceboro Dam (6-15-2016) View Looking Downstream from Dam.
Fishway on left of photograph.



Grand Falls Dam. Woodland Dam reported replacing gear on tainter gate in 2016. No other changes reported in 2016. Maine Emergency Management Agency, Dam Safety Program and the owner Woodland Pulp LLC conduct periodic dam safety inspections at the site.

Grand Falls Dam (6-15-2016) Upstream Side of Spillway from US Side.

Grand Falls Dam (6-15-2016) View looking Downstream from Dam.

Grand Falls Dam (6-15-2016) View of Denil Fishway Alongside Powerhouse.

Milltown Dam. During the Board's annual site visits, it has been observed that there is a crack in the floor of the powerhouse near units 5/6/7. This is not a new issue as the crack has been apparent since the 1980s. However, several years ago NB Power reported to the Board that there was increased movement in the crack. At that time (2003) NB Power took actions to assess the situation and established procedures to prevent further movement of the wall. NB Power set up heated hoarding on the outside face of the wall to prevent freezing and thawing action and has continued to use this method. NB Power continues to monitor the wall to make sure that additional actions are not required. Each year, NB Power technical staff conducts an annual inspection of the facility structures and prepares an annual report documenting the visual inspection. In addition, NB power engages an independent engineering consultant to provide periodic review of the facilities. Milltown provided a copy of their their annual inspection report completed in 2015 that indicated satisfactory conditions at the dam and powerhouse. NP Power completes annual dam inspections and and an independent engineering inspection every 4 years, last Quadrennial Inspection by Hatch Engineering in April 2013).

Milltown Dam (6-15-2016) View of Powerhouse with Enclosure on Tailrace Wall and Fishway Below Dam.

APPENDIX 3

WATER LEVELS AND FLOWS

(This page intentionally left blank.)

GRAND LAKE AT FOREST CITY
DAILY MEAN WATER LEVEL IN METERS FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	132.111	132.196	132.270	132.369	132.206	132.258	132.158	132.002	131.898	131.501	131.446	131.435	1
2	132.114	132.192	132.266	132.403	132.203	132.242	132.166	131.992	131.889	131.494	131.439	131.449	2
3	132.116	132.191	132.259	132.425	132.220	132.236	132.163	131.982	131.874	131.488	131.439	131.457	3
4	132.123	132.198	132.243	132.433	132.221	132.237	132.149	131.970	131.861	131.482	131.443	131.461	4
5	132.120	132.205	132.227	132.423	132.233	132.232	132.139	131.957	131.848	131.476	131.432	131.455	5
6	132.118	132.212	132.205	132.400	132.241	132.241	132.132	131.955	131.838	131.473	131.429	131.459	6
7	132.117	132.211	132.190	132.379	132.243	132.244	132.141	131.959	131.824	131.470	131.423	131.455	7
8	132.118	132.211	132.181	132.401	132.261	132.276	132.159	131.949	131.810	131.462	131.419	131.454	8
9	132.115	132.214	132.176	132.412	132.283	132.280	132.150	131.932	131.800	131.462	131.416	131.458	9
10	132.117	132.211	132.175	132.411	132.283	132.272	132.151	131.917	131.785	131.478	131.410	131.459	10
11	132.171	132.207	132.181	132.391	132.284	132.262	132.148	131.911	131.770	131.462	131.410	131.450	11
12	132.193	132.202	132.178	132.397	132.280	132.258	132.138	131.910	131.754	131.453	131.402	131.447	12
13	132.219	132.199	132.175	132.420	132.273	132.264	132.128	131.903	131.733	131.445	131.394	131.448	13
14	132.233	132.194	132.173	132.420	132.285	132.258	132.115	131.910	131.719	131.449	131.390	131.444	14
15	132.240	132.188	132.171	132.411	132.293	132.248	132.114	131.913	131.702	131.436	131.387	131.447	15
16	132.245	132.196	132.188	132.391	132.307	132.237	132.108	131.904	131.682	131.427	131.399	131.448	16
17	132.249	132.232	132.202	132.366	132.311	132.229	132.098	131.935	131.662	131.426	131.421	131.436	17
18	132.249	132.250	132.218	132.345	132.313	132.220	132.087	131.939	131.653	131.417	131.423	131.447	18
19	132.246	132.258	132.225	132.326	132.314	132.209	132.086	131.938	131.647	131.414	131.419	131.450	19
20	132.243	132.262	132.227	132.312	132.313	132.198	132.072	131.927	131.640	131.409	131.412	131.447	20
21	132.240	132.267	132.233	132.296	132.307	132.196	132.057	131.915	131.629	131.406	131.397	131.447	21
22	132.237	132.266	132.235	132.284	132.299	132.194	132.047	131.939	131.614	131.458	131.397	131.446	22
23	132.234	132.259	132.235	132.279	132.295	132.194	132.043	131.950	131.608	131.476	131.399	131.446	23
24	132.230	132.255	132.234	132.271	132.285	132.192	132.042	131.946	131.594	131.475	131.387	131.445	24
25	132.226	132.269	132.240	132.256	132.279	132.183	132.031	131.944	131.575	131.470	131.382	131.446	25
26	132.221	132.291	132.242	132.241	132.281	132.175	132.027	131.943	131.553	131.467	131.386	131.444	26
27	132.217	132.293	132.242	132.235	132.267	132.163	132.022	131.940	131.540	131.461	131.398	131.460	27
28	132.212	132.289	132.247	132.226	132.270	132.156	132.019	131.926	131.531	131.456	131.399	131.463	28
29	132.209	132.281	132.302	132.215	132.263	132.162	132.032	131.922	131.520	131.457	131.395	131.465	29
30	132.204		132.325	132.211	132.260	132.167	132.025	131.911	131.508	131.460	131.419	131.486	30
31	132.200		132.346		132.261		132.011	131.902		131.457		131.487	31
TOTAL	4097.887	3834.699	4099.011	#######	4100.434	3966.683	4094.958	#######	3951.061	4075.167	3942.312	4075.041	TOTAL
MEAN	132.190	132.231	132.226	132.345	132.272	132.223	132.095	131.937	131.702	131.457	131.410	131.453	MEAN
MAX	132.249	132.293	132.346	132.433	132.314	132.280	132.166	132.002	131.898	131.501	131.446	131.487	MAX
MIN	132.111	132.188	132.171	132.211	132.203	132.156	132.011	131.902	131.508	131.406	131.382	131.435	MIN

SUMMARY FOR THE YEAR 2016
Mean water level, 131.962 m
Maximum daily water level, 132.433 m On 2016-04-04
Minimum daily water level, 131.382 m On 2016-11-25

NOTE: WATER LEVELS ARE PROVISIONAL AND ARE SUPPLIED BY ENVIRONMENT CANADA IN COOPERATION WITH WOODLAND PULP LLC

TABLE I

FOREST CITY STREAM BELOW FOREST CITY DAM
DAILY MEAN WATER LEVEL IN METERS FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	3.27	6.22	20.60	8.92	4.91	3.62	4.70	5.57	5.32	3.92	2.58	2.98	1
2	3.28	6.20	20.60	11.00	4.27	3.35	5.28	5.08	6.10	3.90	2.57	3.01	2
3	3.29	6.24	20.50	11.00	3.56	3.35	5.25	5.07	6.80	3.27	2.58	3.02	3
4	3.29	6.24	20.40	18.50	3.58	3.36	5.23	5.06	6.76	2.92	2.57	3.02	4
5	3.30	6.22	20.20	25.00	3.58	3.39	5.73	5.03	6.73	2.91	2.55	3.03	5
6	3.32	6.26	19.00	28.50	3.60	3.39	4.51	5.03	7.39	2.89	2.54	3.02	6
7	3.32	6.25	15.00	28.50	3.61	3.39	5.04	5.01	9.31	2.73	2.53	3.03	7
8	4.24	6.26	11.00	29.20	3.64	4.57	6.09	4.98	9.92	2.57	2.52	3.03	8
9	5.25	6.26	8.79	29.10	4.32	5.92	6.08	4.96	9.83	2.57	2.51	3.03	9
10	5.29	6.26	7.98	29.00	5.16	5.92	6.07	4.95	9.73	2.60	2.50	2.46	10
11	5.36	6.22	7.97	28.90	5.16	5.90	6.45	4.93	9.65	2.55	2.49	3.28	11
12	5.43	6.22	7.98	28.90	5.16	5.89	6.73	4.60	9.51	2.54	2.44	3.32	12
13	5.47	6.22	7.92	29.20	5.17	5.87	6.71	4.35	9.42	2.52	2.43	3.07	13
14	5.50	6.18	7.40	29.20	5.17	5.86	6.68	4.37	9.32	2.57	2.43	3.04	14
15	5.84	6.20	6.50	29.00	5.20	5.84	6.68	4.36	9.21	2.60	2.43	3.04	15
16	6.29	6.26	6.53	28.80	5.19	5.84	6.65	4.35	9.10	2.59	2.48	3.03	16
17	6.31	6.26	6.57	28.30	5.20	5.40	6.64	4.43	8.97	2.59	2.49	3.02	17
18	6.30	7.72	6.59	24.80	5.21	4.80	5.82	4.43	8.91	2.57	2.75	3.04	18
19	6.28	11.20	6.59	20.00	5.22	4.80	5.37	4.40	8.89	2.55	3.01	3.04	19
20	6.27	12.60	6.61	17.60	6.28	4.33	5.33	4.40	8.85	2.53	3.01	3.05	20
21	6.27	12.60	6.63	14.70	7.28	3.91	5.32	4.39	8.76	2.56	3.00	3.04	21
22	6.28	12.60	5.90	11.90	7.27	3.91	6.02	4.42	8.64	2.67	2.94	3.03	22
23	6.31	13.60	5.24	10.70	7.23	3.92	6.53	4.44	8.61	2.67	2.86	3.03	23
24	6.31	16.10	4.72	10.60	6.69	4.23	6.52	4.45	8.50	2.66	2.83	3.03	24
25	6.31	18.40	4.26	10.60	5.43	4.46	6.51	4.45	8.37	2.64	2.83	3.01	25
26	6.31	19.50	4.23	9.28	4.71	4.45	6.50	4.44	7.21	2.63	2.85	3.02	26
27	6.28	20.90	4.25	8.46	4.70	4.44	6.48	4.44	5.61	2.63	2.86	3.08	27
28	6.28	20.90	4.26	7.36	4.69	4.43	6.47	4.42	5.57	2.62	2.85	3.07	28
29	6.26	20.80	4.31	5.38	4.68	4.46	6.49	4.39	5.52	2.61	2.87	3.10	29
30	6.25		4.37	4.91	4.66	4.45	6.47	4.74	4.51	2.60	2.94	3.15	30
31	6.25		5.60		4.34		6.44	5.33		2.59		3.14	31
TOTAL	166	293	289	577	155	137	187	145	241	84.8	80.2	94.3	TOTAL
MEAN	5.36	10.1	9.31	19.2	5.00	4.58	6.03	4.69	8.03	2.73	2.67	3.04	MEAN
MAX	6.31	20.9	20.6	29.2	7.28	5.92	6.73	5.57	9.92	3.92	3.01	3.32	MAX
MIN	3.27	6.18	4.23	4.91	3.56	3.35	4.51	4.35	4.51	2.52	2.43	2.46	MIN

SUMMARY FOR THE YEAR 2016
Total discharge 211500 DAM
Mean discharge, 7.07 m^3/s
Maximum daily discharge, 29.2 m^3/s On 2016-04-08
Minimum daily discharge, 2.43 m^3/s On 2016-11-13

NOTE: DISCHARGE DATA ARE PROVISIONAL AND ARE SUPPLIED BY ENVIRONMENT CANADA IN COOPERATION WITH WOODLAND PULP LLC

TABLE II

SPEDNIC LAKE AT ST. CROIX
DAILY MEAN WATER LEVEL IN METERS FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	116.928	116.806	117.038	117.094	116.906	116.828	116.675	116.524	116.240	115.860	115.624	115.512	1
2	116.935	116.793	117.046	117.143	116.889	116.805	116.689	116.510	116.225	115.844	115.617	115.537	2
3	116.941	116.776	117.059	117.204	116.891	116.796	116.691	116.497	116.208	115.828	115.615	115.552	3
4	116.948	116.777	117.047	117.210	116.877	116.790	116.664	116.485	116.187	115.809	115.628	115.567	4
5	116.943	116.780	117.038	117.214	116.877	116.773	116.649	116.468	116.169	115.791	115.605	115.555	5
6	116.935	116.777	117.015	117.200	116.877	116.776	116.640	116.458	116.155	115.773	115.598	115.564	6
7	116.929	116.767	117.001	117.177	116.869	116.779	116.642	116.458	116.142	115.755	115.589	115.563	7
8	116.923	116.761	116.996	117.232	116.879	116.810	116.664	116.447	116.129	115.730	115.579	115.566	8
9	116.911	116.756	116.980	117.291	116.913	116.826	116.657	116.421	116.128	115.725	115.579	115.580	9
10	116.900	116.741	116.977	117.308	116.902	116.812	116.658	116.399	116.117	115.749	115.566	115.580	10
11	116.953	116.731	116.979	117.269	116.899	116.803	116.660	116.387	116.116	115.709	115.576	115.564	11
12	116.988	116.716	116.971	117.278	116.891	116.798	116.658	116.378	116.106	115.681	115.564	115.565	12
13	117.022	116.703	116.973	117.317	116.877	116.806	116.652	116.365	116.086	115.667	115.540	115.565	13
14	117.036	116.687	116.956	117.318	116.896	116.807	116.645	116.364	116.077	115.679	115.527	115.562	14
15	117.042	116.667	116.949	117.294	116.899	116.797	116.653	116.362	116.066	115.644	115.518	115.555	15
16	117.044	116.661	116.965	117.261	116.929	116.784	116.645	116.345	116.047	115.624	115.513	115.544	16
17	117.043	116.707	116.975	117.228	116.924	116.776	116.633	116.367	116.030	115.622	115.529	115.536	17
18	117.037	116.736	116.997	117.194	116.916	116.765	116.625	116.379	116.028	115.595	115.527	115.540	18
19	117.028	116.750	117.006	117.160	116.911	116.752	116.634	116.378	116.020	115.598	115.515	115.540	19
20	117.018	116.762	117.004	117.130	116.911	116.735	116.622	116.357	116.011	115.576	115.506	115.529	20
21	117.005	116.789	117.010	117.101	116.906	116.737	116.600	116.338	116.008	115.566	115.505	115.523	21
22	116.991	116.803	117.013	117.078	116.898	116.734	116.589	116.352	115.995	115.613	115.516	115.517	22
23	116.976	116.807	117.005	117.069	116.895	116.738	116.582	116.358	115.988	115.652	115.524	115.511	23
24	116.960	116.810	116.997	117.059	116.887	116.734	116.576	116.342	115.984	115.663	115.494	115.504	24
25	116.941	116.839	116.994	117.028	116.881	116.717	116.559	116.328	115.973	115.659	115.483	115.504	25
26	116.920	116.931	116.996	116.999	116.885	116.703	116.553	116.321	115.945	115.647	115.480	115.494	26
27	116.906	116.981	116.984	116.986	116.860	116.689	116.552	116.315	115.923	115.633	115.494	115.504	27
28	116.886	117.013	116.980	116.966	116.862	116.679	116.546	116.290	115.908	115.626	115.503	115.510	28
29	116.867	117.028	117.037	116.941	116.845	116.680	116.553	116.289	115.892	115.641	115.480	115.509	29
30	116.847		117.056	116.925	116.840	116.689	116.552	116.267	115.876	115.646	115.501	115.528	30
31	116.826		117.074		116.840		116.536	116.249		115.645		115.529	31
TOTAL	3625.625	3386.855	3627.119	#######	3623.531	3502.917	3615.253	#######	3481.778	3586.251	3466.296	3581.706	TOTAL
MEAN	116.956	116.788	117.004	117.156	116.888	116.764	116.621	116.381	116.059	115.686	115.543	115.539	MEAN
MAX	117.044	117.028	117.074	117.318	116.929	116.828	116.691	116.524	116.240	115.860	115.628	115.580	MAX
MIN	116.826	116.661	116.949	116.925	116.840	116.679	116.536	116.249	115.876	115.566	115.480	115.494	MIN

SUMMARY FOR THE YEAR 2016
Mean water level, 116.449 m
Maximum daily water level, 117.318 m On 2016-04-14
Minimum daily water level, 115.480 m On 2016-11-26

NOTE: WATER LEVELS ARE IN METERS AND ARE REFERENCED TO GEODETIC SURVEY OF CANADA DATUM. WATER LEVELS ARE PROVISIONAL AND ARE SUPPLIED BY ENVIRONMENT CANADA IN COOPERATION WITH WOODLAND PULP LLC

TABLE III

ST. CROIX RIVER AT VANCEBORO
DAILY MEAN DISCHARGE IN METERS PER SECOND FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	16.4	31.1	55.5	31.7	27.9	15.2	11.21	14.4	18.2	18.3	11.6	11.4	1
2	16.5	28.9	56.6	34.0	25.2	15.1	14.8	14.3	18.8	18.2	11.6	11.4	2
3	16.5	28.6	60.0	34.3	23.0	15.1	14.8	14.3	19.7	18.2	11.6	11.4	3
4	19.1	28.9	60.9	43.3	22.9	15.1	14.7	14.2	19.6	18.1	11.6	11.5	4
5	21.7	28.9	60.9	56.6	22.9	15.0	11.7	14.2	19.5	18.0	11.6	10.4	5
6	21.7	28.9	56.9	65.7	22.9	15.1	9.8	14.2	19.5	18.0	11.6	9.3	6
7	21.7	28.6	47.6	68.8	22.9	15.1	9.80	14.2	19.4	17.9	11.5	9.29	7
8	24.5	28.6	42.8	73.3	23.0	15.2	14.07	14.1	19.3	17.8	11.5	9.26	8
9	26.7	28.6	37.7	80.7	23.1	15.2	16.6	14.8	19.3	17.8	11.5	9.32	9
10	26.7	28.6	33.4	86.6	23.0	15.1	16.6	15.5	19.3	17.1	11.5	9.29	10
11	27.0	28.6	33.4	88.3	21.3	15.1	12.6	16.7	19.3	16.1	11.5	9.26	11
12	27.2	28.6	33.1	88.3	20.0	15.1	9.8	17.6	19.2	15.0	11.5	9.26	12
13	27.3	28.3	33.1	93.2	19.9	15.1	9.77	17.5	19.1	13.5	11.4	9.26	13
14	27.4	28.3	30.9	100.0	20.0	15.1	9.80	17.5	19.1	13.3	11.4	11.84	14
15	29.7	28.2	28.1	101	20.0	15.1	13.11	17.5	19.1	13.1	11.4	14.7	15
16	32.3	28.1	28.2	101	20.2	15.1	14.8	17.4	19.0	13.1	11.3	14.7	16
17	32.3	28.3	28.2	100	20.1	14.2	14.8	17.6	18.9	13.1	11.4	14.6	17
18	32.6	31.1	28.3	92	20.1	13.4	13.4	17.6	18.9	13.0	11.4	14.6	18
19	32.6	34.0	28.3	82.4	20.0	13.4	12.5	17.6	18.9	12.9	11.3	14.6	19
20	32.3	34.0	28.3	74.8	20.0	12.7	12.5	17.5	18.8	12.1	11.3	14.6	20
21	32.0	34.3	28.3	58.6	20.0	11.5	12.4	17.4	18.8	11.5	11.4	14.5	21
22	32.0	34.3	28.3	48.1	20.0	10.1	14.6	17.5	18.8	11.7	11.4	14.5	22
23	32.0	36.0	28.3	44.2	20.0	9.7	15.8	17.5	18.8	11.8	11.4	14.5	23
24	31.7	42.2	26.1	44.2	19.3	12.46	15.7	17.4	18.7	11.8	11.3	14.4	24
25	31.7	50.1	24.7	44.2	18.7	15.2	15.7	17.4	18.7	11.7	11.3	14.5	25
26	33.4	53.0	24.7	40.8	18.7	15.1	13.8	17.4	18.6	11.7	11.2	14.4	26
27	34.3	55.2	24.6	37.7	18.6	12.6	12.1	17.3	18.5	11.7	11.3	14.4	27
28	34.3	55.2	24.7	34.8	18.6	9.5	13.5	17.2	18.4	11.6	11.3	14.5	28
29	34.0	55.5	24.9	30.0	18.5	8.98	14.5	17.2	18.4	11.7	11.3	14.5	29
30	34.0		24.9	28.0	18.5	8.98	14.5	17.8	18.3	11.7	11.3	14.6	30
31	33.7		27.9		16.4		14.4	18.4		11.7		14.6	31
TOTAL	875	1003	1100	1907	646	410	414	511	569	443	343	389	TOTAL
MEAN	28.2	34.6	35.5	63.6	20.8	13.7	13.4	16.5	19.0	14.3	11.4	12.6	MEAN
MAX	34.3	55.5	60.9	101	27.9	15.2	16.6	18.4	19.7	18.3	11.6	14.7	MAX
MIN	16.4	28.1	24.6	28.0	16.4	8.98	9.77	14.1	18.2	11.5	11.2	9.26	MIN

SUMMARY FOR THE YEAR 2016
Total discharge 743900 DAM
Mean discharge, 23.6 m^3/s
Maximum daily discharge, 101 m^3/s On 2016-04-15
Minimum daily discharge, 8.98 m^3/s On 2016-06-29

NOTE: DATA ARE SUPPLIED BY THE UNITED STATES GEOLOGICAL SURVEY AND ARE PROVISIONAL

TABLE IV

GRAND FALLS FLOWAGE AT GRAND FALLS
DAILY MEAN WATER LEVEL IN METERS FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	61.824	61.805	61.837	61.910	61.725	61.735	61.681	61.575	61.613	61.497	61.727	61.828	1
2	61.812	61.813	61.823	61.896	61.714	61.729	61.686	61.570	61.610	61.502	61.730	61.872	2
3	61.794	61.809	61.836	61.886	61.716	61.717	61.694	61.564	61.613	61.499	61.737	61.863	3
4	61.768	61.835	61.838	61.833	61.704	61.706	61.680	61.558	61.614	61.497	61.744	61.846	4
5	61.743	61.875	61.894	61.735	61.704	61.702	61.666	61.551	61.612	61.497	61.748	61.835	5
6	61.774	61.909	61.905	61.681	61.715	61.725	61.648	61.541	61.606	61.494	61.744	61.853	6
7	61.787	61.929	61.901	61.657	61.733	61.738	61.646	61.530	61.613	61.491	61.738	61.843	7
8	61.786	61.938	61.899	61.712	61.765	61.763	61.655	61.525	61.609	61.488	61.739	61.832	8
9	61.784	61.946	61.873	61.763	61.822	61.787	61.663	61.504	61.608	61.484	61.736	61.827	9
10	61.786	61.950	61.858	61.799	61.838	61.780	61.675	61.491	61.600	61.500	61.732	61.830	10
11	61.856	61.953	61.875	61.791	61.843	61.801	61.681	61.481	61.600	61.501	61.733	61.814	11
12	61.904	61.951	61.888	61.790	61.845	61.811	61.692	61.479	61.595	61.505	61.719	61.806	12
13	61.950	61.941	61.885	61.785	61.833	61.821	61.690	61.477	61.586	61.509	61.717	61.803	13
14	61.938	61.933	61.875	61.799	61.838	61.825	61.678	61.491	61.576	61.505	61.707	61.791	14
15	61.893	61.922	61.859	61.791	61.844	61.823	61.661	61.495	61.563	61.496	61.698	61.786	15
16	61.840	61.913	61.872	61.765	61.867	61.818	61.652	61.495	61.559	61.499	61.702	61.790	16
17	61.817	61.939	61.915	61.733	61.866	61.806	61.654	61.505	61.556	61.497	61.724	61.783	17
18	61.852	61.942	61.931	61.691	61.857	61.806	61.662	61.536	61.555	61.490	61.728	61.785	18
19	61.864	61.928	61.944	61.662	61.850	61.783	61.658	61.538	61.546	61.490	61.740	61.769	19
20	61.838	61.918	61.897	61.683	61.842	61.767	61.648	61.537	61.541	61.483	61.754	61.757	20
21	61.813	61.900	61.856	61.718	61.829	61.755	61.642	61.545	61.543	61.486	61.768	61.767	21
22	61.818	61.869	61.821	61.744	61.806	61.744	61.632	61.568	61.533	61.553	61.786	61.775	22
23	61.807	61.825	61.781	61.744	61.780	61.745	61.621	61.600	61.536	61.643	61.787	61.779	23
24	61.790	61.762	61.769	61.759	61.768	61.732	61.615	61.611	61.535	61.678	61.770	61.778	24
25	61.780	61.740	61.767	61.757	61.782	61.722	61.610	61.620	61.528	61.685	61.768	61.770	25
26	61.761	61.871	61.778	61.740	61.775	61.716	61.608	61.620	61.522	61.685	61.768	61.773	26
27	61.748	61.934	61.758	61.731	61.756	61.712	61.606	61.614	61.511	61.691	61.772	61.767	27
28	61.768	61.918	61.777	61.725	61.747	61.706	61.597	61.614	61.493	61.686	61.784	61.778	28
29	61.783	61.872	61.832	61.738	61.736	61.694	61.591	61.617	61.489	61.705	61.777	61.794	29
30	61.792		61.874	61.734	61.742	61.690	61.586	61.601	61.493	61.723	61.788	61.824	30
31	61.800		61.913		61.747		61.583	61.598		61.726		61.820	31
TOTAL	1916.270	1794.840	1917.531	#######	1915.389	1852.659	1911.061	#######	1846.958	1908.185	1852.365	1915.938	TOTAL
MEAN	61.815	61.891	61.856	61.758	61.787	61.755	61.647	61.550	61.565	61.554	61.746	61.804	MEAN
MAX	61.950	61.953	61.944	61.910	61.867	61.825	61.694	61.620	61.614	61.726	61.788	61.872	MAX
MIN	61.743	61.740	61.758	61.657	61.704	61.690	61.583	61.477	61.489	61.483	61.698	61.757	MIN

SUMMARY FOR THE YEAR 2016
Mean water level, 61.727 m
Maximum daily water level, 61.953 m On 2016-02-11
Minimum daily water level, 61.477 m On 2016-08-13

NOTE: WATER LEVELS ARE IN METERS AND ARE REFERENCED TO GEODETIC SURVEY OF CANADA DATUM. WATER LEVELS ARE PROVISIONAL AND ARE SUPPLIED BY ENVIRONMENT CANADA IN COOPERATION WITH WOODLAND PULP LLC

TABLE V

ST. CROIX RIVER AT BARING MAINE
DAILY MEAN DISCHARGE IN METERS PER SECOND FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	86.1	59.7	232	150	56.1	33.4	27.4	26.2	25.8	26.1	30.6	45.3	1
2	85.2	60.9	196	166	56.1	33.1	28.6	26.1	25.5	26.1	28.6	72.5	2
3	85.0	59.5	189	180	61.7	33.1	27.7	25.9	26.0	26.1	27.1	94.3	3
4	81.6B	65.1	189B	178	55.5	32.6	27.1	25.8	25.5	26.0	27.2	92.6	4
5	64.8B	72.2	150	183	68.5	29.2	26.9	25.7	25.5	26.4	28.3	78.7	5
6	43.3B	60.0	152	174	62.0	30.0	27.1	26.1	25.6	26.5	28.9	59.2	6
7	58.9	67.7	142	172	59.5	34.0	27.7	25.8	25.7	26.5	27.9	58.9	7
8	58.3	68.2	131	190	60.9	50.4	28.6	25.5	25.7	26.3	25.8	56.9	8
9	60.3	73.6	129	220	64.8	49.0	28.0	26.5	25.8	26.6	25.8	46.7	9
10	77.0	66.0	119	226	62.3	38.2	30.6	26.2	25.7	27.2	25.6	37.7	10
11	164	64.6	105	224	61.7	30.9	32.6	26.6	25.7	26.6	25.7	36.2	11
12	170	63.7B	108	231	60.9	30.9	30.3	26.8	25.7	26.7	26.6	37.9	12
13	172B	64.3B	108	253	59.2	30.9	27.3	26.5	25.7	26.9	26.5	39.1	13
14	168B	63.4B	106	251	56.4	30.9	27.9	25.8	25.8	26.6	26.5	35.1	14
15	160B	60.3B	106	247	53.5	30.9	30.9	25.6	25.7	26.4	26.5	33.4	15
16	154	79.9	94	240	61.4	30.9	30.0	25.4	25.7	26.4	26.9	31.7B	16
17	129	122	94.0	227	58.3	30.9	28.9	26.2	25.7	26.4	26.9	32.3B	17
18	102	160	112.0	219	57.5	29.2	28.9	25.7	26.9	26.3	27.2	37.1B	18
19	91.7	170	121	197	58.6	42.5	31.1	25.5	26.1	26.5	26.9	51.3B	19
20	98.3B	165	133	153	58.3	35.4	28.1	25.5	26.0	26.4	26.8	47.3B	20
21	94.6B	162	129	139	59.7	34.8	27.6	25.6	26.0	26.6	26.8	39.6	21
22	79.0B	157	121	127	60.3	28.6	27.3	26.1	25.8	32.8	26.8	34.8	22
23	81.6B	152	108	106	57.2	26.9	27.2	25.8	26.0	35.7	27.0	36.5	23
24	80.4B	159	100	88	49.0	26.9	27.1	25.7	25.7	34.5	26.5	36.8	24
25	80.7B	176	96	86.9	46.4	26.8	26.4	25.6	25.2	34.0	26.5	41.3	25
26	81.3B	240	84.4	86.1	43.9	26.7	26.1	25.5	25.1	33.7	26.5	37.9B	26
27	80.4	297	90.9	81.3	43.9	26.6	25.7	25.5	25.2	31.4	26.5	41.3	27
28	61.4	289	85.0	68.0	44.2	26.7	26.4	25.3	25.3	31.1	28.6	45	28
29	61.2	259	110.0	57.8	40.5	29.2	26.5	25.4	25.2	31.1	32.3	45.0	29
30	58.6		132	54.4	36.0	28.1	26.5	25.3	26.1	31.1	37.9	59.2	30
31	59.7		132		35.7		26.4	25.3		31.1		70.5	31
TOTAL	2929	3558	3884	4976	1710	967	869	801	771	882	828	1515	TOTAL
MEAN	94.5	123	125	166	55.2	32.2	28.0	25.8	25.7	28.5	27.6	48.9	MEAN
MAX	172	297	232	253	68.5	50.4	32.6	26.8	26.9	35.7	37.9	94.3	MAX
MIN	43.3	59.5	84.4	54.4	35.7	26.6	25.7	25.3	25.1	26.0	25.6	31.7	MIN

SUMMARY FOR THE YEAR 2016
Total discharge 2046700 DAM
Mean discharge, 65.0 m^3/s
Maximum daily discharge, 297 m^3/s On 2016-02-27
Minimum daily discharge, 25.1 m^3/s On 2016-09-26

NOTE: DATA ARE SUPPLIED BY THE UNITED STATES GEOLOGICAL SURVEY AND ARE PROVISIONAL
B - BACKWATER

TABLE VI

ST. CROIX RIVER AT MILLTOWN DAM
DAILY MEAN WATER LEVEL IN METERS FOR 2016

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	13.692	13.661	13.819	13.760	13.678	13.681	13.732	13.741	---	13.725	13.632	13.733	1
2	13.684	13.684	13.783	13.686	13.737	13.685	13.713	13.737	---	13.727	13.680	13.851	2
3	13.720	13.676	13.790	13.795	13.674	13.682	13.731	13.751	---	13.730	13.623	13.830	3
4	13.687	13.686	13.757	13.725	13.690	13.689	13.732	13.759	---	13.724	13.635	13.816	4
5	13.700	13.678	13.750	13.745	13.708	13.684	13.735	13.768	---	13.725	13.630	13.777	5
6	13.687	13.657	13.761	13.698	13.683	13.709	13.734	13.757	---	13.713	13.612	13.746	6
7	13.724	13.666	13.728	13.724	13.720	13.703	13.731	13.736	13.693	13.722	13.618	13.686	7
8	13.694	13.660	13.713	13.803	13.726	13.701	13.694	13.752	13.718	13.720	13.635	13.579	8
9	13.712	13.680	13.703	13.806	13.703	13.697	13.716	13.743	13.715	13.721	13.642	13.500	9
10	13.762	13.659	13.732	13.845	13.669	13.671	13.850	13.739	13.736	13.725	13.640	13.697	10
11	13.804	13.682	13.722	13.792	13.685	13.682	13.753	13.740	13.717	13.724	13.649	13.697	11
12	13.748	13.686	13.763	13.782	13.712	13.685	13.735	13.734	13.721	13.731	13.650	13.724	12
13	13.733	13.683	13.710	13.811	13.695	13.659	13.723	13.738	13.692	13.720	13.654	13.693	13
14	13.740	13.689	13.697	13.781	13.684	13.688	13.740	13.745	13.695	13.732	13.648	13.704	14
15	13.737	13.691	13.704	13.756	13.675	13.722	13.733	---	13.717	13.724	13.652	13.697	15
16	13.736	13.703	13.705	13.772	13.714	13.679	13.746	---	13.717	13.728	13.641	13.701	16
17	13.707	13.710	13.709	13.744	13.688	13.729	13.759	---	13.716	13.725	13.634	13.703	17
18	13.742	13.778	13.747	13.734	13.667	13.727	13.757	---	13.711	13.723	13.632	13.689	18
19	13.726	13.782	13.776	13.782	13.662	13.756	13.766	---	13.709	13.726	13.641	13.726	19
20	13.726	13.737	13.737	13.746	13.698	13.727	13.741	---	13.709	13.729	13.637	13.707	20
21	13.655	13.721	13.701	13.664	13.717	13.726	13.738	---	13.722	13.718	13.644	13.700	21
22	13.659	13.758	13.675	13.639	13.718	13.715	13.738	---	13.731	13.760	13.642	13.696	22
23	13.659	13.718	13.687	13.650	13.691	13.747	13.742	---	13.733	13.725	13.661	13.700	23
24	13.691	13.758	13.667	13.626	13.680	13.747	13.742	---	13.728	13.728	13.679	13.698	24
25	13.689	13.755	13.707	13.652	13.716	13.750	13.734	---	13.741	13.722	13.678	13.714	25
26	13.694	13.851	13.713	13.657	13.680	13.749	13.744	---	13.728	13.725	13.673	13.693	26
27	13.678	13.960	13.737	13.628	13.684	13.749	13.743	---	13.727	13.724	13.670	13.726	27
28	13.682	13.904	13.687	13.629	13.679	13.737	13.740	---	13.714	13.721	13.670	13.701	28
29	13.701	13.882	13.765	13.656	13.670	13.738	13.742	---	13.714	13.720	13.673	13.692	29
30	13.666		13.777	13.691	13.695	13.730	13.740	---	13.730	13.720	13.670	13.722	30
31	13.603		13.766		13.686		13.743	---		13.690		13.728	31
TOTAL	424.837	398.157	425.687	411.781	424.484	411.345	425.969	192.441	329.235	425.447	409.446	425.028	TOTAL
MEAN	13.704	13.730	13.732	13.726	13.693	13.712	13.741	13.746	13.718	13.724	13.648	13.711	MEAN
MAX	13.804	13.960	13.819	13.845	13.737	13.756	13.850	13.768	13.741	13.760	13.680	13.851	MAX
MIN	13.603	13.657	13.667	13.626	13.662	13.659	13.694	13.734	13.692	13.690	13.612	13.500	MIN

SUMMARY FOR THE YEAR 2016
Mean water level, 13.715 m
Maximum daily water level, 13.960 m On 2016-02-27
Minimum daily water level, 115.480 m On 2016-11-26

NOTE: WATER LEVELS ARE IN METERS AND ARE REFERENCED TO GEODETIC SURVEY OF CANADA DATUM. THE WATER LEVEL DATA ARE PROVISIONAL AND ARE SUPPLIED BY ENVIRONMENT CANADA IN COOPERATION WITH NEW BRUNSWICK POWER.

TABLE VII

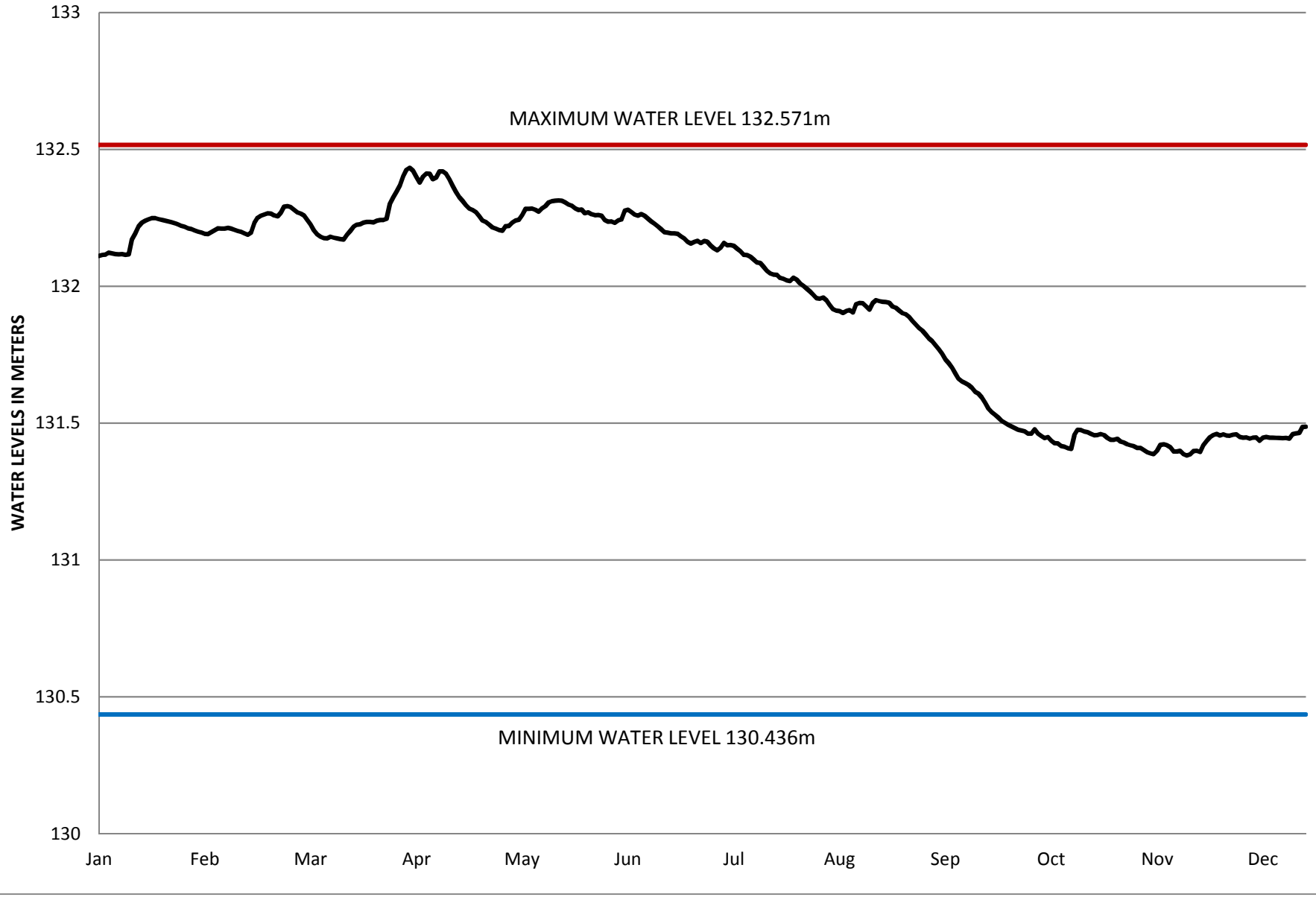
APPENDIX 4

HYDROGRAPHS

(This page intentionally left blank.)

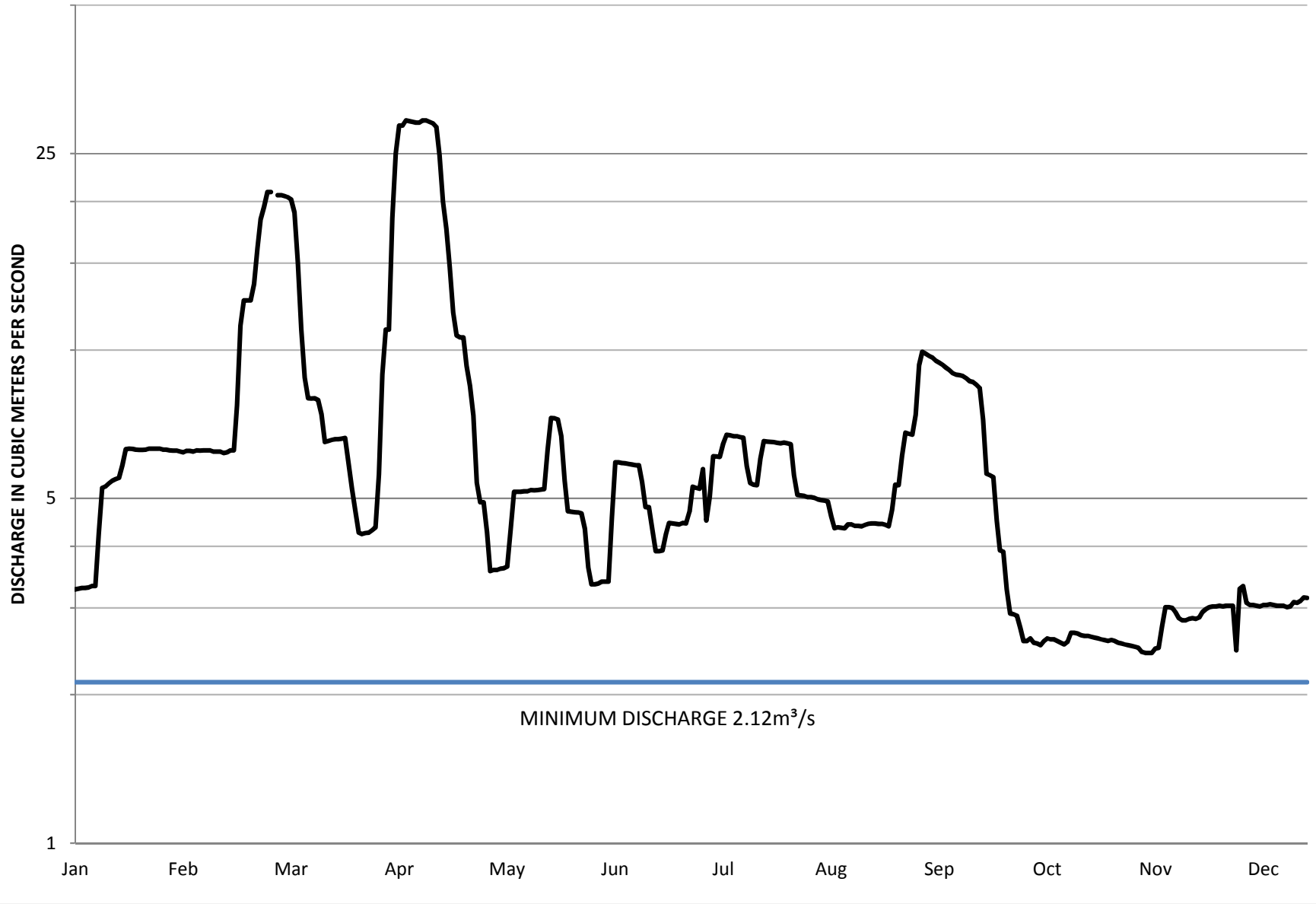
YEAR: 2016 STATION ID: 01AR009 - GRAND LAKE AT FOREST CITY

FIGURE I



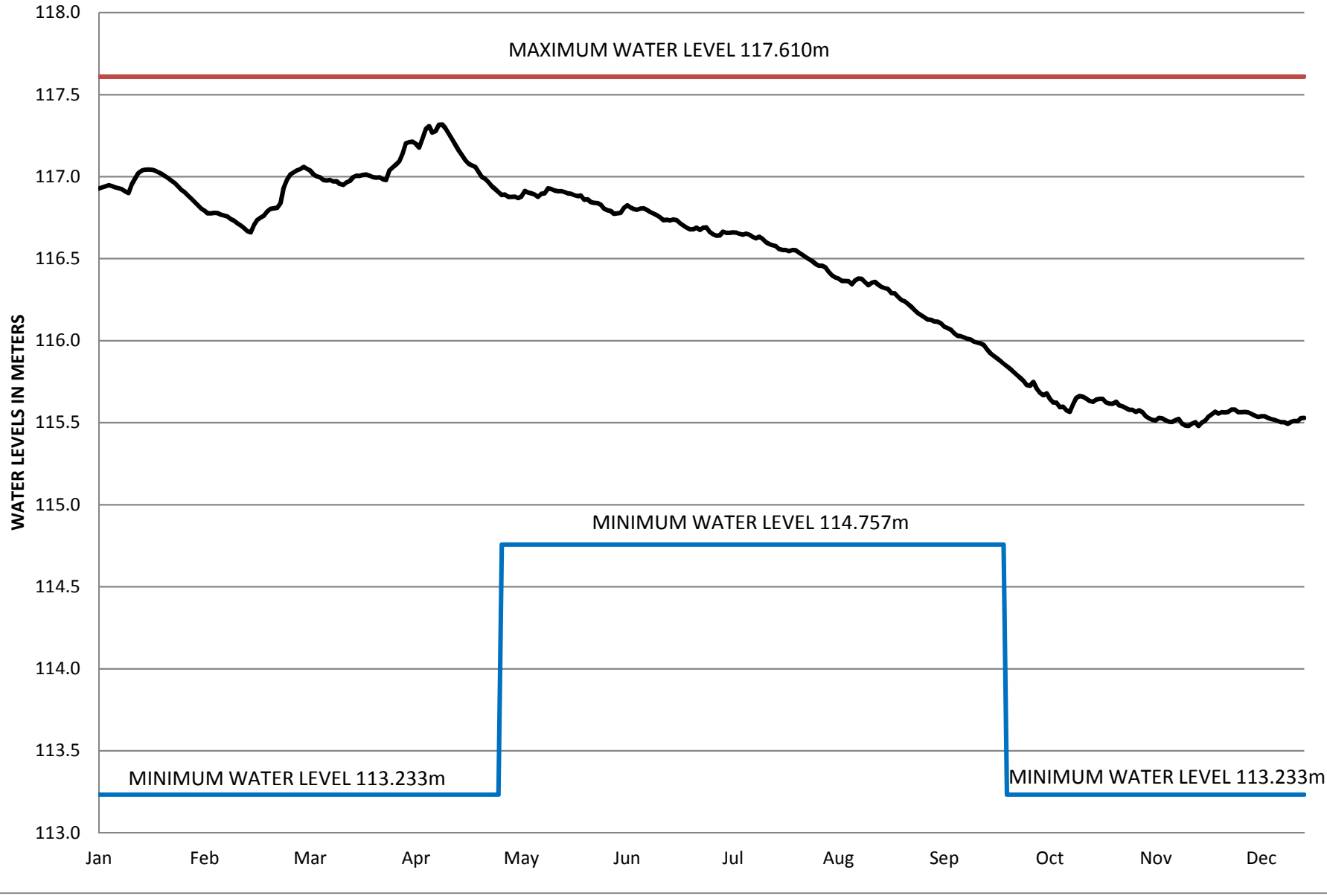
YEAR: 2016 STATION ID: 01AR011 - FOREST CITY STREAM BELOW FOREST CITY DAM

FIGURE II



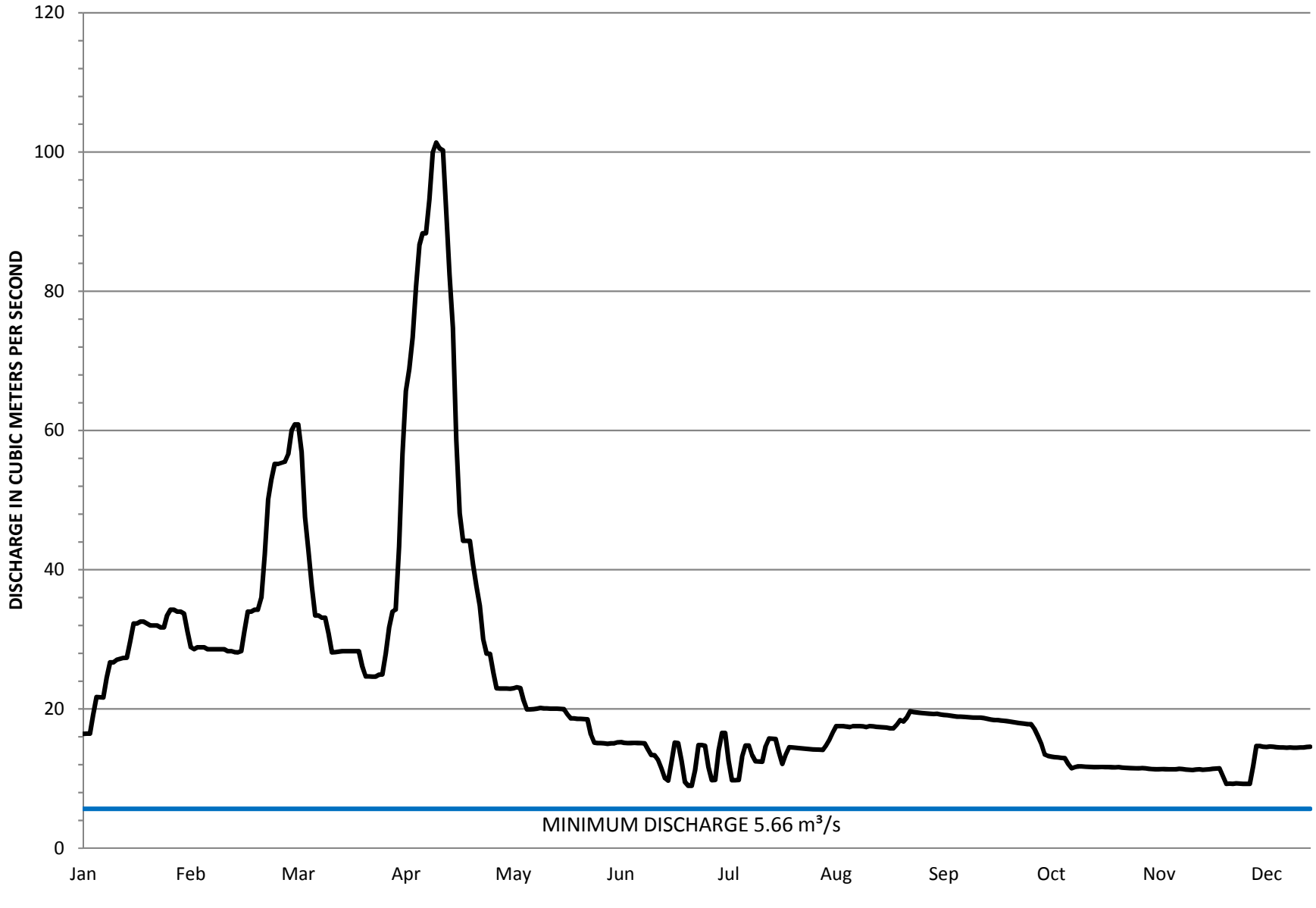
YEAR: 2016 STATION ID: 01AR010 - SPEDNIC LAKE AT ST. CROIX

FIGURE III



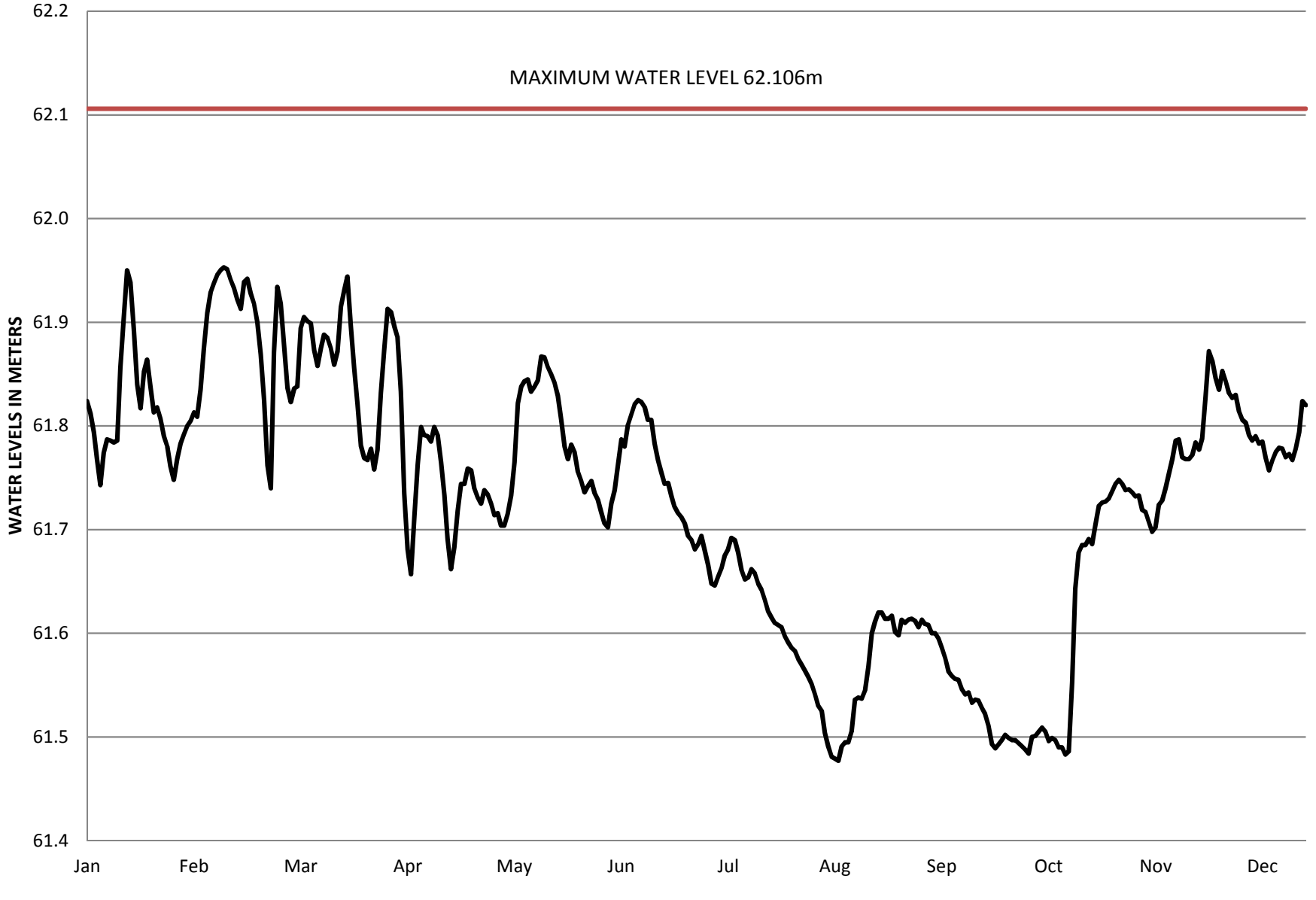
YEAR: 2016 STATION ID: 01AR004 - ST. CROIX RIVER AT VANCEBORO

FIGURE IV



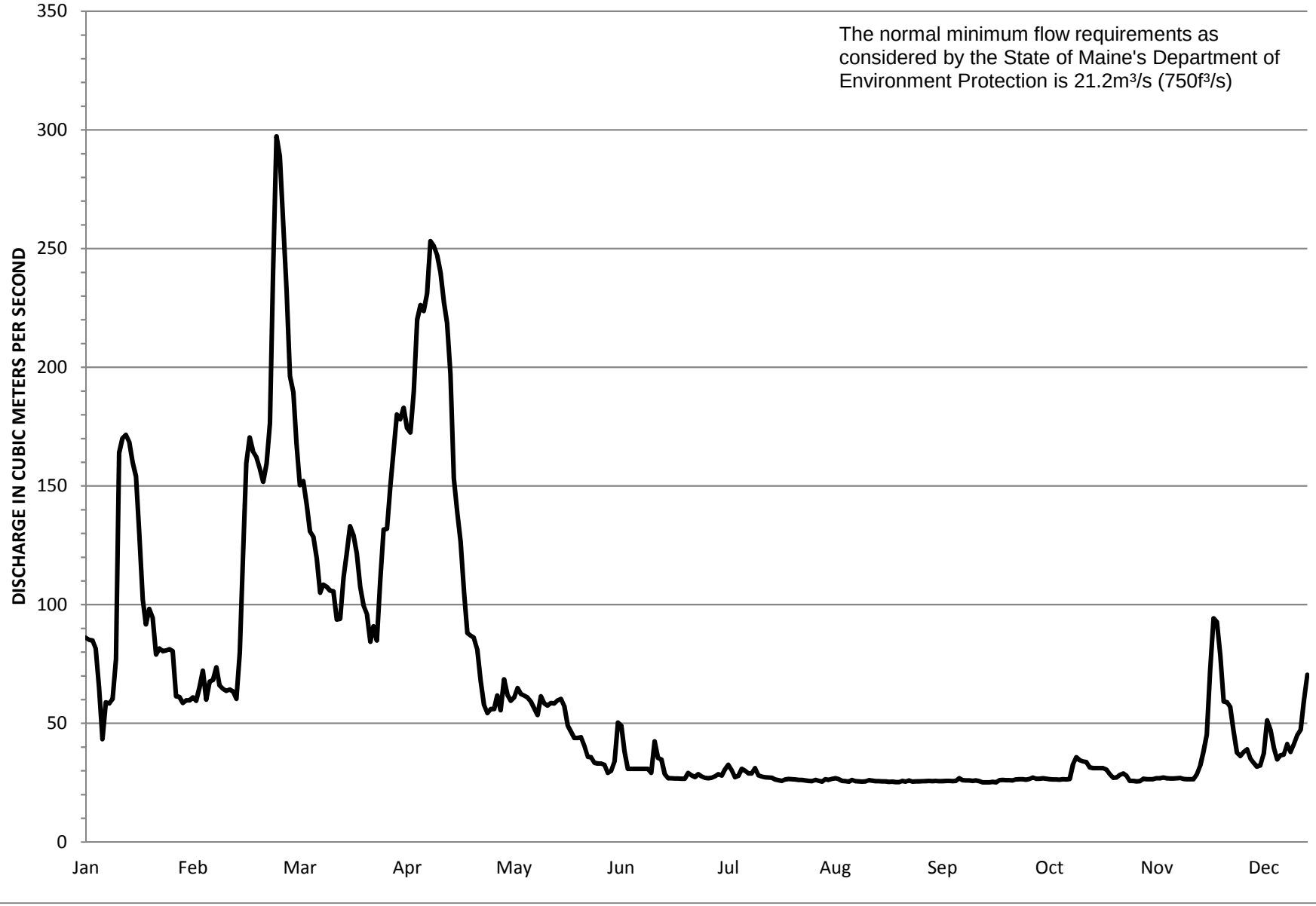
YEAR: 2016 STATION ID: 01AR013 - GRAND FALLS FLOWAGE AT GRAND FALLS

FIGURE V



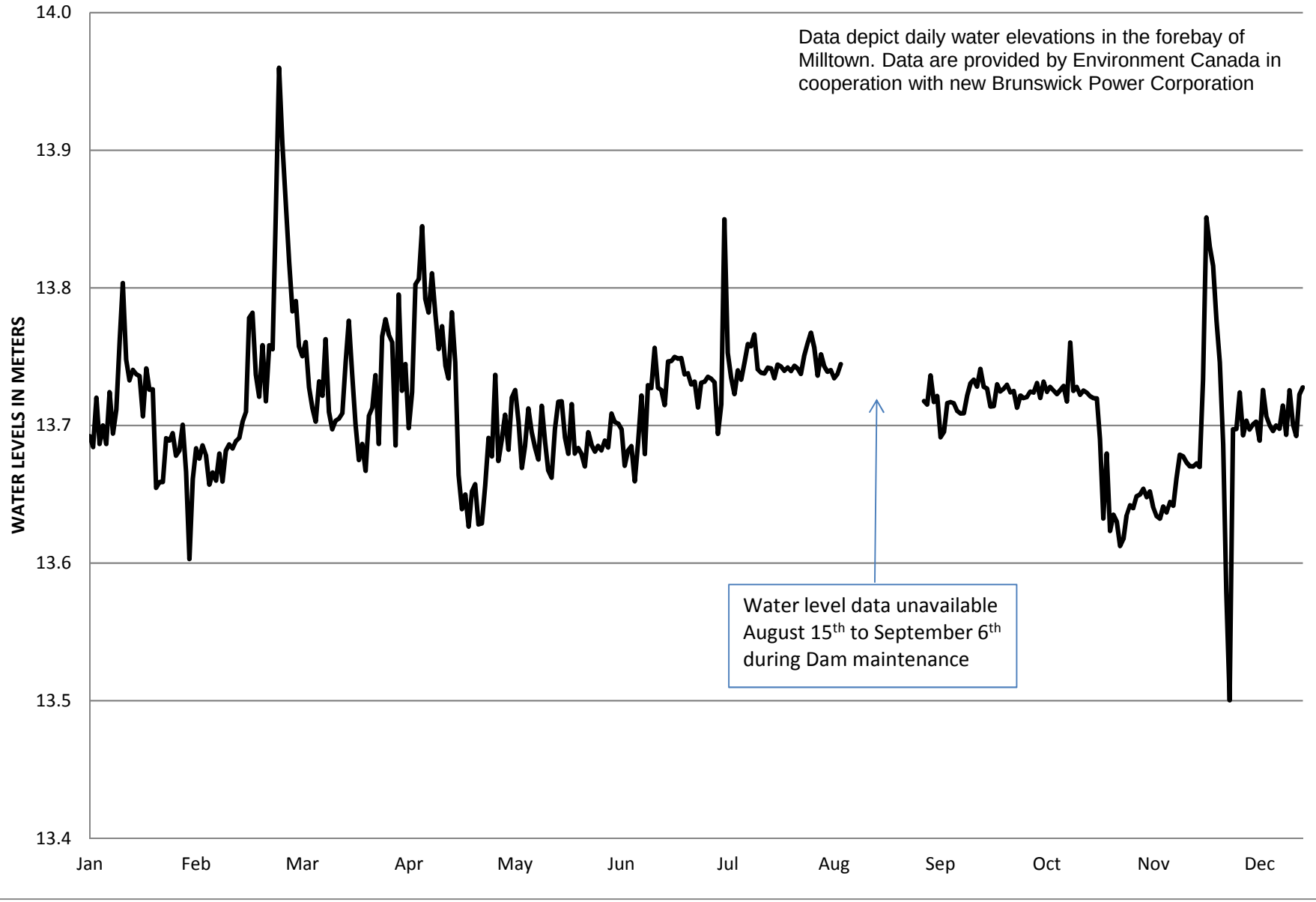
YEAR: 2016 STATION ID: 01AR005 - ST. CROIX RIVER AT BARING MAINE

FIGURE VI



YEAR: 2016 STATION ID: 01AR014 - ST. CROIX RIVER AT MILLTOWN DAM

FIGURE VII



APPENDIX 5

WATER QUALTIY DATA

(This page intentionally left blank.)

Appendix 5

Focus on automated water quality monitoring, September 23 to October 5th

Automated water quality data collected at the Milltown Dam revealed a sudden spike in specific conductance on September 24th, from 87 to 105 µS/cm. Subsequently, there was a significant drop in specific conductance to 30 µS/cm, on September 25th, followed by a short spike up to 46.5 µS/cm on the 29th, quickly dropping back to 30 µS/cm until October 5th. Specific conductivity then began rising to about 95 µS/cm – a level similar to the one observed before September 24th (figure 1). During the same time interval, conductivity and water levels at the Forest City monitoring station, the upstream reference site, were stable (figure 2). In addition, a water sample (ID: 15/16/24541) taken by the New Brunswick Department of Environment and Local Government, 1km upstream of the Milltown dam, on September 27th, indicate lower levels of phosphorus, colour, specific conductance and total organic carbon than those measured by Environment and Climate Change Canada on September 7 and October 19

It was revealed that the Woodland Pulp Mill in Baileyville, ME, 16 km upstream, experienced a spill of treated wastewater (primary) on September 23rd, followed by a shut-down until September 27th. On September 28th, there was a smaller spill of treated wastewater (primary), after which the mill closed operations until October 5th.

These observations highlight that specific conductance in the low reaches of the St. Croix River, in the absence of treated mill effluents, can be similar to those found in its upper less developed reaches and demonstrate the extent to which this point source may be influencing water quality of the river. These findings indicate that automated monitoring at the Milltown dam provides a useful signal related to the conditions of the river in the lower reaches, particularly with spills or other events that could be missed by routine water quality sampling.

Figure 1. Conductivity and water level at Milltown Dam
September 15 to October 10, 2016

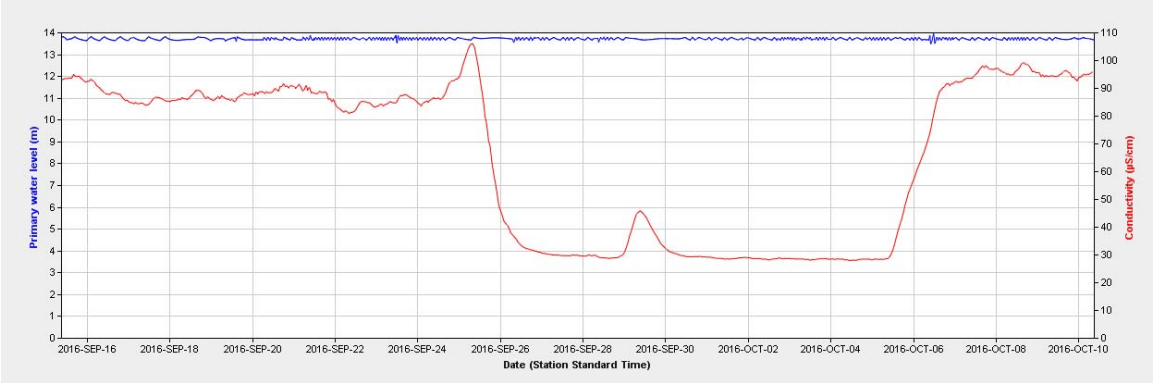
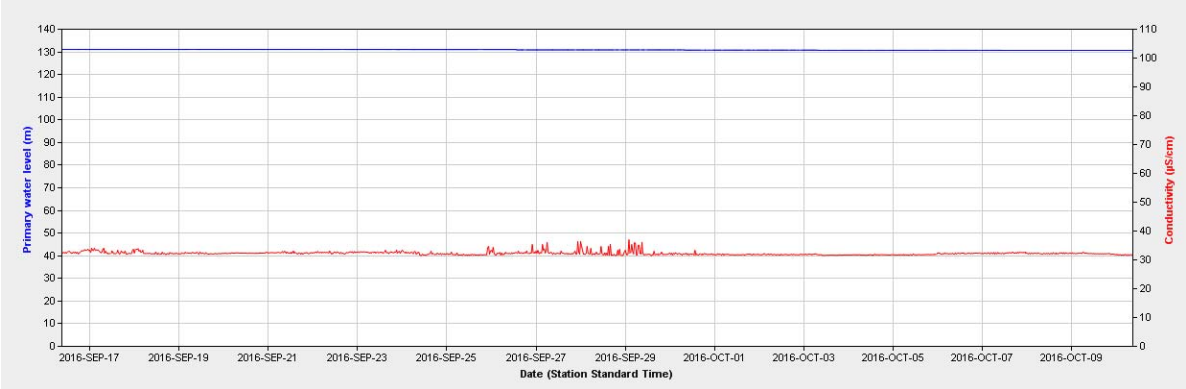


Figure 2. Conductivity and water level at Forest City
September 15 to October 10, 2016



Appendix 5: Table of monthly mean, maximum and minimum temperature, dissolved oxygen, pH, specific conductance, and turbidity on the St. Croix River at Milltown, NB, 2016.

St. Croix River at Milltown, NB - 2016

Temperature (°C)

	January	February	March	April	May	June	July	August	September	October	November	December
Min	0.01	0.2	0.2	2.47	9.88	16.35	19.46	22.647	15.3	8.55	3.68	0.03
Max	1.12	2.14	4.73	12.5	20.657	24.33	27.77	26.95	24.59	16.86	9.05	4.371
Mean	0.165	0.675	2.648	7.604	14.502	19.67	24.157	23.874	20.513	13.273	6.751	1.722

Dissolved Oxygen (mg/L)

	January	February	March	April	May	June	July	August	September	October	November	December
Min	12.75	12.964	12.65	10.838	8.978	7.814	7.508	7.742	7.741	9.023	10.717	12.295
Max	13.52	14.32	14.45	13.61	11.16	9.426	8.363	8.562	9.399	11.036	12.597	14.059
Mean	13.214	13.834	13.422	12.062	10.223	8.827	7.963	8.267	8.463	9.747	11.451	13.323

pH (pH units)

	January	February	March	April	May	June	July	August	September	October	November	December
Min	6.258	6.486	6.92	6.522	6.729	6.849	6.84	6.99	6.69	6.46	5.625	5.85
Max	6.915	7.06	7.15	7.12	6.926	7.224	7.19	7.27	7.3	7.419	6.486	6.679
Mean	6.62	6.95	7.038	6.847	6.836	7.083	7.035	7.108	7.111	7.121	5.961	6.239

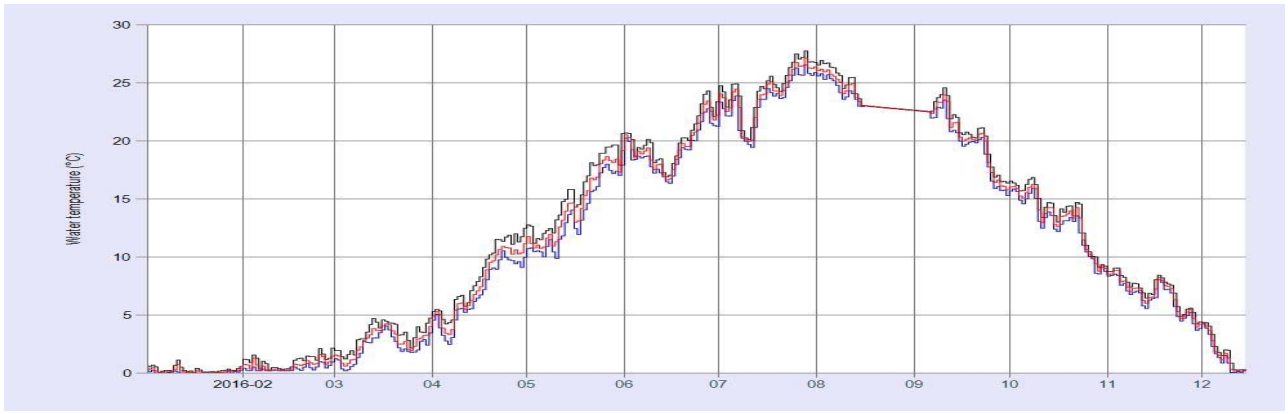
Specific Conductance (µS/cm)

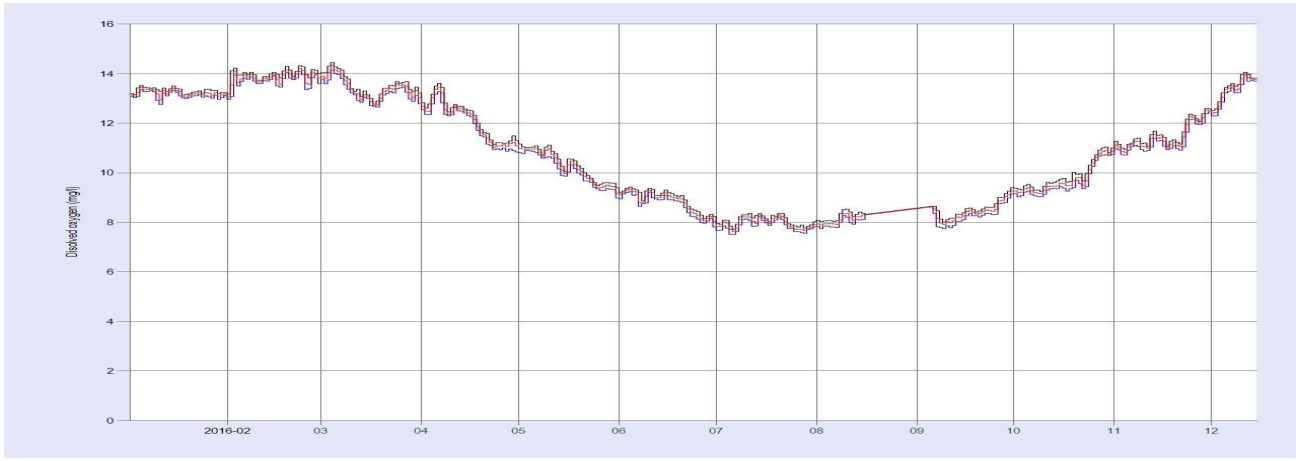
	January	February	March	April	May	June	July	August	September	October	November	December
Min	25.9	26.5	28.5	27.6	42.6	49.3	35.3	80.7	28.7	28	83.5	47.4
Max	53.5	52.3	45.8	51.1	76.2	114	118.7	102.8	106.1	103.6	115.6	86.8
Mean	37.321	39.086	35.441	33.194	53.598	86.422	82.254	88.529	78.724	82.376	99.747	65.222

Turbidity (NTU)

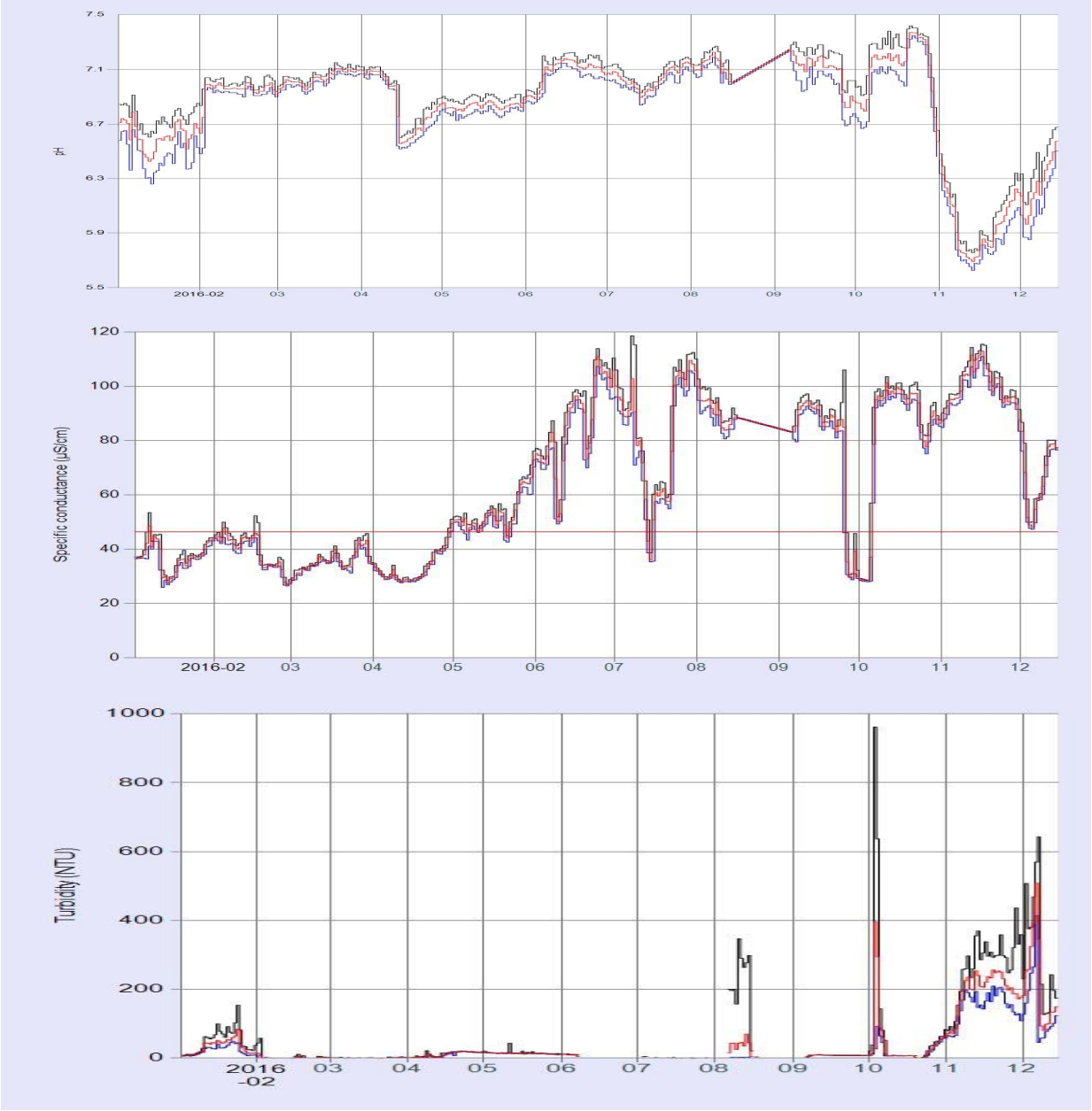
	January	February	March	April	May	June	July	August	September	October	November	December
Min	4.8	0	0	0.2	9.569	0	0	0	0	0	61.1	45.3
Max	153.07	57.6	3.3	21.2	42.623	11.918	4.2	346.4	9.6	962	436	643
Mean	31.046	1.276	0.304	10.48	13.245	2.135	0.014	11.8	6.149	41.554	193.746	220.509

Appendix 5: St. Croix River at Milltown





Maximum Average Minimum


pH
7.5
7.1
6.7
6.3
5.9
5.5
2016-02
03
04
05
06
07
08
09
10
11
12
Specific conductance (µS/cm)
120
100
80
60
40
20
0
Turbidity (NTU)
1000
800
600
400
200
0
Maximum
Average
Minimum

Appendix 5. Table of monthly mean, maximum and minimum temperature and specific conductance on the St. Croix River at Forest city, NB, 2016.

St. Croix River at Forest City, NB - 2016

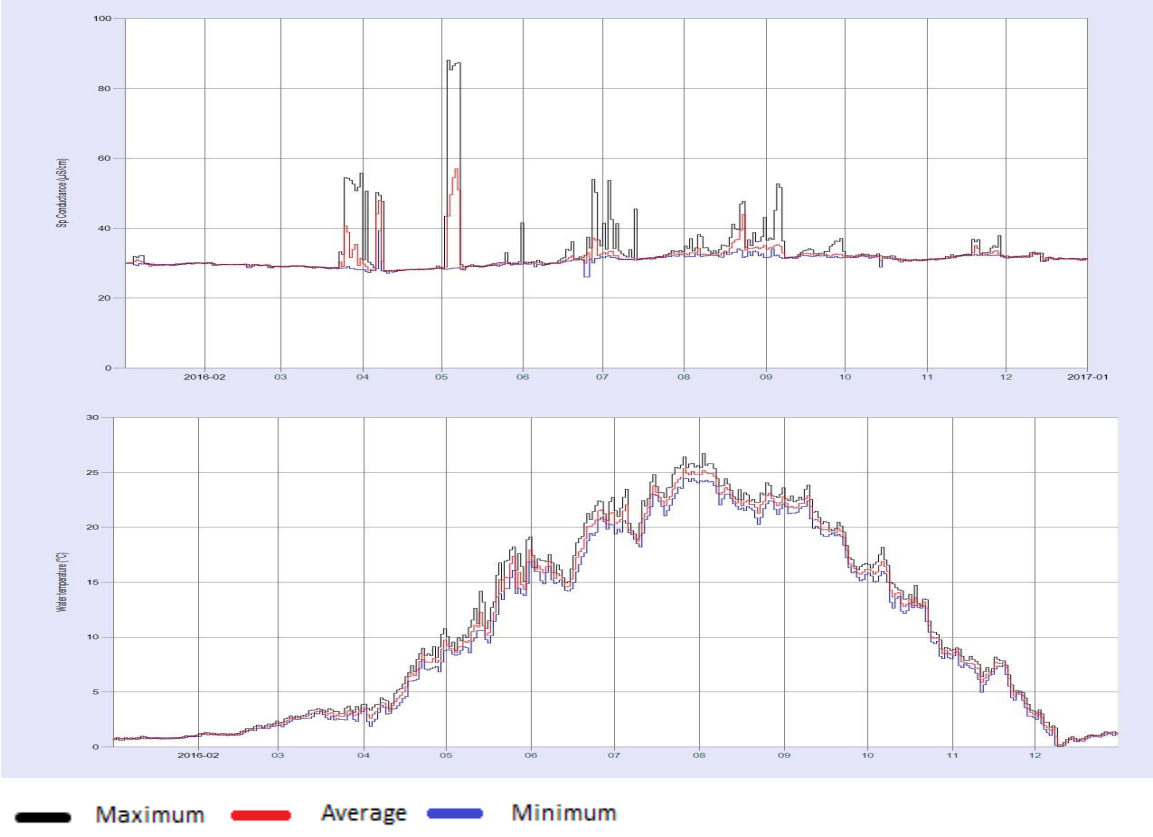
Temperature (°C)

	January	February	March	April	May	June	July	August	September	October	November	December
Min	0.56	0.912	1.814	1.86	8.35	14.19	18.2	20.26	15.11	8.02	2.794	0.011
Max	1.018	2.139	3.705	10.28	18.87	22.41	26.42	26.73	23.85	18.18	9.02	3.374
Mean	0.797	1.38	2.811	5.433	12.155	17.653	22.277	23.056	19.909	13.152	6.589	1.207

Specific Conductance (µS/cm)

	January	February	March	April	May	June	July	August	September	October	November	December
Min	29.15	28.59	28.12	27.09	28.03	26.02	30.86	31.54	31.33	28.87	30.88	30.46
Max	32.19	30.18	55.78	50.64	88.1	53.97	53.7	47.69	52.72	32.69	37.89	33.17
Mean	29.88	29.46	30.19	29.486	32.887	31.101	31.931	34.184	32.755	31.454	32.22	31.57

Appendix 5: Figure of daily mean, maximum and minimum specific conductance and temperature on the St. Croix River at Forest City, NB, 2016.



Appendix 5: Grab Sample Results

St. Croix River at Milltown (NB01AR0021), 2016

Analyte	Units	Guideline[2]	Feb. 2	Apr. 4	June 7	July 13	Sept. 7	Oct. 19	Dec. 14
Alkalinity, Total (CaCO3)	mg/L		<20	<20	<20	<20	<20.0	<20.0	<20.0
Aluminum[1]	µg/L	100	103	140	111	56	78	89.2	141
Antimony[1]	µg/L		0.03	0.04	0.04	0.05	0.04	0.04	0.04
Arsenic[1]	µg/L	5	0.32	0.27	0.51	0.63	0.66	0.45	0.43
Barium[1]	µg/L		6	4	10	5	10	11	8.8
Beryllium[1]	µg/L		0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01
Boron[1]	µg/L		<1	<1	<1	<1	<1	<1	3
Cadmium[1]	µg/L	calculated	0.02	<0.02	0.07	0.02	0.05	0.06	0.04
Calcium	mg/L		3.79	2.59	4.82	3.6	5.24	5.24	4.88
Carbon, Total Organic	mg/L		7.57	5.97	7.1	6.8	8.83	6.43	11.6
Chloride	mg/L	120	4.7	2.6	8	3.2	7.4	8.7	7.0
Chromium[1]	µg/L	8.9	0.17	0.19	0.16	0.14	0.11	0.11	0.19
Cobalt[1]	µg/L		0.05	0.06	0.05	0.05	0.04	0.04	0.06
Colour, apparent	Colour units		54	51	62	42	50	44	81
Conductivity	µS/cm		47.1	30	84.9	41.2	83.0	93.9	79.3
Copper[1]	µg/L	calculated	0.32	0.38	0.39	0.39	0.34	0.41	0.41
Iron[1]	mg/L	0.3	0.14	0.16	0.18	0.21	0.14	0.13	0.21
Lead[1]	µg/L	calculated	0.1	0.14	0.15	0.11	0.10	0.14	0.16
Magnesium	mg/L		0.65	0.52	0.74	0.63	0.79	0.74	0.88
Manganese[1]	µg/L	73	31	22	65	56	58	62	58
Molybdenum[1]	µg/L		0.08	0.07	0.15	0.13	0.13	0.13	0.12
Nickel[1]	µg/L	calculated	0.26	0.28	0.33	0.27	0.26	0.24	0.33
Nitrate as N	mg/L	2.9	0.04	0.02	0.11	0.02	0.08	0.04	0.04
Nitrogen, Total	mg/L		0.32	0.27	0.42	0.36	0.46	0.39	0.50
pH	pH units	6.5-9.0	7	6.96	7.35	7.23	7.29	7.48	7.13
Phosphorus, Total	mg/L	0.03[3]	0.014	0.014	0.043	0.022	0.037	0.032	0.027
Potassium[1]	mg/L		0.6	0.4	1.3	0.5	1.2	1.5	1.3
Selenium[1]	µg/L	1	0.07	0.04	0.05	0.07	0.05	0.06	0.06
Silver[1]	µg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	mg/L		4.95	2.66	10.4	3.71	10.9	12.1	9.81
Strontium[1]	µg/L		18	13	24	18	26	24	24
Sulfate	mg/L		4.4	2.4	10.4	3.3	8.1	10.2	9.0
Thallium[1]	µg/L	0.8	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin[1]	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.02
Titanium (Total)	µg/L		0.99	2.12	0.93	0.83	0.53	0.61	1.59
Turbidity	NTU	15	1.1	29.6	1.2	2	1.1	1.4	2.0

Uranium[1]	µg/L		0.08	0.06	0.08	0.06	0.07	0.06	0.08
Vanadium[1]	µg/L		0.21	0.23	0.32	0.24	0.27	0.28	0.33
Zinc[1]	µg/L	30[4]	2.51	1.95	4.21	2.09	3.05	4.31	4.21

Notes:

µg/L - microgram per litre; mg/L - milligrams per litre; CaCO3 - calcium carbonate; µS/cm - microSiemens per centimetre; NTU - nephelometric turbidity units
Highlighted cell indicates exceedence.
[1] Measured as total recoverable.
[2] Guidelines refer to the Canadian Council of Ministers of the Environment (CCME) guidelines unless otherwise indicated.
[3] OMOE, 1994.
[4] BC MOE, 1999.

St. Croix River at Forest City, ME (NB01AR0151), 2016

Analyte	Units	Guideline[2]	Feb. 2	Apr. 4	June 7	July 13	Sept. 7	Oct. 19	Dec. 14
Alkalinity, Total (CaCO3)	mg/L		<20	<20	<20	<20	<20	<20	<20
Aluminum[1]	µg/L	100	9	14	12	13	10	7.4	15.2
Antimony[1]	µg/L		0.03	0.03	0.03	0.03	0.04	0.04	0.03
Arsenic[1]	µg/L	5	0.26	0.22	0.23	0.19	0.29	0.26	0.27
Barium[1]	µg/L		2	2	2	2	2	1.8	1.7
Beryllium[1]	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron[1]	µg/L		<10	<10	<10	<10	<10	<10	1.1
Cadmium[1]	µg/L	calculated	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Calcium	mg/L		4.34	4.05	4.12	4.11	4.1	4.22	4.29
Carbon, Total Organic	mg/L		3.69	3.58	3.8	3.93	3.36	3.41	3.68
Chloride	mg/L	120	1.4	1.4	1.5	1.5	1.4	1.5	1.5
Chromium[1]	µg/L	8.9	0.06	0.06	0.06	0.05	0.06	0.06	0.08
Cobalt[1]	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Colour, apparent	Colour units		12	13	12	16	14	10	9
Conductivity	µS/cm		33.1	31.9	32	32.2	32	33.8	33.2
Copper[1]	µg/L	calculated	0.26	0.24	0.29	0.25	0.25	0.31	0.26
Iron[1]	mg/L	0.3	0.02	0.02	0.02	<0.02	<0.02	0.02	0.05
Lead[1]	µg/L	calculated	<0.03	<0.03	0.03	<0.03	<0.03	<0.03	0.05
Magnesium	mg/L		0.63	0.58	0.59	0.59	0.6	0.6	0.63
Manganese[1]	µg/L	73	7	6	6	4	5	7	16.6
Molybdenum[1]	µg/L		0.06	0.06	0.06	0.05	0.06	0.06	0.06
Nickel[1]	µg/L	calculated	0.12	0.12	0.15	0.13	0.21	0.14	0.15
Nitrate as N	mg/L	2.9	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
Nitrogen, Total	mg/L		0.17	0.17	0.2	0.17	0.17	0.27	0.23
pH	pH units	6.5-9.0	7.3	7.25	7.3	7.36	7.22	7.42	7.19
Phosphorus, Total	mg/L	0.03[3]	0.005	0.005	0.009	0.004	0.005	0.008	0.007

Potassium[1]	mg/L		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.3
Selenium[1]	µg/L	1	0.04	0.06	0.05	0.05	0.05	0.04	0.04
Silver[1]	µg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	mg/L		1.47	1.38	1.39	1.36	1.47	1.45	1.44
Strontium[1]	µg/L		23	21	22	22	22	23	23
Sulfate	mg/L		1.7	1.7	1.7	1.7	1.5	1.6	1.6
Thallium[1]	µg/L	0.8	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin[1]	µg/L		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.02
Titanium (Total)	µg/L		0.1	<0.25	0.28	0.13	0.13	0.13	0.53
Turbidity	NTU	15	0.9	2.8	0.7	0.6	0.4	0.5	0.5
Uranium[1]	µg/L		0.02	0.02	0.03	0.02	0.02	0.03	0.02
Vanadium[1]	µg/L		0.04	0.04	0.05	0.04	0.06	0.06	0.06
Zinc[1]	µg/L	30[4]	0.19	0.21	0.36	0.17	0.14	0.53	0.59

Notes:
µg/L - microgram per litre; mg/L - milligrams per litre; CaCO3 - calcium carbonate; µS/cm - microSiemens per centimetre; NTU - nephelometric turbidity units
Highlighted cell indicates exceedence.
[1] Measured as total recoverable.
[2] Guidelines refer to the Canadian Council of Ministers of the Environment (CCME) guidelines unless otherwise indicated.
[3] OMOE, 1994.
[4] BC MOE, 1999.

APPENDIX 6

MILLTOWN FISH DATA

(This page intentionally left blank.)

Table St. Croix River ME/NB alewife/gaspereau/blueback herring spawning runs, 1981- present **(bold = 7-day peak)**

Sources: Fisheries & Oceans Canada (1981-1990), Atlantic Salmon Federation (2012-2014), St. Croix International Waterway Commission (1991-2011, 2015-present).

YEARS >>>	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
April 30-May2	--	0	0	0	0	5460	0	0	0	0	0	0	0	0	0	0	0	0
May 3-9	--	0	0	0	0	16410	9400	24410	0	29690	170	0	0	0	0	2814	0	0
May 10-16	7510	32160	16970	6000	0	75150	171500	468750	0	305370	14740	8910	0	0	5898	11178	0	**77394**
May 17-23	47450	64120	**44050**	40300	70000	429400	559500	760280	200610	319380	133820	**74120**	12000	94304	**109388**	202188	**122478**	25705
May 24-30	47770	**74800**	33760	**67100**	**149890**	**772800**	**674700**	**764990**	**464390**	**411090**	**154560**	45520	**146600**	99150	99847	188538	93000	71534
May 31- June 6	**48310**	56930	20770	26200	96740	628300	645300	370750	424550	141490	51110	24780	102800	**125900**	50946	**231870**	4091	2684
June 7-13	16000	4610	35650	13300	26900	57200	480400	187800	63940	132030	4010	50420	2260	15400	0	9390	5951	0
June 14-20	1760	250	620	0	21040	0	83900	13770	11370	0	0	0	26060	0	0	0	0	0
June 21-27	790	210	0	0	1060	0	0	0	0	0	0	0	0	0	0	0	0	0
June 28 - July 4	30	20	0	0	3270	0	0	0	0	0	0	0	0	0	0	0	0	0
July 5-11	0	1	130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 12-18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 19-25	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 26 - later			0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Escapement	169620	233102	151952	152900	368900	1984720	2624700	2590750	1164860	1339050	358410	203750	289720	334754	266079	645978	225521	177317
Harvest	0	0	0	0	0	0	0	0	0	192200	228500	0	8000	15400	8000	0	0	0
TOTAL RUN	169620	233102	151952	152900	368900	1984720	2624700	2590750	1164860	1531250	586910	203750	297720	350154	274079	645978	225521	177317

YEARS >>>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
April 14-29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
April 30-May2	0	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	0	0
May 3-9	0	**3966**	0	2	0	0	0	18	0	0	0	0	0	993	342	0	0	0
May 10-16	195	142	160	6	3	0	0	577	0	4	1	9748	1657	343	362	7	16	125
May 17-23	5933	2011	505	23	603	0	2	3111	0	33	12	**17731**	**13053**	**22260**	178	16	126	269
May 24-30	**13615**	377	**2625**	325	2115	0	20	**3155**	2	119	3740	17008	1227	11190	**10542**	29	**32637**	**14304**
May 31-June 6	5476	2067	1735	**494**	**3163**	0	5277	2540	0	**11797**	42	8520	7750	1175	5107	**19971**	16875	12781
June 7-13	108	6	123	35	999	**951**	**6220**	1096	**1225**	61	2	4700	1387	197	37	6775	27150	3038
June 14-20	0	0	54	15	1018	108	113	1227	66	23	**6627**	1126	50	10	83	95	11871	2000
June 21-27	0	0	0	0	0	79	0	105	1	221	26	255	10	0	23	143	3817	471
June 28-July 4	0	0	0	0	--	150	--	--	--	3	0	45	7	--	3	267	816	27
July 5-11	0	0	0	0	--	11	--	--	--	--	--	9	1	--	--	9	161	1
July 12-18	0	0	0	0	--	0	--	--	--	--	--	3	--	--	--	--	34	--
July 19-25	0	0	0	0	--	0	--	--	--	--	--	--	--	--	--	--	--	--
July 26 - later	0	0	0	0	--	0	--	--	--	--	--	--	--	--	--	--	--	--
Escapement	25327	8569	5202	900	7901	1299	11632	11829	1294	12261	10450	59145	25142	36168	16677	27312	93503	33016
Harvest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL RUN	25327	8569	5202	900	7901	1299	11632	11829	1294	12261	10450	59145	25142	36168	16677	27312	93503	33016

Note 1. Enumeration. Prior to 1999, river herring were enumerated by counting all fish for 10min/hr and multiplying by 6 to yield an hourly total, for each hour the fishway was open. In 1999 and 2000, "light" run periods were enumerated by shutting off the fishway exit for 4 hour intervals and then individually counting all fish in the trap, while "heavy" run periods were enumerated as in previous years. Since 2001. all fish have been counted individually.

Note 2. Upstream passage. Beginning in 1995, the State of Maine blocked the upstream fishways at Woodland and Grand Falls to spawning river herring. In 2001, Fisheries & Oceans Canada began to truck a portion of the spawning run from Milltown to Woodland Flowage. Number of river herring transported to Woodland: 2001 (3756), 2002 (807), 2003 (6805), 2004 (392), 2005 (7100), 2006 (6653), 2007 (1169). In 2008, Maine removed the Woodland fishway barrier, allowing river herring direct access to Woodland Flowage, and Fisheries & Oceans discontinued its trucking operation. In 2013, Maine removed the Grand Falls fishway barrier, allowing river herring access the upper watershed.

Note 3. Duration of count. Monitoring was discontinued on June 27 in 2006, 2007 and 2012; on July 3 in 2008; July 4 in 2009 and 2013; July 8 in 2014; July 11 in 2011 and 2016; July 18 in 2015 and July 19 in 2010 at the presumed end of each year's run. Any fish entering the river after these dates were not recorded

Note 4. Correction of 1994, 1995 and 2010 counts. In 2016, errors in the day counts for these three years was discovered and corrected. This increased earlier reported totals for 1995 and 2010 and decreased 1994.